DOCKET NO. SA-510

EXHIBIT NO. 2H

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

EXCERPTS FROM:
B-737/400
PILOT'S HANDBOOK
HYDRAULIC SYSTEM

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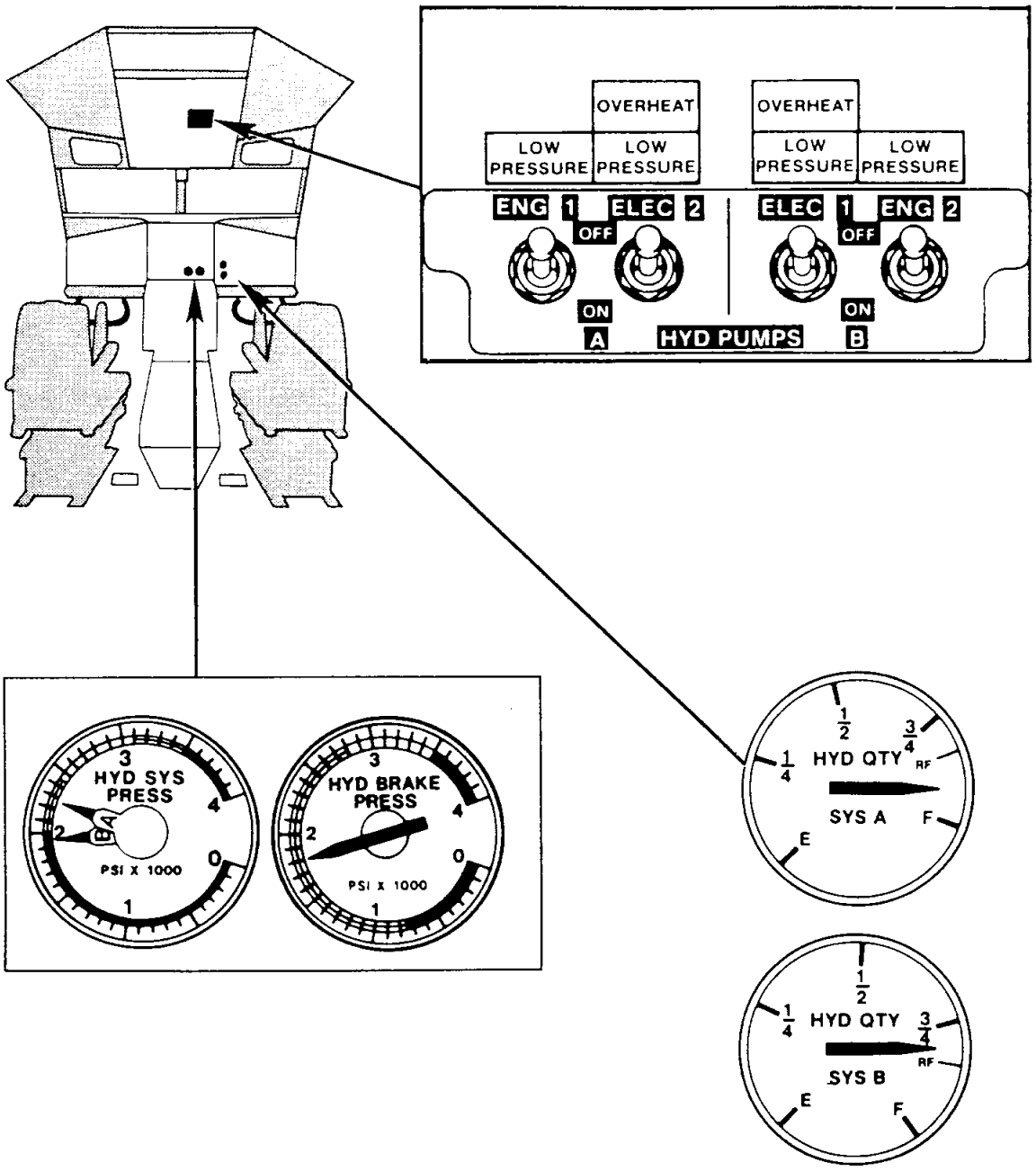

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INTRODUCTION

Hydraulic power is provided by three independent sources as follows:

— SYSTEM "A" — System "A" pressure is provided by the No. 1 engine-driven pump and an electric motor pump powered by the No. 2 electrical system.

