

CHAPTER 14 – HYDRAULIC POWER

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1. INTRODUCTION

Hydraulic power is provided by three independent systems designated No.1, No.2 and No.3. All systems operate at a nominal pressure of 3000 psi (20,685 kPa) and use synthetic hydraulic fluid "Skydrol".

WARNING

Skydrol is highly corrosive and can produce severe skin and eye irritation.

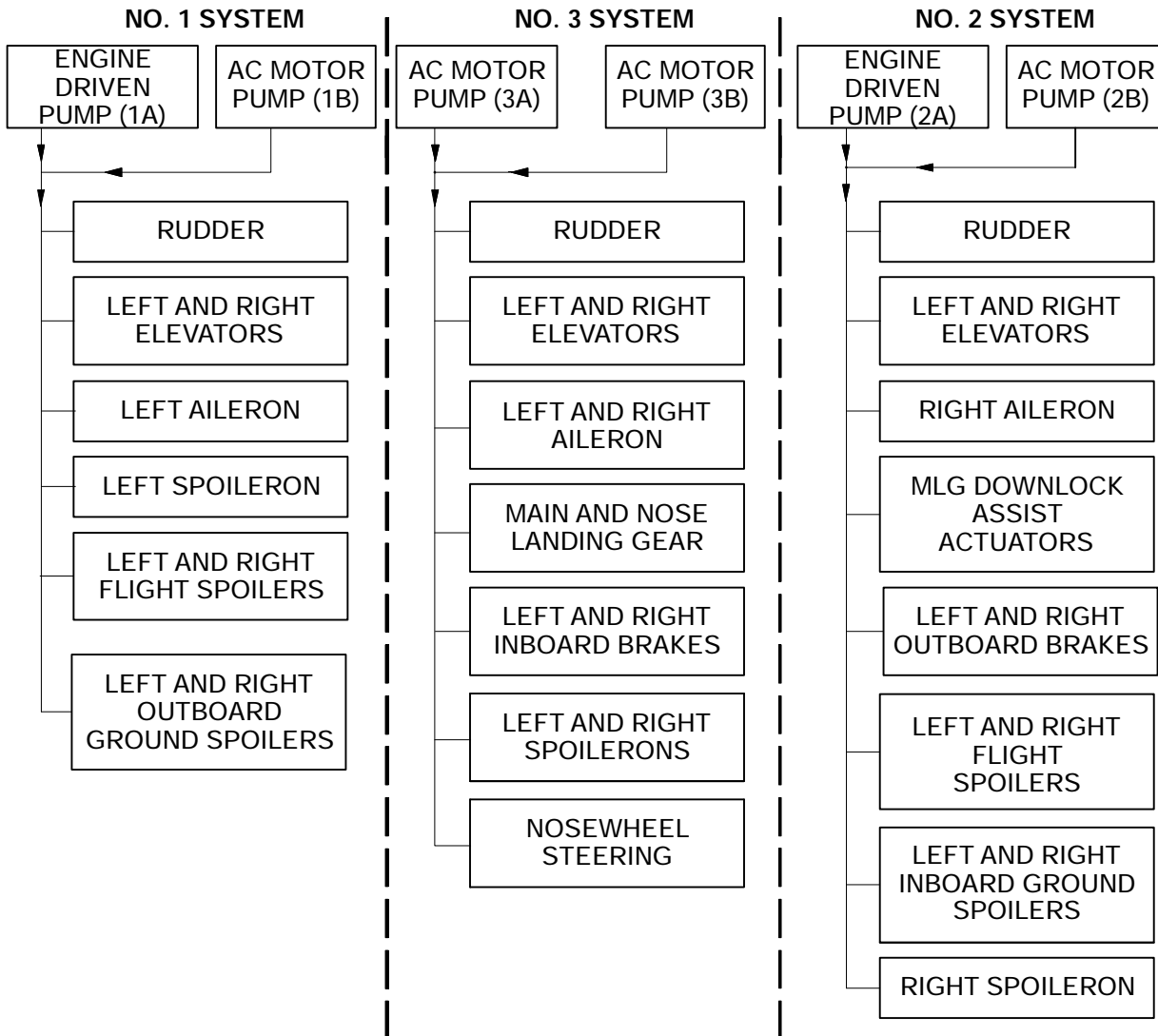
Systems 1 and 2 are serviced by ground service panels located in the aft equipment compartment. System 3 is serviced by a ground service panel located on the right side of the fuselage, aft of the wing root.

Each system has two hydraulic pumps; a main pump (A) for normal power and a backup pump (B) for supplementary power. System No.1 and 2 main pumps are engine driven pumps (EDP's). System 1 EDP (1A) is driven by the left engine and system 2 EDP (2A) is driven by the right engine. System 1 and 2 backup pumps (1B and 2B) are electrical AC motor pumps (ACMP's). Both hydraulic pumps for system No.3 are ACMP's. In system No.3, the main pump (3A) normally runs continuously, while the backup pump (3B) is available during periods of high flow requirements.

