2A-29-10: General

1. **Description:**

The G550 aircraft has two hydraulic systems, left and right, each powered by an engine driven pump installed on the respective left and right engine that pressurizes fluid contained in dedicated reservoirs. The engine-driven pumps are not equipped with off / on switches, but continuously operate unless the respective engine is shut down with the cockpit fire handle. Both systems are independent, each with separate lines and no common point for fluid interchange to preserve the integrity of each system. However, since the failure of an engine-driven pump or the engine itself would result in the loss of the autonomous hydraulic system, replacement power sources are available. An overview of the two hydraulic systems is shown in Figure 1.

Hydraulically powered aircraft components, except the engine thrust reversers, are redundantly protected with either an alternate hydraulic power source, dual (left and right) hydraulic actuators, hydraulic accumulator pressure or compressed nitrogen (N_2) bottle pressure. Control surfaces used throughout the flight regime are powered using actuators connected to both hydraulic systems, with either system capable of independently powering the controls. See the following table.

LEFT HYDRAULIC SYSTEM POWER	FLIGHT CONTROL SURFACE	RIGHT HYDRAULIC SYSTEM POWER
X	Elevator	X
X	Aileron	X
X	Rudder / Yaw Damper *	X
X	Flight Spoilers	X
X	Speedbrakes	X
X	Stick Pusher	X
*Because the rudder is essential to the control of the aircraft when operating with only one engine, the rudder and yaw damper is also be powered by an Auxiliary electric pump using left system fluid. See the following text and table.		

Control surfaces and aircraft sub-systems used in the takeoff and landing phases of flight are subject to many cycles, higher force loads, and a require a greater range of movement. For design simplicity they are powered by a single system, the left hydraulic system. However, these components are protected with a high level of redundancy. The left hydraulic system is unique in that left system fluid may be pressurized by two sources other than the engine driven pump. An electrically driven Auxiliary (AUX) pump, or an impeller driven by right hydraulic system pressure, termed the Power Transfer Unit (PTU) can pressurize left system hydraulic fluid. These two surrogate hydraulic pressurization sources offer additional redundancy by using separate quantities of left system hydraulic fluid. The PTU pressurizes normal left system fluid, but the AUX pump uses a dedicated quantity of left system fluid preserved within the left system reservoir in the event of left system fluid loss. If all left and AUX hydraulic fluid is lost, the components essential to landing can be operated using pressure stored in accumulators or nitrogen bottles. The following table illustrates the actuation power sources for takeoff and landing controls, subsystems and actuators:

Control, Subsystem or Actuator	Primary Actuation Source	Secondary Actuation Source	Emergency Actuation Source
Landing Gear	Left Hydraulic System Engine Pump	PTU*	Pressurized Nitrogen Bottle
Brakes	Left Hydraulic System Engine Pump	AUX hydraulic pump or PTU	Hydraulic Accumulator
Nose Wheel Steering	Left Hydraulic System Engine Pump	AUX hydraulic pump or PTU	None
Flaps	Left Hydraulic System Engine Pump	AUX hydraulic pump or PTU	None
Ground Spoilers	Left and Right Hydraulic System Engine Pumps (left system pressure required)	AUX hydraulic pump or PTU	None
*AUX pump pressure is not used as an alternate method of gear extension because the landing gear actuators require one (1) gallon of fluid to operate. The left reservoir preserves only two (2) gallons for Aux pump pressurization, so sufficient fluid would not be available for other components if the landing gear were operated using Aux pump pressure and fluid.			

Left and right systems use Type IV phosphate ester-based hydraulic fluid (Hy-Jet IV, Skydrol LD-4, etc.) that has an operational temperature range from -40°C to +255°C. An external service panel mounted on the underside of the tail of the aircraft has provisions for servicing the reservoirs of both hydraulic systems as well as connections for attaching pressurized lines and system drain lines. The panel and specific servicing instructions are shown in Section 09-02-00.

Each hydraulic system is described in the following sections:

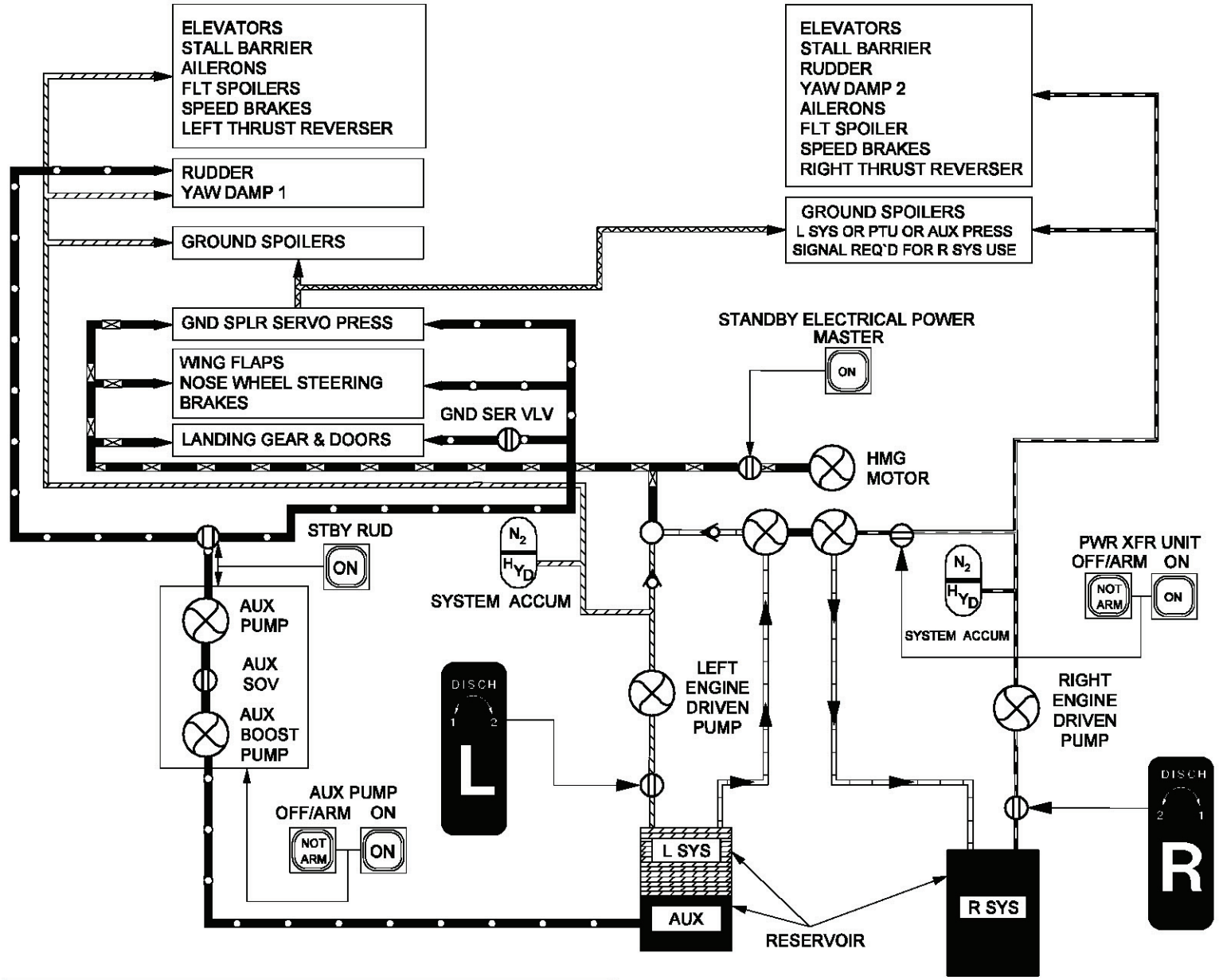
- 2A-29-20: Left Hydraulic System
- 2A-29-30: Right Hydraulic System

2. **Limitations:**

Approved Hydraulic Fluid Types:

The following fire-resistant Type 4 hydraulic fluids are approved for use:

- HyJet IV
- HyJeT IV-A
- Skydrol LD-4
- Skydrol 500B-4



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Component Hydraulic
Power Sources
Figure 1

2A-29-20: Left Hydraulic System

1. General Description:

The left hydraulic system supplies fluid drawn from a reservoir and pressurized by an engine-driven pump to all aircraft components and subsystems that require the additional force of hydraulic pressure for normal operation. Since left hydraulic system pressure is the only actuating force for some aircraft components and subsystems, two additional means of pressurizing the left system are incorporated to compensate for the loss of the left engine or pump: an electric Auxiliary (AUX) pump and an impeller driven by right system pressure termed the Power Transfer Unit (PTU). The AUX pump is provided with a dedicated volume of hydraulic fluid in the left system reservoir to ensure that AUX pump pressure is available if left system fluid is lost. See the left hydraulic system diagram in Figure 2 and the component locations shown in Figure 3.

In addition to supplying pressurized hydraulic fluid to aircraft actuators, the left system can be used to power an electrical generator if normal engine and APU generators are not available. The Standby Electrical Power System Hydraulic Motor Generator (HMG) is a variable piston hydraulic motor that uses left system pressure to rotate a generator shaft at eight thousand (8,000) rpm to produce Alternating Current (AC). For more information regarding the Standby Electrical Power System HMG, see section 2A-24-00.

