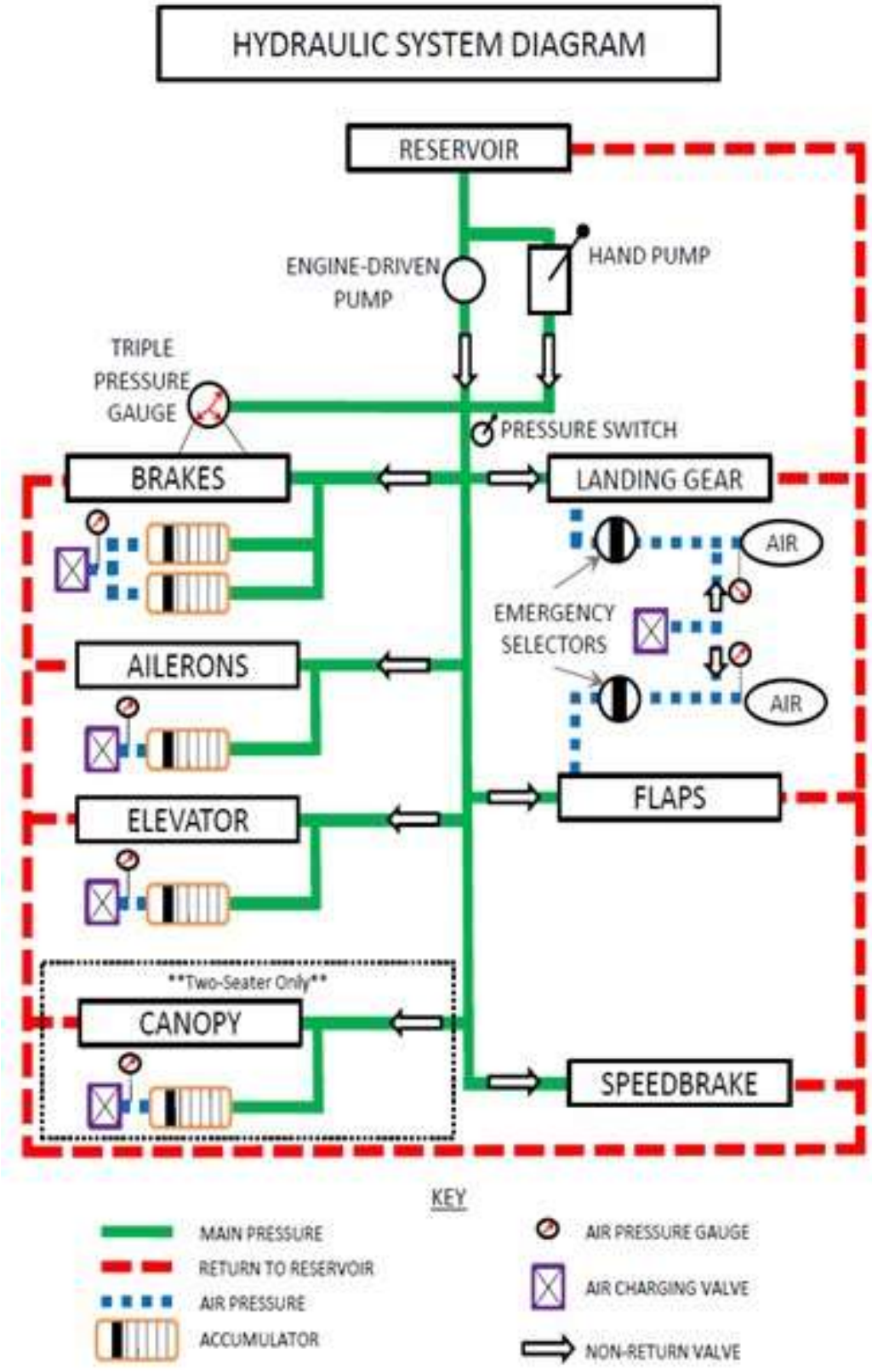
4. HYDRAULIC SYSTEM

Hydraulic Diagram



Accumulators

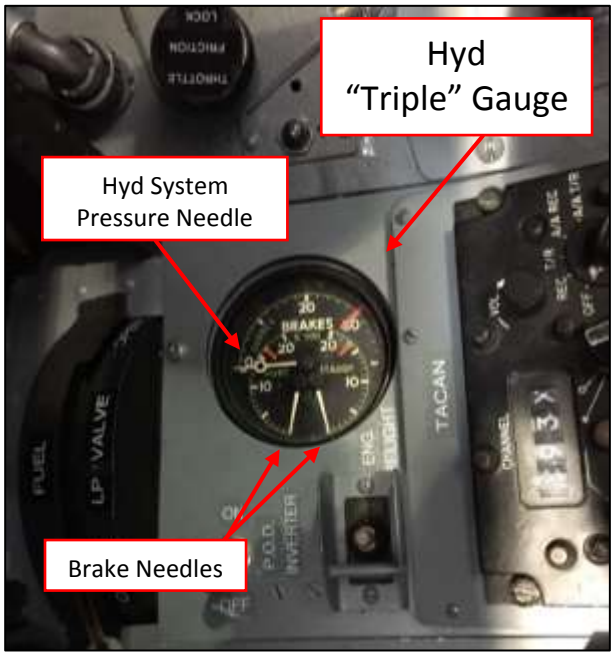
Four (five) hydraulic accumulators are provided:

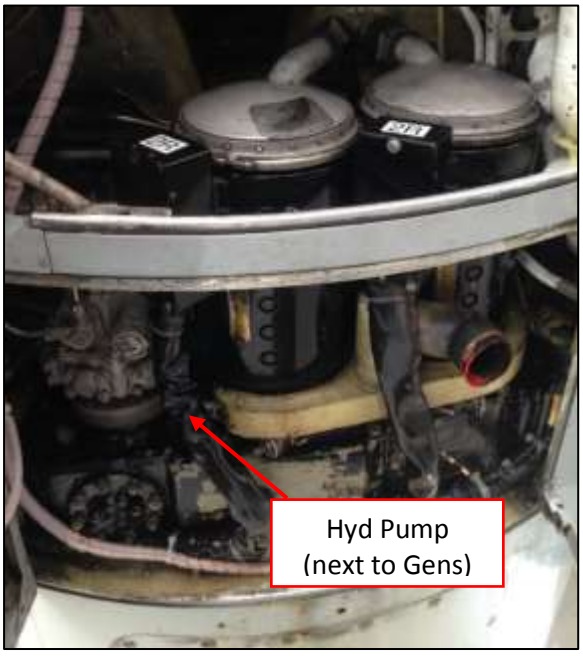
Service	*Number of Accumulators*	*Air Charge PSI*	*Pressure Gauge*	*Charge Point*
Wheel brakes	2	750	Left shelf	Nose wheel bay
Ailerons	1	900	Right wheel bay	
Elevator	1	1575	Left side of fin	
Two-seater canopy	1	1575	Left fuselage	Avionics bay

Hydraulic System

An engine-driven hydraulic pump draws fluid from a reservoir in the engine bay on the right side of the aircraft. The pump maintains a system pressure of 2850 +200/-150 PSI for the normal operation of the aircraft systems. This range is published as 2700-3050 PSI. The main pointer of the triple pressure gauge, located behind the throttle on the left shelf, indicates the main hydraulic pressure. The smaller gauges indicate left and right brake pressure.

NG TWO-SEATER: The brake accumulator and the triple pressure gauge are at the forward end of the left shelf.





Significant drops in pressure are normal during the operation of hydraulic systems. However, pilot experience has shown that if the pressure drops below 2000 PSI, it is indicative of a pending hydraulic failure and/or some other system issue such as low hydraulic fluid levels. There is a prioritizing valve that prevents pressure from going to any system other than the flight controls if the pressure drops below approximately 1200 PSI.