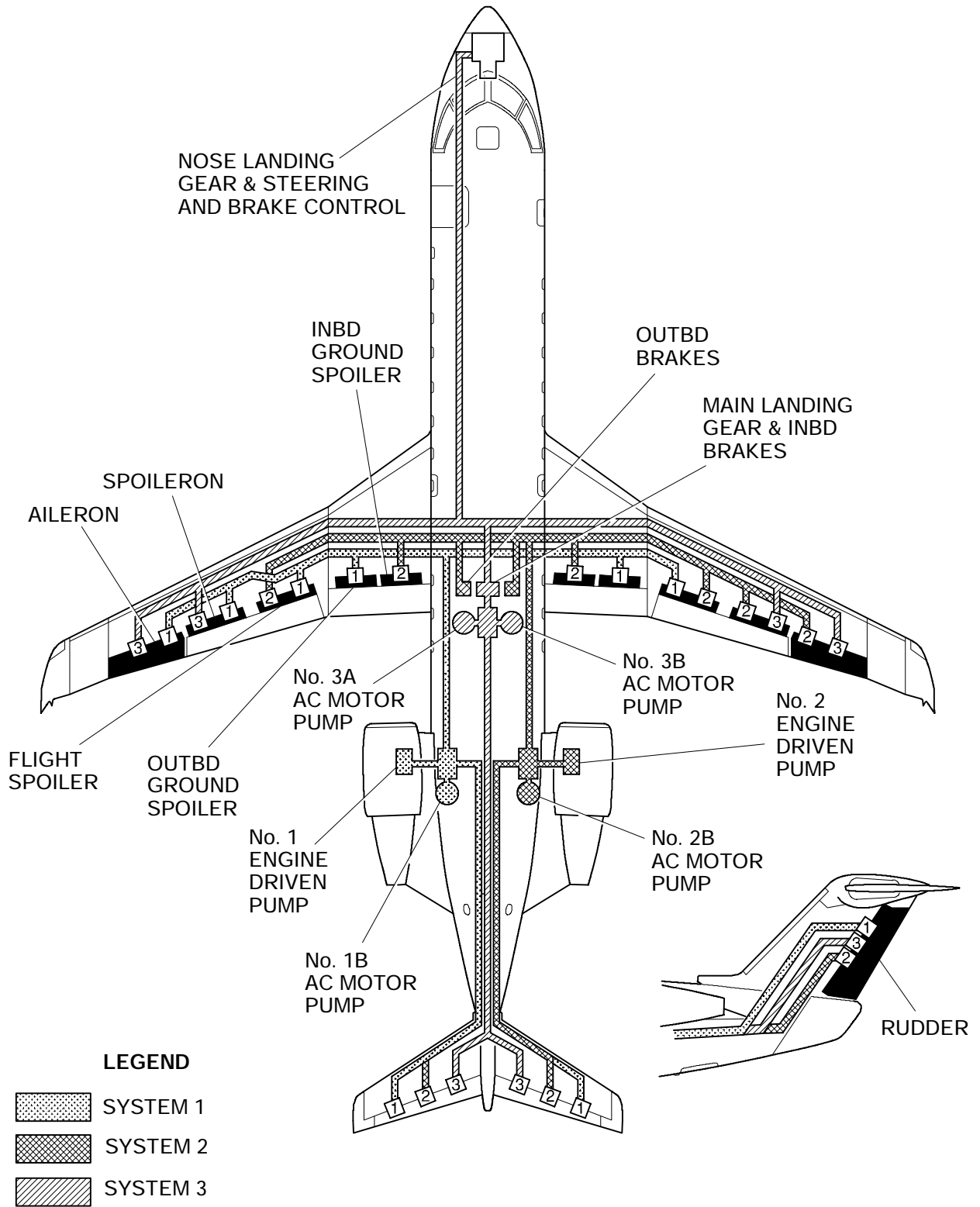
The hydraulic systems supply power to operate the rudder, elevators, ailerons, spoilerons, flight spoilers, ground spoilers, wheel brakes, nosewheel steering and landing gear extension and retraction. The rudder, elevators and ailerons are powered by more than one hydraulic system to prevent loss of critical flight controls.

During a total AC power failure in flight, pump 3B will be automatically powered by the air driven generator (ADG) when it is deployed. This will provide hydraulic pressure to the landing gear, brakes and nosewheel steering and also provides backup hydraulic pressure to the primary flight controls.

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Hydraulic Systems Diagram
Figure 14-10-1