The elements that make up the left hydraulic system are:

- Engine-driven Hydraulic Pump
- Fluid Distribution Components
- Reservoir, Fluid Replenishing, and Quantity Gage
- Electric Auxiliary (AUX) Pump
- Power Transfer Unit (PTU)
- Standby Electrical Power System Hydraulic Motor Generator (HMG)
- System Displays

2. Description of Subsystems, Units and Components:

A. Engine-Driven Hydraulic Pump:

The engine-driven hydraulic pump is mounted on the engine accessory gear box within the nacelle. Engine rotation is translated by the gear interface to spin the hydraulic pump so that the pump operates whenever the engine is running. Hydraulic pump output is three thousand pounds per square inch (3,000 psi) at flow rates between eighteen gallons per minute (18 gpm) at engine idle and twenty-eight gallons per minute (28 gpm) at maximum engine thrust. When the engine and pump begin to turn, suction is generated in the supply line to the pump. The supply line connects the pump to the left hydraulic reservoir located within the aft equipment bay of the aircraft.

There is no switch to disable the hydraulic pump; instead, a shutoff valve, located in the aft equipment bay, is installed in the supply line between the reservoir and the pump. The shutoff valve is powered by twenty-eight volt direct current (28v DC) from the left essential bus, and controlled by the left engine fire handle on the forward section of the cockpit center console. Pulling out the fire handle closes the shutoff valve, preventing hydraulic fluid from entering the engine nacelle. The shutoff valve may be physically opened or closed by positioning a pointer / handle on the valve body in the

equipment bay.

If the engine the engine fails but is not shut down with the fire handle, the windmilling engine will continue to turn the hydraulic pump. An airspeed sufficient to achieve approximately twenty-five to thirty percent (25-30%) High Pressure (HP) turbine rpm will provide sufficient hydraulic pressure to operate the flight controls.

B. Fluid Distribution Components:

The hydraulic system is a distributed system rather than a serial system - i.e., although pressurized fluid does flow through the system, fluid remains in the system lines after the engine is shut down. When the engine is started and the engine-driven pump pressurizes the fluid in the lines, the pressure is effective almost immediately at all points in the system. The following description is for illustrative purposes, and uses a sequential format rather than the immediate pressurization of components.

Engine pump fluid first is routed through an acoustic filter that curtails noise in the hydraulic lines caused by pressure fluctuations when hydraulically powered aircraft components are activated, then enters a supply line to the thrust reversers at the aft end of the engine prior to exiting the engine nacelle.

After leaving the nacelle, hydraulic lines route fluid to the aft equipment bay to pressurize a system accumulator and then enter a filter manifold in the equipment bay. The manifold contains a pressurized fluid filter, a fluid return filter, an AUX pump return filter and an engine and PTU case drain return filter. Locating all filters within a common manifold allows access to the replaceable elements of the filters without draining system hydraulic fluid. The filter manifold also contains a pressure switch and a pressure transmitter. The pressure switch is used to monitor pump operation and signal automatic activation of the AUX pump (when the AUX pump is armed) if system pressure drops below fifteen hundred (1,500) psi. System fluid passes through the pressure filter, pressure switch and transmitter, then exits the manifold.

From the filtration manifold in the aft equipment bay, fluid enter lines supplying aircraft components and subsystems. Lines run aft to supply the elevators, stick pusher and rudder / yaw damper, and forward to the ailerons, spoilers, speedbrakes, flaps, landing gear and doors, brakes, nose wheel steering and main cabin door.

A pressure relief valve in the forward hydraulic supply lines is installed in the right main wheel well. The pressure relief valve opens if system pressure exceeds three thousand eight hundred fifty (3,8500) psi. Pressure is reduced by routing some of the system fluid back to the reservoir through the return filter in the filtration manifold. When system pressure falls to three thousand two hundred (3,200) psi, the relief valve closes.

After pressurizing aircraft subsystems and components, system fluid enters a radiator type heat exchanger located in the right wing fuel tank. The hot hydraulic fluid is cooled by fuel in the tank (and tank fuel is slightly warmed, although the high ratio of fuel to hydraulic fluid results in a minimal temperature rise) then returned to the system reservoir, passing through the return filter enroute.

C. Reservoir, Quantity Gage and Fluid Replenishment:

The left system hydraulic reservoir is located on the left side of the aft equipment bay. The reservoir is a cylindrical container divided internally into two compartments, one for left system fluid and the other for AUX pump fluid. Centered within the cylinder is a spool shaped piston that slides within the reservoir cylinder. Each end of the piston terminates in a plate-like divider connected with a central shaft. The central shaft penetrates the internal cylinder wall separating the left and AUX fluid supplies. The larger plate on the aft end of the shaft defines the volume of the fluid within the reservoir. When fluid is added to the reservoir, the fluid forces the large plate of the spool to the end of the reservoir cylinder when the reservoir is full. The smaller plate at the opposite end of the shaft is surrounded by an extension of the reservoir cylinder with a smaller cross section. The design of the reservoir enables system return fluid, ported into the smaller cylinder extension, to exert a force on the smaller plate end of the central shaft thus pulling the larger plate against the left and AUX system fluid within the reservoir. This action, called bootstrap pressure, pressurizes the contents of the reservoir to approximately thirty to forty (30 - 40) psi., promoting fluid flow to the engine-driven or AUX pump.

The total capacity of the left hydraulic system, including the fluid in system lines is twenty point six (20.6) gallons, with the reservoir containing five point seven (5.7) gallons, of which three point seven (3.7) gallons are available to the left system and two (2) gallons reserved for use by the AUX pump. The internal wall separating the two quantities is perforated by a baffle so that servicing the reservoir fills both compartments of the container. If left system fluid is depleted by a leak, the large end of the central spool is pulled toward the wall separating left and AUX fluid, with the baffle opening in the wall continually admitting left system fluid into the AUX compartment to ensure the integrity of the AUX fluid supply. If all three point seven (3.7) gallons of left fluid is lost, the large end of the spool bottoms out at wall dividing the compartments, preserving the AUX pump fluid.

The fluid quantity within the reservoir is displayed in two locations:

(1) A direct reading circular gage, mounted on the side of the reservoir, has a needle pointer and colored bands to indicate quantity. The gage is illustrated in Figure 4. A green band arcs between the FULL and REFILL marks and a red band arcs between the REFILL mark and the EMPTY mark.

(2) An electrically powered float within the reservoir provides quantity data to the cockpit. The float moves with fluid quantity, with float displacement measured by a Linear Variable Displacement Transducer (LVDT). The LVDT is powered by twenty-eight volt direct current (28v DC) from the left essential bus or the ground service bus. Quantity information is derived from the displacement measured by the LVDT, and transmitted electrically to Modular Avionics Unit (MAU) #1 where it is converted from analog to digital format and forwarded to the Monitor and Warning System (MWS) for presentation on cockpit Hydraulics Synoptic, Summary, Secondary Engine, Engine Start and Ground Service system window displays. The quantity interface is shown in Figure 5.

The hydraulic quantity displayed on cockpit synoptic / system windows is the most accurate reading of fluid in the reservoir. The cockpit indications are refined to compensate for expansion or contraction of reservoir fluid caused by temperature variations. A constant value of twenty-one degrees centigrade (21°C) is used as an indication standard. The actual temperature within the reservoir is sampled by a temperature probe that reports data to MAU #1. The MWS uses the difference between actual reservoir temperature and the constant assumed temperature (21°C) to add or subtract a formulated quantity to the amount reported by the LVDT. The quantity shown on cockpit window displays is thus adjusted to read as if reservoir temperature remained at 21°C. This adjustment compensates for the normally indicated loss of fluid as the density of the hydraulic fluid in the reservoir increases as a result of cold temperatures during high altitude flight (volume or quantity would decrease as density increases).

The MWS further refines the quantity indication for the amount of hydraulic fluid required to retract the landing gear. Approximately one (1) gallon of fluid is retained within the retract side of the landing gear actuator when the landing gear is in the up position. The MWS will add one (1) gallon to the LVDT reported quantity whenever the landing gear is retracted.

The temperature and landing gear compensatory quantities are algebraically additive.

(3) The analog quantity signal from the LVDT is shared with a digital hydraulic quantity gage on the hydraulic fluid replenisher panel. The panel is located on the right side of the aft equipment bay adjacent to the reservoirs. The indicator on the panel shows the quantity in both left and right reservoirs, displayed as horizontal bar graphs. The bar graphs extend from a refill mark on the left to a full mark on the right. The indicator has a green band between the full and add marks on the display, and an amber band to the left of the add mark. The bar graph is not shown if the quantity in the left reservoir is below one point eight gallons (1.8 gal), instead the word REFILL is shown in place of the bar graph. (Right reservoir quantity is not shown if below one half gallon - 0.5 gal). The panel contains two switches below the digital display. The switch on the right selects the indicator ON or OFF. The switch on the left has three positions: select and test are momentary positions, with the switch returning to a center neutral position. The down test position initiates a self test of the display, during which first a checkerboard pattern is shown, then a reverse checkerboard pattern. Following the patterns, the indicator bar graphs are displayed with either the left or right quantity indicated numerically below the bar graphs and the word OK shown in the right lower corner (assuming quantities are correctly serviced).

When the left switch is positioned up to the SELECT position, the numerical indication of quantity will reflect the opposite reservoir from the one previously shown - i.e. the select position alternates between left and right reservoirs each time the switch is selected up.

