2A-29-10: General

The hydraulic system for the Gulfstream IV (Figure 1) provides a means to store hydraulic fluid and deliver hydraulic fluid under pressure to using systems. Two engine-driven main hydraulic systems are installed in the aircraft. They are the Combined system (left engine) and the Flight system (right engine). System design is such that a single hydraulic system failure will not result in loss of the entire hydraulic system.

In addition to the main hydraulic systems, two auxiliary hydraulic systems are incorporated to provide operational redundancy and to perform various utility functions, in some cases without the need for operating engines or external power sources. The two auxiliary hydraulic systems are the hydraulically-driven Utility system and the electrically-driven Auxiliary system.

Each primary flight control actuator (aileron, elevator and rudder) and each spoiler actuator are termed “dual-tandem actuators”, in that both Combined system and Flight system power is used through independent load paths, yet summed for output. Thus, if a loss of either hydraulic system input to actuator did occur, the remaining hydraulic system continues to allow actuator function.

The system is designed for use with Type IV phosphate ester-based hydraulic fluid (Hy-Jet IV, Hy-Jet IV-A, Skydrol LD-4 and Skydrol 500B-4).

The hydraulic system is divided into 2 subsystems:

- 2A-29-20: Main Hydraulic Systems
- 2A-29-30: Auxiliary Hydraulic Systems

A master table of component availability by hydraulic system is shown on the following page.

Master Table of Component Availability
Table 1

SYSTEM/COMPONENT:	HYDRAULIC SYSTEM:			
	COMB	FLT	UTIL	AUX
Elevators	X	X		
Stall Barrier	X		X	
Ailerons	X	X		
Speed Brakes	X	X		
Flight Spoilers	X	X		
Ground Spoilers	X	X **(1)**		
Rudder	X	X		
Yaw Damper		X		
Left Thrust Reverser	X			
Right Thrust Reverser		X		
Utility Pump Motor		X		
Wing Flaps	X		X	X
Landing Gear and Doors	X		X	X **(2)**
Nosewheel Steering	X		X	
Brakes	X		X	X **(3)**
STBY ELEC PWR SYS Motor	X			
Parking Brake Pressure				X
Main Entrance Door				X
Cargo Door **(4)**				X

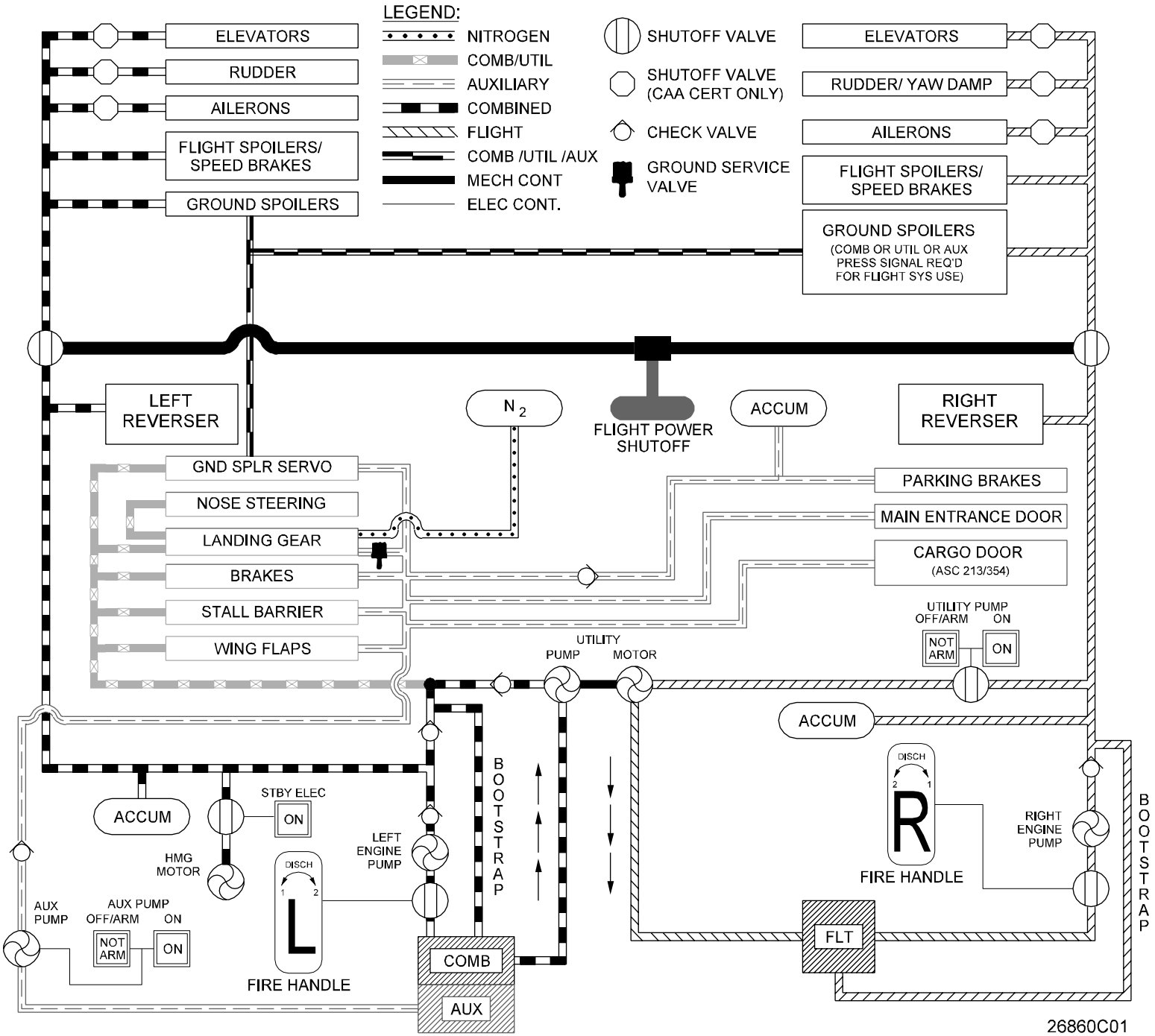
NOTE(S):

(1) If servo pressure signal from COMB, UTIL or AUX is present.

(2) Ground use only, through ground service valve.

(3) Automatic (if armed) on ground with COMB and UTIL failure.

(4) Aircraft with Aircraft Service Change (ASC) 213 or 354 incorporated.



Hydraulic Schematic Block Diagram
Figure 1

2A-29-20: Main Hydraulic Systems

1. General Description:

The main hydraulic systems provide the primary means to store hydraulic fluid and deliver hydraulic fluid under pressure to the using systems. Each of the main hydraulic systems (Combined system and Flight system) is supplied pressurized fluid by a dedicated engine-driven pump. The left engine-driven pump provides pressurized fluid at 3000 ±50 psi (static) to the Combined system and its using components. The right engine-driven pump provides pressurized fluid at 3000 ±50 psi (static) to the Flight system and its using components. The systems' fluids do not intermix. Each reservoir is pressurized by its own hydraulic system at a 50:1 ratio. With hydraulic system pressure at 3000 psi, the respective reservoir pressurizes to 60 psi.

A. Combined Hydraulic System:

The Combined system (Figure 2) performs the majority of hydraulic functions for the aircraft, thus it has the largest fluid quantity of the two systems. Its pump is located on the left engine, and its reservoir and manifold are located on the left side of the aft equipment (tail) compartment.

Total system capacity is approximately 15.5 gallons (58.6 liters). This includes the reservoir, lines and all system components. Pressurized fluid is provided to the following systems, units and components:

- Ailerons
- Speed Brakes
- Flight Spoilers
- Ground Spoilers
- Rudder
- Elevator
- Stall Barrier
- Landing Gear and Gear Doors
- Left Thrust Reverser
- Flaps
- Wheel Brakes
- Nosewheel Steering
- Standby Electrical Power System Motor

B. Flight Hydraulic System:

Functionally and structurally similar, the Flight system (Figure 3) compliments the Combined system by sharing the workload, yet remaining independent and isolated for specific functions. Its pump is located on the right engine, and its reservoir and manifold are located on right side of the tail compartment.

Total system capacity is approximately 4.5 gallons (17 liters). This includes the reservoir, lines and all system components. Pressurized fluid is provided to the following systems, units and components:

- Ailerons
- Speed Brakes

- Flight Spoilers
- Ground Spoilers
- Rudder
- Elevator
- Yaw Damper
- Right Thrust Reverser
- Utility Pump Motor

C. Fluid Replenishing System:

Hydraulic system fluid replenishing can be accomplished by using either the fill connection on the ground test panel (underside of the aircraft, just forward of the tail compartment door) or an onboard replenishing system (inside the tail compartment).

2. Description of Subsystems, Units and Components:

A. Combined System and Flight System Reservoirs:

(See Figure 4 and Figure 5.)

(1) Combined System Reservoir Particulars:

The Combined system reservoir contains two chambers separated by a bulkhead; one chamber supplies the Combined and Utility systems, and the other supplies the Auxiliary system. Total capacity of the reservoir is 5.5 gallons (20.8 liters) with a Combined system working volume of 3.75 gallons (14.2 liters) and an Auxiliary system working volume of 1.75 gallons (6.6 liters). Both chambers are full under normal operating conditions. An opening at the top of the reservoir bulkhead allows fluid flow from the Combined chamber to the Auxiliary chamber. Filling of both chambers can be accomplished using either the fill connection on the ground test panel (underside of the aircraft, just forward of the tail compartment door) or a replenishing system (inside the tail compartment).

Four suction ports are included on the reservoir: engine pump, utility pump, auxiliary pump and ground test rig. Six return ports are also incorporated. Other ports include one each for the bleed line and pressure relief valve.

(2) Flight System Reservoir Particulars:

The Flight system reservoir differs from the Combined system reservoir in that it is a smaller, single chamber reservoir. Total capacity of the reservoir is 1.25 gallons (4.7 liters) with working volume of 0.86 gallons (3.25 liters). Filling is accomplished using the same methods as the Combined system reservoir.

Five ports are included on the Flight system reservoir: suction, return, drain, bleed and relief valve.

(3) Reservoir Pressure Relief Valves:

A pressure relief valve is installed on each reservoir to prevent overpressurization. If reservoir pressure exceeds 100 psi, the valve opens to vent excess pressure overboard through a vent line. The valve closes at 75 psi.

(4) Reservoir Thermal Switches:

A thermal switch is installed on each reservoir to monitor system fluid temperature. If fluid temperature reaches 220 ±5°F (104 ±3°C), the thermal switch closes causing a blue CMB HYD HOT or FLT HYD HOT advisory message to be displayed on the Crew Alerting System (CAS). As fluid temperature drops to 175 ±10°F (79 ±6°C), the thermal switch opens, clearing the CAS message.

NOTE:

Automatic operation of the utility pump is not possible with a FLT HYD HOT advisory message displayed.

(5) Reservoir Manual Bleeder Valves:

A manual bleeder valve installed on each reservoir provides a means to relieve trapped air pressure acquired during servicing. Pressing and holding the BLEED button on the valve opens the valve, venting excess air pressure overboard through a vent line.

(6) Reservoir Fluid Quantity Transmitters:

A fluid quantity transmitter installed on each reservoir measures fluid quantity by using the reservoir piston's movement to actuate a spring-loaded tape reel mechanism. When supplied with 28V DC from the Essential DC bus, the quantity transmitter supplies an output voltage proportional to fluid quantity to the Data Acquisition Units (DAUs) for display on the HYDRAULICS system page.

