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02-29 ATA 29 - HYDRAULIC SYSTEM

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INTRODUCTION

The hydraulic power system provides pressure for actuation of several airplane components.

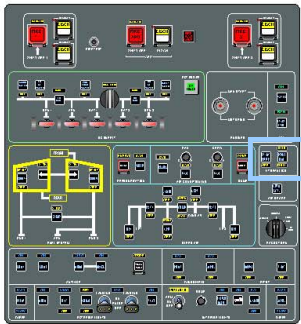
It is composed of two fully independent systems (HYD 1 and HYD 2 systems) operating simultaneously and powered by three engine-driven pumps and an electrical stand-by pump.

Hydraulic system is of the “set and forget” type. After initialization for flight (ST-BY PUMP set to AUTO), no crew action is required for the rest of the flight if no failure occurs.

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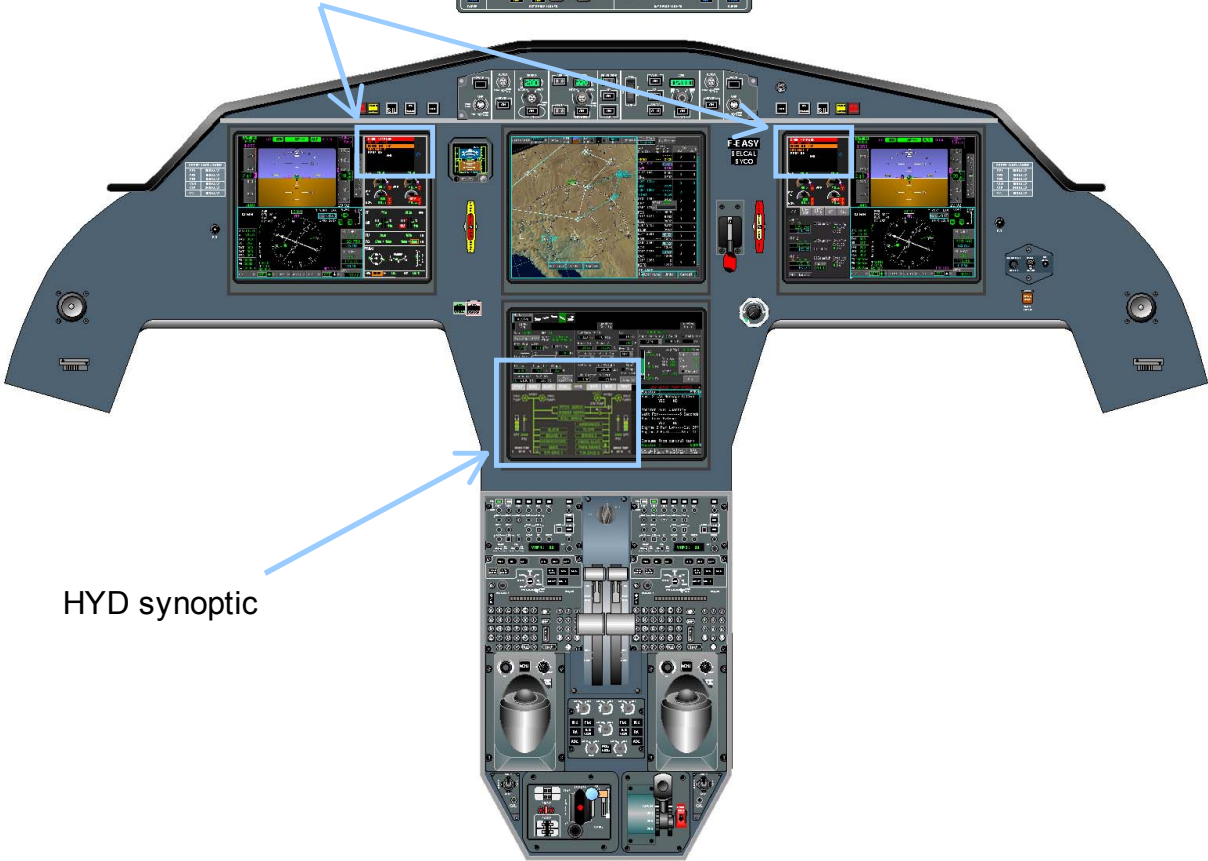


HYDR
Circuit breakers



Electrical ST-BY PUMP
and ISOLATION VALVE
controls

CAS windows



HYD synoptic

FIGURE 02-29-05-00 FLIGHT DECK OVERVIEW

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SOURCES

Each hydraulic system has its own hydraulic fluid reservoir located in the aft servicing compartment.

Both systems are pressurized by LP bleed air through a common system for fuel and hydraulic pressurization systems. The reservoirs are pressurized to avoid pump cavitation.

HYD 1 RESERVOIR	HYD 2 RESERVOIR
1.95 USG (7.4 l)	1.58 USG (6 l)

Main hydraulic power is provided by three engine-driven mechanical pumps.

HYD 1 system is supplied by two pumps:

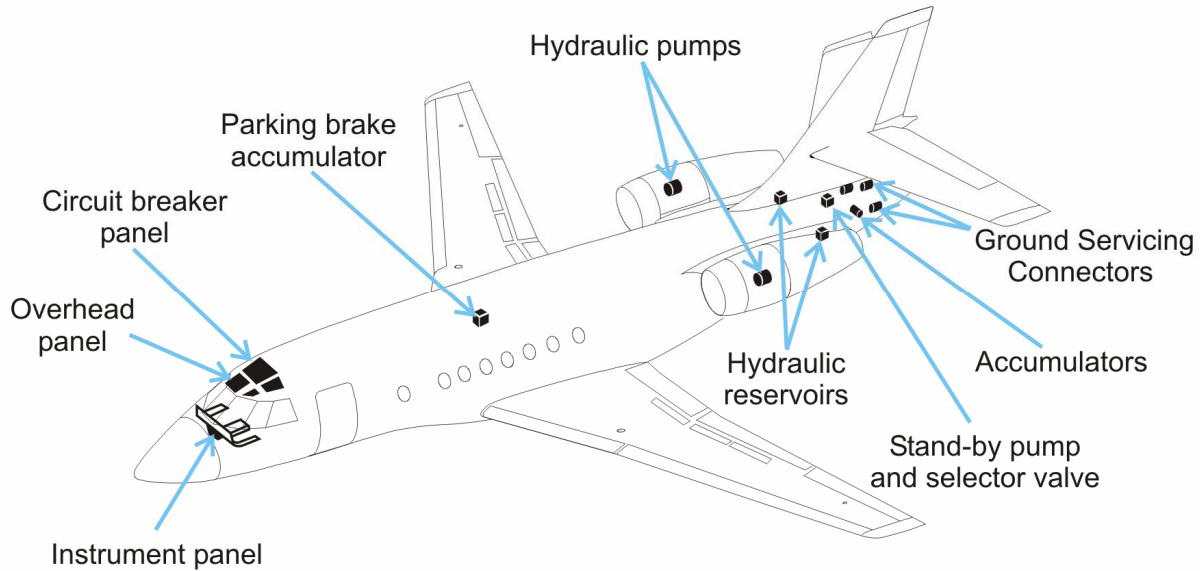
- engine 1 hydraulic pump,
- engine 2 hydraulic pump.

HYD 2 system is supplied by two pumps:

- engine 2 hydraulic pump,
- electrical stand-by pump, automatically activated in case of HYD 2 pressure drop below 1,650 ±100 psi (fail-safe system).