If the quantity within the reservoir drops to refill level, fluid may be added

using the controls on the replenishing panel in the aft equipment bay adjacent to the reservoirs, as illustrated in Figure 6. The replenishing panel has a container that holds up to one and one half gallon (1 ½ gal) of hydraulic fluid. Below the container on the face of the panel is a pushbutton switch and a selector lever. Fluid may be transferred from the container to either reservoir by positioning the selector lever to the left or right reservoir and depressing the pushbutton. The pushbutton starts an electric pump that transfers the fluid from the container to the reservoir. The pump is powered by twenty-eight volt direct current (28v DC) from the ground service bus. When the hydraulic systems are pressurized, the left system is considered full at four point eight (4.8) gallons (the right system is full at 1.6 gallons).

D. Electric Auxiliary (AUX) Pump:

The electrically powered Auxiliary (AUX) pump is plumbed into the left hydraulic system lines in the right main landing gear wheel well. The pump is powered by the left essential DC bus, and can produce a flow of two (2) gallons per minute at three thousand (3,000) psi. The pump is cooled by an integral fan and protected by an overheat switch that shuts off the pump if pump temperature exceeds 356°F (pump operation will resume when the temperature falls to 341°F or less). The pump is also protected by an overload sensor that limits current draw by the pump to two hundred (200) amperes. The overload shutdown can be reset by selecting the pump off then back on.

Since the AUX pump is located at some distance from the left system reservoir, a boost pump is installed in the supply line to the AUX pump. The boost pump is also powered by essential DC, and is overload protected by a sensor that will shut off the pump if it draws more than fifteen (15) amperes. The operation of the boost pump is automatic whenever the AUX pump is operating. The boost pump comes on whenever the pressure in the supply line to the AUX pump falls below twenty (20) psi, and the boost pump shuts off when supply pressure reaches twenty-five (25) psi.

The AUX pump can provide hydraulic pressure to operate the following components essential to configuring the aircraft for approach and landing if no other means of pressurizing the left hydraulic system is available:

(1) Rudder and yaw damper

(2) Flaps

(3) Ground spoilers

(4) Brakes

(5) Nose wheel steering

However, the AUX pump cannot power all listed items at the same time. A valve installed in the AUX pump lines will route pressurized hydraulic fluid to either the rudder and yaw damper or the other listed components. The intention is to power the rudder and yaw damper when the aircraft is at higher airspeeds, when more force would be required to operate flight controls, then at the lower airspeeds associated with an approach when control forces are less, make the AUX pressure available to configure the aircraft for landing.

The AUX pump is also used to close the main cabin door, pressurize the brake accumulator and operate the landing gear and gear doors for

maintenance operations. For more information regarding main cabin door operation, see section 2A-52-00: Doors, and for landing gear and brake accumulator operation, see section 2A-32-00: Landing Gear.

Operation of the AUX pump is controlled with seven (7) switches. On the HYDRAULIC CONT panel on the cockpit overhead are two AUX PUMP pushbutton switches: OFF/ARM and ON (see Figure 7). With the OFF/ ARM pushbutton depressed to the normal ARM position, the AUX pump will come on whenever left system pressure falls below fifteen hundred (1,500) psi and a brake pedal is depressed more than ten degrees (10°). If the OFF/ARM switch is selected to OFF, automatic operation of the AUX pump is inhibited, and the amber NOT ARM legend in the switch is illuminated. The ON switch will operate the AUX pump regardless of left system pressure.

Another pushbutton switch, labelled STBY RUD, located on the lower face of the instrument panel on the pilot side next to the standby instruments, will also operate the AUX pump. The switch is depicted in Figure 8. Depressing the switch will illuminate the amber ON legend in the switch and open the standby rudder valve to direct AUX pump pressure to the rudder and yaw damper, provided the aircraft is in the air (weight off wheels). If using the AUX pump to power system components during abnormal operations, the standby rudder switch is selected on until configuring the aircraft for landing. At that time the standby rudder switch is selected off, and the AUX pump selected on with the switch on the HYDRAULIC CONT panel. After the aircraft has been configured for landing, the standby rudder switch is reselected to on, powering the rudder / yaw damper until touchdown. When the weight-on-wheels (WOW) switches compress upon landing, the standby rudder valve will close, porting AUX pump pressure to the ground spoiler servos, nose wheel steering and brakes.

Any of the three main cabin door control switches will operate the AUX pump to close the cabin door, provided the DOOR SAFETY switch on the cockpit overhead panel is not selected to the ON position. The door control switches are installed in the following locations:

- On the cockpit overhead
- On the observer and monitor panel
- Within the service panel on the aircraft exterior forward and below the main cabin door

The AUX pump may also be powered to operate the landing gear and landing gear doors for maintenance purposes using the ground service valve installed in the panel on the right side of the aircraft aft of the nose wheel well. The ground service valve must be held open for the AUX pump to operate. See the illustration in Figure 9.

E. Power Transfer Unit (PTU):

The Power Transfer Unit (PTU) is a hydraulic motor / pump installation located in the aft equipment bay on the right side of the aircraft. The motor side of the installation is driven by the right hydraulic system and controlled by a shutoff valve. The pump side is plumbed to the left hydraulic system and connected to the motor side by a common shaft. When the shutoff valve is open, the right hydraulic system is ported to the motor at twenty-

eight (28) gallons per minute, turning the pump side at thirty-nine hundred revolutions per minute (3,900 rpm) producing a flow of twenty-two and one half (22½) gallons per minute at three thousand (3,000) psi in the left hydraulic system. The right system motor function is protected by a hydraulic fuse. The fuse will prevent operation of the motor it diverts too much flow from the right system to prevent adequate operation of the flight controls, since operation of the PTU assumes loss of the left hydraulic system and only right system pressure is available for flight controls. The fuse will activate if the right system flow to the PTU exceeds thirty-four (34) gallons per minute.

The switches controlling the operation of the PTU are located on the PWR XFR UNIT of the HYDRAULIC CONT panel on the cockpit overhead, shown in Figure 7. The left switch is labelled OFF / ARM, and is normally selected to the ARM position. If the switch is selected OFF, the amber NOT ARM legend in the switch will illuminate. When the switch is armed, the shutoff valve directing right system pressure to the motor of the PTU will open whenever left system pressure drops below fifteen hundred (1,500) psi to provide pressurization of the left system. Automatic operation will be inhibited, however, if the fluid quantity in the left system is one (1) gallon or less or if the temperature in the right system reservoir exceeds one hundred four point four degrees centigrade (104.4°C). The right PWR XFR UNIT switch, labelled ON, will open the shutoff valve and operate the PTU regardless of left system fluid quantity or right system temperature (the amber ON legend in the switch will illuminate when the switch is depressed to the on position).

Whenever the PTU is operating, pressurized left system fluid is available to actuate the following components:

- Flaps
- Landing gear
- Brakes
- Nose wheel steering
- Ground spoiler servos
- Standby Electrical Power System Hydraulic Motor Generator (HMG)

F. Standby Electrical Power System Hydraulic Motor Generator (HMG):

The Hydraulic Motor Generator (HMG) is located in the left main landing gear wheel well. The HMG is an electrical generator that can be driven by left system or PTU pressure rotating the generator shaft. Operation of the Standby Electrical Power System HMG is controlled by the STANDBY ELECTRICAL POWER MASTER switch on the cockpit overhead (see Figure 10). When the switch is selected ON (the amber ON legend in the switch will illuminate), a solenoid controlled valve will open, porting left or PTU hydraulic pressure to the variable piston drive of the generator. The generator has a normal operating speed of eight thousand (8,000) rpm and is capable of supplying ten thousand volt /amperes (10k VA) of Alternating Current (AC) power. For more information on the Standby Electrical Power System HMG, see section 2A-24-00: Electrical Power.

G. System Displays:

Performance of the hydraulic system components may be monitored on the Hydraulics or Summary synoptic 2/3 window displays or the Ground Service system 1/6 window display. The Hydraulics synoptic display offers the most comprehensive view of the left and right systems, containing the following information:

- Hydraulic pressure - displayed in a range from 0 - 4,000 psi with a 100 psi resolution (readings below 200 psi are shown as 0 psi). The pressure readouts are displayed in white when within the range of 1,500 to 3,400 psi, otherwise the readout is shown in amber
- Hydraulic pumps - displayed symbolically and color coded to reflect operating status for engine-driven, AUX and PTU pumps. The pumps are represented by a round circle with three green vanes when pumps are operating and producing pressures ≥ 1,500 psi, the symbol changes to a white circle with no vanes if the pumps are not operating or the shutoff valve to the pump is in transition, and if pump operation is unsatisfactory (low pressure < 1,500 psi, overheated or overloaded) the pump is illustrated by an amber circle without vanes.
- Hydraulic valves - shown as circles with an internal line representing a standard gate valve. The internal symbol line is aligned with the respective hydraulic line when the valve is open, perpendicular to the hydraulic line when closed, or shown as a diagonal when in transition. The color of the valve representation corresponds to operating conditions: green when in agreement with commanded position and pressure ≥ 1,500 psi, amber when valve position does not correspond to commanded position, and white for all other conditions (off).
- Hydraulic temperatures - displayed for each reservoir with a range of -60° to 150°C with a resolution of 1°C. The digital readouts are green when temperatures are between 79.4° and 104.4°C, white when below 79.4°C, and amber when above 104.4°C.
- Hydraulic quantities - system fluid is displayed numerically in gallons with a resolution of 0.1 gal for the left, right and AUX portion of the left reservoir, and graphically by a green raster bar graph within the volume of the reservoir symbols. Labels depicting full and low fluid levels are shown to the side of the reservoirs, with full corresponding to 4.8 gal for left and 1.6 gal for the right. The low label is set at 3.0 gal for the left (JAR configured aircraft at 2.8 gal) and 1.0 for the right. When reservoir quantities are zero (0), the green raster graph is replaced with an “X”.