Hydraulic Systems Overview
Figure 14-10-2



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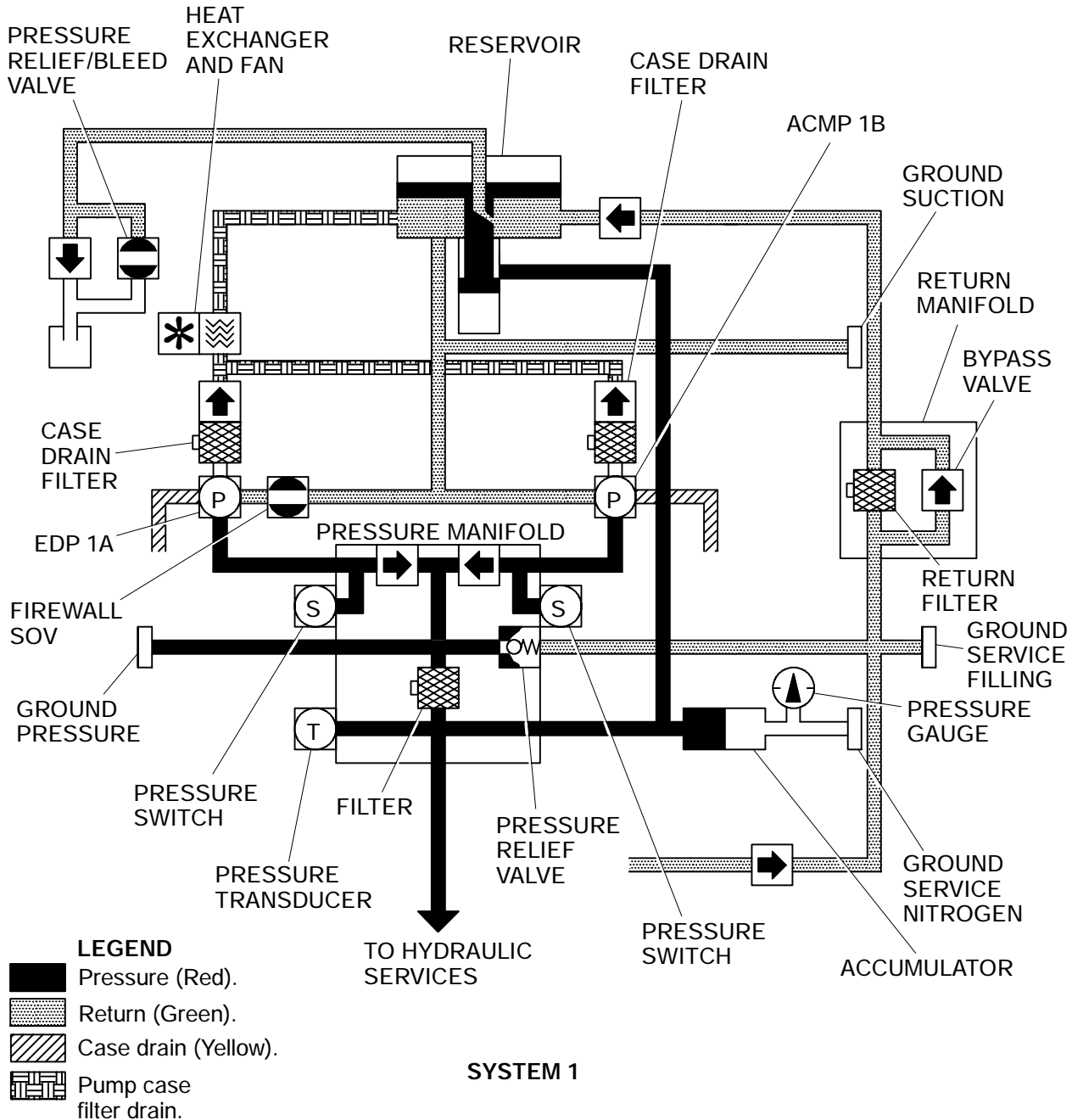
1. HYDRAULIC SYSTEMS NO.1 AND NO.2

Each hydraulic system consists of the following components:

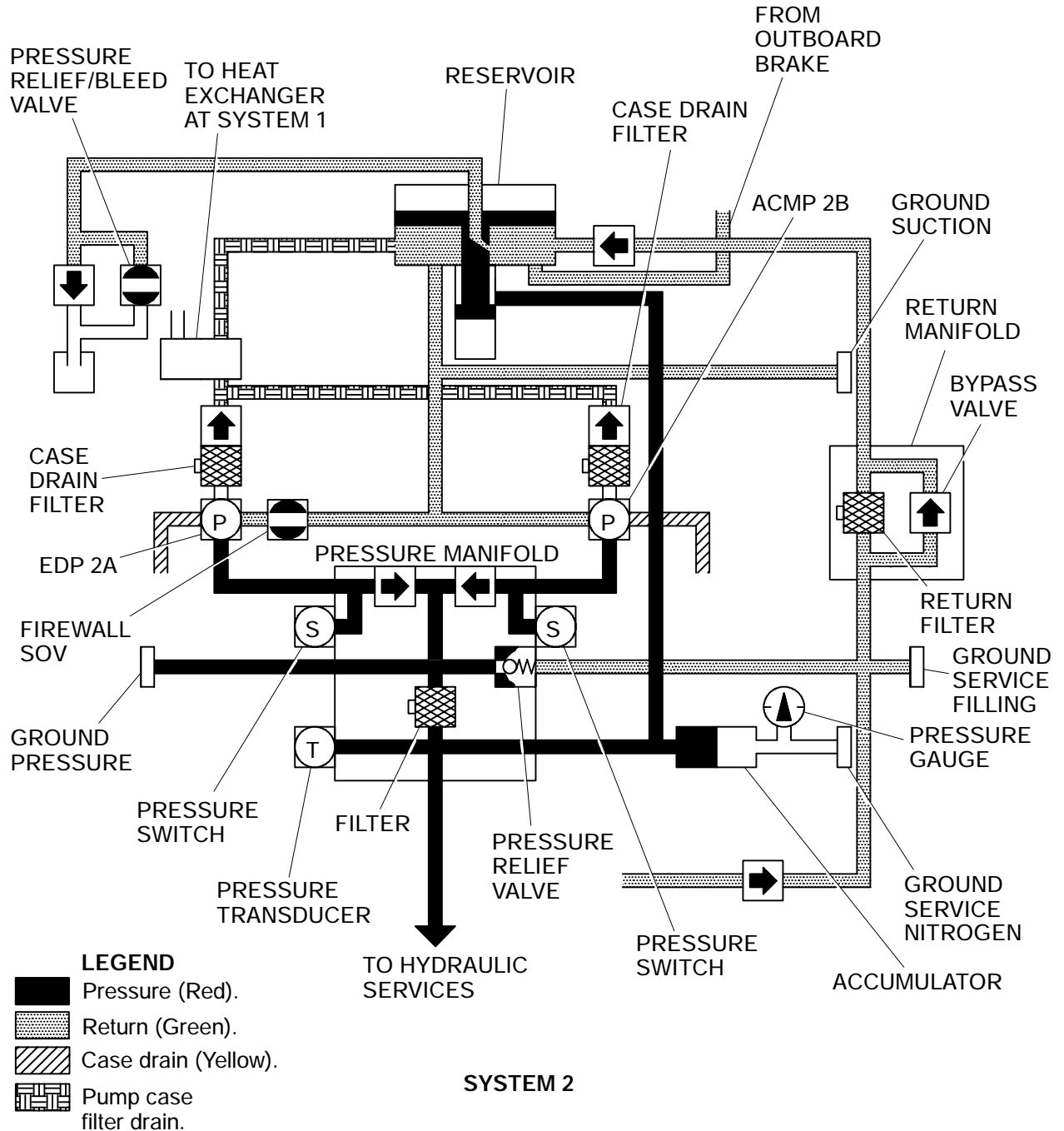
- Engine driven pump (EDP)
- AC motor pump (ACMP)
- Shutoff valve
- Reservoir
- Accumulator
- Pressure and return manifolds
- Filters
- Ground servicing panel.