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EQUIPMENT LOCATION



02-29-05-01 EQUIPMENT LOCATION

The hydraulic system components are mainly installed in the hydraulic racks in the aft servicing compartment.

Except for very few items, the HYD 1 system components are located on the left side of the airplane, the HYD 2 system and stand-by components on the right side.

External hydraulic cart connections are provided for ground checks and maintenance tests of each system.

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SUB-SYSTEMS

HYDRAULIC ENGINE-DRIVEN PUMPS

The three self-regulating, piston-type pumps are driven by the accessory gearbox of the corresponding engine.

They regulate automatically the output pressure at 3,000 psi (\pm 200 psi).

The pumps are not controlled from the cockpit.

The pumps are lubricated by the hydraulic fluid. A shear section in the pump drive shaft protects the engine gearbox in case of pump seizure.

STAND-BY ELECTRICAL PUMP

In case of HYD 2 pump failure, a stand-by electrical pump (ESS bus) allows operation of components powered by the No 2 system.

In AUTO mode, the stand-by pump starts automatically as soon as a pressure drop (pressure below $1,650 \pm 100$ psi) is detected in the HYD 2 system: the stand-by pump cycles continuously between 1,650 and 2,300 psi (\pm 100 psi) as long as it is not switched off.

The stand-by electrical pump may also be used, on ground only, to pressurize the No 1 hydraulic system for maintenance checks. The mechanical selector that switches the pump between HYD 1 and HYD 2 systems is located in the aft servicing compartment (right side).

CAUTION

The stand-by pump selector must be set to IN FLIGHT position prior to flight.

NOTE

The stand-by pump must be switched off in case of HYD 2 system leakage

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HYDRAULIC ISOLATION VALVE

Located on the HYD 2 system, it isolates the pitch and rudder servo-actuator hydraulic systems from the other user systems when the stand-by pump is active.

This valve is controlled by HYDR 2 ISOL selector switch on the overhead panel.

When the selector switch is set to AUTO:

- on ground, or in flight with the slats extended, the hydraulic isolation valve is controlled to open position, allowing the stand-by electrical pump to supply fully hydraulic system 2,
- in flight with the slats retracted, the valve is closed. Only pitch and rudder servo-actuators are powered by the stand-by pump.

When the selector switch is set to OPEN, the hydraulic isolation valve is directly controlled to open position.

When the selector switch is set to CLOSE, the hydraulic isolation valve is directly controlled to close position.

NOTE 1

The isolation valve must be set to CLOSE in case of HYD 2 system leakage, if fluid quantity drops to 0.

NOTE 2

When the hydraulic isolation valve is set to CLOSE, the airbrakes are no longer available.

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ACCUMULATORS

Each system includes a hydraulic accumulator to dampen pressure surges in the system and provide instantaneously available reserve power. Each system also includes an accumulator that supplies limited hydraulic pressure to the thrust reverser. Each accumulator is precharged for life and does not feature any pressure gauge or charging valve.

The No 2 system includes one additional accumulator to provide reserve power to the parking brake system in case of total loss of normal braking system. A hydraulic pressure gauge located in the LH wheel well is installed on the supplied by this accumulator.

NOTE

After engine shutdown or hydraulic failure, hydraulic pressure in each system accumulator drops to zero. Check valves maintain the pressure in the parking brake and thrust reverser accumulators.

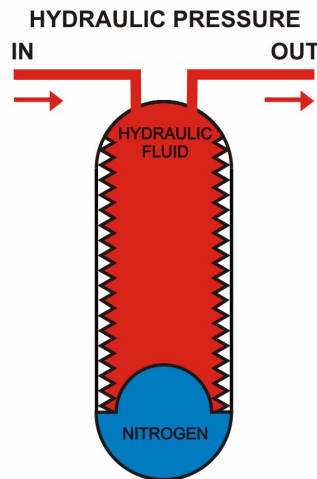


FIGURE 02-29-10-00 ACCUMULATOR DIAGRAM

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DISTRIBUTION

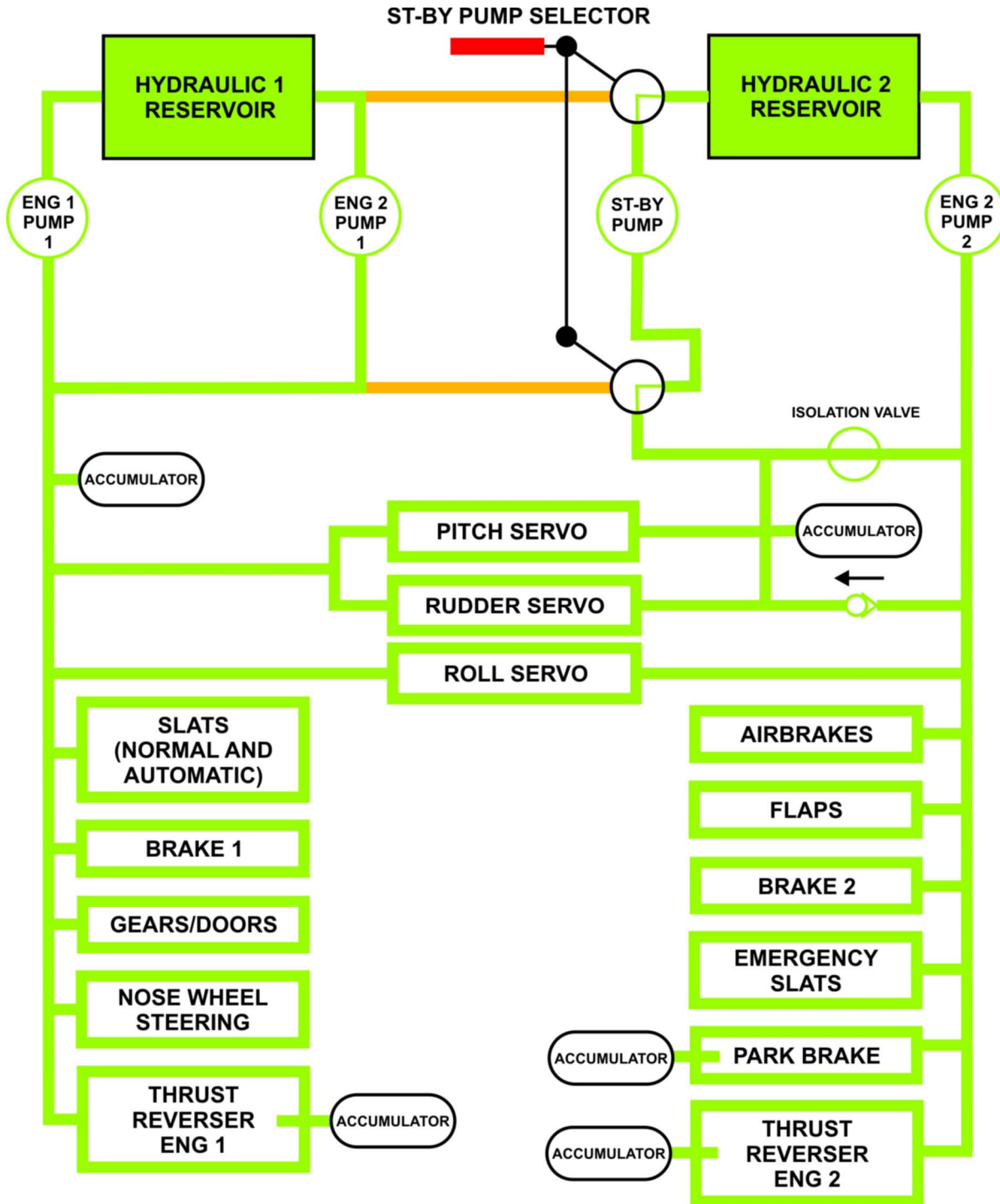


FIGURE 02-29-10-01 HYDRAULIC SYSTEM DIAGRAM

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HYD 1 SYSTEM

HYD 1 system is pressurized by two self-regulating (constant pressure) hydraulic pumps driven by the No 1 and No 2 engine gearboxes (HYDR #1 ENG 1 PUMP and HYDR #1 ENG 2 PUMP).