On the Summary synoptic window, hydraulic pressures and quantities are shown digitally in colors reflecting system operation - white for normal ranges and amber for abnormal conditions.

The Ground Service system window has bar graph displays of reservoir quantities with digital readouts below the graphs in ranges reflecting an unpressurized condition: 0 -5.8 gal for the left reservoir, 0 - 1.9 gal for the right, with a resolution of 0.1 gal. Full and Low marks are shown on the bar graphs representing levels shown in the following table:

Graph Region	Left Quantity	Right Quantity
Bottom to Low	0.0 - 3.0 gal *	0.0 - 1.0 gal
Low to Full	3.0 - 4.8 gal *	1.0 - 1.5 gal
Full to Top	4.8 - 5.8 gal	1.5 - 1.9 gal
* JAR configured aircraft have 2.8 gal as Low mark		

3. **Controls and Indications:**

A. Circuit Breakers (CBs):

The following CBs protect components of the left hydraulic system:

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
L HYD S/O	LEER	A-16	L ESS DC Bus
L HYD QTY	LEER	A-17	L ESS DC Bus
L HYD PRESS	LEER	A-18	L ESS DC Bus
HYD CONT	LEER	B-17	L ESS DC Bus
OILER/HYD PUMPS	REER	C-9	GND SVC Bus
AUX HYD PRESS	LEER	C-17	L ESS DC Bus
AUX HYD PUMP	LEER	C-16	L ESS DC Bus
PTU HYD PRESS	REER	C-7	R ESS DC Bus
HMG CONT #1	LEER	J-12	L ESS DC Bus
HMG CONT #2	REER	E-31	BATT Bus

B. Crew Alerting System (CAS) Messages:

The following CAS messages are associated with operation of the left hydraulic system:

Area Monitored:	CAS Message:	Message Color:
AUX Boost Pump Pressure	Aux Hydraulic Boost Fail	Amber
AUX Pump Pressure	Aux Hydraulic Fail	Amber
AUX Pump Temperature > 356°F	Aux Hydraulic Hot	Amber
Aux Pump Fluid Flow	Aux Hydraulic Pump Overload	Amber
Hydraulic Reservoir Quantity	Hydraulic Quantity Low, L	Amber
Hydraulic Reservoir Temperature	Hydraulic Reservoir Hot, L	Amber
Engine-driven Pump and/or System Pressure	Hydraulic System Fail, L	Amber
PTU Pump Pressure < 1,500 psi	PTU Hydraulic Fail	Amber
AUX Pump Pressure	Aux Hydraulic On	Blue
Standby Electrical Power MASTER Switch	HMG Switch On	Blue
Hydraulic Reservoir Temperature Sensor	Hydraulic Temp Sen Fail, L	Blue
PTU Pump Pressure	PTU Hydraulic On	Blue
Standby Rudder Switch	Standby Rudder Hyd On	Blue

4. **Limitations:**

   A. **Flight Manual Limitations:**

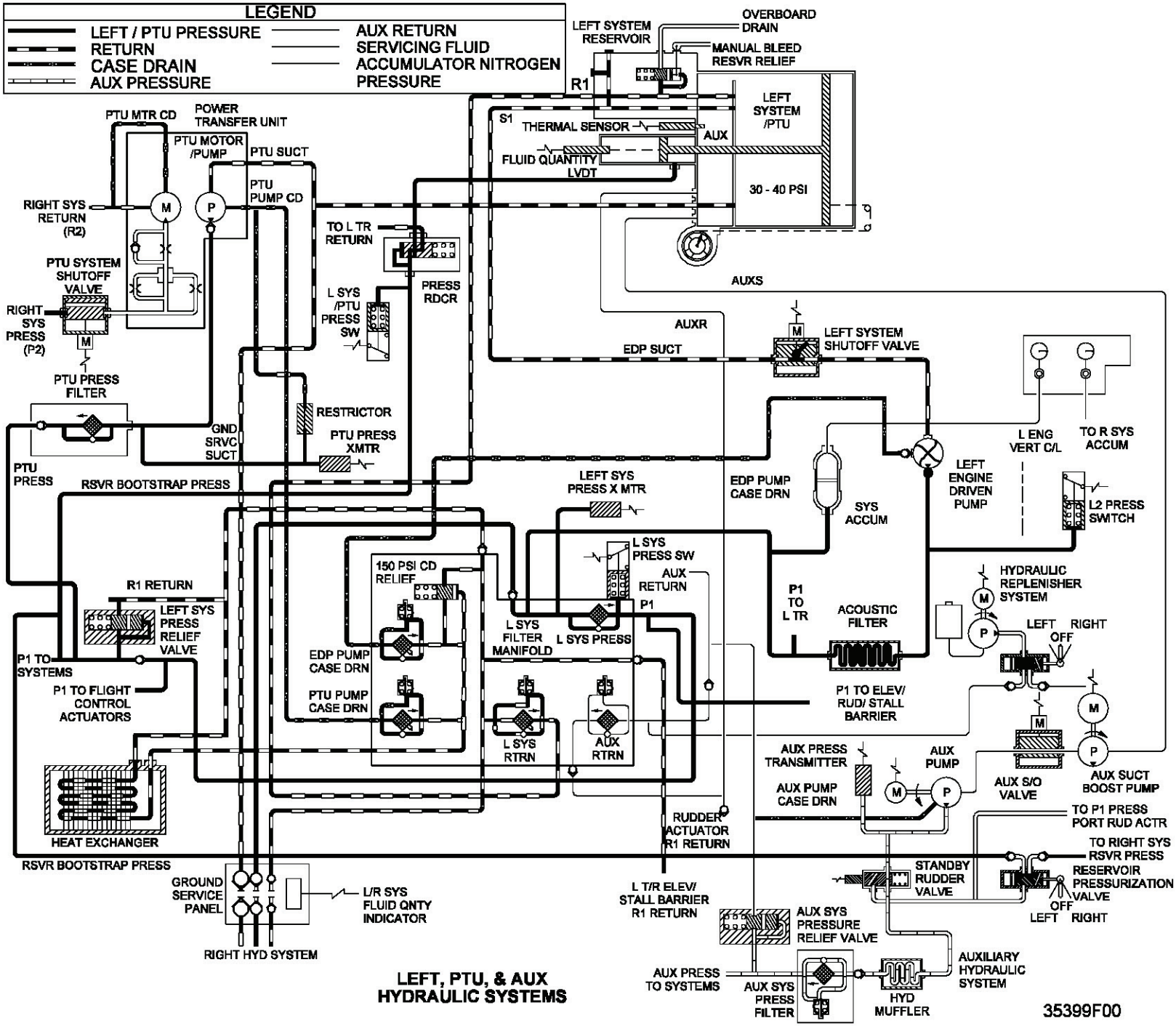
      (1) **Maximum Reservoir Quantities (Pressurized) As Indicated on the Hydraulics Synoptic Page:**

      - Left Hydraulic System: 4.8 gallons
      - Right Hydraulic System: 1.6 gallons

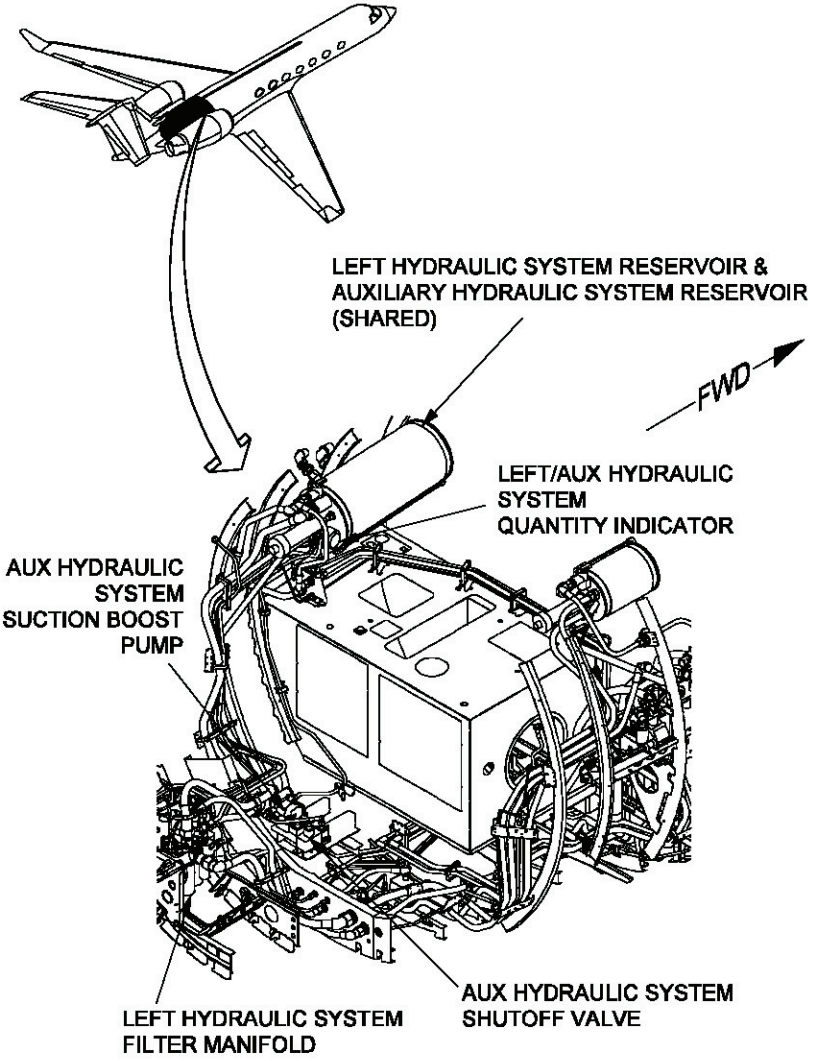
      Refer to placard in aft equipment bay.