Both No.1 and No.2 systems share a ram air heat exchanger for fluid cooling. Fluid from each system is not mixed with the other system as it passes through the heat exchanger. A fan within the heat exchanger assists in cooling the hydraulic fluid when the aircraft is on the ground.

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Hydraulic Systems 1 and 2 Schematic
Figure 14-20-1 Sheet 1



Hydraulic Systems 1 and 2 Schematic
Figure 14-20-1 Sheet 2

A. Engine Driven Pumps

EDP's 1A and 2A draw fluid from their respective reservoirs through firewall shutoff valves. Fluid is pumped at 3000 psi to the applicable pressure manifold, filtered and distributed to the aircraft hydraulically actuated components.

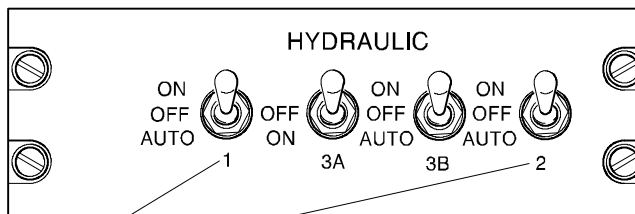
B. AC Motor Pumps (ACMP)

Each ACMP provides a nominal outlet pressure of 3000 psi. AC motor pump 1B is powered from AC bus 2 and AC motor pump 2B is powered from AC bus 1. Each AC motor pump is controlled by a separate switch on the HYDRAULIC pump control panel located on the overhead panel in the flight compartment. When a pump switch is set to AUTO, the pump will automatically start under the following conditions:

- IDG 2 must be operating for hydraulic pump 1B operation
- IDG 1 must be operating for hydraulic pump 2B operation
- IDG 1 or IDG 2 must be operating for ACMP 3B operation
- Flaps are out of the 0° position.

NOTE

AC motor pumps 1B and 2B do not automatically start during or after an engine failure.



AC Motor Pump 1 and 2

Used to control the operation of AC motor pumps 1B and 2B.

- ON - Pump will operate at 3000 psi output
- OFF - Pump inoperative
- AUTO - Pump will operate in AUTO position, when the flaps are greater than 0-degrees and the respective generator is on-line:
 - IDG2 for pump 1B
 - IDG1 for pump 2B

**Hydraulic Control Panel
Overhead Panel**

Hydraulic Control Panel
Figure 14-20-2

C. Hydraulic Shutoff Valves

Electrically operated, normally open, hydraulic shutoff valves are installed in the suction lines of the engine driven pumps (1A and 2A). During an engine fire condition, the corresponding shutoff valve is motored closed when the ENG FIRE PUSH switchlight is pressed. (See Chapter 10, Fire Protection).

Valve position is indicated on the EICAS, HYD synoptic page.

D. Reservoir

System 1 and 2 reservoirs are storage tanks that hold a reserve supply of hydraulic fluid for their respective systems. The reservoirs are also partially pressurized with system pressure to maintain a positive flow of fluid to the EDP and/or ACMP

E. Accumulator

An accumulator installed in each system stores hydraulic pressure. The accumulator is charged with nitrogen and is used to dampen pressure surges and to maintain system pressure during momentary system demand increases.

Hydraulic Temperature

Displays reservoir fluid temperature (in 1°C increments).

- Green - < 96°C (205°F).
- Amber - ≥ 96°C (205°F).
- Amber dashes - Invalid data.

Reservoir Output Line

- Green - Sufficient quantity (≥ 5%).
- Blank - Insufficient quantity (< 5%).

Engine Driven Pump Input Line

- Green - SOV open.
- Red - SOV not closed with an engine fire.