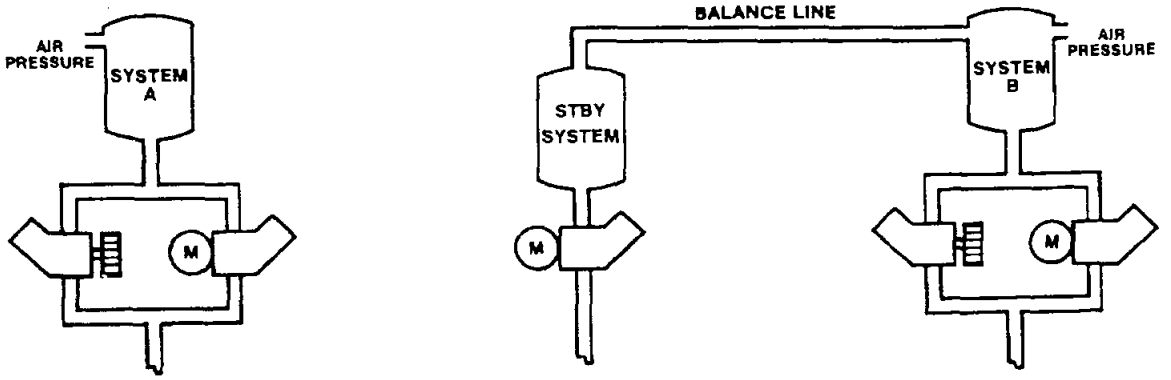
— SYSTEM "B" — System "B" pressure is provided by the No. 2 engine-driven pump and an electric motor pump powered by the No. 1 electrical system.

— STANDBY SYSTEM — The standby system is used in the event of loss of either system "A" or system "B" pressure. Standby pressure is provided by one electric motor-driven pump.

Nominal operating pressure for each hydraulic system is 3,000 PSI.

Each hydraulic system has a fluid reservoir located in the main wheel well area. The system "A" and system "B" reservoirs are pressurized by the pneumatic manifold. The standby reservoir is pressurized, and the fluid maintained at the full level, by an interconnected balance line to the system "B" reservoir, pressurization of all three reservoirs ensures a positive fluid flow to all hydraulic pumps.

A power transfer unit (PTU) provides an alternate source of hydraulic pressure to insure operation of the auto slat system and leading edge flaps and slats if required. The PTU valve will open should the system "B" engine driven pump pressure drop below limits when airborne with the flaps less than 15 but not up. System "A" pressure drives a hydraulic motor, which in turn drives a pump, pressurizing system "B" fluid.



HYDRAULIC SYSTEM "A"

DESCRIPTION

System "A" fluid quantity is displayed on an indicator located on the F/O's panel. System "A" utilizes two pumps, one is engine-driven from the No. 1 engine, the other is an electric motor pump powered by the No. 2 electrical system. A hydraulic shutoff valve, controlled by engine fire shutoff handle No. 1, is installed in the supply line between the reservoir and the engine driven pump. Pulling the engine fire shutoff handle shuts off the fluid flow to the pump and deactivates the associated LOW PRESSURE light.

The engine-driven hydraulic pump output pressure is controlled by the ENG pump ON/OFF switch. Positioning the switch to OFF activates the solenoid-held blocking valve and isolates fluid flow from the using units.