      (2) **Left And Right Hydraulic System Accumulator Precharge:**

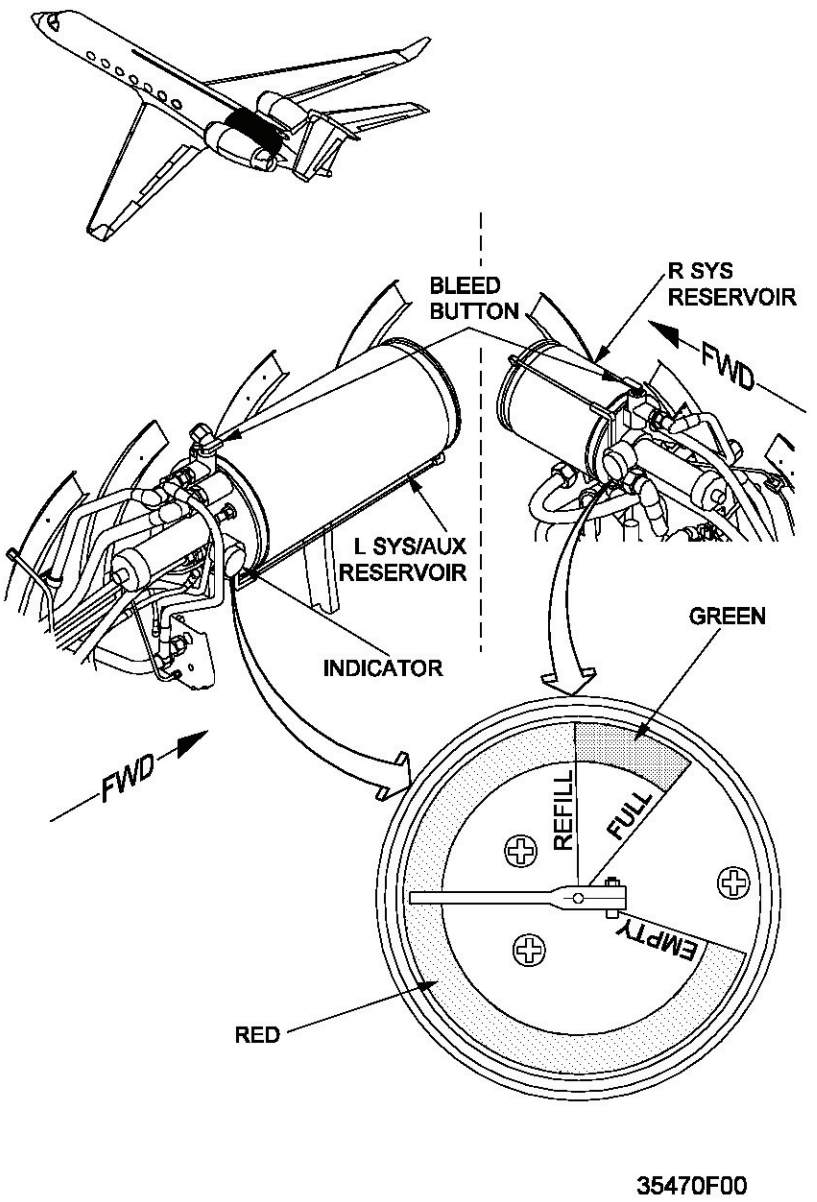
      1200 psi at 70°F / 21°C, ±25 psi for each 10°F / 5°C difference in temperature from 70°F / 21°C.



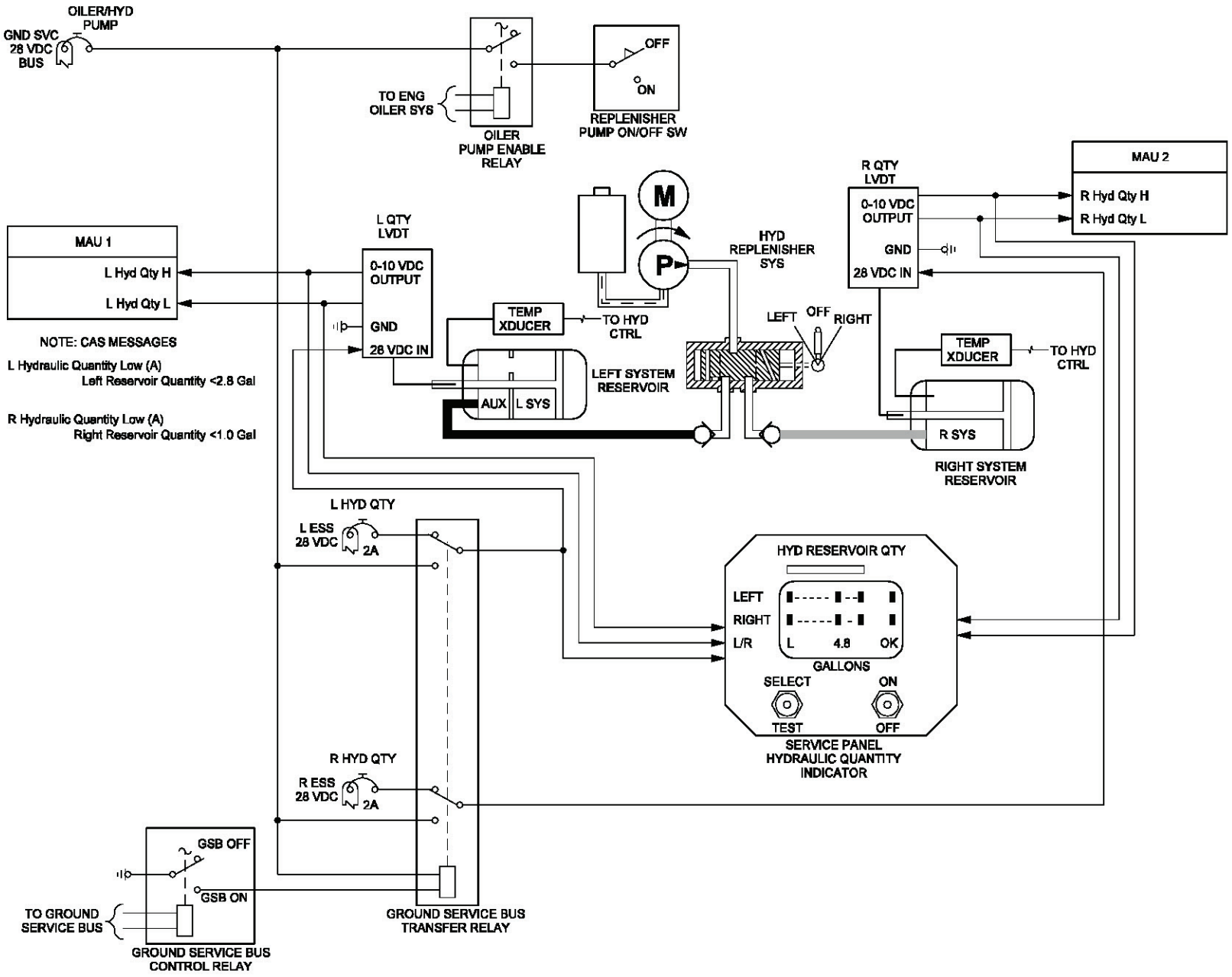
Left Hydraulic System
Flow Diagram
Figure 2