(7) Reservoir Sight Gauges:

A visual sight gauge on the aft end of each reservoir piston provides an indication of reservoir fluid quantity by denoting the FULL and REFILL fluid levels. No electrical power is necessary to use the visual sight gauge, but the system must pressurized to 3000 psi to obtain an accurate reading. The proper fluid level for the reservoir is the FULL indication on the sight gauge.

(8) Reservoir Vacuum Relief Check Valve (Combined System Only):

The Combined system's reservoir vacuum relief valve opens at a set negative pressure to allow ambient air into the reservoir. This prevents auxiliary hydraulic pump cavitation.

(9) Reservoir Piston Scuppers:

A piston scupper is installed on each reservoir to catch any fluid leakage from the reservoir piston end. This leakage is then vented overboard.

B. System Shutoff Valves:

System shutoff valves (Figure 6) are installed in the tail compartment to control fluid flow from each reservoir to its respective engine-driven hydraulic pump. They are normally open, electrically operated, motor-driven, gate-type valves.

Pulling the associated FIRE handle supplies 28V DC from the Essential DC bus to the valve motor. The motor then drives the valve closed. Pushing in the associated FIRE handle opens the valve.

Valve position signals are supplied to the Fault Warning Computer (FWC) for use on the Engine Instruments display, ENGINE START system page

and HYDRAULICS system page. When the valve is in transit, amber dashes are shown in the associated system pressure display window. When the valve is closed, amber crosshatching is shown in the window.

Valve position is also shown on the valve itself by a red pointer flag/lever pointing to either OPEN or CLOSED. The flag/lever may be manually moved to the desired position. However, if the valve is moved to the CLOSED position, the associated HYD S/O circuit breaker must also be pulled to prevent the valve from being driven to its normally open position when power is applied to the aircraft.

C. Manually Operated Shutoff Valves:

A manually operated shutoff valve controls hydraulic fluid flow from the Combined and Flight hydraulic systems to the flight control actuators. Pulling the FLIGHT POWER SHUT OFF handle on the cockpit center pedestal (Figure 7) closes the shutoff valve through the use of a controlex cable. For detailed information on this system, see Section 2A-27-00: Flight Controls.

D. Engine Driven Hydraulic Pumps:

A positive displacement, constant delivery hydraulic pump is installed on each engine's right-hand high pressure gearbox (Combined on left engine, Flight on right engine). The pumps draw fluid from their respective reservoir and deliver the fluid under pressure to the using systems.

A small quantity of hydraulic fluid lubricates and cools the pump. This fluid is then returned to the reservoir through the bypass port.

During normal operations, fluid flows through the heat exchanger and engine pump bypass to the reservoir. At low ambient temperatures, when fluid is viscous, a relief valve opens at 100 psi to route engine pump bypass flow through the main return filter to the reservoir.

E. Hydraulic Heat Exchangers:

Combined and Flight hydraulic system fluid is circulated though dedicated hydraulic heat exchangers installed in the wing fuel hoppers (Combined in left hopper, Flight in right hopper). Functioning as a radiator, each heat exchanger allows the warmer hydraulic fluid to dissipate heat into the surrounding cooler fuel. This has an added benefit in that raising the fuel temperature within the hopper helps to alleviate cold-soak conditions.

F. Check Valves, Snubbers and Pressure Transmitters:

Pressurized fluid from each system's engine driven pump passes through a check valve installed to prevent reverse flow to the pump. A snubber installed downstream of the check valve at the pressure transmitter's inlet port damps any pressure surges in order to prevent erratic pressure indications.

Each system's pressure transmitter receives 28V DC power from the Essential DC bus. It then provides a variable output signal, proportional to fluid pressure, to the respective DAU. The DAU in turn prompts these signals for display on the Engine Instruments display, ENGINE START system page and HYDRAULICS system page.

G. Pressure Switches:

Each hydraulic system has a pressure switch installed downstream of the pressure transmitter to monitor system pressure.

As Combined system pressure builds to 1500 psi, its pressure switch opens, causing the amber CMB HYD FAIL message to be removed from CAS. In addition, the system's low pressure relay is de-energized. Conversely, as pressure falls to 800 psi, the pressure switch closes, causing the amber CMB HYD FAIL message to be displayed on CAS and the system's low pressure relay to be energized. (See Section 2A-29-30, Auxiliary Hydraulic Systems, for a description of the low pressure relay.)

As Flight system pressure builds to 1500 psi, its pressure switch opens, causing the amber FLT HYD FAIL message to be removed from CAS. As pressure falls to 800 psi, the pressure switch closes, causing the amber FLT HYD FAIL message to be displayed on CAS.

NOTE:

Automatic operation of the utility pump is not possible with Combined system pressure greater than 800 psi or with Flight system pressure less than 2000 psi.

H. System Filter Manifolds:

(See Figure 8 and Figure 9.)

The Combined and Flight hydraulic systems each have a dedicated filter manifold located in the tail compartment (Combined on left side, Flight on right side). Each manifold consists of three filters: main pressure, main return and engine pump bypass.

Differential Pressure Indicators (DPIs) for each filter provide a visual means of noting filter bypass by causing a red indicator on the DPI to "pop up" when the pressure differential between the filter inlet and outlet exceeds a preset value. The DPI indicator may be reset for monitoring or troubleshooting as required.

As fluid flows from the hydraulic pump, it passes through the main pressure filter. This filter is a "non-bypass" filter, meaning there is no alternate path to bypass the filter element; fluid will continue to flow through the element, though at reduced rates.

The main return and engine pump bypass filters are bypass type filters in that a relief valve is incorporated. If the filter element begins to clog, the pressure differential between the filter inlet and outlet opens a relief valve, allowing the fluid to bypass the filter element.

I. System Accumulators:

Each system contains an accumulator installed between the main pressure filter and the using systems to damp any pressure surges caused by the associated engine driven hydraulic pump or the using system. Each accumulator is a 50 cubic inch (0.8 liter) capacity cylinder charged with nitrogen to 1000 psi at 70° F (21.1°C). Filler valves and pressure gauges for the accumulators are installed on the ground test panel (Figure 10).

Each accumulator cylinder contains a free moving piston that divides the cylinder into two chambers. One chamber contains the nitrogen charge while the other contains pressurized fluid from the hydraulic system. As pressurized fluid acts against the piston, it compresses the nitrogen charge, providing shock damping by absorbing pressure transients. Should pressure within the accumulator exceed 3850 psi, a relief valve will open to

vent excess pressure.

J. Pressure Relief Valves:

The Combined system and Flight system each contain a pressure relief valve to prevent system overpressurization. The Combined system relief valve is installed in the left main wheel well while the Flight system relief valve is installed in the tail compartment.

If system pressure exceeds 3850 psi, the relief valve opens to route system pressure back to the respective reservoir through the main return filter. The using systems are still supplied with pressurized fluid. When system pressure falls to 3200 psi, the valve closes.

K. Ground Test Panel:

The ground test panel (Figure 10) is located on the underside of the aircraft, just forward of the tail compartment door. It contains a reservoir fill, pressure and suction quick disconnect group for both the Combined and Flight systems. It also contains an accumulator air filler valve, accumulator pressure gauge and reservoir quantity gauge for each hydraulic system.

L. Replenishing System:

The Combined system and Flight system reservoirs can be replenished through use of a hydraulic replenisher panel (Figure 11) located in the tail compartment. The reservoir to be serviced is selected manually with a control valve, with actual replenishment taking place through use of a hand pump. Reservoir quantity can then be viewed on the hydraulic quantity indicator (with hydraulic power applied). Procedures for Combined system and Flight system hydraulic reservoir servicing can be found in Chapter 9: Handling and Servicing Procedures.

3. Controls and Indications:

NOTE:

A description of the Engine Instruments display, ENGINE START system page and HYDRAULICS system page can be found in Section 5: Engine Instruments and Crew Alerting System (EICAS), of Honeywell's SPZ-8000 (or SPZ-8400) Digital Automatic Flight Control System Pilot's Manual for the Gulfstream IV.

A. Circuit Breakers:

The main hydraulic system is protected by the following circuit breakers (CBs):

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
COMB HYD PRESS	CPO	A-3	ESS 28 VDC Bus
COMB HYD QTY	CPO	A-4	ESS 28 VDC Bus
L HYD S/O	CPO	A-5	ESS 28 VDC Bus
FLT HYD QTY	CPO	B-4	ESS 28 VDC Bus
R HYD S/O	CPO	B-5	ESS 28 VDC Bus
FLT HYD PRESS	CPO	C-4	ESS 28 VDC Bus
FLIGHT HYD CONT	CPO	C-5	L MAIN 28 VDC Bus

B. Caution (Amber) Messages and Annunciations:

CAS Message:	Cause or Meaning:
CMB HYD FAIL	Combined hydraulic system pressure low.
FLT HYD FAIL	Flight hydraulic system pressure low.

C. Advisory (Blue) Messages and Annunciations:

CAS Message:	Cause or Meaning:
CMB HYD HOT	Combined hydraulic system reservoir fluid temperature has reached 220 ±5°F (104 ±3°C).
FLT HYD HOT	Flight hydraulic system reservoir fluid temperature has reached 220 ±5°F (104 ±3°C).

4. Limitations:

A. Flight Manual Limitations:

(1) Hydraulic Fluids:

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

- Hy-Jet IV
- Hy-Jet IV-A
- Skydrol LD-4
- Skydrol 500B-4

B. System Notes:

(1) Although pulling the FIRE handle inhibits hydraulic fluid flow from the reservoir to its respective engine-driven hydraulic pump, it also closes the fuel shutoff valve, shuts off the alternator and disables the thrust reverser, effectively shutting down the associated engine. The flight crew should not pull the FIRE handles except in circumstances when available guidance indicates doing so.

(2) Hydraulic fluids conforming to MIL-H-5606 and MIL-H-83282 are used in the landing gear shock struts of Gulfstream IV aircraft. Hydraulic fluids conforming to MIL-H-5606 and MIL-H-83282 are red in color and are **NEVER, UNDER ANY CIRCUMSTANCES**, to be mixed with the Type IV Phosphate Ester-based hydraulic fluids used in the hydraulic systems of Gulfstream IV aircraft. Type IV Phosphate Ester-based hydraulic fluids are purple in color.