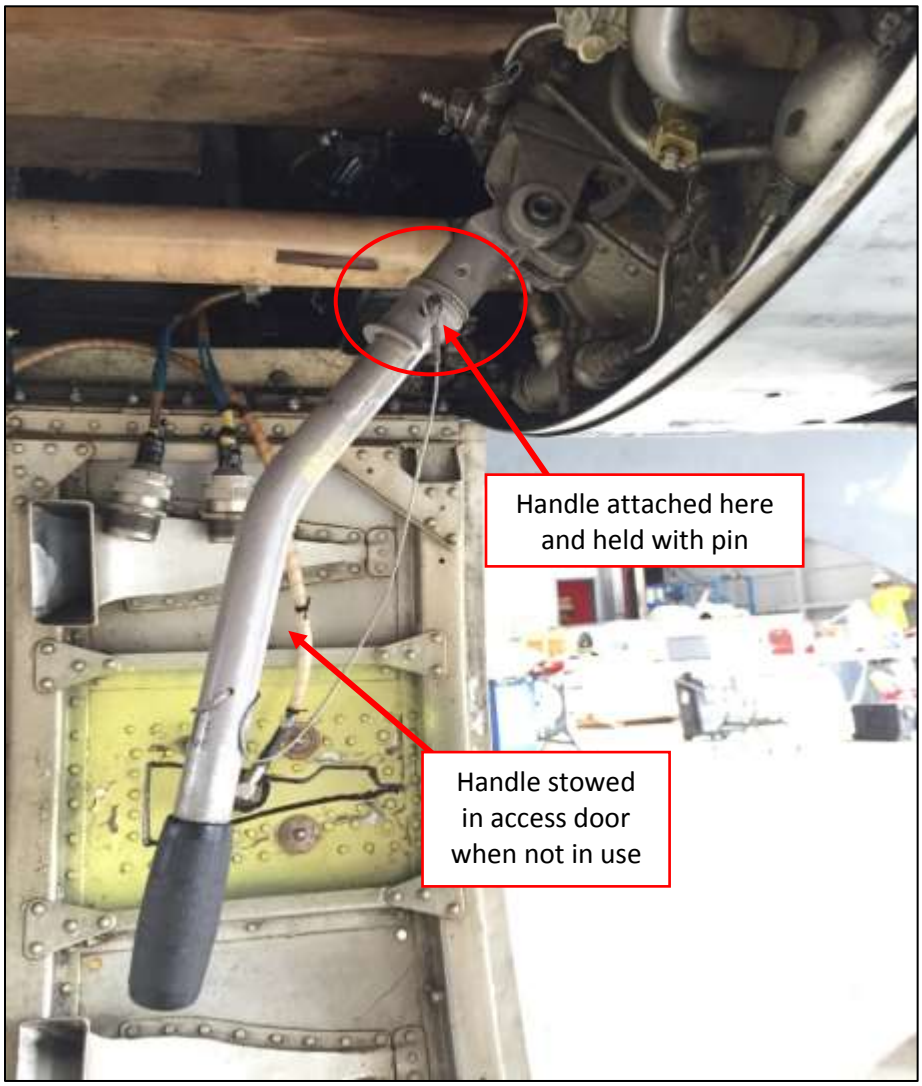
The following systems are hydraulically operated:

- Landing gear and doors
- Flaps
- Wheel brakes
- Aileron and elevator hydroboosters
- Speed brake
- Two-seater canopy

NG TWO-SEATER: The canopy accumulator gauge is on the upper left side of the fuselage. Unlike the other accumulators, a WHITE triangle marks the minimum air charge PSI at 1575 PSI. Although the minimum required to open the canopy is 2000 PSI, the red triangle actually points to 2200 PSI. **Click this link for a full description**.

Hydraulic Hand Pump

On the ground, when the engine is not running, hydraulic pressure can be supplied to the system to charge the accumulators or to operate any of the systems by means of a hand-operated hydraulic pump. This pump is in the engine bay and the pump handle is stowed in clips on the inside of the engine bay access door.



Hydraulic Pressure Failure

The first indication of a hydraulic system malfunction is given by the reading of the main pointer of the triple pressure gauge falling below normal when no service is being operated. If the hydraulic pump itself fails, the sequence of indications is somewhat predictable. As the system pressure drops below 600 PSI, the red HYDRAULIC PRESSURE failure warning light on the left quarter panel illuminates. As the pressure continues to decrease below 400 PSI the elevator and aileron MIs will shift to WHITE followed by the flight controls reverting to manual when system pressure reaches 200 PSI.

