A350
TECHNICAL TRAINING MANUAL
MAINTENANCE COURSE - T1+T2 - RR Trent XWB
Hydraulic Power

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It will not be updated.

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HYDRAULIC POWER

V1813401 - V01T0M0

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Generalities

There are two main hydraulic-power systems, the Green and the Yellow systems. These two hydraulic systems operate at the same time. Each hydraulic system operates independently. There is no hydraulic fluid flow between them.
The Green hydraulic system supplies hydraulic power to the consumers that follow:
- The flap Power Control Unit (PCU)
- The Main Landing Gear (MLG) pitch trimmer (left and right)
- The left and right outboard ailerons
- The Electro-Hydrostatic Actuator (EHA) of the right inboard aileron (for refilling)
- Left and right spoilers 3, 4 and 6
- The rudder middle actuator
- The EHA of the rudder lower actuator (for refilling)
- The left elevator
- The EHA of the left elevator (for refilling)
- The Ram Air Turbine (RAT) for the retraction actuator
- The MLG extension/retraction system, with a priority valve
- The normal and parking brakes - "The Green group"

The Yellow hydraulic system supplies hydraulic power to the consumers that follow:
- The slat and flap PCU
- The back-up power supply
- The left and right outboard ailerons
- The left and right inboard ailerons
- The EHA of the left inboard aileron (for refilling)
- Left and right spoilers 1, 2 and 7
- The Electrical Backup Hydraulic Actuator (EBHA) of left and right spoiler 5
- The rudder upper actuator
- The right elevator
- The Nose Wheel Steering (NWS)
- The Nose Landing Gear (NLG) extension/retraction system
- The normal and parking brakes - "The Yellow group"
- The FWD and AFT Cargo Door Actuation System (CDAS).

The hydraulic fuses close the hydraulic lines if there is a large leak. The priority valve makes sure that the MLG extension/retraction system only gets a supply of hydraulic fluid if sufficient pressure is available.
The rudder isolation valve is a manually-operated valve that isolates the rudder actuators (Minimum Equipment List (MEL) function).