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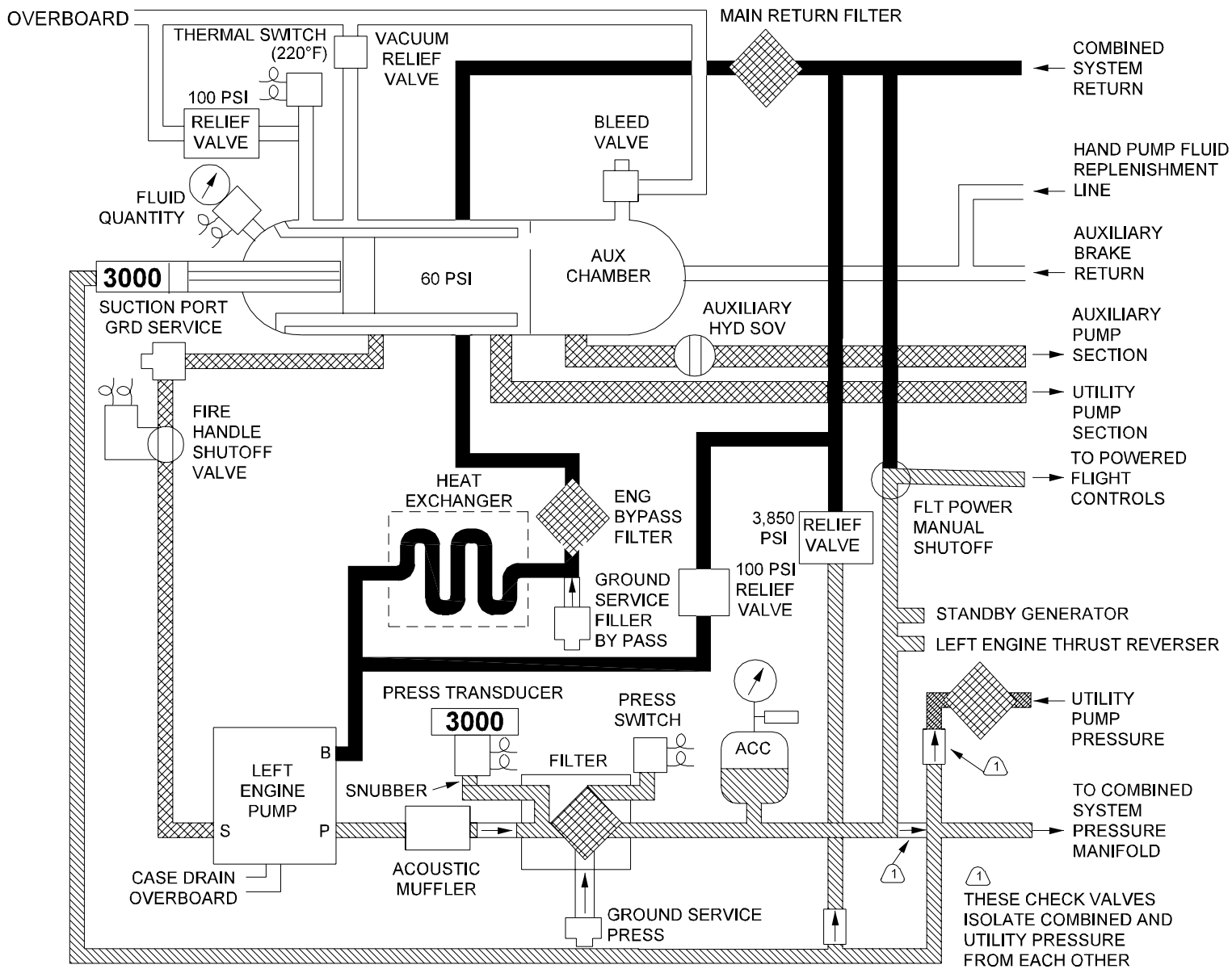

LEGEND

- COMBINED PRESSURE
- RETURN
- SUCTION
- OVERBOARD
- UTILITY PRESSURE

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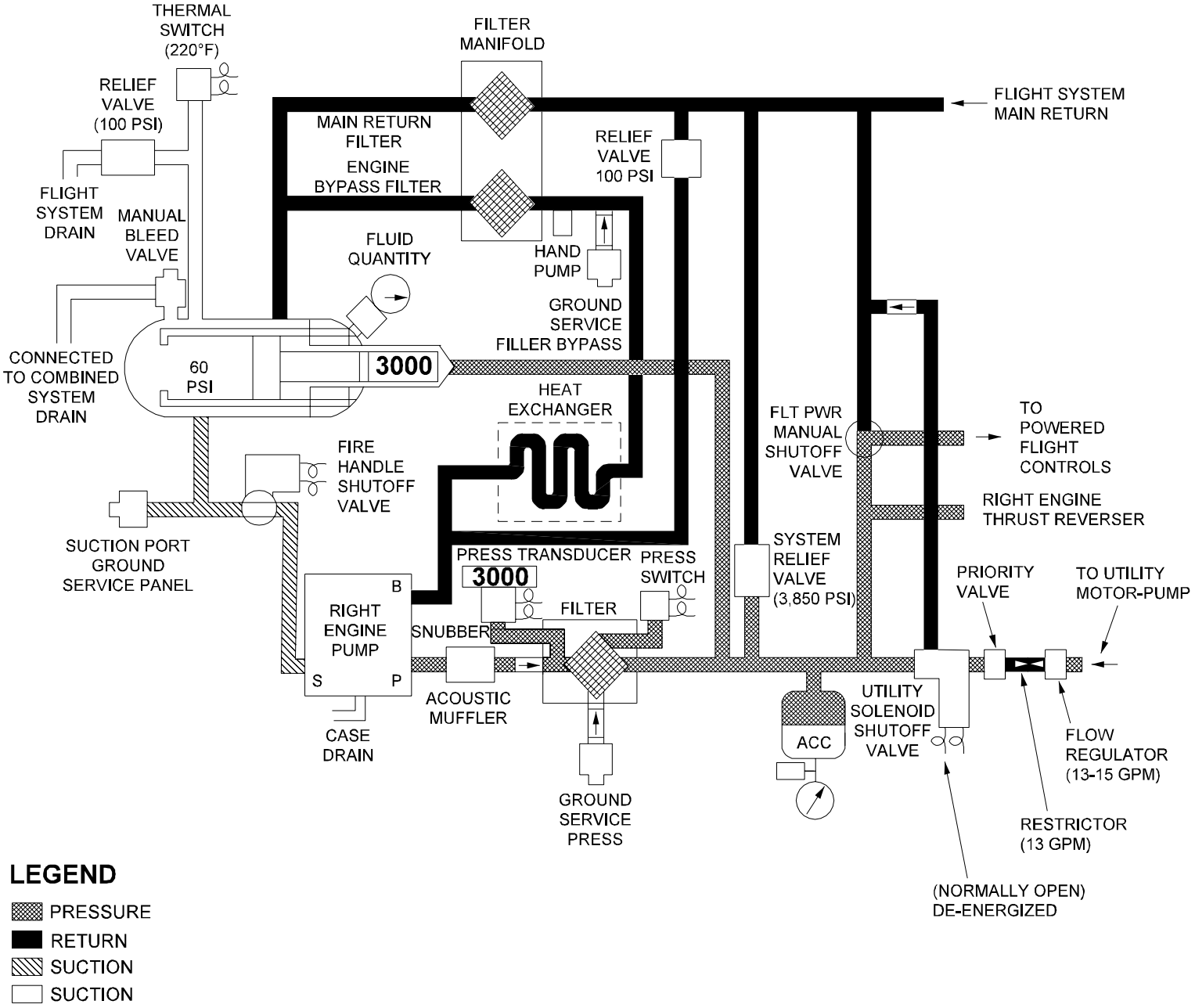
Combined Hydraulic System Simplified Block Diagram
Figure 2



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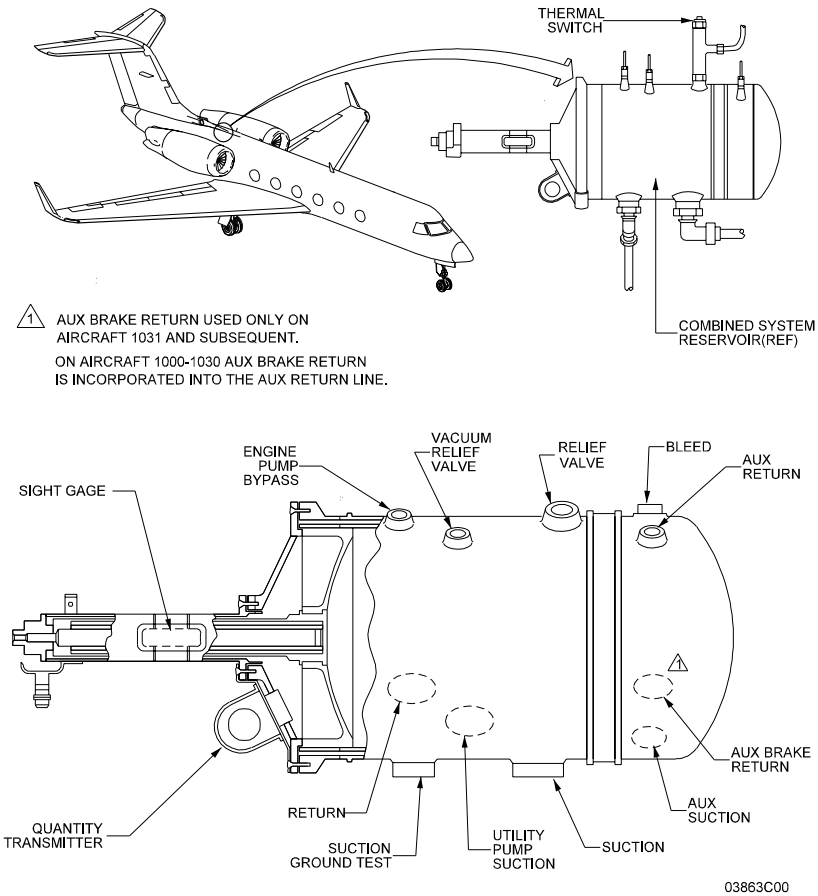
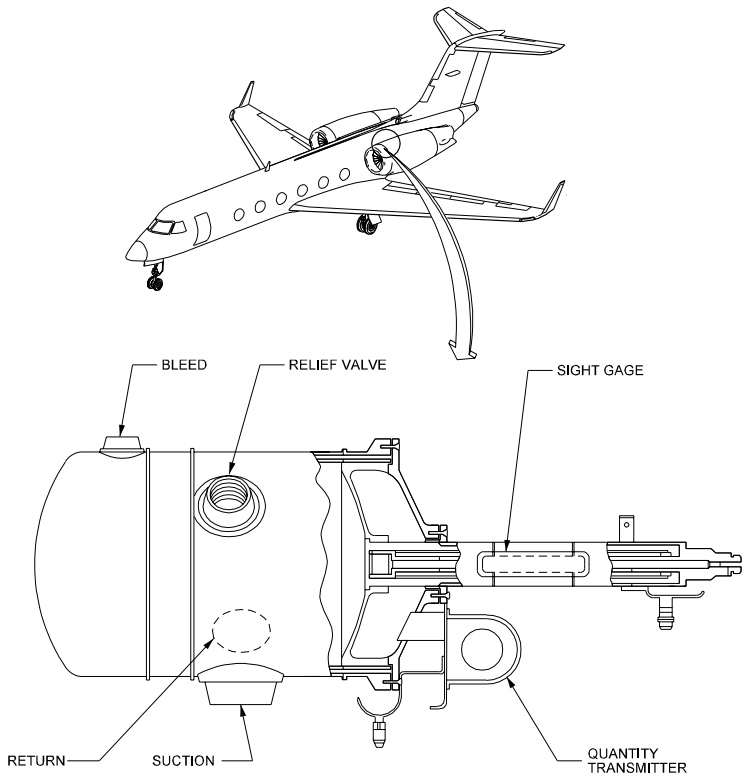
Flight Hydraulic System
Simplified Block Diagram
Figure 3