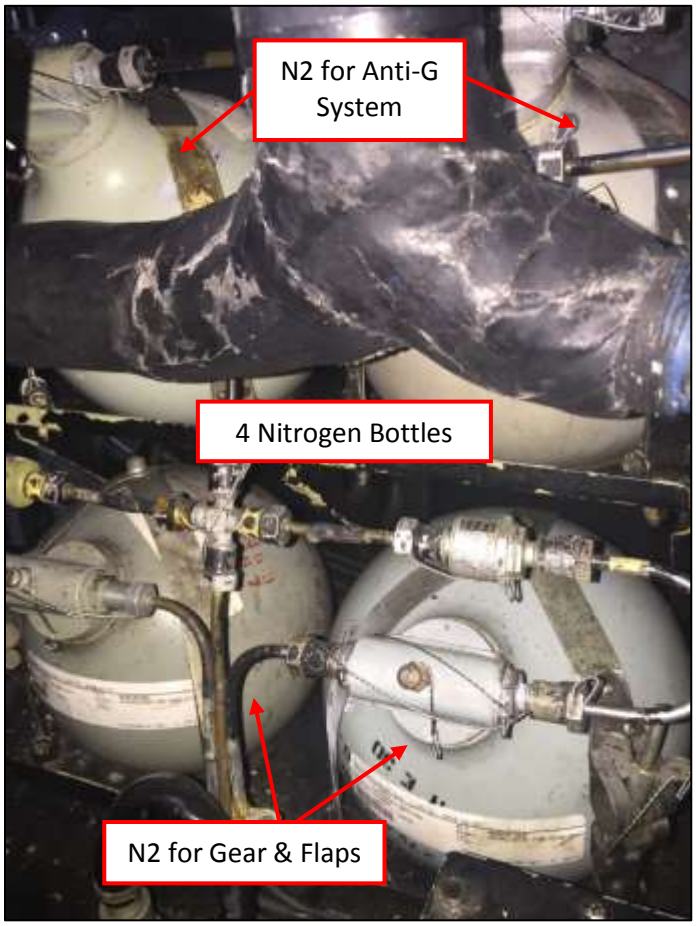
ATAC NOTE:

- *The above hydraulic failure sequence applies when the hydraulic pump itself fails. However, pilot experience has shown that if there is some other failure in the system such as a leak, the pressure at which the red warning light illuminates and the flight controls revert to manual may differ significantly.*
- *ATAC pilots have experienced manual flight control reversion with the pressure indicating 1000-1200 PSI (vice 200 PSI) with the red warning light illuminating about the same time or slightly before. Additionally, total hydraulic failures have occurred with the gauge continually indicating 1200 PSI.*
- *Thus, at the first indication of a hydraulic issue (pressure, lights, leak seen by a wingman, etc), pilots should assume a pending hydraulic failure and take action per the PCL while closely monitoring the "feel" of the flight controls and be prepared for a manual reversion.*

- NG: the G3X has been updated with a discrete Master Warning System. If the hydraulic system pressure drops below 600 PSI, the system will trigger a YELLOW Master Warning "triangle" on the left side of the PFD or a Master Warning "box" on the right side of the compass rose on the lower portion of the G3X display along with an aural tone.
- Note: The G3X displays either the Master Warning "triangle" or the "box" depending on what is selected on the lower half of the G3X. If the MAP is selected, then only the "triangle" is displayed on the PFD. However, if the Compass Rose is selected, then only the Master Warning "box" is displayed to the right of the compass rose (see pictures below).

If the hydraulic pressure fails, the accumulators provide a reserve of pressure for limited operation of the wheel brakes and the powered flying controls. The capacity of the aileron and elevator accumulators should provide for up to 3.5 full reversals of each control. However, even if no control movements are made, the accumulator pressure is not maintained because of normal hydraulic component seepage. When the accumulators are exhausted, the controls revert automatically to manual.

Hydraulic accumulators are not provided for the landing gear, flaps or speed brake. If the hydraulic supply pressure fails, these systems cannot be operated hydraulically. An emergency air bottle system (nitrogen) is provided to lower the landing gear and full flaps, only once, and neither can subsequently be raised.



Activating the emergency landing gear and/or flap systems is performed by pushing the center “button” on the respective emergency handle and then pulling it all the way out of its housing tube (see pictures below). This action is done in two distinct motions. First, the safety wire that protects the handle from inadvertent actuation must be broken. Then, the handle must be pulled all the way out to actuate the valves that supply pressure to lower the gear and/or flaps. Both of these actions will be accompanied by a “snap/pop” as the safety wire breaks and the valves are actuated.

When you “blow” the landing gear down, hydraulic fluid is ported overboard out of the lower portion of the right wing. Thus, if another aircraft is doing a visual inspection, they should expect to see the fluid which may not be associated with a leak.

See pictures below of the Emergency Landing Gear and Emergency Flap handles following emergency extension. Note the amount/length of travel for each handle following full actuation/extension.

5. FLIGHT CONTROLS

Flight Controls

The ailerons and elevators are normally operated hydraulically from the aircraft hydraulic system, though a manual control capability is provided. Both controls are fully powered and stick forces are provided by spring-feel systems. The stick force provided by the elevator spring feel is supplemented by a bob-weight in the system.