The electric motor pump is controlled by the ELEC 2 pump ON/OFF switch. Temperature sensors are located in the case drain line and pump housing. If the fluid or pump becomes overheated, the OVERHEAT light illuminates. On some aircraft, if the pump becomes overheated, power to the motor is switched off and the LOW PRESSURE light illuminates. If the fluid becomes overheated, the OVERHEAT light illuminates.

Hydraulic fluid is used for cooling and lubrication of the pumps and passes through a heat exchanger before returning to the reservoir. The heat exchanger for system "A" is located in the No. 1 main fuel tank.

Pressure transmitters, located in the engine-driven and electric motor pump output lines, send signals to illuminate the appropriate LOW PRESSURE light if pump output pressure is below acceptable limits. Check valves isolate the two pumps. A system transmitter sends the combined pressure of the pumps to the "A" needle of the hydraulic system pressure indicator.

If a leak develops in the engine-driven pump, or its associated lines, a standpipe in the reservoir prevents a total system fluid loss. The reservoir indicates approximately ¼ full. System "A" pressure is maintained by the electric motor-driven pump. Should a leak occur in any other system "A" components or lines, the quantity in the reservoir steadily decreases to zero.

The using units are the power transfer unit, ailerons, rudder, left thrust reverser, elevator and elevator feel, inboard flight spoilers, alternate brakes, ground spoilers, autopilot "A", nosewheel steering, landing gear transfer unit, and landing gear.

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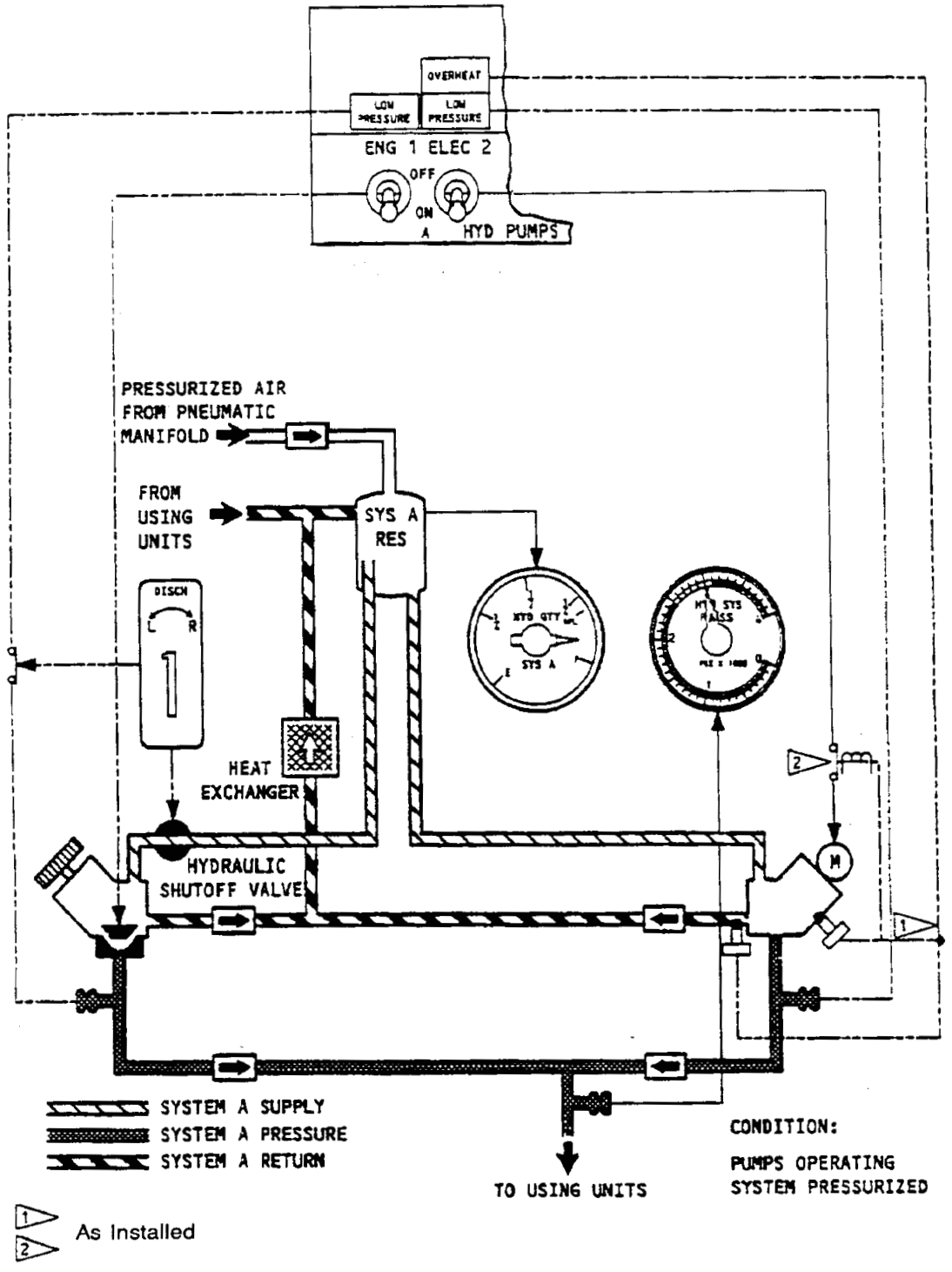
HYDRAULIC SYSTEM "A" (cont'd.)