Left Hydraulic System Components
Figure 3



Hydraulic Reservoir Quantity Indicators
Figure 4



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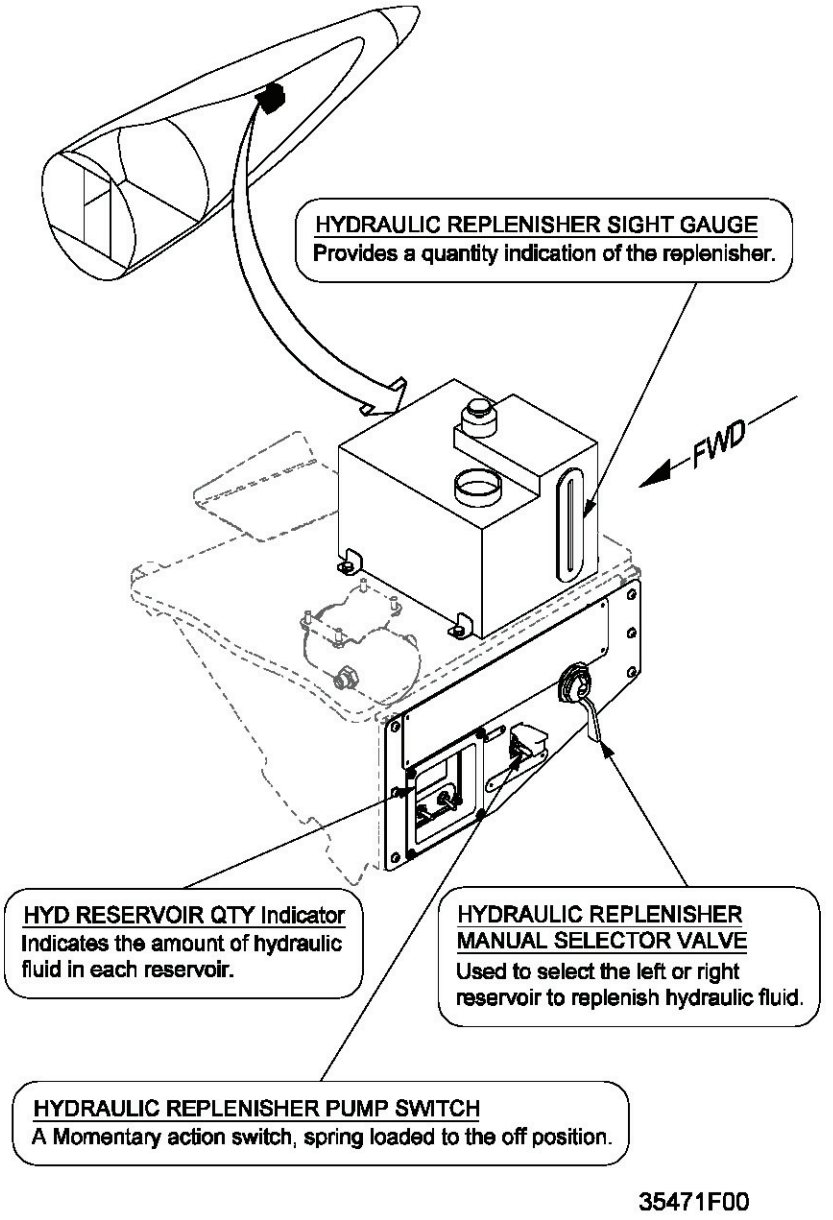
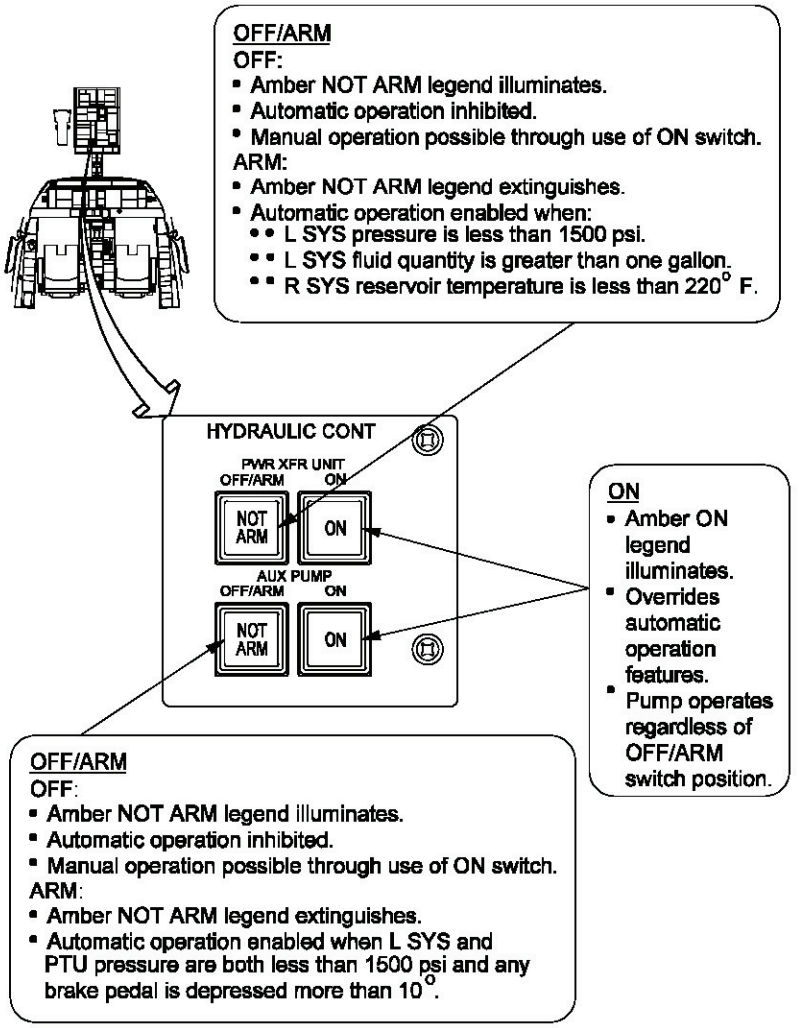
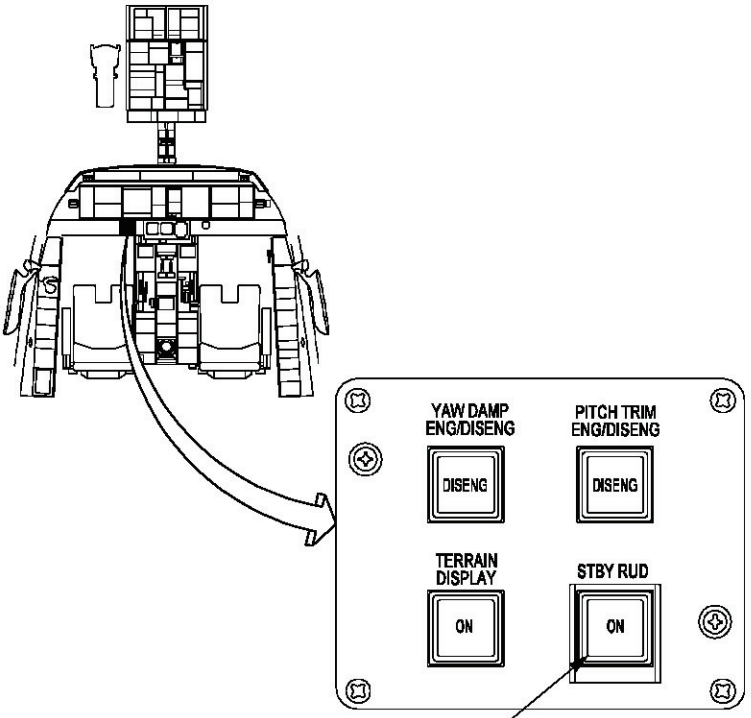
Hydraulic Quantity Block Diagram
Figure 5



Hydraulic Replenisher Panel
Figure 6



AUX Pump and PTU Control Switches
Figure 7



STBY RUD

ON:

- **Amber ON legend illuminates.**
- **AUX pressure is provided exclusively to rudder actuator / yaw damper system when nose landing gear weight-on-wheels is in the AIR mode. A shift to the GROUND mode returns AUX pressure to systems normally provided pressure.**

OFF:

- **Amber ON legend extinguishes.**
- **AUX pressure to rudder actuator / yaw damper system is inhibited.**
- **AUX system functions normally.**