Pump Output and Pressure Manifold Lines

- Green - Pressure (> 1800 psi).
- Amber - Low pressure (< 1800 psi).

Pressure Manifold Output

- Green - Pressure > 1800 psi.
- Amber - Pressure < 1800 psi.

Hydraulic Quantity

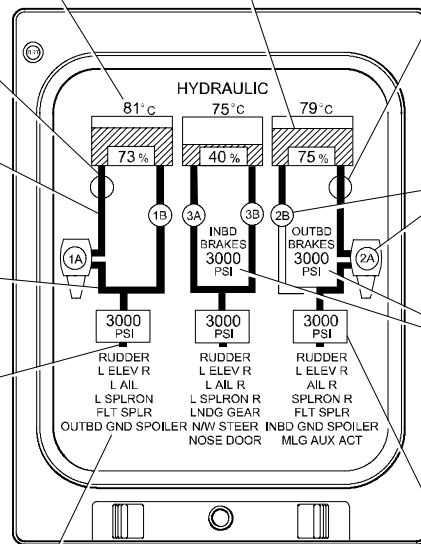
Displays reservoir fluid quantity (in 5% increments). Normal quantity is 45 to 85 percent.

- White - Hydraulic quantity < 45% or > 85%.
- Green - Hydraulic quantity ≥ 45% and ≤ 85%.
- Amber dashes - Invalid data.

Shutoff Valve Position Indicator

- valve open (white)
- valve closed (white)
- failed (half-intensity magenta)

Valve outline will turn amber if valve fails to attain commanded position.



Pump

- Displays pump status.
- White - Pump not operating and selected off.
 - Green - Pump output normal.
 - Amber - Pump output low.
 - Half-intensity magenta - Invalid data.

Inboard and Outboard Brake Pressure Readout

- Displays, in 100 psi increments, pressure at outboard brake system.
- Green - Between 1000 and 3200 psi.
 - Amber - Less than 1000 psi.
 - White - Over 3200 psi.

Hydraulic Page

System Distribution Table

Displays status of corresponding airplane systems.

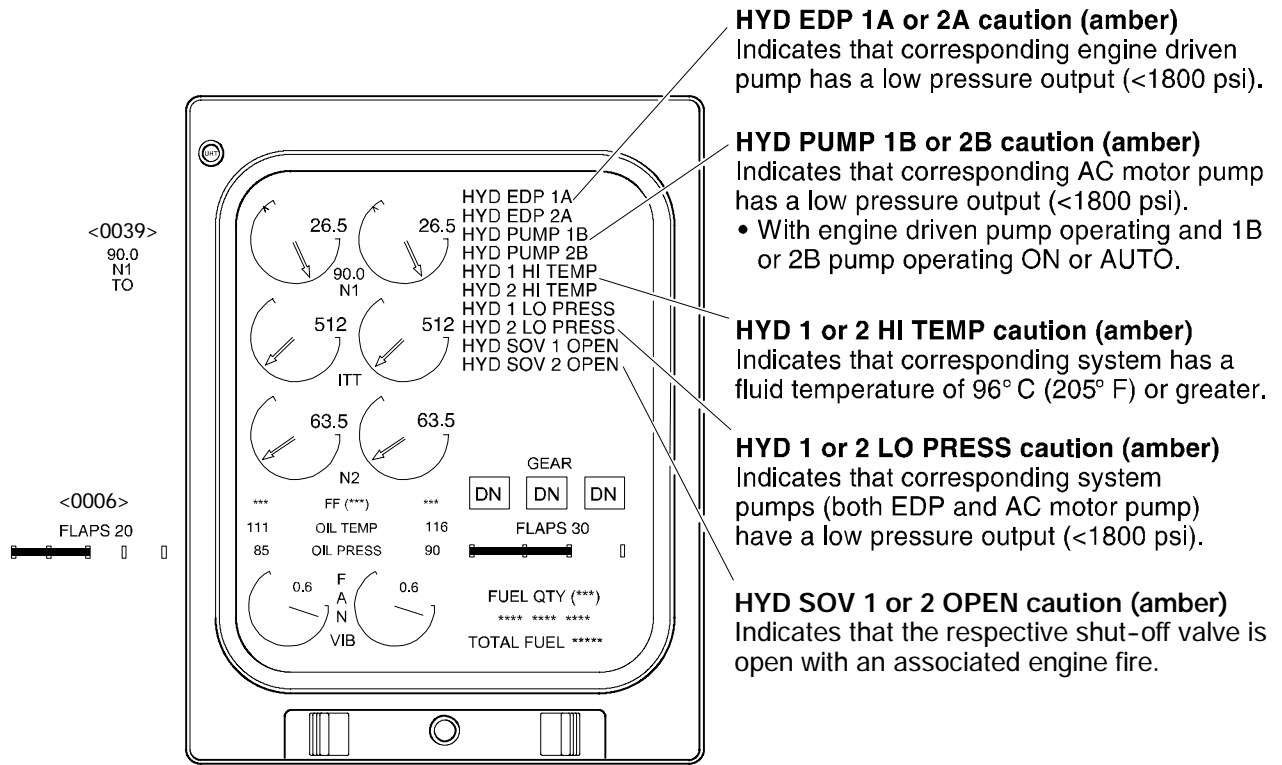
- White - Adequate pressure to operate (> 1800 psi).
- Amber - Hydraulic supply to system inadequate (< 1800 psi).
- Half-intensity magenta - Invalid data.