Both pumps draw operating fluid from the No 1 hydraulic reservoir and feed the system at a rated pressure of 3,000 psi (\pm 200 psi).

The output pressure of the pumps hydraulically charges the No 1 system accumulator and supplies pressure to:

- pitch servo-actuator (one barrel), rudder servo-actuator (one barrel), aileron servo-actuator (one barrel),
- normal and automatic slats,
- No 1 braking system,
- landing gears and corresponding doors,
- nose wheel steering,
- No 1 engine thrust reverser (with one pressure accumulator, not monitored).

HYD 2 SYSTEM

HYD 2 system is pressurized by one self-regulating (constant pressure) hydraulic pump (same characteristics as HYD 1 system pumps), driven by No 2 engine gearbox (HYDR #2 PUMP).

HYD 2 system can be pressurized by an electrical pump (ST-BY PUMP) connected to ESS bus (automatically activated in case of pressure drop below 1,650 psi).

PUMP 2 draws operating fluid from the No 2 hydraulic reservoir and feeds the system at a rated pressure of 3,000 psi (\pm 200 psi).

The output pressure of the pump hydraulically charges the No 2 system accumulator and supplies pressure to :

- pitch servo-actuator (one barrel), rudder servo-actuator (one barrel), aileron servo-actuator (one barrel),
- airbrakes,
- flaps,
- No 2 braking system,
- emergency slats,
- parking brake (with one monitored pressure accumulator),
- thrust reverser (with one pressure accumulator, not monitored).

Hydraulic fluid pressure and level are measured and displayed in hydraulic synoptic and status page.

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CONTROLS

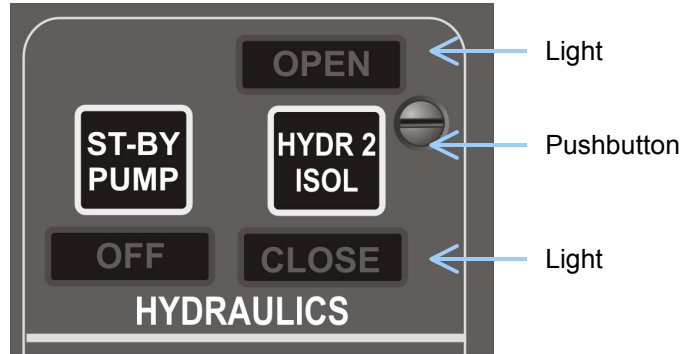





















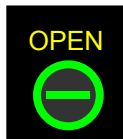







FIGURE 02-29-15-00 STAND-BY PUMP AND ISOLATION VALVE OVERHEAD PANEL CONTROLS

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SYNTHETIC TABLE

CONTROL	FUNCTION	TO ACTIVATE	SYNOPTIC
		TO DE-ACTIVATE	
	<ul style="list-style-type: none"> - ST-BY pump can be set to AUTO or OFF - It must be in AUTO position in flight (normal condition) - In the AUTO position, ST-BY pump starts operation when HYD 2 pressure drops below 1,650 psi and stops when pressure reaches 2,300 psi (green range on the psi scale is adjusted to normal operating range) 	Push on (AUTO)  	In AUTO mode  In AUTO mode running for more than 60 sec  On GROUND TEST 
		Push OFF  	OFF 
			Invalid data 

CONTROL	FUNCTION	TO ACTIVATE	SYNOPTIC
		TO DE-ACTIVATE	
	<ul style="list-style-type: none"> - HYDR 2 ISOL can be set to AUTO, OPEN or CLOSE - It must be in AUTO position in flight (normal condition) - In the AUTO position, on the ground, the isolation valve is automatically open. - In the AUTO position, in flight, the isolation valve is automatically open if the slats are extended, closed otherwise. 	Push AUTO   	In AUTO mode, open, nominal  In AUTO mode, closed, nominal  In AUTO mode, open, abnormal  In AUTO mode, closed, abnormal 
		Push OPEN   	In OPEN mode 
		Push CLOSE   	In CLOSE mode 
			Invalid data 

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INDICATION

Hydraulic indications are displayed on the MDU:

- in the HYD page,
- in the STAT page (hydraulic fluid quantity and pressure indications).

Direct-reading indicators are also available for the reservoir fluid levels in the aft servicing compartment.

MULTIFUNCTION DISPLAY UNIT (MDU)

Hydraulic synoptic page

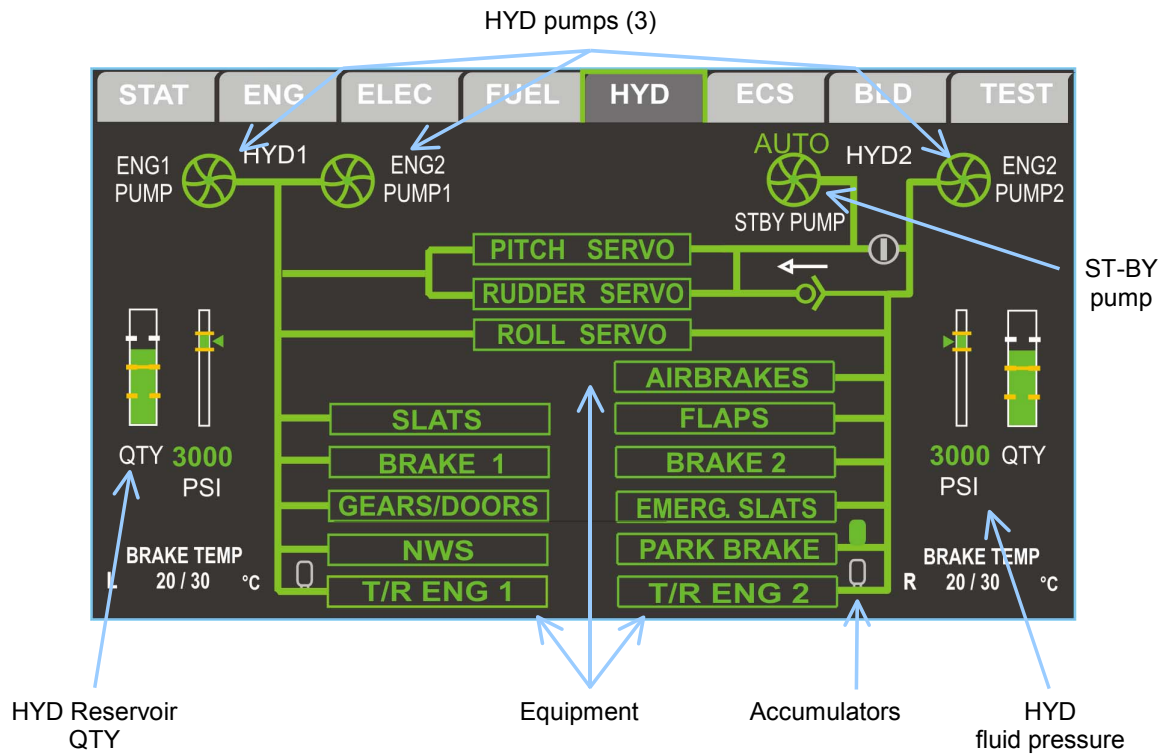


FIGURE 02-29-15-01 HYDRAULIC SYNOPTIC

NOTE

When the stand-by pump is active, the green range of the pressure indication scale is 1,550 to 2,400 psi.