With properly rigged flight controls, the pilot will experience the following approximate stick forces with modified flight controls:

- *Power OFF: Lateral—9-lbs; FWD—9-lbs; AFT—7-lbs.*
- *Power ON: All directions—2-lbs.*
- *In Power OFF: Full aileron deflection is only 2/3 of that obtained in Power ON.*
- *Note: The control stick will not auto re-center in Power OFF; but, should auto re-center in Power ON.*

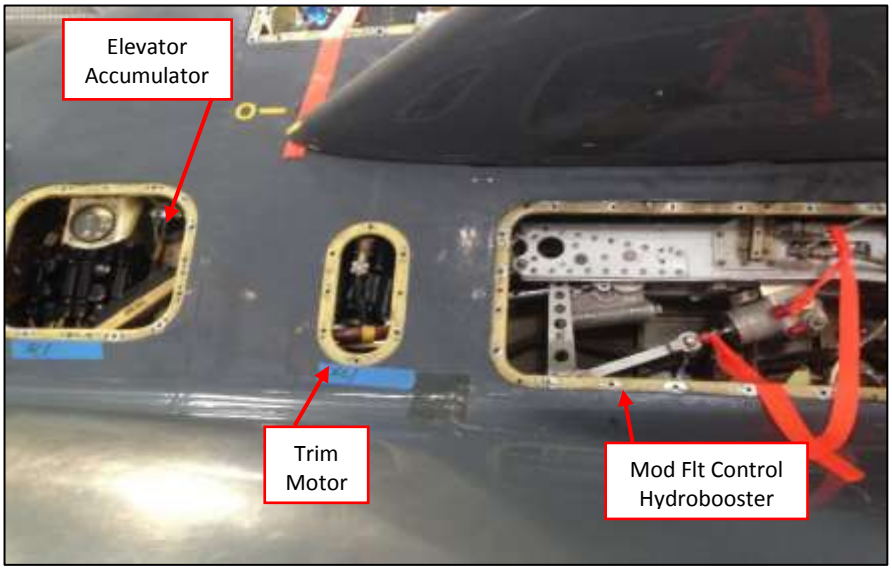
The controls revert to manual automatically in the event of a hydraulic failure. Selection of manual flight controls in flight is prohibited except when required by emergency procedures.

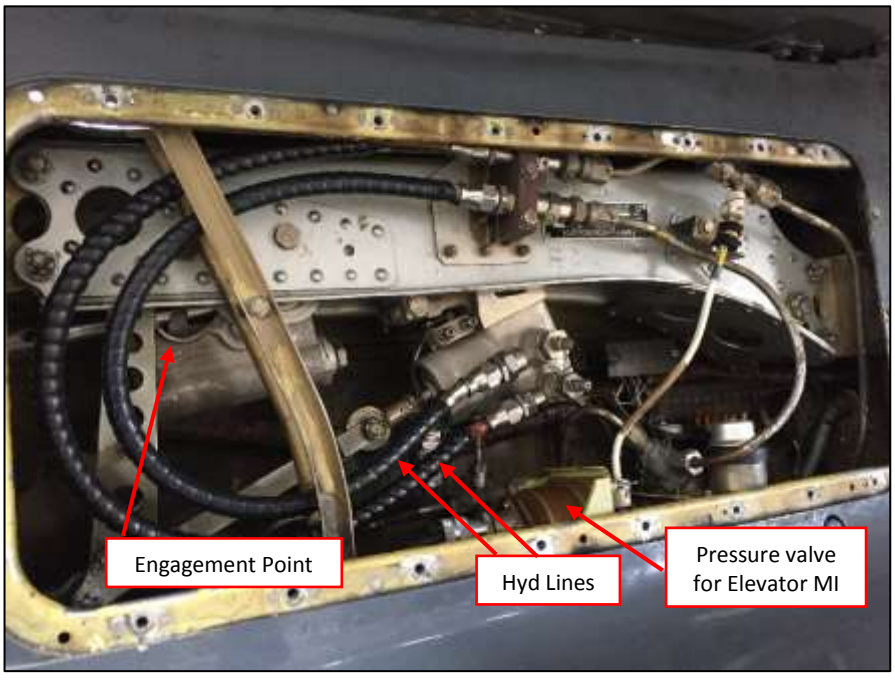
NG: Selection of manual controls in flight is approved by company policy during training and check flights, as well as when required during functional check flights.