Hydraulic Pressure

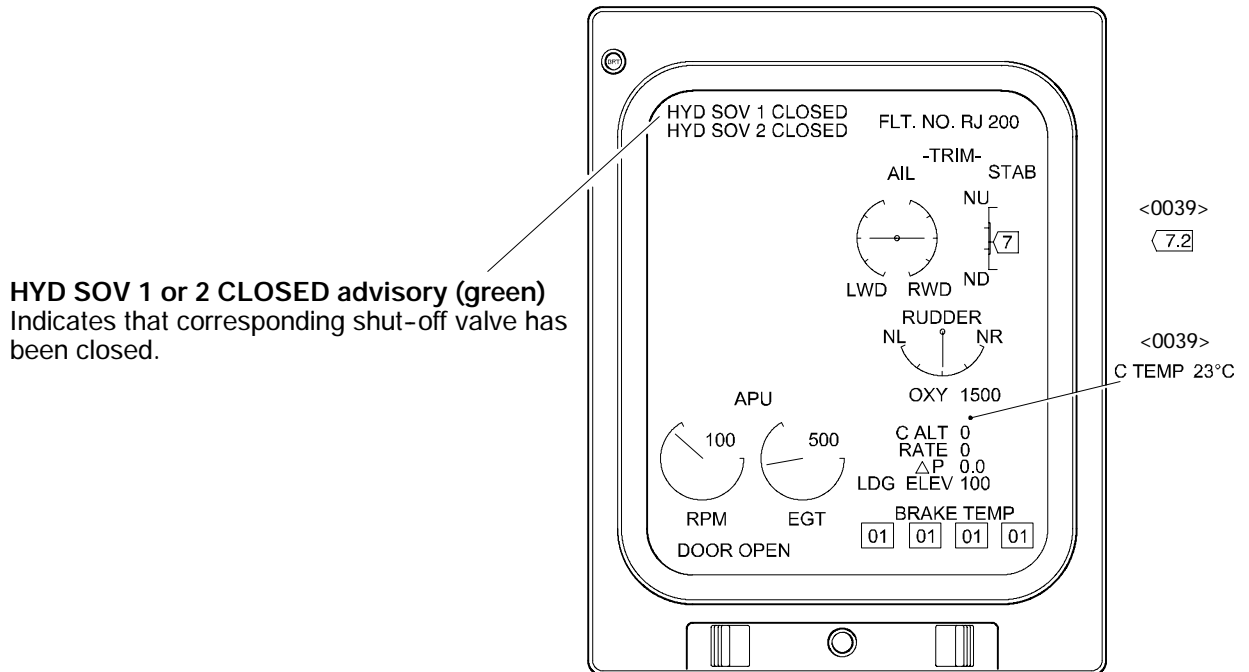
Displays hydraulic pressure (in 100 psi increments). Normal operating pressure is 2800 to 3200 psi.

- White - Hydraulic pressure > 3200 psi.
- Green - Hydraulic pressure > 1800 psi and ≤ 3200 psi.
- Amber - Hydraulic pressure ≤ 1800 psi.
- Amber dashes - Invalid data.