Combined Hydraulic System Reservoir
Figure 4



RESERVOIR CROSS - SECTION

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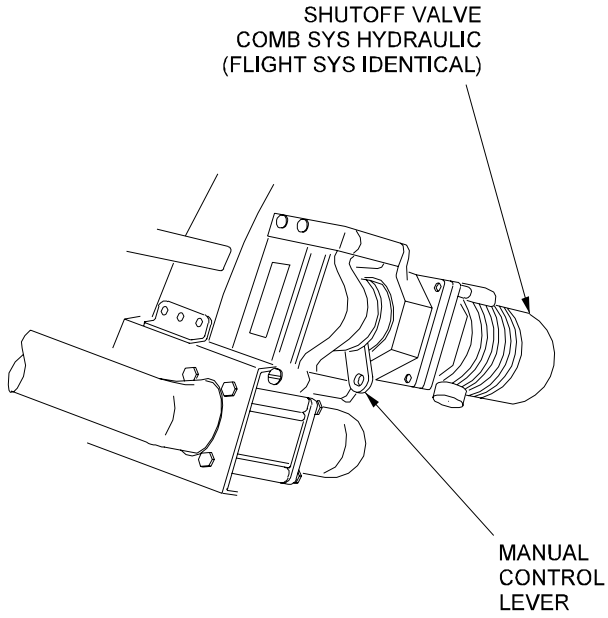
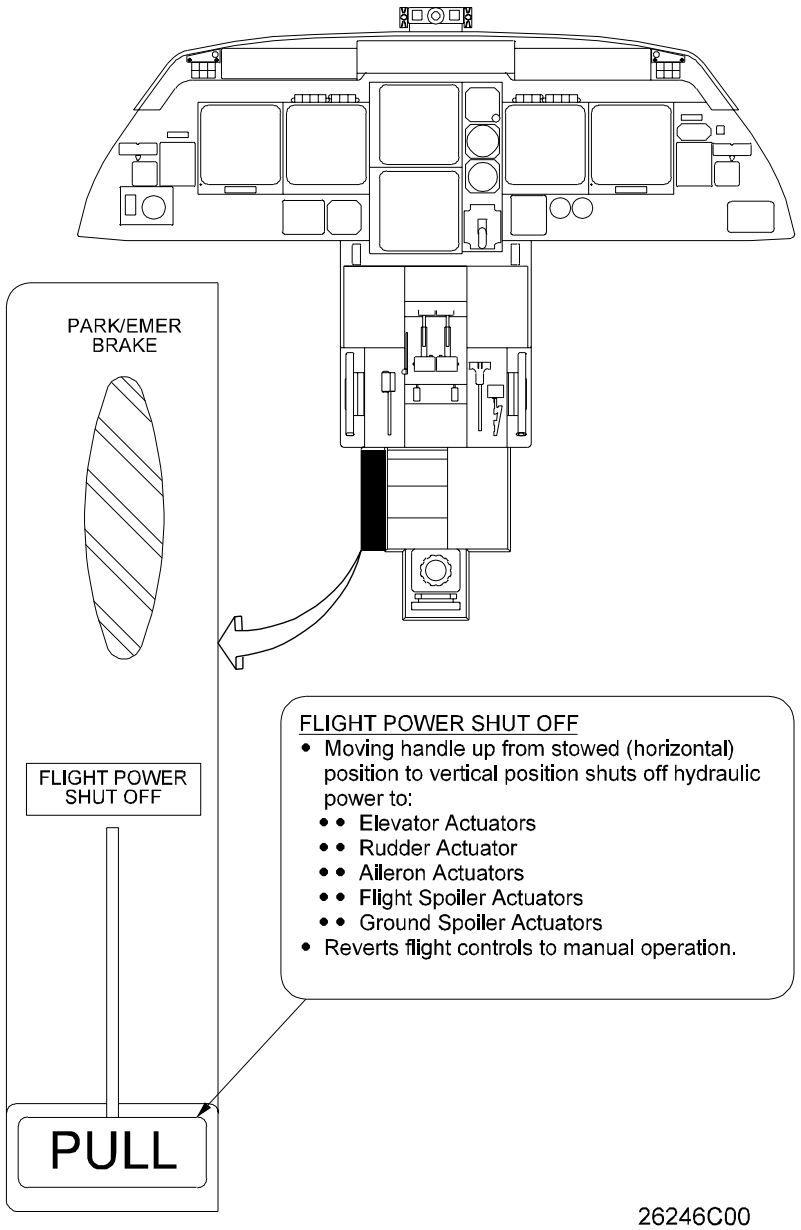
Flight Hydraulic System Reservoir
Figure 5



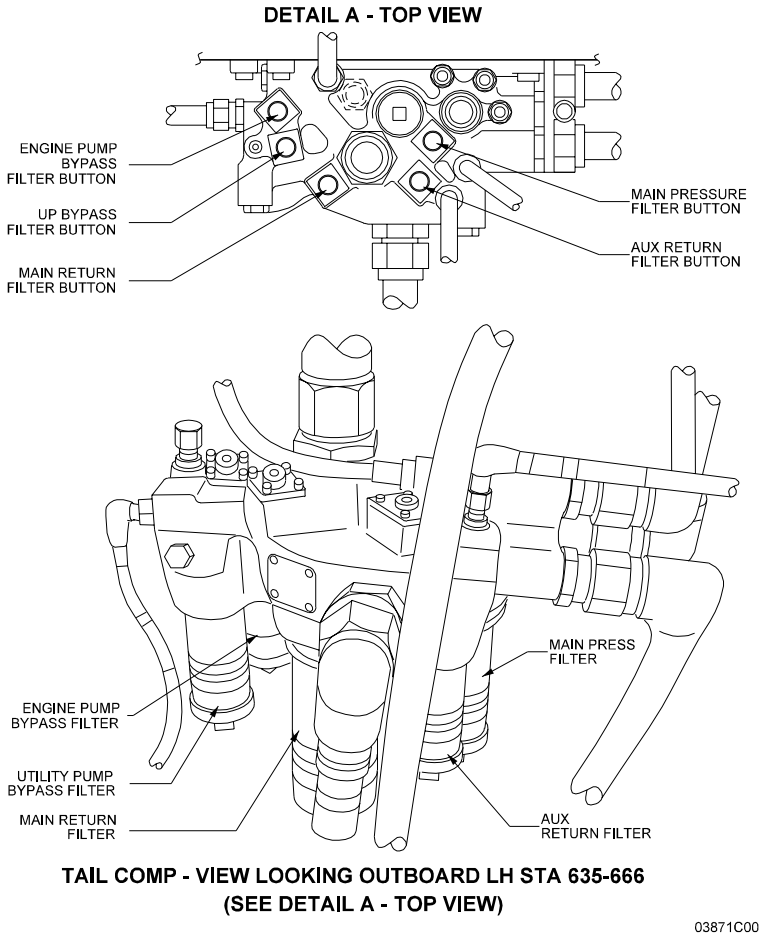
VIEW LOOKING INBOARD
LEFT HAND SIDE
STA 600.00

26485C00

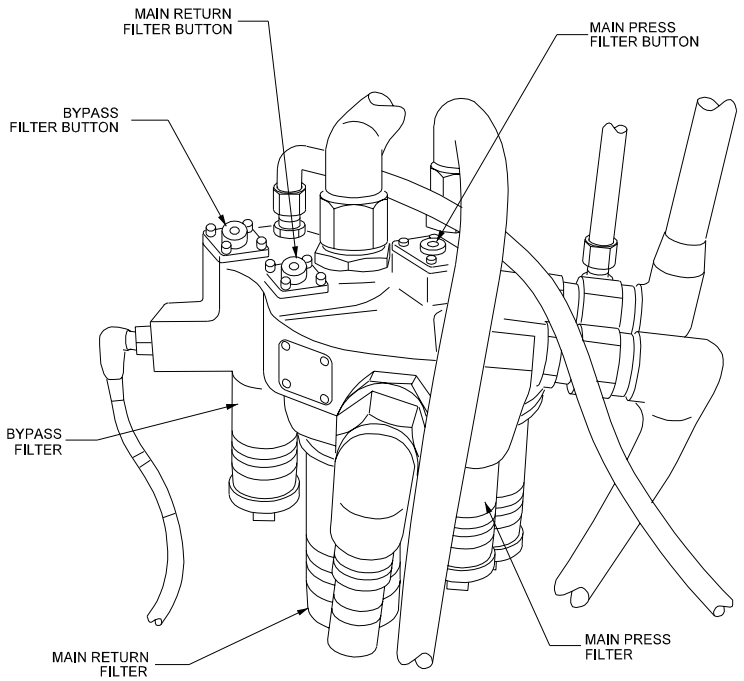
System Shutoff Valve
Figure 6



FLIGHT POWER SHUT OFF Valve
Figure 7



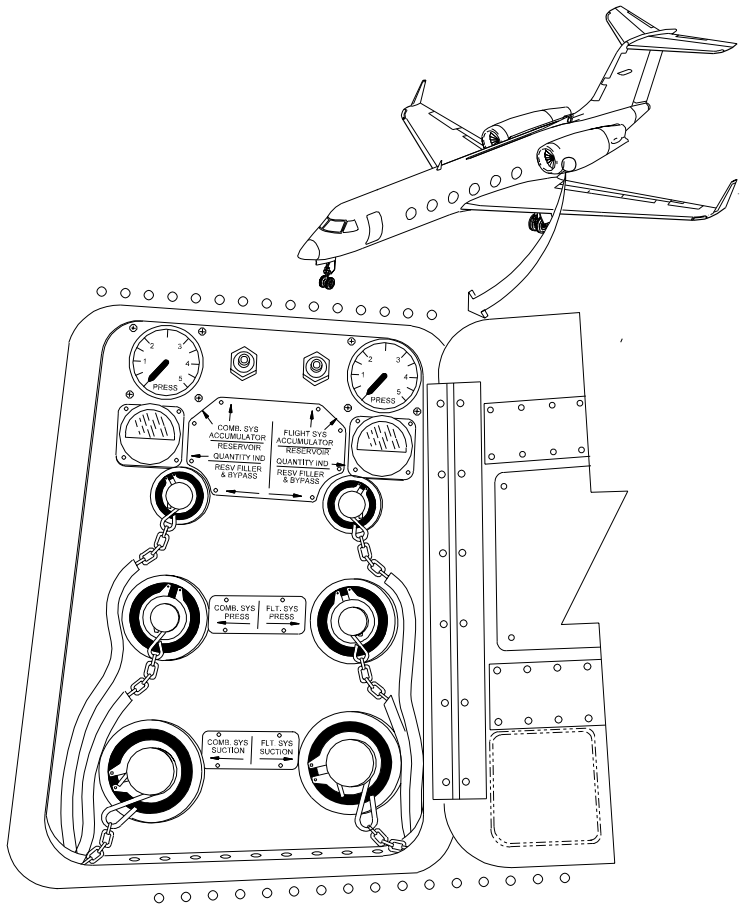
Combined Hydraulic System Filter Manifold
Figure 8