SCHEMATIC



HYDRAULIC SYSTEM "B"

DESCRIPTION

System "B" fluid quantity is displayed on an indicator located on the F/O's panel. System "B" utilizes two pumps, one is engine-driven from the No. 2 engine, the other is an electric motor pump powered by the No. 1 electrical system. A hydraulic shutoff valve, controlled by engine fire shutoff handle No. 2, is installed in the supply line between the reservoir and the engine driven pump. Pulling the engine fire shutoff handle shuts off the fluid flow to the pump and deactivates the associated LOW PRESSURE light.

The system "B" reservoir has two standpipes, one supplies fluid to the engine-driven pump, the other to the electric motor pump. If a leak should develop in the engine-driven pump or its associated lines, the system "B" quantity gauge indicates approximately ½ full. System pressure is maintained by the electric motor pump. If the leak is in the electric motor pump or its associated lines, system "B" pressure is lost; however, sufficient fluid will be retained in the reservoir for operation of the power transfer unit.

The engine-driven hydraulic pump output pressure is controlled by the ENG pump ON/OFF switch. Positioning the switch to OFF activates the solenoid-held blocking valve and isolates fluid flow from the using units.

The electric motor pump is controlled by the ELEC 1 pump ON/OFF switch. Temperature sensors are located in the case drain line and pump housing. If the fluid or pump becomes overheated, the OVERHEAT light illuminates. On some airplanes, if the pump becomes overheated, power to the motor is switched off and the LOW PRESSURE light illuminates. If the fluid becomes overheated, the OVERHEAT light illuminates.

Hydraulic fluid is used for cooling and lubrication of the pumps and passes through a heat exchanger before returning to the reservoir. The heat exchanger for system "B" is located in the No. 2 main fuel tank.

Pressure transmitters, located in the engine-driven and electric motor pump output lines, send signals to illuminate the appropriate LOW PRESSURE light if pump output pressure is below acceptable limits. Check valves isolate the two pumps. A system transmitter sends the combined pressure of the pumps to the "B" needle of the hydraulic system pressure indicator.

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HYDRAULIC SYSTEM "B" (cont'd.)