Systems 1 and 2 – Synoptic Page
Figure 14-20-3



Primary Page



Status Page

**Systems 1 and 2 – EICAS Indications <MST>
Figure 14-20-4**




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Systems 1 and 2**

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F. System Circuit Breakers

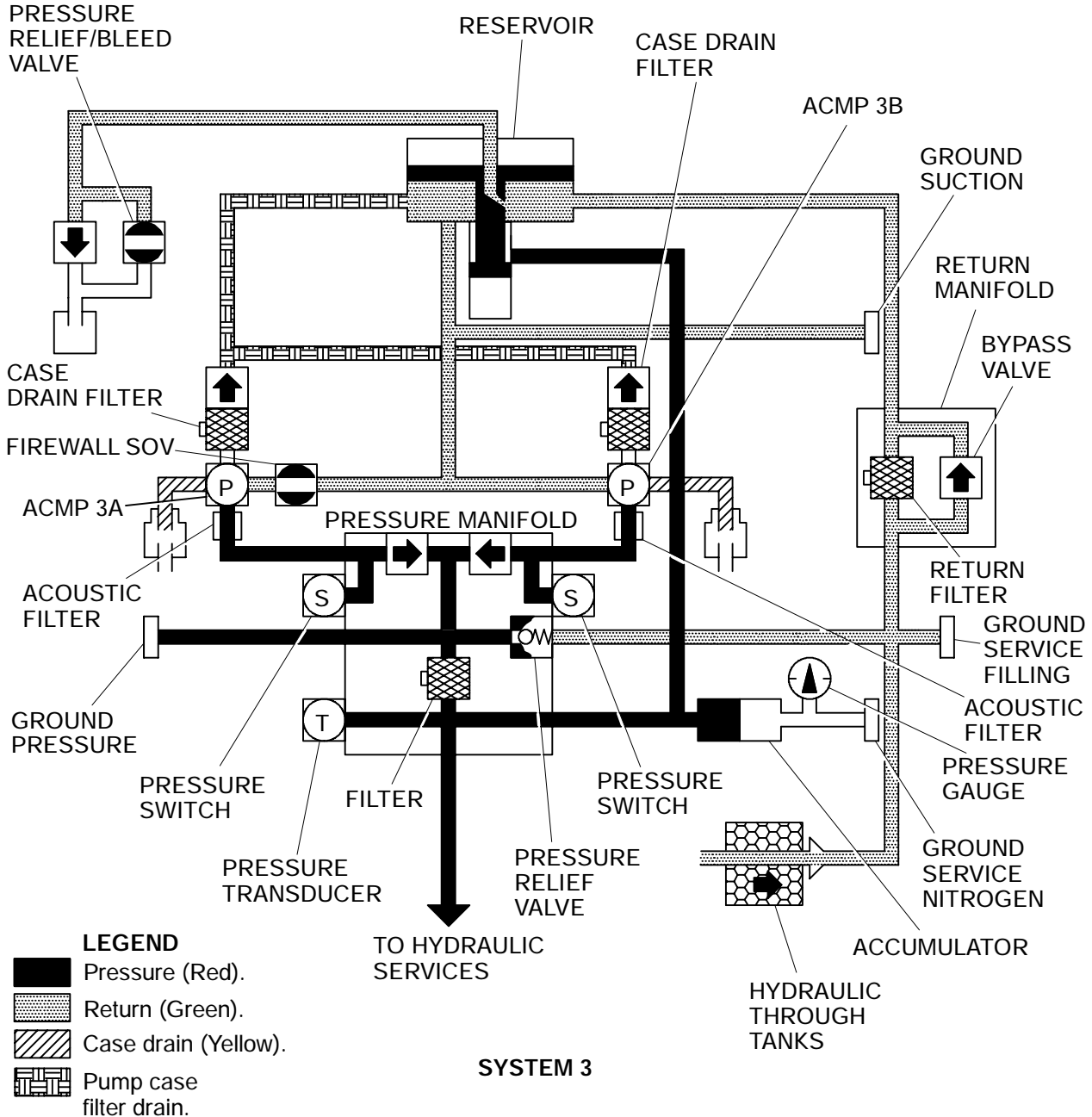
SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Hydraulic Systems	System 1	HYD PUMP 1	AC BUS 2	2	A5	
		AC PUMP CONT 1	DC BUS 2		G14	
		IND 1			G13	
	System 2	HYD PUMP 2	AC BUS 1	1	A5	
		AC PUMP CONT 2	DC BUS 1		G14	
		IND 2			G13	
	Fans	HYD SYST FAN	AC BUS 1	1	A8	
		FAN CONT	DC BUS 1		G12	
	Shutoff Valves	HYD SOV R ENG	DC EMER	1	S4	
		HYD SOV L ENG			S5	

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1. HYDRAULIC SYSTEM NO.3

Hydraulic system No.3 has the same components as systems No.1 and No.2, with the exception that No. 3 system has two AC motor pumps (identified as 3A and 3B) and no engine driven pump (EDP). Hydraulic system No.3 provides a nominal 3000 psi pressure to the ailerons, elevators, rudder, spoilers, landing gear actuators, inboard brakes and the nosewheel steering system. System No.3 hydraulic lines pass through the wings and are cooled by fuel.

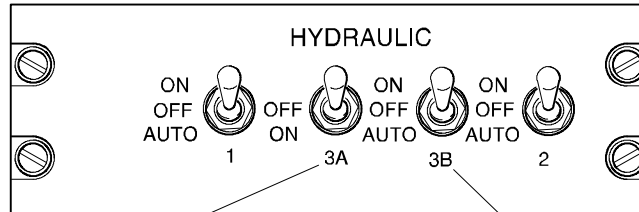
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Hydraulic System 3 – Schematic
Figure 14-30-1

A. AC Motor Pumps

The No. 3 hydraulic system ACMP's are controlled by switches on the HYDRAULIC control panel. System pressure is normally maintained by pump 3A, which runs continuously when selected ON. In normal operations, with the 3B pump switch in AUTO, pump 3B operates during takeoffs and landings. Pump 3B is also automatically powered from the ADG bus when the ADG has been deployed (independent of the flight compartment 3B switch setting).



AC Motor Pump 3A

Used to control the operation of AC motor pump 3A.

- ON - Pump will operate at 3000 psi output.
- OFF - Pump inoperative.

**Hydraulic Control Panel
Overhead Panel**

AC Motor Pump 3B

Used to control the operation of AC motor pump 3B. Pump will operate irrespective of switch position when ADG is deployed.

- ON - Pump will operate at 3000 psi output.
- OFF - Pump inoperative.
- AUTO - Pump will operate in AUTO position, when flaps are greater than 0-degrees and either IDG 1 or IDG 2 is operating.

Hydraulic Control Panel
Figure 14-30-2

Hydraulic Temperature

Displays reservoir fluid temperature (in 1°C increments).

- Green - < 96°C (205°F).
- Amber - ≥ 96°C (205°F).
- Amber dashes - Invalid data.

Reservoir Output Line

- Green - Sufficient quantity (≥ 5%).
- Blank - Insufficient quantity (< 5%).