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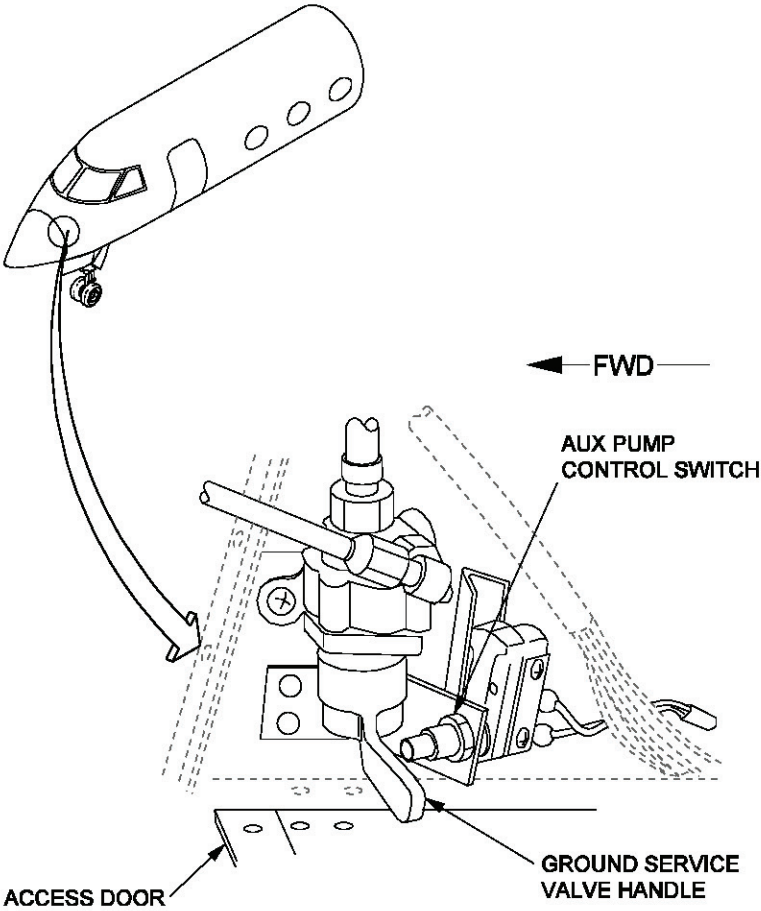
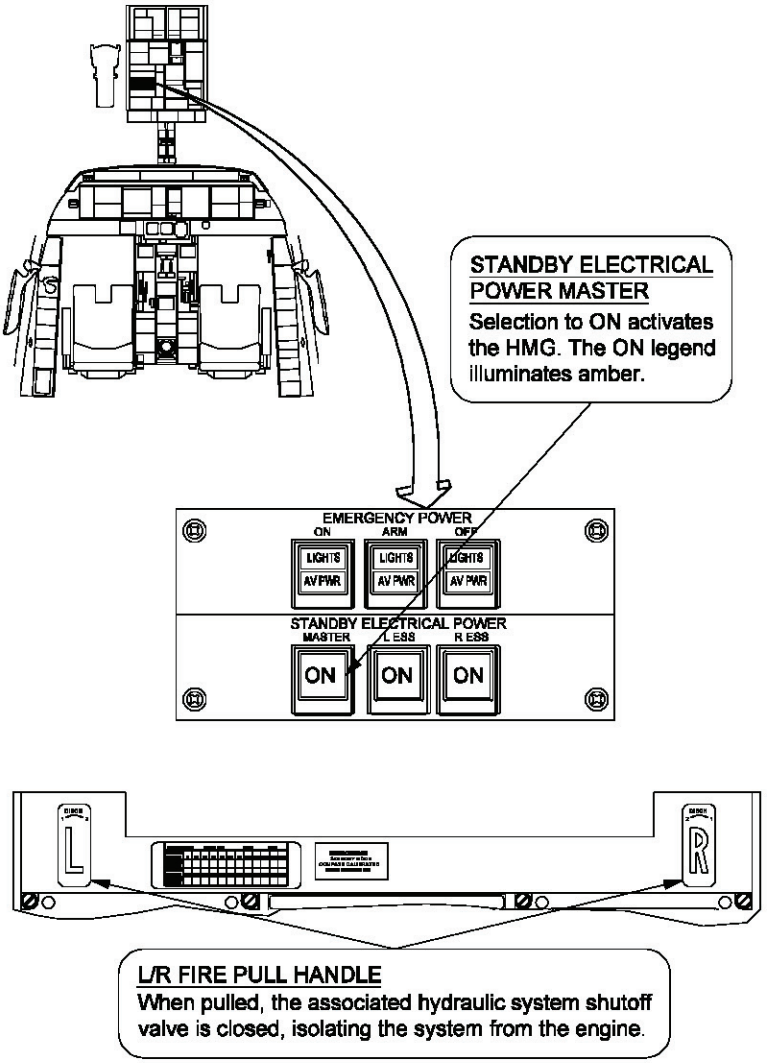
Standby Rudder Switch
Figure 8



Ground Service Valve
Figure 9



Fire Handles And Standby Electrical Power Master Switch
Figure 10

2A-29-30: Right Hydraulic System

1. **General Description:**

   The right hydraulic system is operationally similar to the left system, but is functionally limited to providing redundant hydraulic power to the flight controls, and single source power to the right engine thrust reverser and the motor drive of the PTU impeller. See the illustration of the system in Figure 11 and the depiction of system components in Figure 12. The size of the right system is commensurate with the smaller number of actuators served by the system and absence of actuators requiring large fluid volumes such as the landing gear. The total volume of fluid in the right system is seven gallons (7 gal). The right system, in conjunction with the left system or as a single pressure source, provides power to the following dual system actuators:

   - Elevator
   - Stick Pusher
   - Rudder / Yaw Damper
   - Ailerons
   - Flight Spoilers
   - Speedbrakes
   - Ground Spoilers (however, left system must pressurize the ground spoiler servo valves for the ground spoilers to operate)

   The right system solely and independently powers:

   - Right Engine Thrust Reverser
   - PTU motor

   The right system includes the following components:

   - Engine-Driven Hydraulic Pump
   - Fluid Distribution Components
   - Reservoir, Fluid Replenishing, and Quantity Gage
   - Power Transfer Unit
   - System Displays

2. **Description of Subsystems, Units and Components:**

   Due to the similarity of the right system to the left system, the following descriptions are cursory, with elaboration confined to systems differences. For more information refer back to the left hydraulic system description.

   A. **Engine-Driven Hydraulic Pump:**

      The engine-driven pump for the right hydraulic system is identical to the pump powering the left system. No control is provided for the pump, but flow to the pump may be interrupted by the shutoff valve in the fluid supply line when the engine fire handle is activated.

   B. **Fluid Distribution Components:**

      Right system pressurized fluid follows a similar path as the left system, through the same sequence of acoustic filter, dedicated thrust reverser, system accumulator, filter manifold, to the tail-mounted flight controls and forward to the landing gear wheel well for powering the flight controls installed on the wing, through a pressure relief valve, into the radiator cooler in the left wing fuel tank hopper, through a return filter and back to

the aft equipment bay to be available to power the PTU and return to the reservoir.

The length of pressurized lines in the right system is reduced since no lines extend forward from the wheel well to power the nose landing gear, nose wheel steering and brake accumulator.

C. Reservoir, Quantity Gage and Replenishment:

The right system reservoir is considerably smaller than the left system, with a total capacity of one point eight gallons (1.8 gal) with the system unpressurized. Internally, the reservoir lacks the dividing wall that preserves AUX pump fluid in the left system, but otherwise operates in the same way on a reduced scale. An internal spool is pulled against the contents of the reservoir by right system return pressure to provide fluid pressurization. The right reservoir temperature probe communicates with Modular Avionics Unit (MAU) #2 forwarding temperature data to the Monitor and Warning System (MWS) that is formatted for display on synoptic and system pages.

The quantity of the reservoir is indicated by a direct-reading gage mounted on the exterior, and through the same type of measuring device used in the left system - a Linear Variable Displacement Transducer (LVDT) mounted on a float within the fluid container that signals quantity to the digital gage on the replenishment panel and to MAU #2 for transmission to the MWS for presentation on cockpit displays. The direct-reading gage is circular with a needle pointer that moves over the face of the gage. The gage face has a green band between FULL and REFILL marks and a red band between the REFILL mark and the EMPTY mark.

Servicing the right reservoir is done with the gage and controls on the replenishment panel. The quantity gage is described in the text treating the left system - for the right system, LO indicates less than one point two gallons (1.2 gal), OK for quantities between one point two and one point five gallons (1.2 - 1.5 gal) and HI shown when quantity exceeds one point six gallons (1.6 gal).

Adding fluid to the right system is accomplished by moving the manual selector handle to the right system and depressing the switchbutton to start the electric pump that transfers fluid from the holding tank to the reservoir.

D. Power Transfer Unit (PTU):

The operation of the PTU, detailed in the left hydraulic system description, provides a means to pressurize the left hydraulic system in instances of loss of the left engine or hydraulic pump. Use of the PTU requires that the lines in the left system remain intact and that fluid remains in the left system. Because of the high demands made on the right system by PTU operation - flow of twenty-eight gallons (28 gal) per minute to produce thirty-nine hundred (3,900) rpm - operation of component actuators takes significantly longer. However, the use of the PTU offers the advantage that all hydraulically powered components can be operated without resorting to accumulators or air bottles. An additional benefit is that the landing gear can be retracted if the left engine or pump failure occurred during takeoff, or a missed approach becomes necessary.

E. System Displays:

The cockpit display indications of right hydraulic system performance are fully described in the text covering the left hydraulic system - there are no independent indicators for each system except the direct reading gages on the respective reservoirs.

3. Controls and Indications:

A. Circuit Breakers (CBs):

The following circuit breakers protect components of the right hydraulic system:

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
R HYD PRESS	REER	A-6	R ESS DC Bus
R HYD QTY	REER	A-7	R ESS DC Bus
R HYD S/O	REER	A-8	R ESS DC Bus