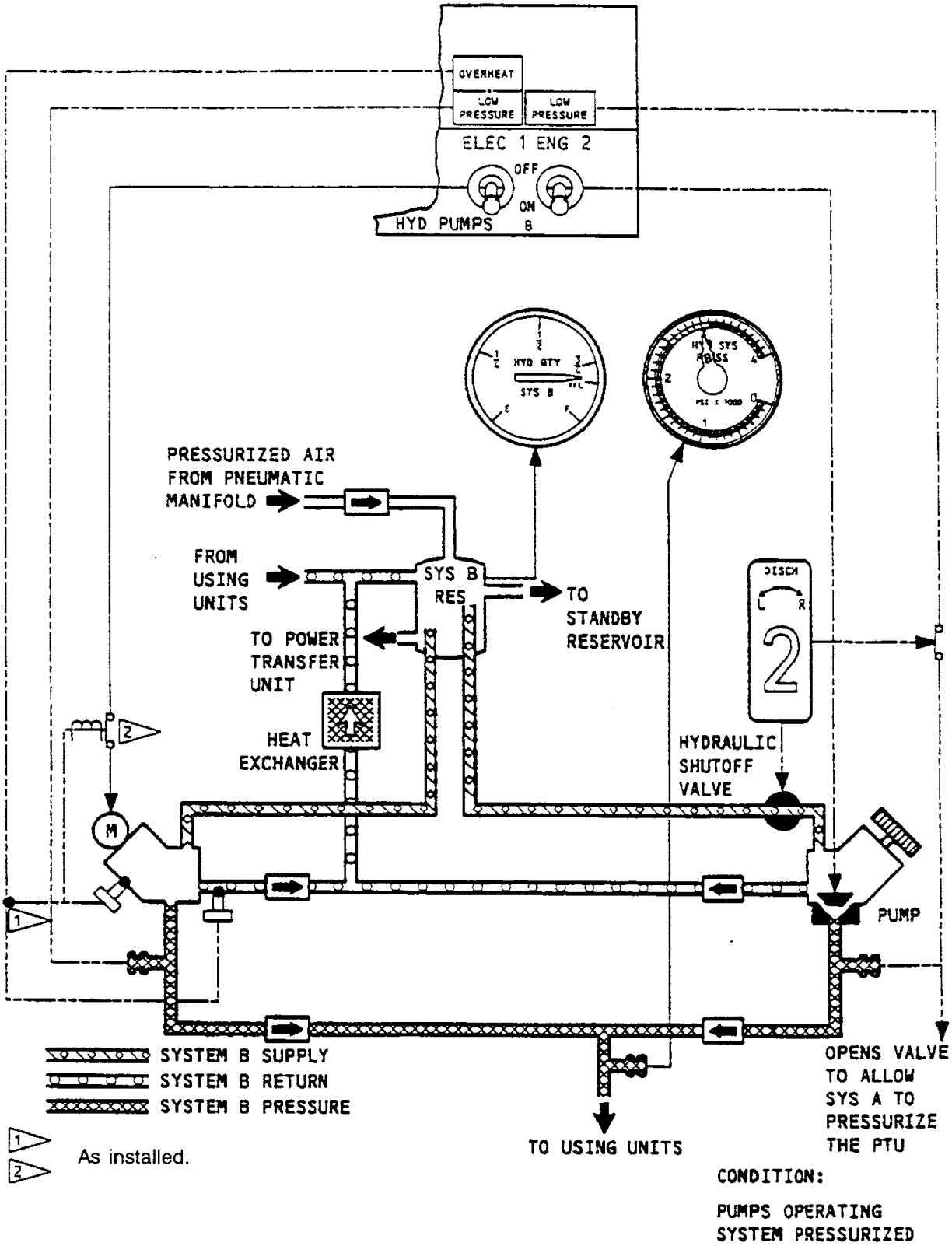
DESCRIPTION (cont'd.)

A power transfer unit provides a back-up source of hydraulic power to operate the autoslats, should the system "B" engine-driven pump pressure drop below limits. System "A" pressure, supplied through a normally closed shutoff valve, will drive a hydraulic motor, which in turn drives a pump. The pump will pressurize system "B" fluid from the reservoir to supply the autoslat system.