Hydraulic Pressure

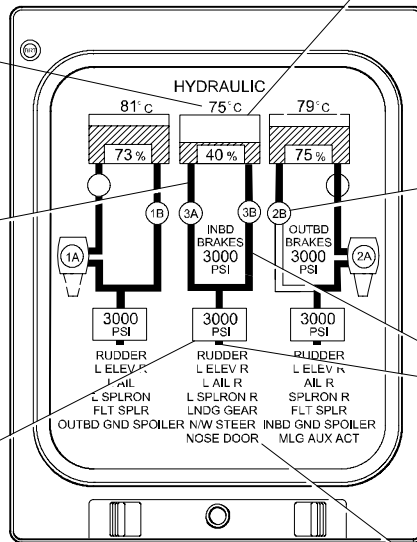
Displays hydraulic pressure (in 100 psi increments).
Normal operating pressure is 2800 to 3200 psi.

- White - Hydraulic pressure > 3200 psi.
- Green - Hydraulic pressure > 1800 psi and ≤ 3200 psi.
- Amber - Hydraulic pressure ≤ 1800 psi.
- Amber dashes - Invalid data.

Hydraulic Quantity

Displays reservoir fluid quantity (in 5% increments).
Normal quantity is 45 to 85 percent.

- White - Hydraulic quantity < 45% or > 85%.
- Green - Hydraulic quantity ≥ 45% and ≤ 85%.
- Amber dashes - Invalid data.



Hydraulic Page

Pump

Displays pump status.

- White - Pump not operating and selected off.
- Green - Pump output normal.
- Amber - Pump output low.
- Half-intensity magenta - Invalid data.

Pump Output and Pressure Manifold Lines

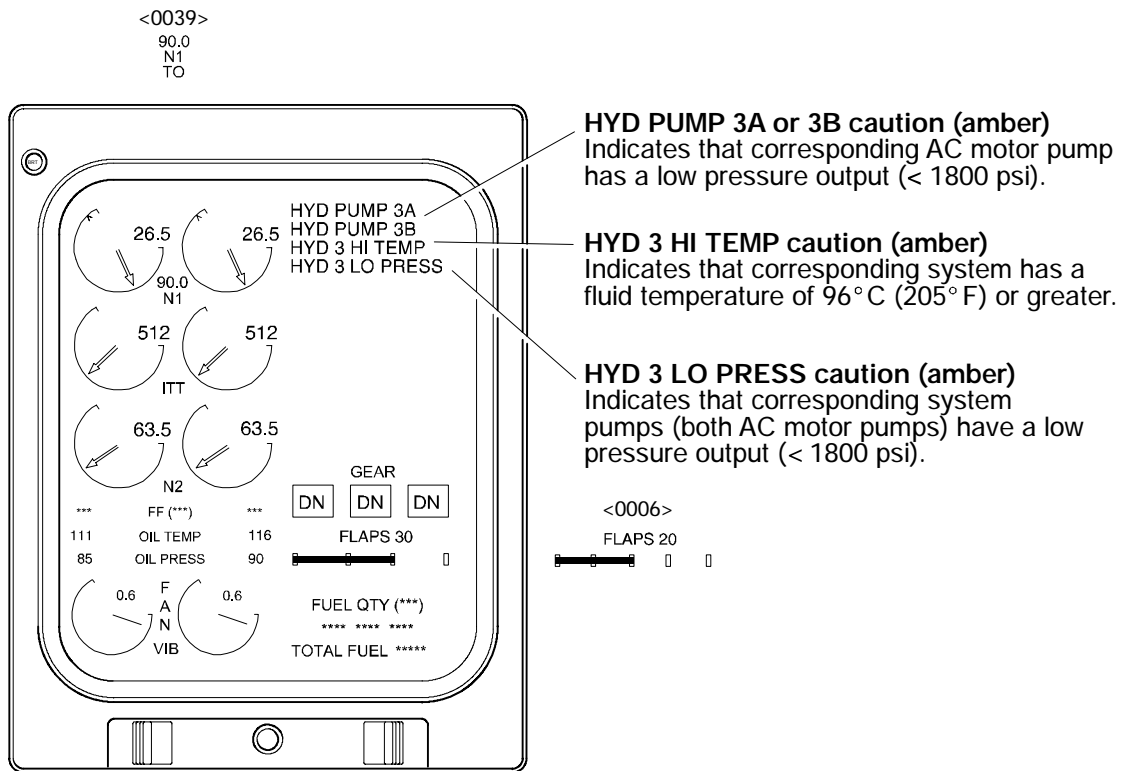
- Green - Pressure > 1800 psi.
- Amber - Pressure < 1800 psi.

System Distribution Table

Displays status of corresponding airplane systems.

- White - Adequate pressure to operate (> 1800 psi).
- Amber - Hydraulic supply to system inadequate (< 1800 psi).
- Half-intensity magenta - Invalid data.

System 3 – Synoptic Page
Figure 14-30-3



Primary Page

**System 3 – EICAS Indications <MST>
Figure 14-30-4**



**HYDRAULIC POWER
System 3**

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B. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Hydraulic System 3	Pumps	HYD PUMP 3A	AC BUS 2	2	A2	
		PUMP CONT 3A	DC BUS 2		G15	
		HYD PUMP 3B	AC BUS 1	1	A2	
		PUMP CONT 3B	DC BUS 1		G11	
		ESS HYD PUMP SUPPLY	ADG BUS	3	A11	
	Indication	HYD SYST IND 3	DC BATTERY BUS	2	N12	