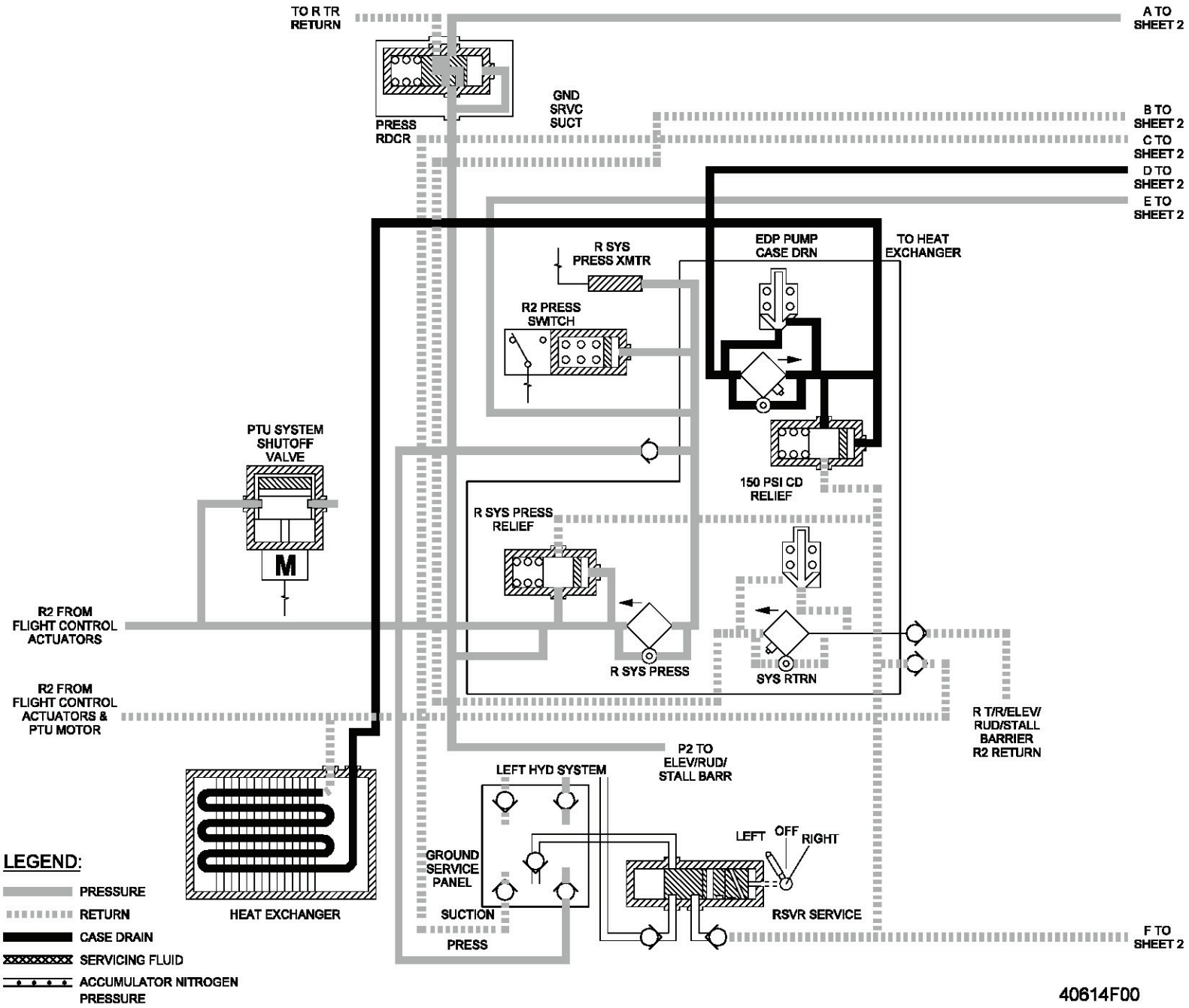
B. Crew Alerting System (CAS) Messages:

The following CAS messages are associated with the operation of the right hydraulic system:

Area Monitored:	CAS Message:	Message Color:
Right System Reservoir Quantity	Hydraulic Quantity Low, R	Amber
Right System Reservoir Temperature	Hydraulic Reservoir Hot, R	Amber
Right System Engine-Driven Pump / Pressure	Hydraulic System Fail, R	Amber
Right System Reservoir Temperature Sensor	Hydraulic Temp Sen Fail, R	Blue

4. Limitations:

Refer to the operational limitations listed in 2A-29-20: Left Hydraulic System.



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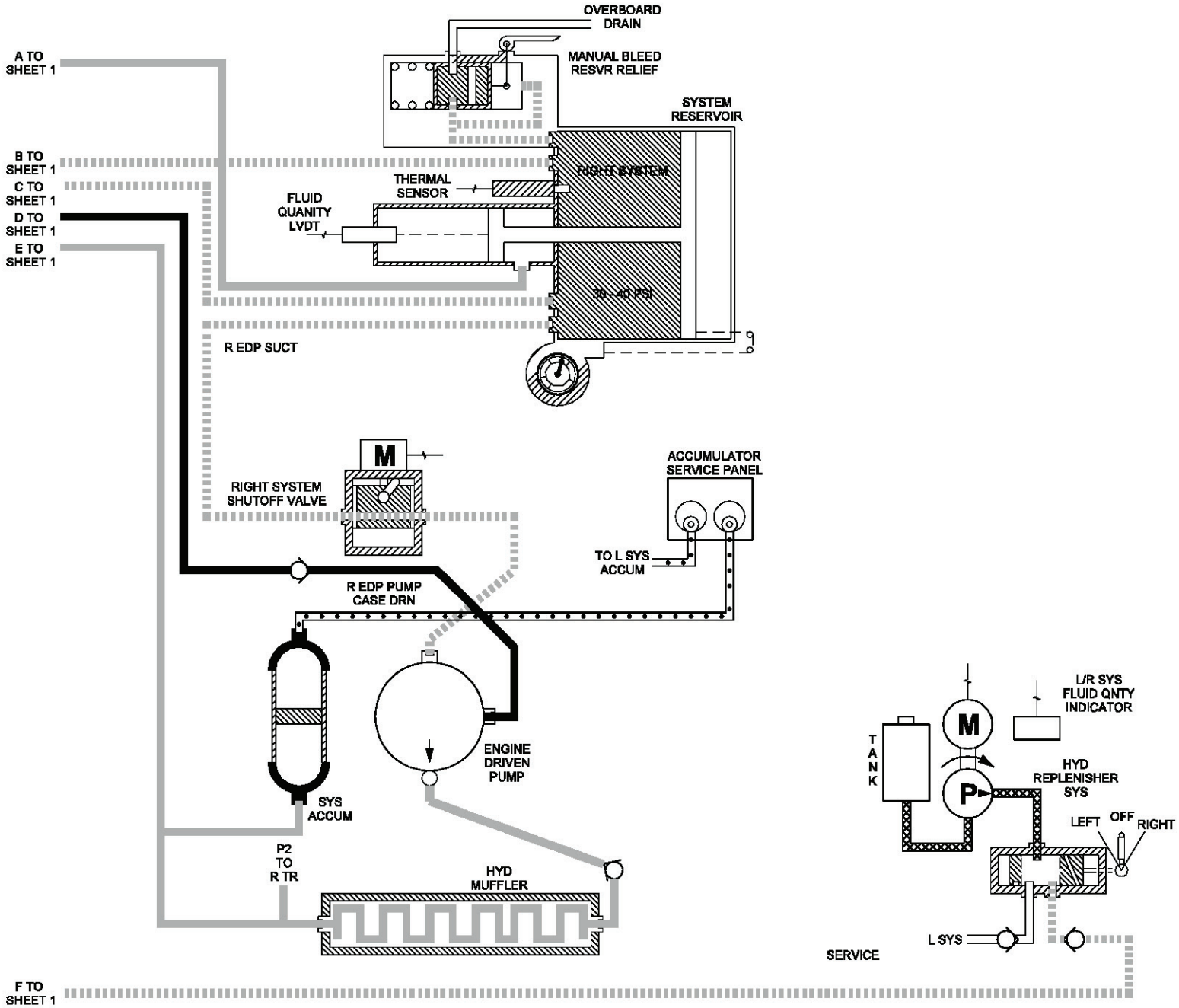
Right Hydraulic System
Figure 11 (Sheet 1 of 2)



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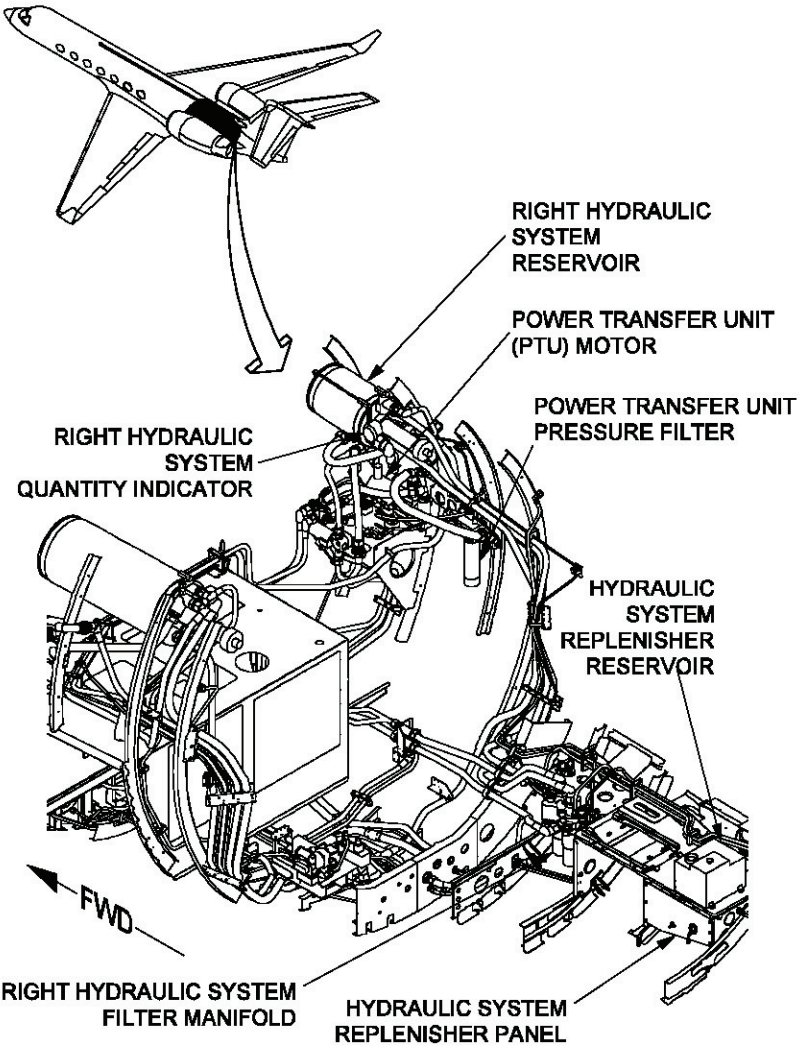
Right Hydraulic System
Figure 11 (Sheet 2 of 2)



Right Hydraulic System Components
Figure 12

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