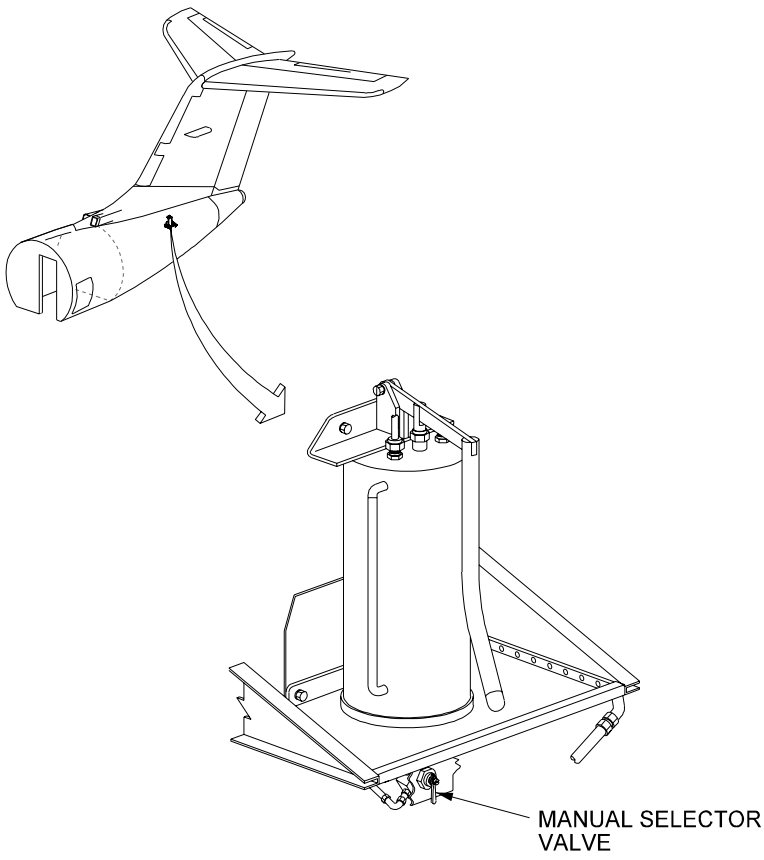
TAIL COMP - VIEW LOOKING OUTBOARD RH STA. 650-668

03872C00

Flight Hydraulic System Filter Manifold
Figure 9



Ground Test Panel
Figure 10



Onboard Hydraulic Replenisher
Figure 11

2A-29-30: Auxiliary Hydraulic Systems

In addition to the two main hydraulic systems, two auxiliary hydraulic systems are incorporated to provide operational redundancy and to perform various utility functions, in some cases without the need for operating engines or external power sources. The two auxiliary hydraulic systems are the electrically-driven Auxiliary system and the hydraulically-driven Utility system. When accordingly configured, both systems are capable of automatic operation when certain conditions are satisfied. In addition, they are capable of manual operation through use of associated control switches.

The Auxiliary and Utility hydraulic systems are described in the following subsections within this section:

- 2A-29-31: Auxiliary Hydraulic System

- 2A-29-32: Utility Hydraulic System

2A-29-31: Auxiliary Hydraulic System

1. General Description:

The Auxiliary hydraulic system (Figure 12) receives pressure from an electrically driven pump which draws fluid from the Auxiliary chamber of the Combined hydraulic system reservoir. The pump provides 3000 psi for the operation of the following systems:

- Wing Flaps
- Ground Spoiler Control Pressure
- Brakes
- Main Entrance Door (see below)
- Parking/Emergency Brakes (see below)
- Landing Gear and Landing Gear Doors (see below)
- Cargo Door (see below)

The Auxiliary hydraulic system functions independently as the only source of hydraulic power for closing the main entrance door and charging the parking/emergency brakes accumulator. In addition, the Auxiliary hydraulic system may be used for ground operation of the landing gear and landing gear doors for maintenance checks, through the use of a ground service valve.

On aircraft with Aircraft Service Change (ASC) 213 or ASC 354 incorporated, the Auxiliary hydraulic system also serves as the only source of hydraulic power for opening and closing the cargo door.

2. Description of Subsystems, Units and Components:

The Auxiliary hydraulic system consists of the following units and components:

A. Auxiliary Reservoir Chamber:

The Combined system reservoir contains two chambers separated by a bulkhead; one chamber supplies the Combined and Utility systems, and the other supplies the Auxiliary system. Total capacity of the reservoir is 5.5 gallons (20.8 liters) with an Auxiliary system working volume of 1.75 gallons (6.6 liters). Both chambers are full under normal operating conditions. An opening at the top of the reservoir bulkhead allows fluid flow from the Combined chamber to the Auxiliary chamber. Filling of both chambers can be accomplished using either the fill connection on the ground test panel (underside of the aircraft, just forward of the tail compartment door) or a replenishing system (inside the tail compartment).

B. Shutoff Valve:

An electrically operated solenoid shutoff valve controls fluid flow to the Auxiliary hydraulic pump. Controlled by the same circuits that operate the Auxiliary hydraulic pump power relay, the shutoff valve receives 28V DC power from the Essential DC bus through the AUX HYD PUMP circuit breaker. When the Auxiliary hydraulic pump receives power, the shutoff valve opens to allow hydraulic fluid from the Auxiliary chamber to the Auxiliary pump.

C. Auxiliary Hydraulic Pump:

The electrically driven Auxiliary hydraulic pump, commonly referred to as the “Aux pump”, is installed on the aft side of the left main wheel well. It consists of a fan-cooled 28V DC motor that drives a variable-delivery, axial-piston type pump.

The Aux pump motor receives 28V DC from the Essential DC bus (via the Battery Tie bus) through the Aux pump power relay. The power relay, in turn, receives power from the Essential DC bus through the AUX HYD PUMP circuit breaker.

When activated, the Aux pump motor initially draws a maximum of 750 amps, decreasing to 66-70 amps as the motor reaches operating speed. If the motor continuously draws more then 80 amps, the Aux pump overload sensor trips the AUX HYD PUMP circuit breaker. This de-energizes the Aux pump power relay and the Aux pump stops.

A thermal switch is installed on the Aux pump case to monitor pump temperature. If pump temperature reaches 300 ±10°F (149 ±6°C), the thermal switch closes causing an amber AUXILIARY HYD HOT caution message to be displayed on the Crew Alerting System (CAS).

D. Pressure Snubber and Transmitter:

A pressure snubber is installed upstream of the pressure transmitter to damp any pressure surges in order to prevent erratic pressure indications. The pressure transmitter receives 28V DC power from the Essential DC bus through the AUX HYD PRESS circuit breaker. It then provides a variable output signal, proportional to fluid pressure, to the Data Acquisition Unit (DAU). The DAU, in turn, prompts these signals for display on the Engine Instruments display, ENGINE START system page and HYDRAULICS system page.

E. System Filters:

The Auxiliary hydraulic system main and return filters are bypass type filters in that a relief valve is incorporated. If either filter element begins to clog, the pressure differential between the filter inlet and outlet opens a relief valve, allowing the fluid to bypass the filter element. Both filters also include a check valve that prevents back pressure from reaching the Aux pump discharge port.

Differential Pressure Indicators (DPIs) for each filter provide a visual means of noting filter bypass by causing a red indicator on the DPI to “pop up” when the pressure differential between the filter inlet and outlet exceeds a preset value. The DPI indicator may be reset for monitoring or troubleshooting as required.

F. Relief Valve:

The Auxiliary hydraulic system contains a pressure relief valve to prevent system overpressurization. The relief valve is installed in the left main wheel well. If system pressure exceeds 3850 psi, the relief valve opens to route system pressure back to the Combined system reservoir Auxiliary chamber. When system pressure falls to 3500 psi, the valve closes.

3. Controls and Indications:

A. System Control:

(1) AUX PUMP OFF/ARM and ON/OFF Switches (Figure 18):

The Aux pump is normally operated with the AUX PUMP ON/OFF switch located in the HYDRAULIC CONTROL section of the cockpit overhead panel. Selection to ON starts the pump, deslection stops the pump.

The AUX PUMP OFF/ARM switch provides a means of automatically starting the Aux pump. With the OFF/ARM switch selected to ARM, the Aux pump will start automatically if:

- Either nutcracker is in the GROUND mode
- Combined and Utility hydraulic system pressures are less than 1500 psi
- Any toe brake pedal is depressed more than 10°

With the OFF/ARM switch selected to OFF, automatic operation is inhibited.

(2) DOOR Switch Controls (Figure 13 and Figure 14):

As stated previously, the Aux pump is the only source of hydraulic power for closing the main entrance door. Provided the DOOR SAFETY SWITCH is not selected to SAFE, the Aux pump will start automatically when either the INSIDE DOOR CONT SWITCH (pilot's circuit breaker panel) or OUTSIDE DOOR SWITCH (forward left fuselage) are selected to CLOSE. It will continue running until the door is closed and locked, when it will shut off automatically and return the appropriate DOOR switch to neutral.

(3) Ground Service Valve Controls (Figure 15):

A ground service valve is located inside an access door just aft of the right nose landing gear door. With power applied to the Essential 28V DC bus, movement of the spring-loaded valve handle permits fluid flow to the landing gear and landing gear doors. At the same time, the moving handle contacts an Aux pump control switch, activating the Aux pump. Releasing the handle stops the Aux pump and returns the valve to its normal position.

(4) Cargo Door Switch Controls:

On aircraft with ASC 213 or ASC 354 incorporated, the Auxiliary hydraulic system also serves as the only source of hydraulic power for opening and closing the cargo door. Unlike main entrance door operation, however, cargo door operation requires that the Aux pump be manually selected on and off using the cockpit switches when opening and closing the cargo door using its OPEN/CLOSE switch. For a detailed description of the cargo door, see Section 2A-52-00, Doors.

B. Auxiliary Hydraulic Pump Controls – Preflight Check:

During preflight, automatic operation of the Aux pump should be tested as follows:

(1) Verify that both Combined and Utility hydraulic system pressures are below 1500 psi.

(2) Select the AUX PUMP OFF/ARM switch to ARM (NOT ARM switch legend extinguished).

(3) Depress any brake pedal.

(4) Verify the Aux pump starts and remains on after releasing the brake pedal.

(5) Select the AUX PUMP OFF/ARM switch to OFF (NOT ARM switch legend illuminated).

C. Circuit Breakers:

The Auxiliary hydraulic system is protected by the following circuit breakers (CBs):

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
AUX HYD PRESS	CPO	D-4	ESS 28 VDC Bus
AUX HYD PUMP	CPO	D-5	ESS 28 VDC Bus

D. Caution (Amber) Messages and Annunciations:

CAS Message:	Cause or Meaning:
AUXILIARY HYD HOT	Auxiliary hydraulic pump case temperature above 300°F (149°C).

E. Other Indications:

A description of the Engine Instruments display, ENGINE START system page and HYDRAULICS system page can be found in Section 5: Engine Instruments and Crew Alerting System (EICAS), of Honeywell's SPZ-8000 (or SPZ-8400) Digital Automatic Flight Control System Pilot's Manual for the Gulfstream IV.

4. Limitations:

A. Flight Manual Limitations:

There are no flight manual limitations for the Auxiliary hydraulic system at the time of this revision.

B. System Notes:

Because of the high amperage required for Aux pump operation, consider using external electrical power during periods requiring prolonged use of the pump.