The using units are the leading edge flaps and slats, autoslats, ailerons, rudder, right thrust reverser, elevator and elevator feel, outboard flight spoilers, normal brakes, yaw damper, autopilot B, and trailing edge flaps. System "B" pressure is available to power the landing gear transfer unit in the event of a loss of engine No. 1.

HYDRAULIC SYSTEM "B" (cont'd.)

SCHEMATIC



1 2 As installed.

STANDBY HYDRAULIC SYSTEM

DESCRIPTION

The standby hydraulic system is provided as a backup in the event normal system "A" or "B" pressure is lost. The standby system reservoir is connected to the system "B" reservoir through a balance line for pressurization and servicing.

If a leak occurs in the standby system, the standby reservoir quantity decreases to zero, and the LOW QUANTITY light illuminates. The system "B" reservoir fluid level decreases and stabilizes between ½ and the RF indications.

The single electric motor-driven hydraulic standby pump is activated by positioning either FLT CONTROL switch to its STDBY RUD position, or by positioning the ALTERNATE FLAPS master switch to ARM. The standby system is also activated automatically when the flaps are extended and system "A" or system "B" pressure is lost, if the following condition exists: wheel spin-up signal of greater than 60 knots or in flight. This provides power to the standby rudder actuator during takeoff or landing in the event of system "A" or system "B" pressure loss.

Positioning either FLT CONTROL switch to STDBY RUD will also shut off the corresponding hydraulic system pressure to the ailerons, elevators, elevator feel, and the rudder. The associated FLT CONTROL LOW PRESSURE light will be deactivated as the standby rudder valve opens.

In the event of a loss of system "A" or "B" hydraulic pressure during takeoff or landing, the standby system is activated automatically to provide power to the standby rudder actuator. The automatic operation of the standby system pump is deactivated when flaps are moved to UP.

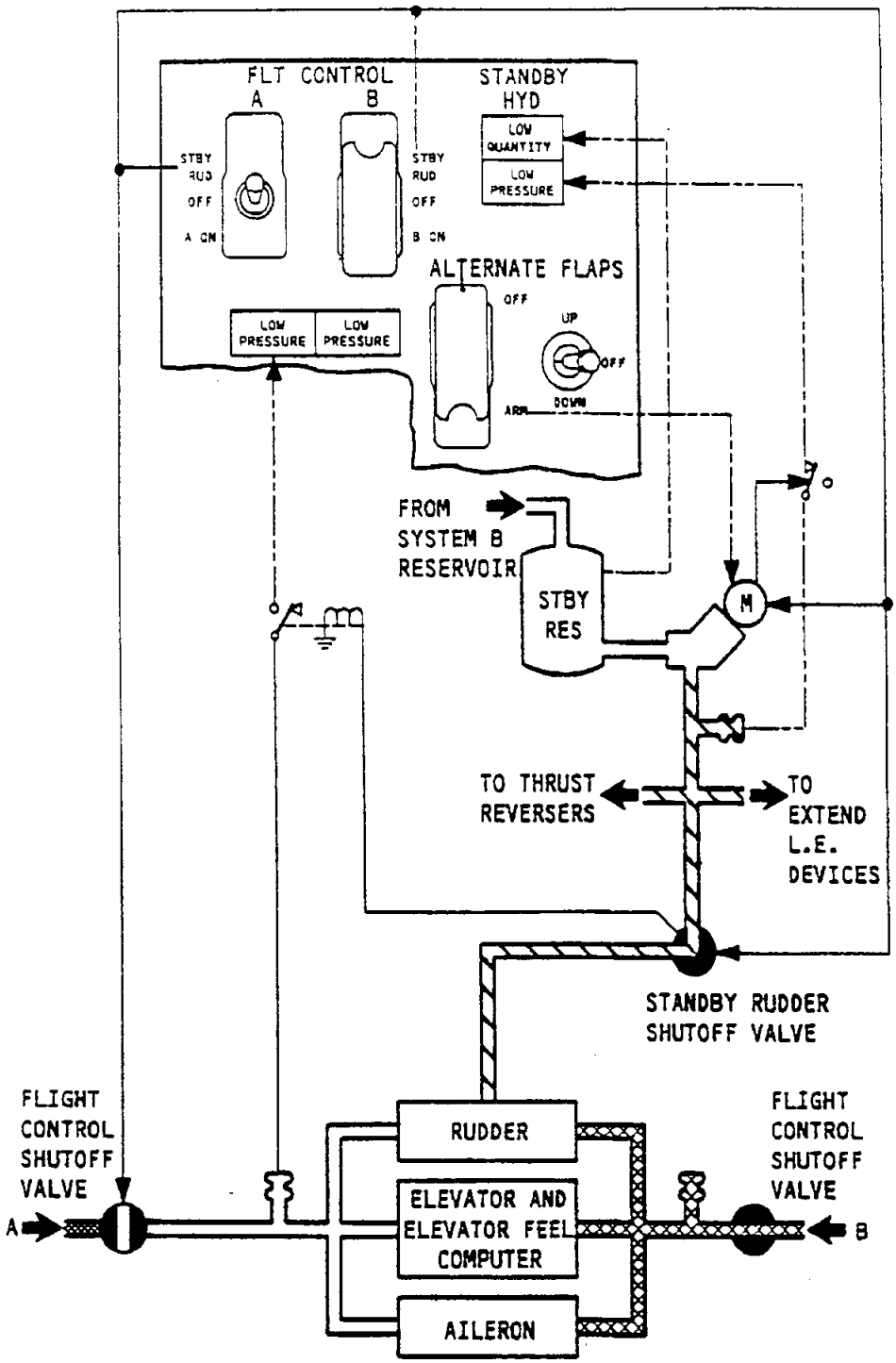
In the event of system "B" pressure loss, the leading edge devices may be extended by positioning the ALTERNATE FLAPS master switch to ARM and momentarily positioning the ALTERNATE FLAPS position switch to DOWN. The leading edge devices are fully extended hydraulically, but cannot be retracted by the standby hydraulic system. The trailing edge flaps may be extended or retracted electrically.