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Examples of hydraulic level indications

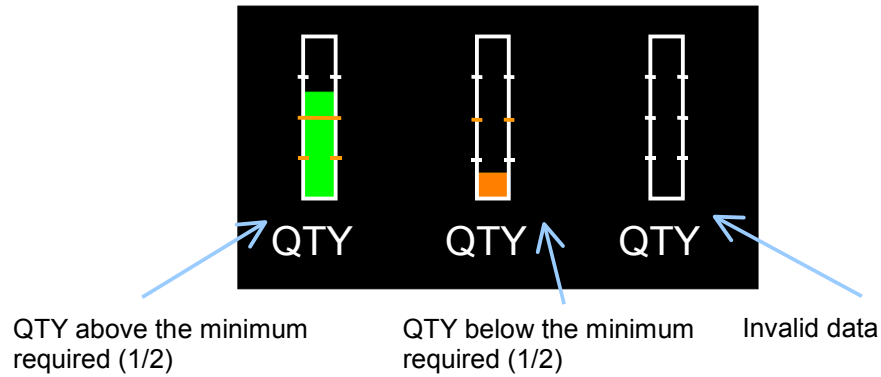


FIGURE 02-29-15-02 HYDRAULIC LEVEL INDICATORS

NOTE
ERRONEOUS INDICATION

When hydraulic tanks are empty, the hydraulic quantity indication is represented by a vertical rectangle filled with green.

Examples of hydraulic pressure indications

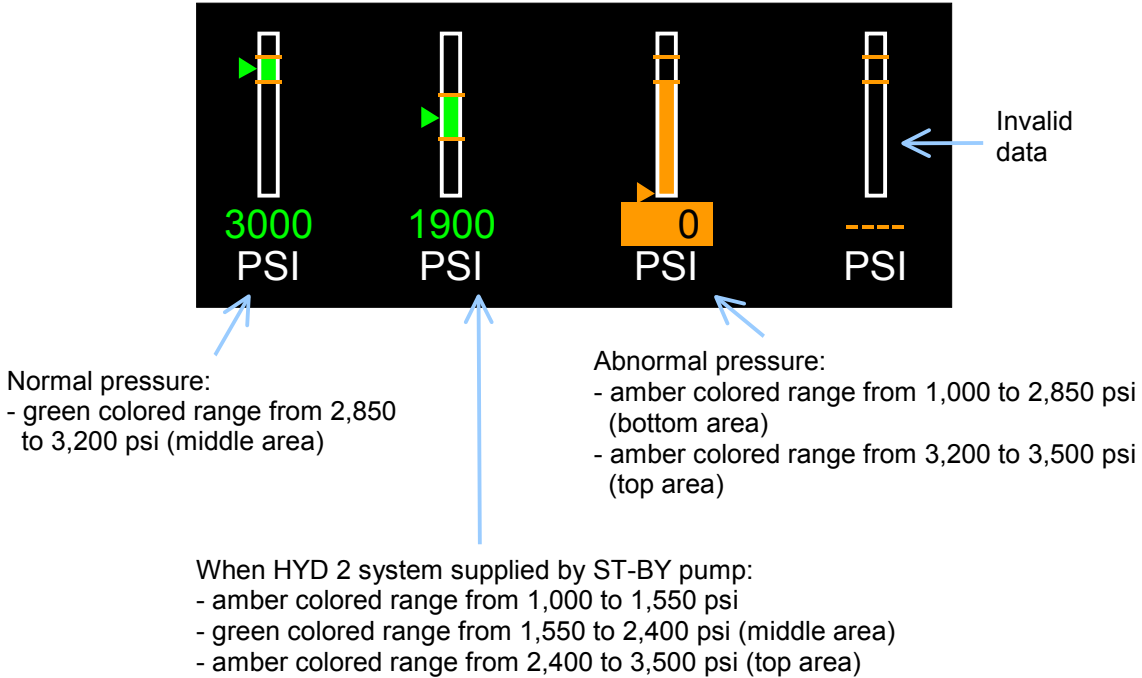


FIGURE 02-29-15-03 HYDRAULIC FLUID PRESSURE INDICATORS

NOTE

ERRONEOUS INDICATION

When hydraulic pressure is below 1,000 psi or above 3,500 psi, the bottoming or top band is black instead of amber.

Examples of hydraulic pump status

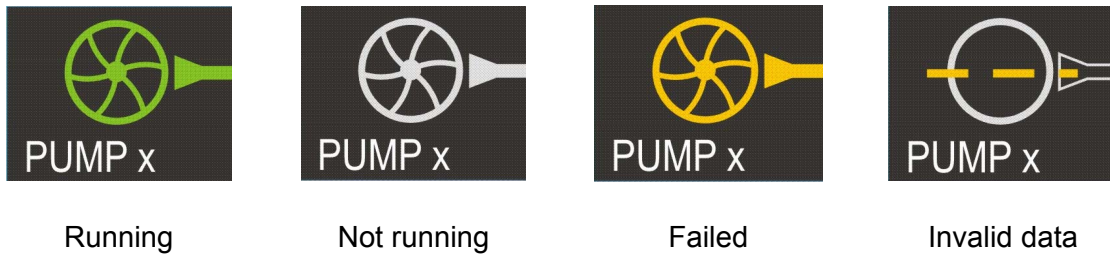


FIGURE 02-29-15-04 HYDRAULIC PUMP STATUS

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Examples of equipment status

In normal operation, symbols are green. If a failure occurs in a system, the symbols of equipment powered by this system become amber.

NOTE

As flight control actuators are connected to HYD 1 and HYD 2 systems, the corresponding symbols are (see figure below):

- GREEN, in normal operating conditions,
- AMBER, in case of total hydraulic power loss,
- Half GREEN / AMBER, in case of loss of one system.