2A-29-32: Utility Hydraulic System

1. General:

The Utility hydraulic system (Figure 16) provides operational redundancy to the Combined hydraulic system. In the event of Combined system failure or Combined system pressure falling to less than 800 psi (such as a windmilling engine), a hydraulic motor powered by Flight hydraulic system pressure operates a hydraulic pump installed in the Combined hydraulic system. The pump, in turn, pressurizes Combined system fluid to 3000 psi for use by the following systems:

- Wing Flaps
- Landing Gear
- Brakes
- Stall Barrier
- Nosewheel Steering

The Utility system also supplies a servo pressure signal to the ground spoiler system, thus enabling operation of the ground spoilers using Flight system pressure, provided all other ground spoilers operational conditions are satisfied.

The Utility system will operate automatically if all of the following conditions are satisfied:

- Combined system hydraulic reservoir fluid quantity is greater than one gallon
- Flight hydraulic system pressure is greater than 2000 psi
- Flight hydraulic system fluid temperature is below 220 ±5°F (104 ±3°C)
- UTILITY PUMP OFF/ARM switch is selected to ARM
- UTILITY PUMP ON/OFF switch is selected to OFF

2. Description of Subsystems, Units and Components:

The Utility hydraulic system consists of the following units and components:

A. System Shutoff Valve:

An electrically operated solenoid shutoff valve controls Flight hydraulic system fluid flow to the Utility hydraulic motor/pump. Normally, with the Combined and Flight hydraulic systems operating at 3000 psi, the solenoid energizes to the closed position to prevent motor/pump operation.

The UTILITY PUMP OFF/ARM and ON/OFF switches (cockpit overhead panel) control the shutoff valve. With the OFF/ARM switch in the ARM position (NOT ARM legend not illuminated) and the ON/OFF switch in the OFF position (ON legend not illuminated), the solenoid valve energizes and de-energizes as conditions are satisfied. Depressing the ON/OFF switch (ON legend illuminated) de-energizes the shutoff valve. The valve then opens, allowing Flight hydraulic system pressure to the motor/pump regardless of the OFF/ARM switch position.

B. Priority Valve:

A priority valve is installed downstream of the shutoff valve to control fluid flow to the motor/pump. Depending on Flight hydraulic system pressure, the priority valve opens and closes to prevent loss of Flight hydraulic system pressure to critical systems such as the flight controls.

When Flight hydraulic system pressure at the valve inlet is above 2000 psi, the priority valve opens and Flight hydraulic system pressure flows to the motor/pump. If demands on the system increase such that pressure at the valve inlet drops below 1730 psi, the valve closes, inhibiting flow to the motor/pump, preventing pressure starvation to critical systems. When Flight hydraulic system pressure rises to 2000 psi, the priority valve reopens.

C. Flow Regulating Valve:

A flow regulating valve installed between the priority valve and the motor/pump limits the Flight hydraulic system flow rate to the motor/pump to 13 Gallons Per Minute (GPM). This prevents the motor/pump from using the entire 22.5 GPM provided by the Flight hydraulic system. The lower volume allowance also assists the motor/pump in reaching its maximum operating speed.

D. Utility Hydraulic Motor/Pump:

The Utility hydraulic motor/pump consists of a fixed-displacement, hydraulically-driven motor that drives a fixed-displacement hydraulic motor by means of an interconnect shaft. The motor/pump assembly is installed in the right side of the tail compartment.

A 1.4 GPM restrictor connects the pump pressure port to the main return line. The restrictor allows a small amount of fluid to circulate within the pump to assist in damping pressure surges, reduce pump noise and reduce starting torque.

E. Pressure Snubber and Transmitter:

A pressure snubber is installed upstream of the pressure transmitter to damp any pressure surges in order to prevent erratic pressure indications. The pressure transmitter receives 28V DC power from the Essential DC bus through the UTILITY HYD PRESS circuit breaker. It then provides a variable output signal, proportional to fluid pressure, to the DAU. The DAU, in turn, prompts these signals for display on the Engine Instruments display, ENGINE START system page and HYDRAULICS system page.

F. System Filters:

The Utility hydraulic system main pressure filter is a “non-bypass” filter, meaning there is no alternate path to bypass the filter element. Fluid will continue to flow through the element at increasingly reduced rates until ceasing completely.

The Utility pump bypass filter is a bypass type filter in that a relief valve is incorporated. If either filter element begins to clog, the pressure differential between the filter inlet and outlet opens a relief valve, allowing the fluid to bypass the filter element.

DPIs for each filter provide a visual means of noting filter bypass by causing a red indicator on the DPI to “pop up” when the pressure differential between the filter inlet and outlet exceeds a preset value. The DPI indicator may be reset for monitoring or troubleshooting as required.

G. Hydraulic Pump Control Circuit:

(See Figure 17).

(1) General:

An electrically-operated hydraulic pump control circuit is incorporated to ensure fail-safe pressure output of the Combined, Flight and Utility hydraulic system pumps during various scenarios. It also provides visual indications (in the form of CAS messages) should the Combined or Flight hydraulic systems overheat or fail. The circuit is composed of the Utility hydraulic system solenoid shutoff valve, the Combined and Flight hydraulic system pressure switches, the Combined and Flight hydraulic system thermal switches and various relays that control the sequence of circuit operation. All scenarios described in the following paragraphs assume proper configuration of the system.

(2) Engine Start Scenario:

As the right engine is started and Flight hydraulic system pressure increases above 1500 psi, the Flight hydraulic system pressure switch opens, causing the amber FLT HYD FAIL message to be

removed from CAS. Since the left engine has not yet been started, Combined hydraulic system pressure is zero. The amber CMB HYD FAIL message is displayed on CAS and the Combined hydraulic system pressure switch is closed. With the pressure switch closed, the hold relay is de-energized, thus no electrical power can be routed to close the Utility hydraulic system solenoid shutoff valve. Since the shutoff valve is open, the Utility pump operates, supplying 3000 psi of hydraulic pressure to its using systems and components. At this point, hydraulic pressure configuration is: Combined = 0, Flight = 3000 and Utility = 3000.

As the left engine is started (with the right engine running) and Combined hydraulic system pressure increases above 1500 psi, the Combined hydraulic system pressure switch opens, causing the amber CMB HYD FAIL message to be removed from CAS. With the pressure switch open, power is routed through both the hold relay and the UTILITY PUMP OFF/ARM switch and delivered to the Utility hydraulic system solenoid shutoff valve. When the shutoff valve closes, Utility pump operation stops. At this point, hydraulic pressure configuration is: Combined = 3000, Flight = 3000 and Utility = 0. This is the normal ground and flight configuration.

(3) Left Engine Failure On Takeoff Scenario:

Should an engine fail during takeoff, immediate landing gear retraction is essential. Assuming that the left engine has failed and is windmilling, the Combined hydraulic system would most likely be unable to provide landing gear retraction pressure, as the windmilling engine would only provide pressure fluctuating in the 800 psi range. In this range, the Combined hydraulic system pressure switch would cycle open and closed, resulting in intermittent operation of the Utility pump. To prevent intermittent Utility pump operation, the Combined hydraulic system pressure switch is also used to energize a hold relay as system pressure drops below 800 psi. With the landing gear control handle in the UP position and any landing gear door not closed, the hold relay remains energized, overriding any pressure switch cycling. Since the relay is held, no electrical power can be routed to close the Utility hydraulic system solenoid shutoff valve, thus the Utility pump operates, supplying 3000 psi of hydraulic pressure to the landing gear system. At this point, hydraulic pressure configuration is: Combined = 0, Flight = 3000 and Utility = 3000.

With all landing gear doors closed and Combined hydraulic system pressure greater than 1500 psi, the hold relay is de-energized, allowing the Utility hydraulic system solenoid shutoff valve to be energized closed. When the shutoff valve closes, Utility pump operation stops and pressure drops to zero. Should Combined hydraulic system pressure remain below 800 psi, however, the Utility hydraulic system solenoid shutoff valve remains de-energized (open) and Utility hydraulic system pressure remains at 3000 psi.

(4) Combined Hydraulic System Fluctuation Scenario:

If the landing gear doors are closed or the landing gear control handle is in the DOWN position, and Combined hydraulic system

pressure fluctuates in a range of greater than 1500 psi to below 800 psi, the Utility hydraulic system will also cycle on and off. Utility hydraulic system will be 3000 psi when Combined hydraulic system pressure is below 800 psi and 0 psi when Combined hydraulic system pressure is above 1500 psi.

(5) Combined Hydraulic System Inflight Failure Scenario:

If the Combined hydraulic system fails during flight, the pressure switch closes as Combined system pressure falls below 800 psi. This causes the amber CMB HYD FAIL message to be displayed on CAS.

With the pressure switch closed, the hold relay is de-energized, thus no electrical power can be routed to close the Utility hydraulic system solenoid shutoff valve. Since the shutoff valve is open, the Utility pump operates, supplying 3000 psi of hydraulic pressure to its using systems and components. At this point, hydraulic pressure configuration is: Combined = 0, Flight = 3000 and Utility = 3000.

(6) Flight Hydraulic System Inflight Failure Scenario:

If the Flight hydraulic system fails during flight, the pressure switch closes as Flight system pressure falls below 800 psi. This causes the amber FLT HYD FAIL message to be displayed on CAS.

Since the Utility hydraulic system solenoid shutoff valve receives its power from the Combined hydraulic system pressure switch, the valve remains closed and the Utility hydraulic pump does not operate. All components that normally receive hydraulic pressure from the Flight hydraulic system remain operative through the use of Combined hydraulic system pressure, with the exception of the right thrust reverser and the Utility hydraulic system motor.

At this point, hydraulic pressure configuration is: Combined = 3000, Flight = 0 and Utility = 0.

(7) Flight Hydraulic System Overheat Scenario:

If the Flight hydraulic system reservoir fluid temperature reaches 220 ±5°F (104 ±3°C), the thermal switch on the reservoir closes causing a blue FLT HYD HOT advisory message to be displayed on CAS. (The same logic applies to the Combined hydraulic system.) In the case of the Flight hydraulic system, however, in addition to causing the FLT HYD HOT message to be displayed, power is also routed to energize and hold the Utility hydraulic system solenoid shutoff valve closed. This prevents Utility hydraulic pump operation. This feature may be overridden by the flight crew, however, provided Flight hydraulic system is above 2000 psi, by selection of the UTILITY PUMP ON/OFF switch to ON.

If Flight hydraulic system reservoir fluid temperature drops to 175 ±10°F (79 ±6°C), the thermal switch opens, clearing the CAS message.

3. Controls and Indications:

(See Figure 18.)

A. Circuit Breakers:

The Utility hydraulic system is protected by the following circuit breakers (CBs):

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
UTILITY HYD PRESS	CPO	B-3	ESS 28 VDC Bus
UTILITY HYD PUMP OFF	CPO	C-3	ESS 28 VDC Bus

B. Caution (Amber) Messages and Annunciations:

CAS Message:	Cause or Meaning:
UTILITY HYD OFF	Utility hydraulic pump has been selected off.

C. Other Indications:

A description of the Engine Instruments display, ENGINE START system page and HYDRAULICS system page can be found in Section 5: Engine Instruments and Crew Alerting System (EICAS), of Honeywell's SPZ-8000 (or SPZ-8400) Digital Automatic Flight Control System Pilot's Manual for the Gulfstream IV.

4. Limitations:

A. Flight Manual Limitations:

There are no flight manual limitations for the Utility hydraulic system at the time of this revision.