With the loss of system "A" or "B", the standby system will provide pressure to operate the respective thrust reverser.

The standby system LOW QUANTITY light is always armed. The LOW PRESSURE light is armed only when standby pump operation has been selected.

STANDBY HYDRAULIC SYSTEM (cont'd.)

SCHEMATIC



STANDBY RUDDER SHUTOFF VALVE and STANDBY PUMP OPERATE AUTOMATICALLY WHEN:

- Loss of system A or B.
- Flaps extended.
- Airborne or wheel speed greater than 60 knots.

CONDITION:

SYSTEM A LOST
STANDBY SYSTEM AND
SYSTEM B PRESSURIZED

HYDRAULIC QUANTITY INDICATION VARIATIONS

System hydraulic quantity indications may vary considerably during normal flight. The quantity of fluid indicated on the cockpit gauges represents only a small percentage of the total hydraulic fluid in the system. Consequently, the loss of a gallon or more of fluid may be quite impressive when viewed on the gauges, but generally has little or no affect on the operations of the systems.

During normal operations, hydraulic quantity indications vary when the system becomes pressurized after engine start, when raising or lowering the landing gear or leading edge devices, or when cold soaking occurs during long periods of cruise.

Erroneous hydraulic quantity indications occur when electrical power to an indicator is lost or a reservoir float malfunctions. During these instances, other system indications remain normal.

If the hydraulic system is not properly pressurized, foaming can occur at higher altitudes. Foaming can be recognized by pressure fluctuations and the blinking of the LOW PRESSURE lights. THE MASTER CAUTION and HYDRAULIC annunciator lights may also illuminate momentarily.