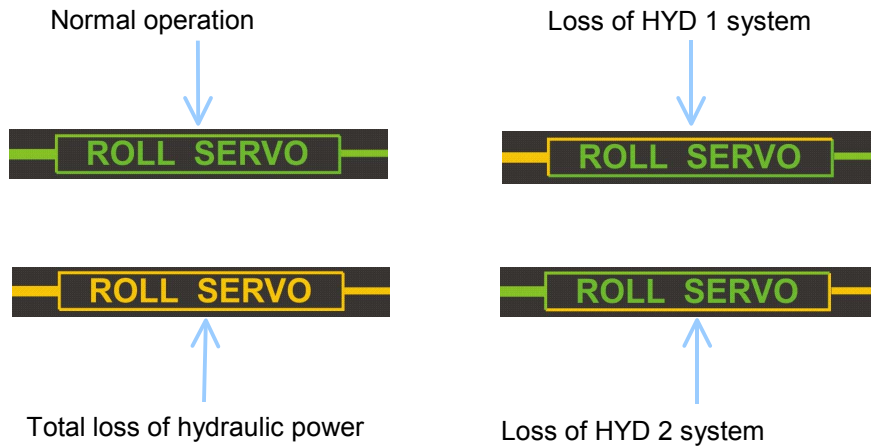


FIGURE 02-29-15-05 SYMBOLS OF FLIGHT CONTROLS

Examples of check valve status

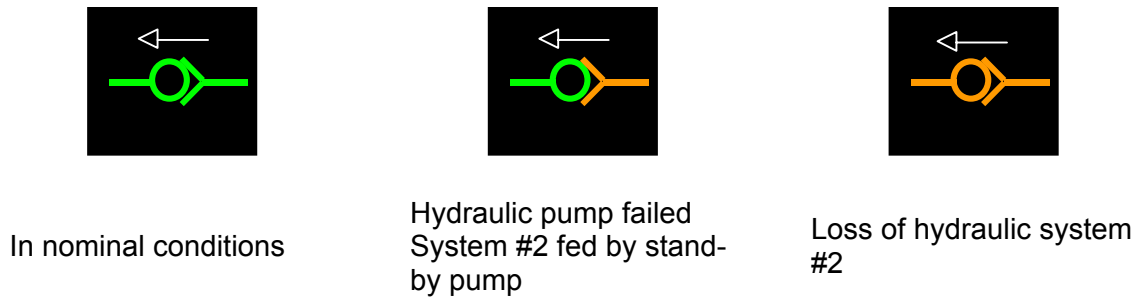


FIGURE 02-29-15-06 CHECK VALVE STATUS

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Park brake and Thrust Reverser (T/R) and corresponding accumulators

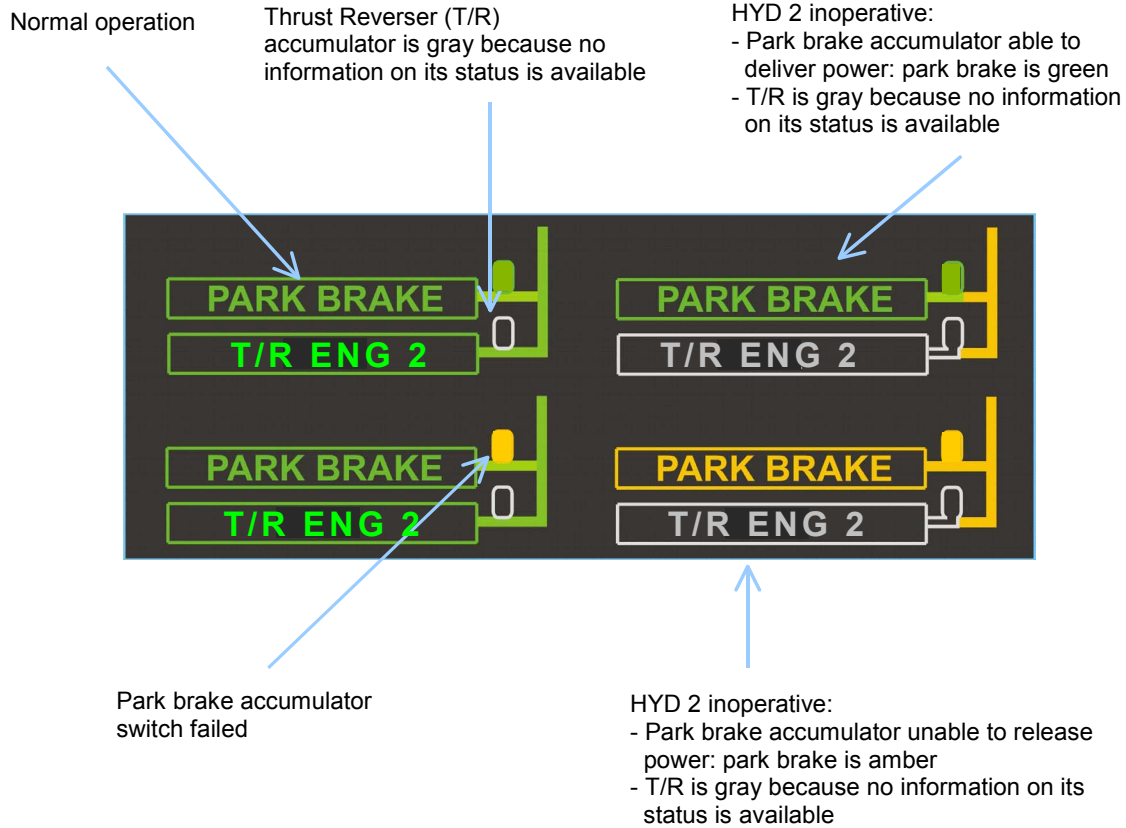
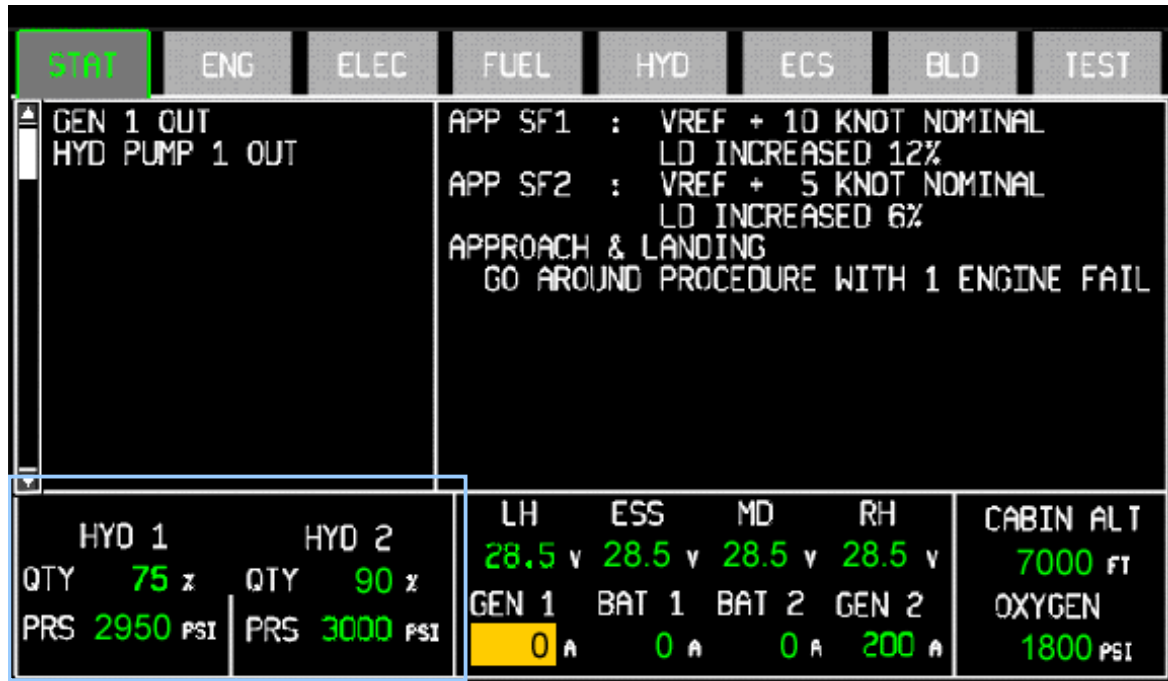


FIGURE 02-29-15-07 PARK BRAKE AND THRUST REVERSER INDICATIONS

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STATUS page



HYD 1 and HYD 2 fluid quantity and pressure indication

FIGURE 02-29-15-08 STATUS PAGE

ERRONEOUS INDICATION

When the HYD # 2 system is fed by stand-by pump, the stand-by pump values appear in amber (nominal range of ST-BY PUMP is $1,550 < P_{psi} < 2,400$). When the HYD # 2 does not operate, pressure delivered by stand-by pump may be seen by hydraulic pump 2 switch, since check valves allow a small volume of fluid to go through. If the pressure on the switch reaches the actuation point, the green range of pressure scale is changed (since hydraulic pump 2 switch signal is used in its definition). After correction, the definition of the green range will no more be based on hydraulic pump 2 switch state.