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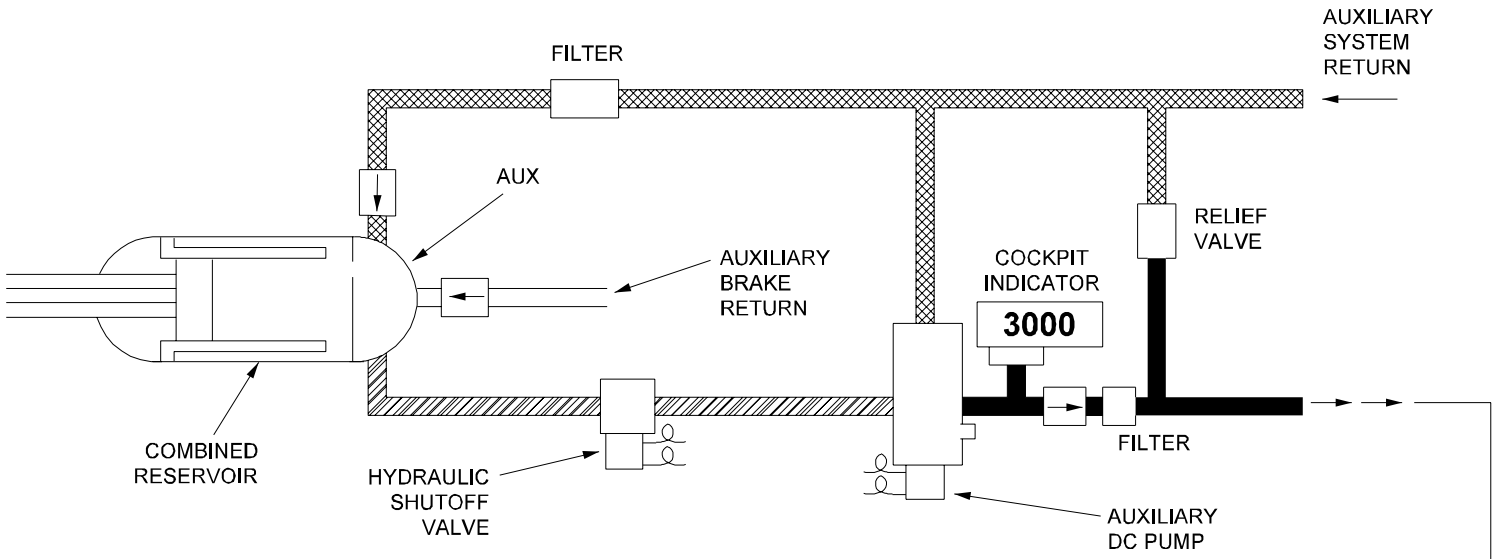

AUXILIARY PRESSURE TO:

- WING FLAPS
- GROUND SPOILER CONTROL
- BRAKES
- MAIN ENTRANCE DOOR
- PARKING/EMERGENCY BRAKE ACCUMULATOR
- LANDING GEAR AND GEAR DOORS (GROUND USE ONLY)
- CARGO DOOR (ASC 213/354)

LEGEND

- SUCTION
- AUXILIARY RETURN
- PRESSURE

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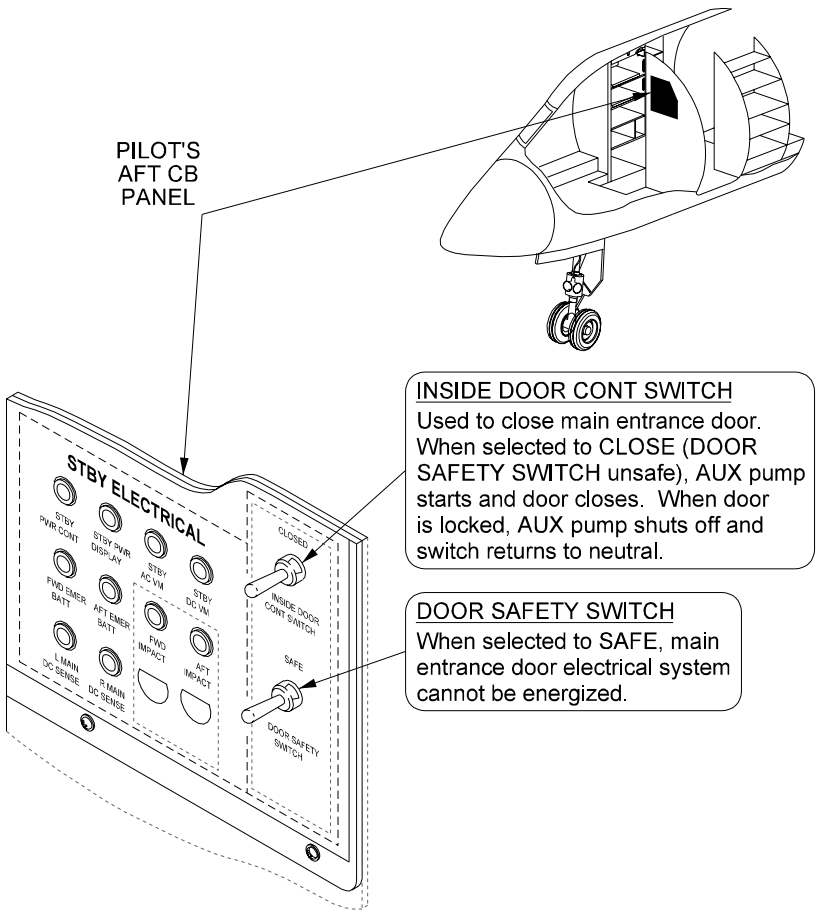
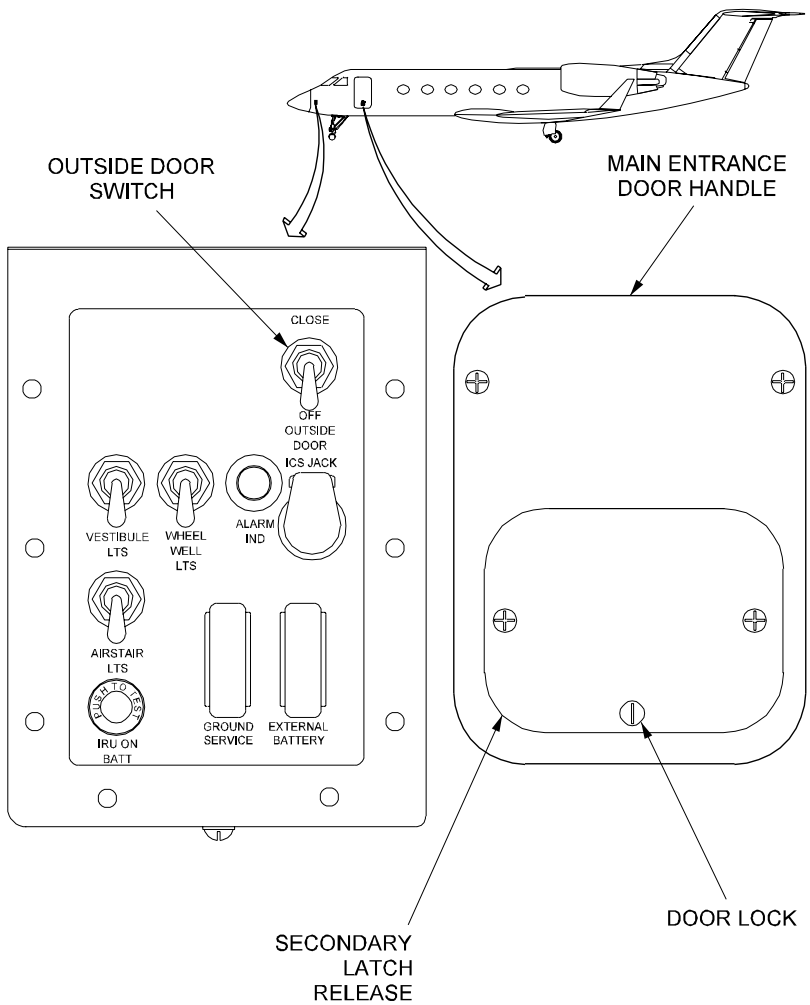
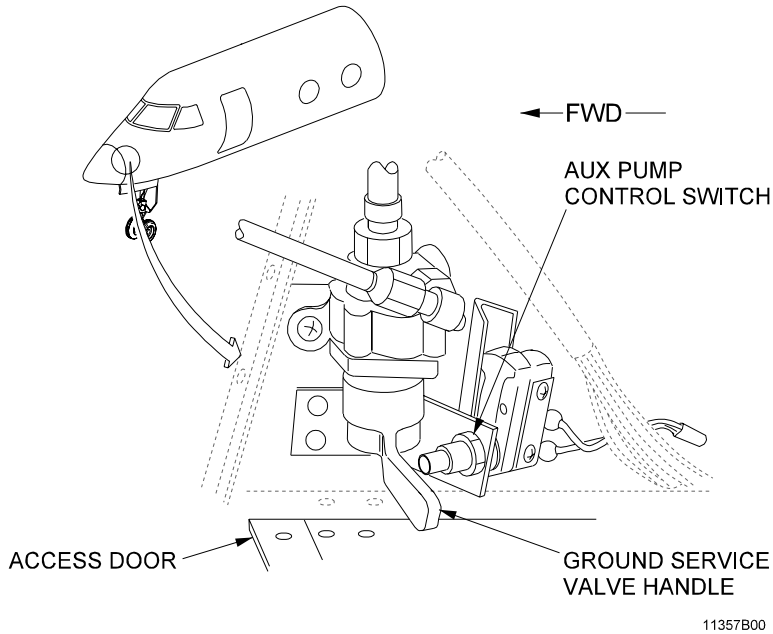
Auxiliary Hydraulic System
Simplified Block Diagram
Figure 12