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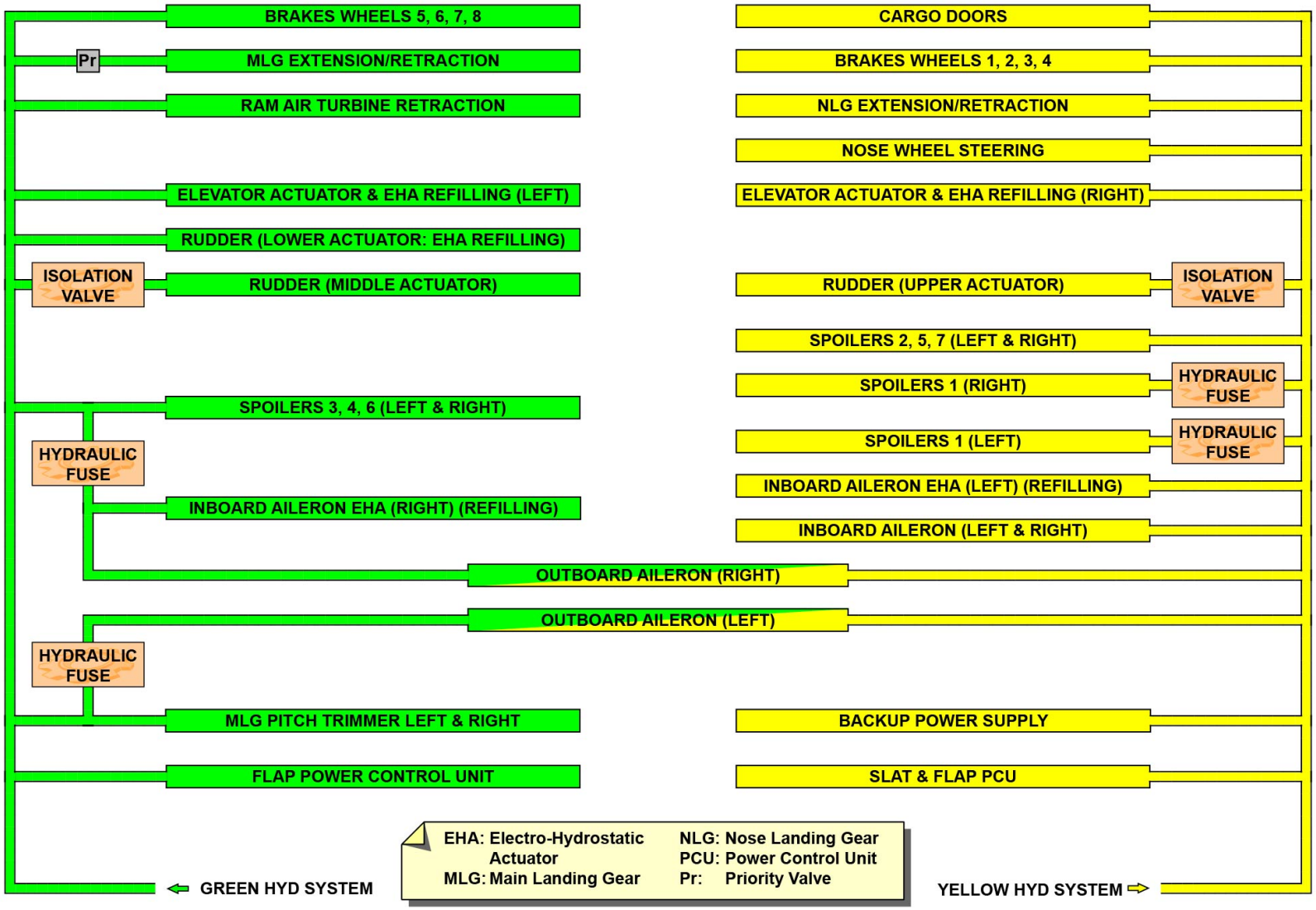

GENERALITIES

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HYDRAULIC SYSTEM DESCRIPTION (2/3)