On hydraulic synoptic, lines between accumulators symbols and corresponding consumers symbols are always hollow green, amber or gray.

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DIRECT READING INDICATORS

Fluid level indicator

Each reservoir is equipped with a window showing the min. and max. fluid levels, respectively corresponding to 6 to 7.4 l (1.59 to 1.95 USG) for hydraulic system 1 reservoir and 4.6 to 6 l (1.22 to 1.59 US gal.) for hydraulic system 2 reservoir

They are located in the aft servicing compartment.



Hydraulic reservoir

Level window

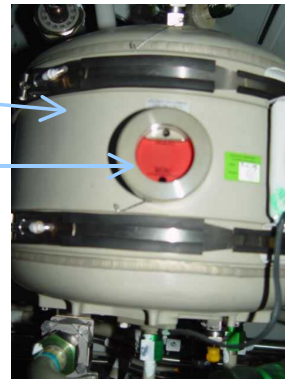


FIGURE 02-29-15-09 HYDRAULIC FLUID LEVEL DIRECT READING INDICATOR

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CIRCUIT BREAKERS

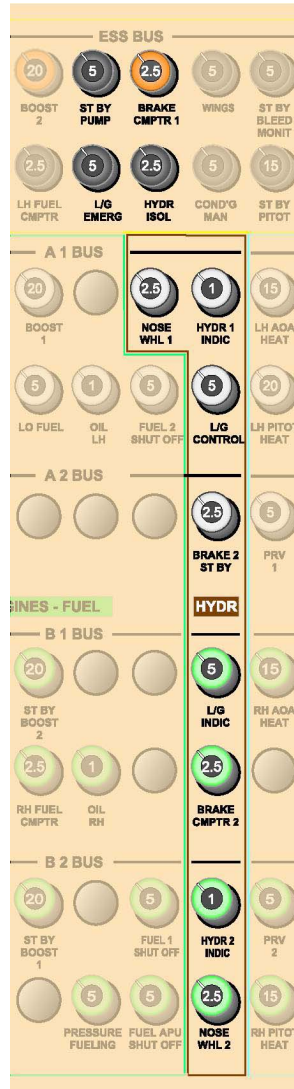


FIGURE 02-29-20-00 HYDRAULIC SYSTEMS CIRCUIT BREAKERS

RELIEF VALVES

Reservoir overpressure is prevented by a relief valve.

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GENERAL

In the following, typical on ground and in-flight situations have been selected to help the crew to understand the symbols provided in the various panels and displays.

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ON GROUND OPERATION

OVERHEAD PANEL

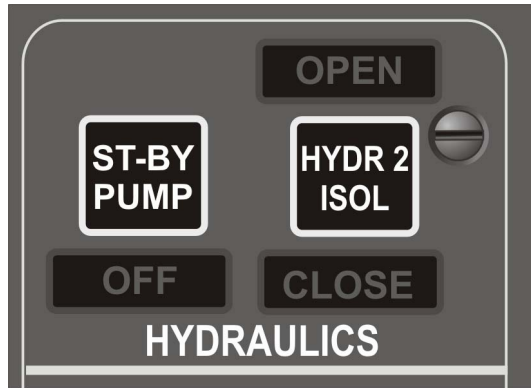


FIGURE 02-29-25-00 HYDRAULICS OVERHEAD PANEL CONTROLS

AIRPLANE WITH AUXILIARY POWER UNIT (APU) OPERATING

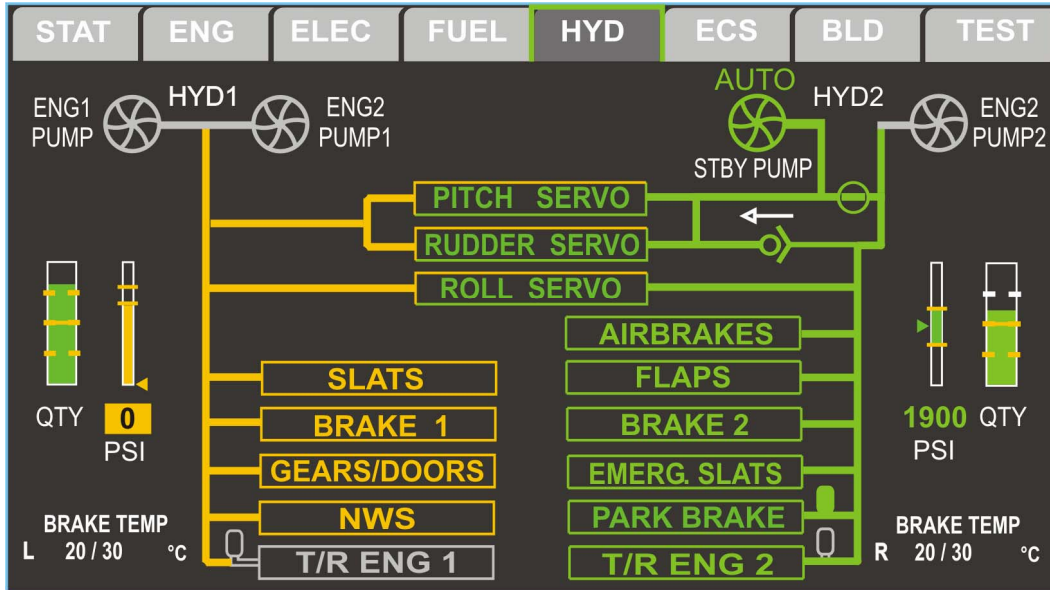


FIGURE 02-29-25-01 HYDRAULIC SYNOPTIC, APU OPERATING AND STAND-BY PUMP AUTO

NORMAL STATUS	RESULT
Hydraulic engine-driven pumps ENG 1 PUMP, ENG 2 PUMP 1 and ENG 2 PUMP 2 are inactive as engines are not running	HYD pumps synoptics are gray and HYD 1 system is inoperative.
ST-BY PUMP overhead panel pushbutton in AUTO position	ST-BY pump cycling as HYD 2 is inactive, HYD 2 equipment synoptics are green.
HYDR 2 ISOL overhead panel pushbutton in AUTO position	Isolation valve is open.