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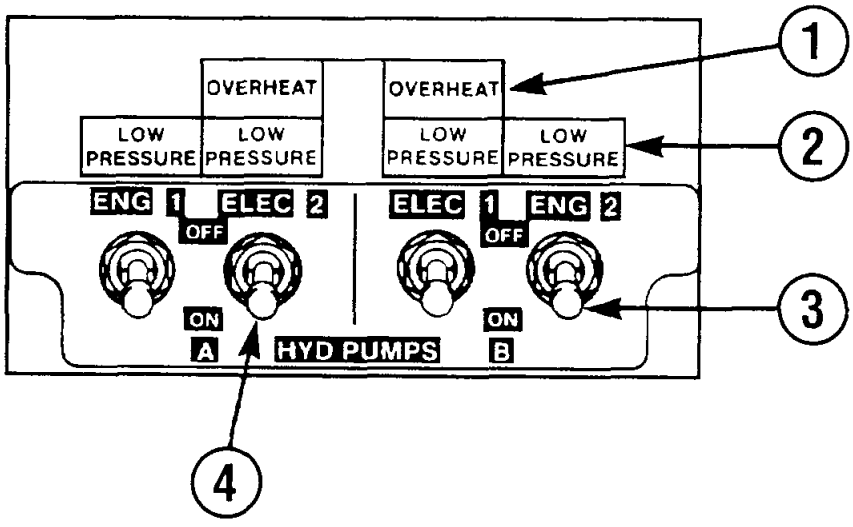
HYDRAULICS

CONTROLS AND INDICATORS



(Overhead Panel)

(1) ELEC MOTOR PUMP OVERHEAT LIGHTS (2, Amber):

ILLUMINATED — Hydraulic fluid used to cool and lubricate the corresponding electric motor-driven pump has overheated.

(2) HYD PUMPS LOW PRESSURE LIGHTS (4, Amber): ←

ILLUMINATED — Output pressure of corresponding pump is low. When a fire shutoff handle is pulled, the fluid flow to the associated engine-driven pump is shut off and the LOW PRESSURE light is deactivated.

(3) ENGINE-DRIVEN PUMP SWITCHES:

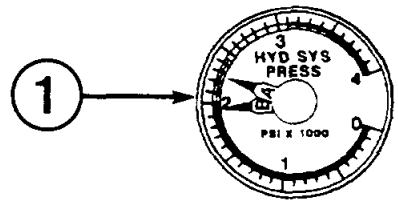
ON — De-energizes blocking valve in pump to allow pump pressure to enter system. Should remain ON at shutdown to prolong solenoid life.

OFF — Energizes blocking valve to block pump output.

(4) ELEC MOTOR PUMP SWITCHES:

ON — Provides power to corresponding electric motor-driven pump.

CONTROLS AND INDICATORS (cont'd.)

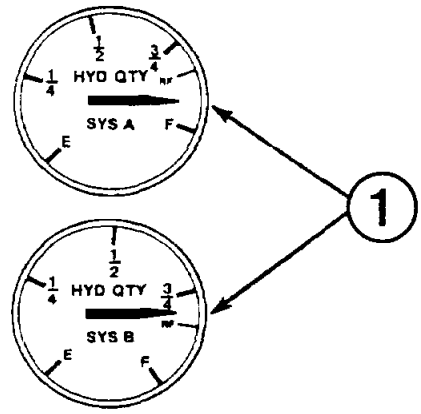


(Center Instrument Panel)

(1) HYD SYS PRESS INDICATOR:

Indicates hydraulic system "A" and "B" pressures. When both pumps for respective systems are OFF, pointers will read zero.

NOMINAL PRESSURE — 3,000 PSI.
MAXIMUM PRESSURE — 3,500 PSI.



(F/O's Instrument Panel)

(1) HYD SYS QTY INDICATORS:

SYS A: **FULL** — 4.7 U.S. Gallons.
REFILL — 4.2 U.S. Gallons.

SYS B: **FULL** — 7.2 U.S. Gallons.
REFILL — 6.4 U.S. Gallons.