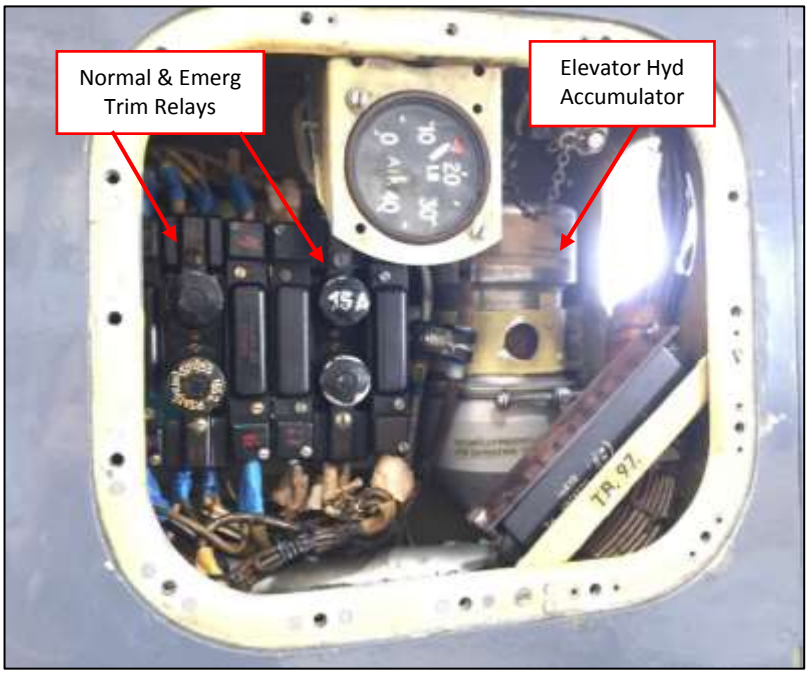
A white datum spot on the instrument panel, near the top left of the main attitude indicator, indicates the ailerons central position. The datum is used as an aid to ensuring that the ailerons are central during spin recovery.

NG: The datum is at the top left of the PFD.

With powered flight controls, a hydrobooster, consisting of a servo valve, jack body and a piston, is fitted close to each control surface (see sequence of pictures below). The control column is connected to the servo valve operating spindle. Depending on the direction of movement of the control column, the valve opens to admit pressure oil to one side of the jack piston and at the same time the other side is opened to return. The piston rod is anchored to the aircraft structure and the jack body is connected directly to one end of the control surface.
When hydraulic pressure is directed by the servo valve to one side of the jack piston, the jack body moves relative to the piston and deflects the control surface. When control column movement ceases, the servo valve closes, causing a hydraulic lock, which prevents further movement of the jack body and control surface. The aileron and elevator magnetic indicators show black when hydraulic power is available to the hydroboosters.







If manual controls are selected, or if the hydraulic pressure falls below 200 PSI, a bypass valve in the jack opens to allow the fluid in the jack to be transferred from one side of the piston to the other. This allows the jack body to be moved freely about the piston by control column movements in order to operate the control surface. Feedback forces from the control surface are transmitted back to the control column resulting in high stick forces when maneuvering.

As discussed in the Hydraulic section, if the hydraulic pump itself fails, the sequence of indications is somewhat predictable. As the system pressure drops below 600 PSI, the red HYDRAULIC PRESSURE failure warning light on the left quarter panel illuminates. As the pressure continues to decrease below 400 PSI the elevator and aileron MIs will shift to WHITE followed by the flight controls reverting to manual when system pressure reaches 200 PSI.

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The electrically operated hydraulic valves for the aileron and elevator power controls are controlled by two ON/OFF switches, one for the aileron and another for the elevator, on the left of the instrument panel.

NG TWO-SEATER: On the right shelf, there are similar aileron and elevator power control switches and magnetic indicators. The right shelf switches are normally in the ON position, and must be in the ON position for the left instrument panel switches to operate normally. For training purposes only, a right shelf switch in the OFF position will override a left instrument panel switch in the ON position, causing the relevant flight control to be OFF.

Hydrobooster Malfunctions

If a hydrobooster bypass valve fails to close when power is selected, the affected hydrobooster remains in manual. In the case of the ailerons, this results in one aileron being in power and the other in manual. On the ground, this can be recognized by the stick juddering when the stick is moved laterally, with stick forces between what is normally felt in manual and what is normally felt in normal power. In the air, the affected aileron floats up (increasing with speed and g) giving a maximum out-of-trim force of about 20 pounds in level flight. The force is reduced when the flaps are lowered. It may be possible to clear the fault by cycling the appropriate power control switch. If not, select and remain in manual.

If a hydrobooster bypass valve fails to open when manual is selected, the stick forces are slightly increased in the associated control but the forces are acceptable. The controls should operate normally if power is reselected.