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IN-FLIGHT OPERATION

OVERHEAD PANEL

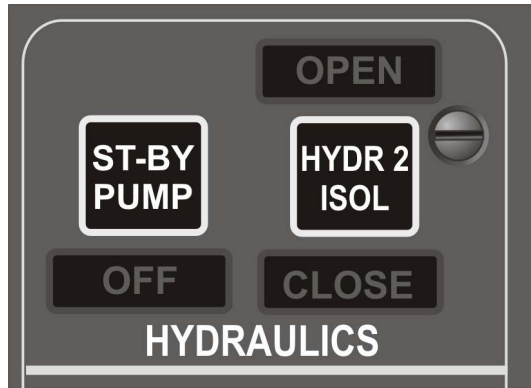


FIGURE 02-29-25-02 HYDRAULICS OVERHEAD PANEL CONTROLS

AIRPLANE FLYING IN NORMAL OPERATION (2 ENGINES RUNNING, SLATS RETRACTED)

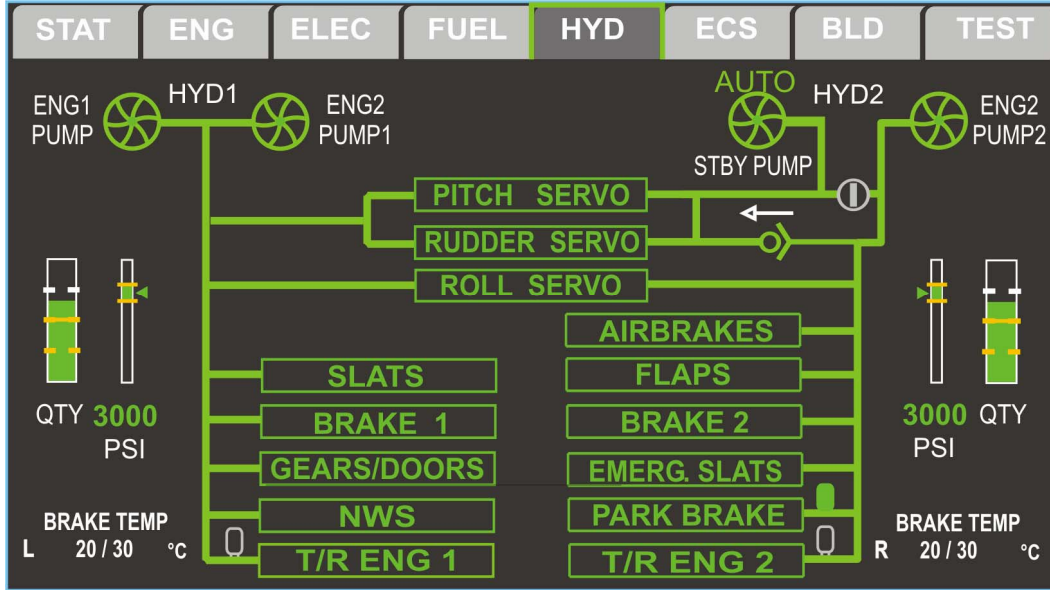


FIGURE 02-29-25-03 HYDRAULIC SYNOPTIC, NORMAL OPERATION

NORMAL STATUS	RESULT
Hydraulic engine-driven pumps ENG 1 PUMP, ENG 2 PUMP 1 and ENG 2 PUMP 2 active	HYD 1 and HYD 2 systems operating: <ul style="list-style-type: none"> - HYD pumps synoptics are green, - HYD 1 and HYD 2 system equipment synoptics are green
ST-BY PUMP overhead panel pushbutton in AUTO position	AUTO indication above ST-BY pump synoptic
HYDR 2 ISOL overhead panel pushbutton in AUTO position	Isolation valve is closed

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GENERAL

In the following, typical abnormal situations have been illustrated to help the crew to understand the symbols provided in the various panels and displays.

HYD 2 SYSTEM FAILURE

ABNORMAL STATUS

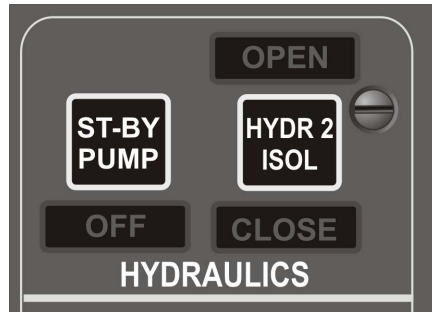


FIGURE 02-29-30-00 HYDRAULICS OVERHEAD PANEL CONTROLS

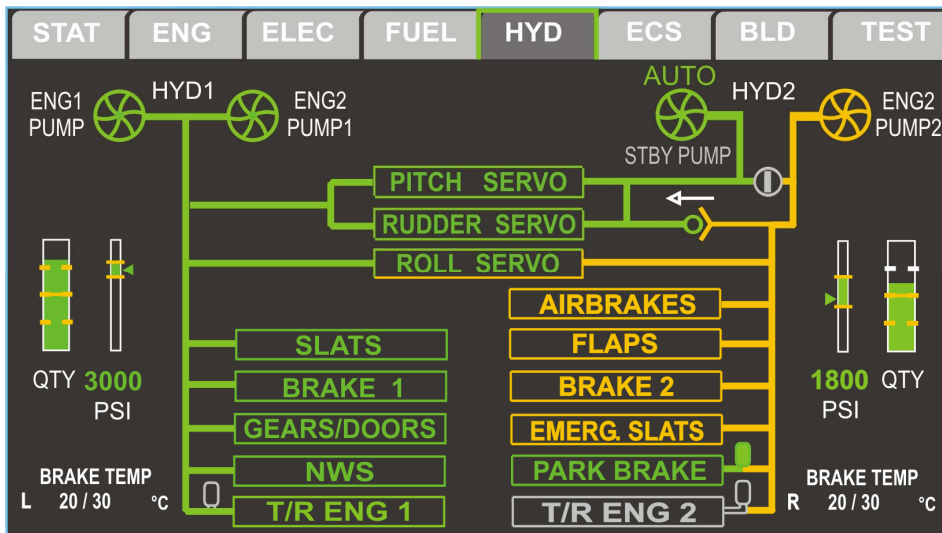


FIGURE 02-29-30-01 HYDRAULIC SYNOPTIC

CONTEXT	RESULT
<p>HYD 2 fluid leak or ENG 2 PUMP 2 failure</p>	<ul style="list-style-type: none"> - HYD 2 fluid quantity synoptic is amber - HYD 2 hydraulic pressure synoptic is green + HYDR #2 PUMP CAS message + light on

IF HYD2 FLUID LEAK ON PITCH OR RUDDER SERVO

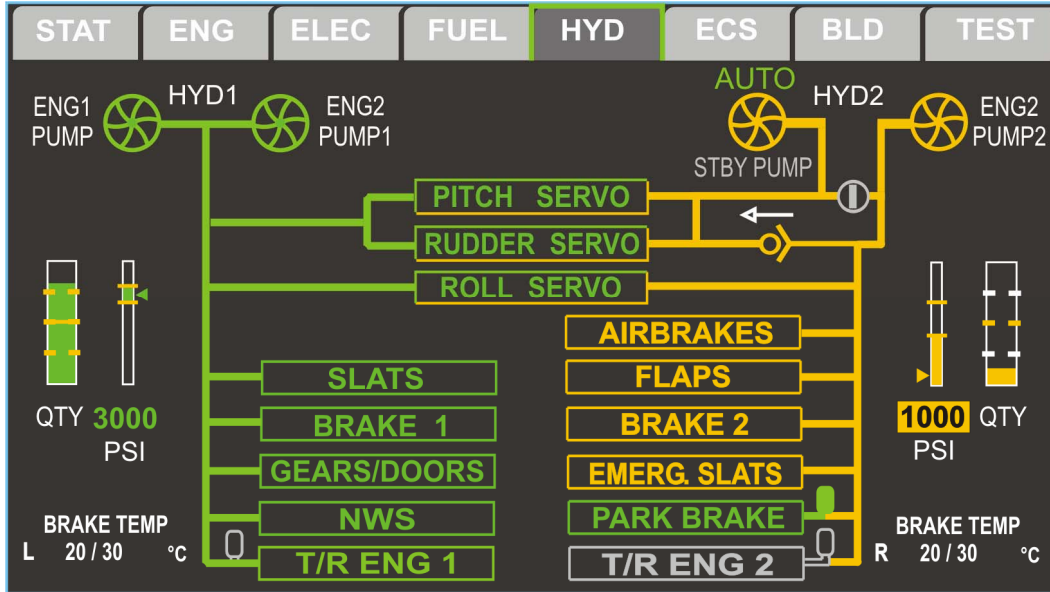


FIGURE 02-29-30-02 HYDRAULIC SYNOPTIC

CONTEXT	RESULT
<p>ST-BY pump on AUTO, running for more than 60 sec</p>	<ul style="list-style-type: none"> - ST-BY pump synoptic is amber - STBY PUMP PERMANENT CAS message - HYDRAULIC LOW LEVEL CAS message + light on