Main Entrance Door Interior Control Switches
Figure 13



Main Entrance Door Exterior Control Switch
Figure 14



Ground Service Valve
Figure 15

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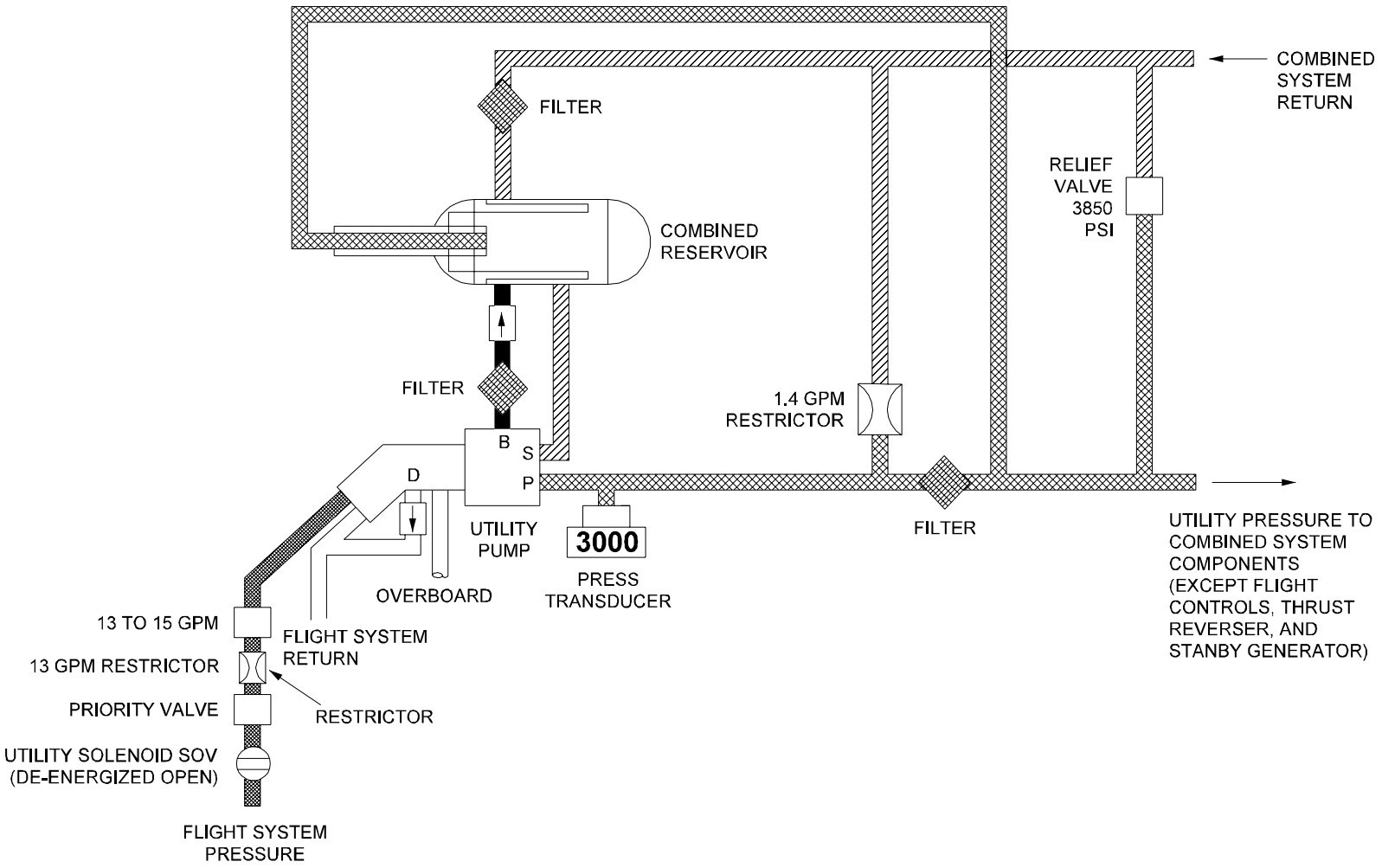

LEGEND

- UTILITY PRESSURE
- COMBINED RETURN
- BYPASS
- FLIGHT PRESSURE

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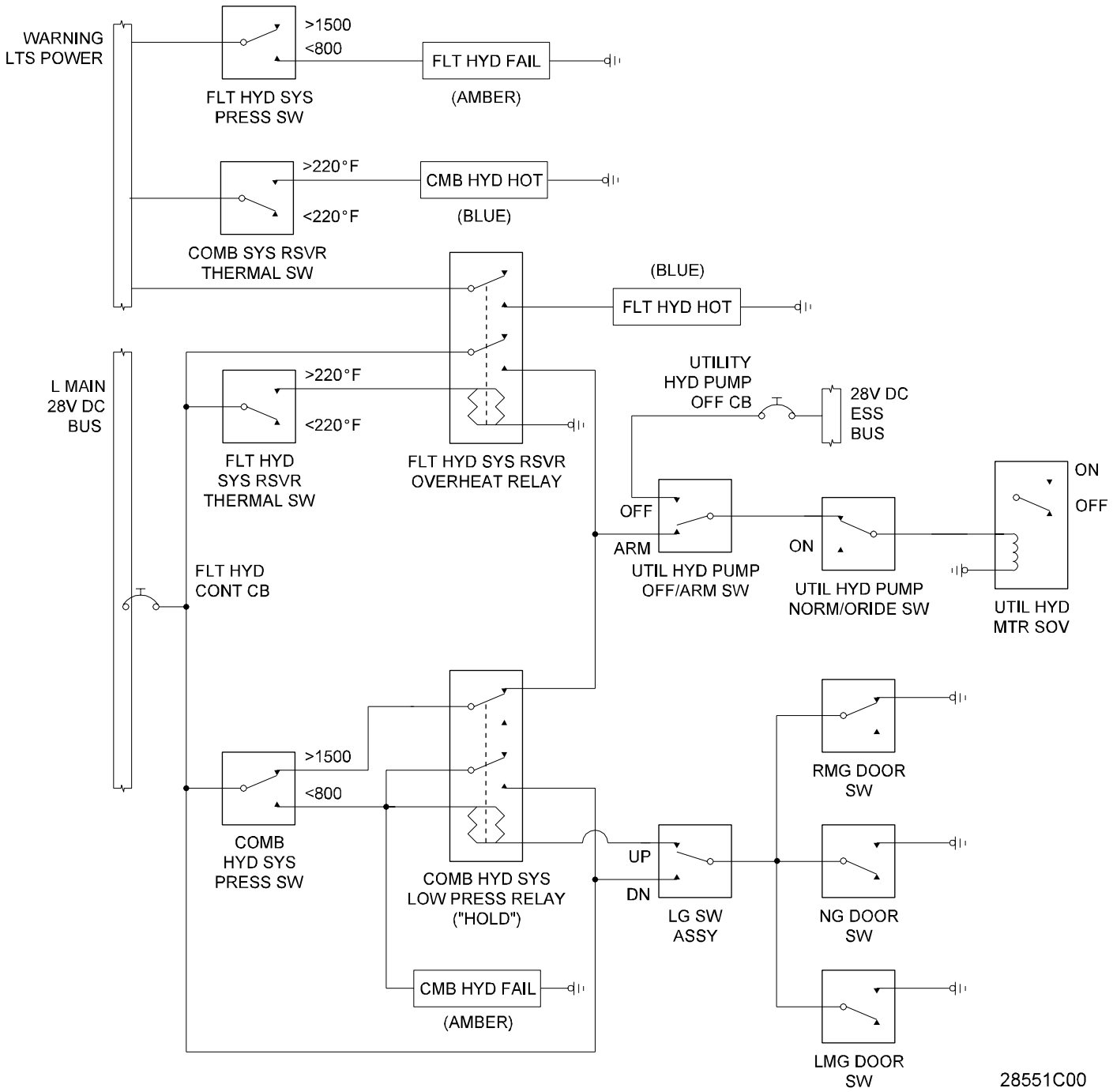
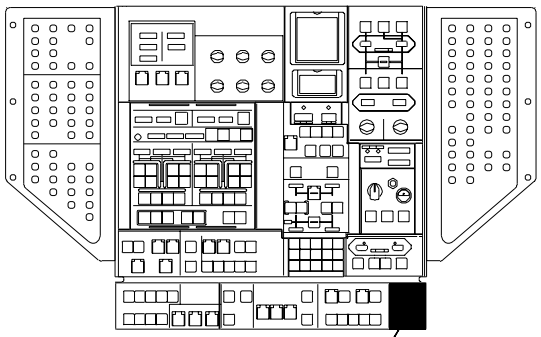
Utility Hydraulic System
Simplified Block Diagram
Figure 16



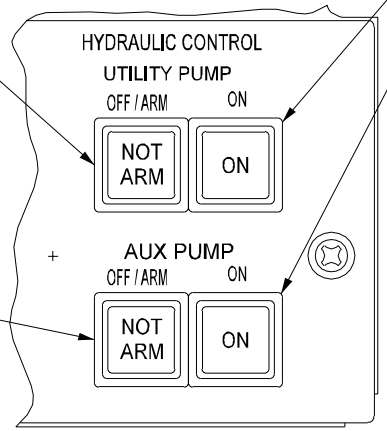
Utility Hydraulic Pump
Control Circuit
Figure 17



OFF / ARM
OFF
- Amber NOT ARM legend is illuminated.
- Automatic operation inhibited.
- Manual operation possible through use of ON switch.

ARM
- Amber NOT ARM legend is extinguished.
- Automatic operation enabled when:
  - COMB SYS pressure is less than 1500 psi.
  - COMB SYS fluid is greater than one gallon.
  - FLIGHT SYS reservior temperature is less than 220 ° F.

ON
- Amber ON legend is illuminated.
- Overrides automatic operation features.
- Pump operates regardless of OFF / ARM switch position.



OFF / ARM
OFF
- Amber NOT ARM legend is illuminated.
- Automatic operation inhibited.
- Manual operation possible through use of ON switch.

ARM
- Amber NOT ARM legend is extinguished.
- Automatic operation enabled when:
  - COMB SYS and UTILITY pressure is less than 1500 psi.
  - Any brake pedal is depressed more than 10° .

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UTILITY PUMP/AUX
PUMP Control Switches
Figure 18

2A-30-10: General Description

The Gulfstream IV uses both pneumatically and electrically powered ice and rain protection systems to provide the flight crew with a means of removing and preventing ice accumulation on the following structures and components:

- Wing Leading Edges
- Engine Cowl Inlet Leading Edges
- Cockpit Windows
- Pitot Probes
- Angle of Attack Probes
- Total Air Temperature Probe

The remainder of the airplane (including the empennage) is designed in a manner that requires no anti-icing equipment.

The ice and rain protection system is divided into the following subsystems:

- 2A-30-20: Wing Anti-Ice System
- 2A-30-30: Cowl Anti-Ice System
- 2A-30-40: Windshield Ice and Rain Protection System
- 2A-30-50: Probe Anti-Ice System

Bleed air for the wing anti-ice system is supplied by the engine bleed air manifold. The engine bleed air manifold is supplied mid-stage air from each engine's 7th stage compressor section through the 7th stage check valve. Depending on conditions, high-stage air may also be supplied by each engine's 12th stage compressor through the 12th stage air control valve (often referred to as the HP valve).

Bleed air for the cowl anti-ice system is supplied directly from the engines' 7th and/or 12th stage compressor offtakes. Each engine also has a mechanical ice shedder on the Low Pressure (LP) compressor (fan) spinner.

Electrically powered heating elements warm the cockpit windows to prevent fogging and ice formation. Precipitation removal from the forward cockpit windows is provided by a pair of electrically operated windshield wipers.

Electrically powered heating elements also warm the pitot probes, Angle of Attack (AOA) probes and Total Air Temperature (TAT) probe.

An ice optional detector is available to provide the flight crew with visual warnings of accumulating ice. Installed on the left forward cheek panel and powered by the AC electrical system, the detector probe vibrates at approximately 40,000 Hertz (Hz) with no ice accumulated. At this frequency, only ice can adhere to the probe, thus false warnings are eliminated. If ice should begin to accumulate on the probe, the resonate frequency will begin to drop, eventually reaching 39,867 Hz. At this threshold, an amber ICE DETECTED caution message is prompted for display on the Crew Alerting System (CAS) and detector probe heat is energized. Detector probe heat then melts away any accumulated ice, allowing the frequency to again increase to 40,000 Hz, shutting off probe heat. If the probe is still free of ice sixty seconds later, the ICE DETECTED CAS message is removed, indicating the airplane is clear of icing conditions.

Currently, there are production provisions for an ice detector "ICE DET" test button on the TEST panel (copilot side of center console [airplanes 1457 and subs]).