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AFTER PROCEDURE COMPLETE

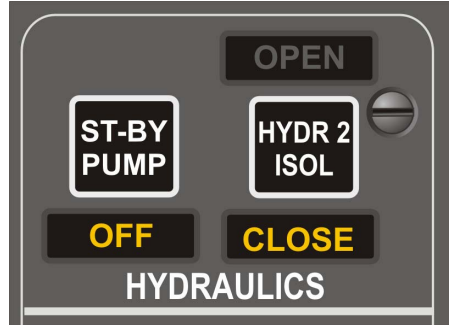


FIGURE 02-29-30-03 HYDRAULICS OVERHEAD PANEL CONTROLS

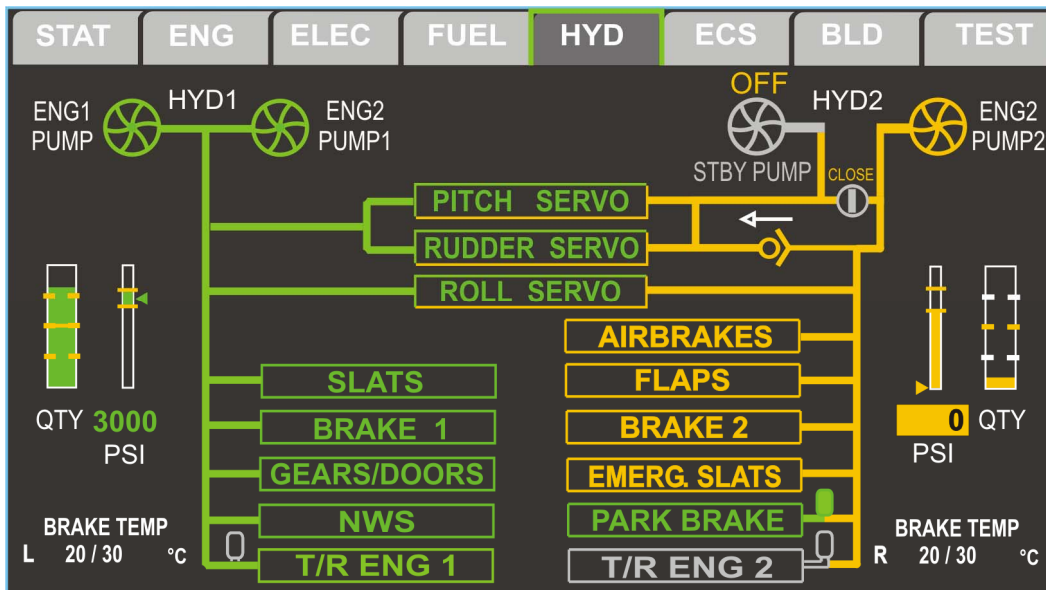


FIGURE 02-29-30-04 HYDRAULIC SYNOPTIC, HYD 2 PRESSURE BELOW 1,500 PSI

ACTION	RESULT
ST-BY PUMP overhead panel pushbutton set to OFF	ST-BY pump synoptic is gray with OFF indication in amber
HYDR 2 ISOL overhead panel pushbutton set to CLOSE	Isolation valve is gray and closed

ENG 1 PUMP AND ENG 2 PUMP 1 FAILURE

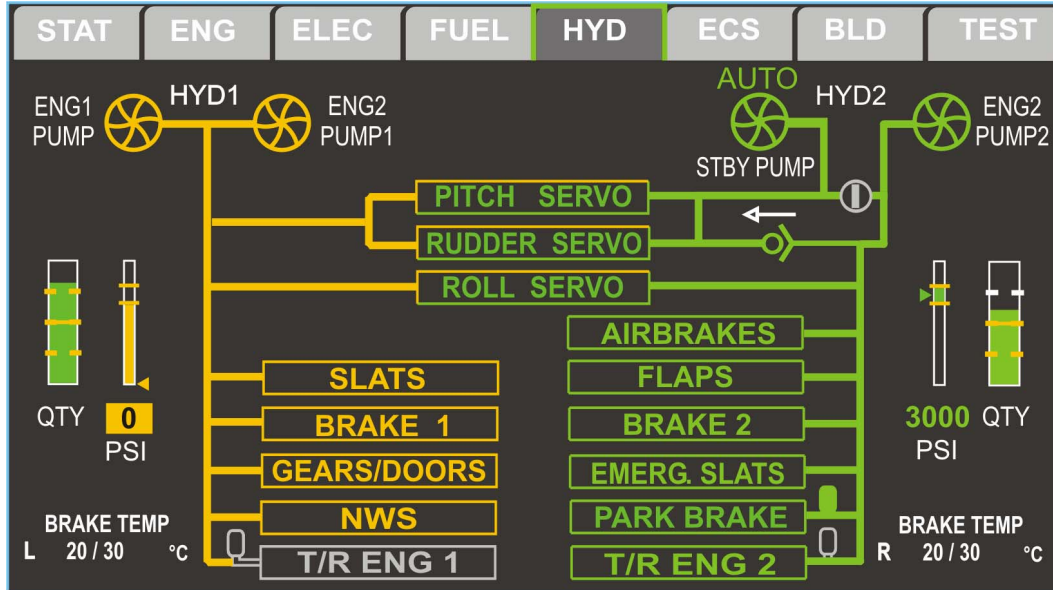


FIGURE 02-29-30-05 HYDRAULIC SYNOPTIC

CONTEXT	RESULT
<p>ENG 1 PUMP and ENG 2 PUMP 1 failure</p>	<ul style="list-style-type: none"> - ENG 1 PUMP, ENG 2 PUMP 1, HYD 1 pressure and equipment synoptics in amber. + HYDR #1 ENG 1+2 PUMP CAS message + light on

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CAS MESSAGES

CAS MESSAGE	DEFINITION
BOTH HYDR SYSTEM	Too low hydraulic pressure at pump outputs with engines running
ABNORMAL ISOL VALVE	After a 2 sec delay, abnormal status of the valve
HYDR #1 ENG .. PUMP	Hydraulic pump 1 or/and 2 failure (HYD 1 system)
HYDR #2 PUMP	Hydraulic pump 2 failure (HYD 2)
HYDRAULIC LOW LEVEL ...	Hydraulic level (1 or/and 2) less than ½
HYDR TK PRESS ..	Air pressure in hydraulic reservoir (1 or/and 2) drops below 16 psi
STBY PUMP ON C#1	Stand-by pump connected to HYD 1 system for maintenance
STBY PUMP PERMANENT	Permanent cycling of stand-by pump
HYDR .. FAIL	On ground, failure of hydraulic pressure switch (1 or/and 2)