System Description

Reservoir

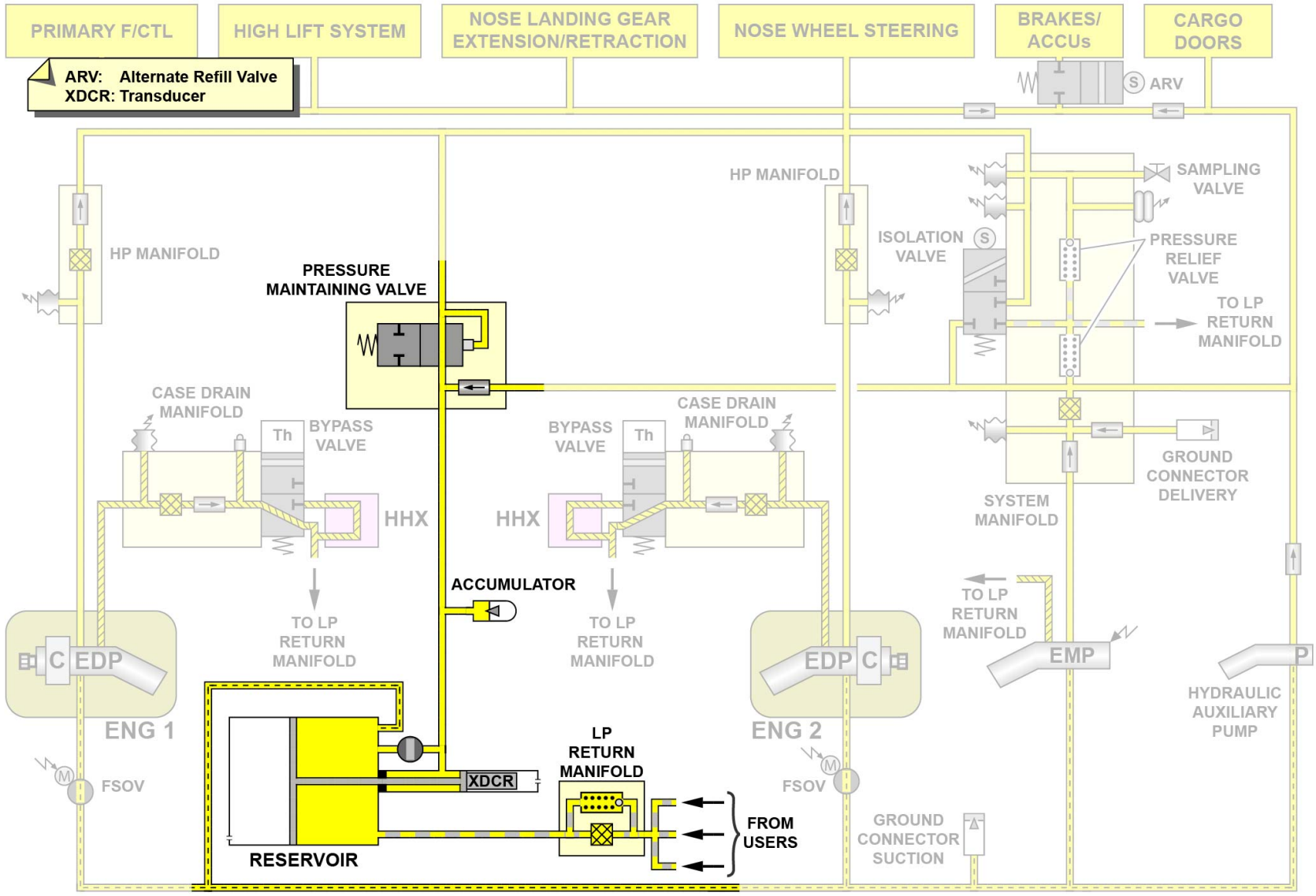
The reservoirs are the fluid storage devices in the systems. Each hydraulic system has a reservoir of the same type but with different capacities. Their function is to supply the pressurized fluid to the pumps.
The reservoirs are self-pressurized (bootstrap type) to 70 psi. This is to prevent pump cavitations, to optimize their hydraulic fluid supply to the pumps and to prevent the ingress of air into the system through the external sealing. They adjust for changes in fluid volume because of the operation of the system consumers and the fluid temperature.
Different components are installed on the reservoir for example the level transducer to monitor the fluid level and the depressurization valve for reservoir depressurization.

Accumulator + Pressure Maintaining Valve

One power accumulator is installed in each hydraulic system. The accumulator is a metal-bellow type, pre-charged with helium (servicing-free type). The accumulator operates as a power source and absorbs the delivery pulsations and pressure surges of the pumps. It compensates for pump response time in the event of high flow demand.
Also, together with a pressure maintaining valve, the accumulator keeps the reservoir pressurized (15 psi for 24 hours) after a system shutdown.

Low-Pressure Return Manifold

The LP Filter Manifold is identical for the Green and the Yellow system. The return flow from the users is filtered through the return filter before it goes into the reservoir. The LP return filter is a bypass type filter, used when the filter element is fully clogged.



SYSTEM DESCRIPTION - RESERVOIR ... LOW-PRESSURE RETURN MANIFOLD

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HYDRAULIC SYSTEM DESCRIPTION (2/3)

System Description (continued)

Fire ShutOff Valve

There are Fire ShutOff Valves (FSOVs) in the suction lines from the reservoirs to each Engine Driven Pump (EDP). They are safety devices to stop the supply of hydraulic fluid to the engine.
Four FSOVs, are installed. The FSOVs can be set to the closed position manually by the ENG FIRE or the OVHT/ISOL pushbuttons. The FSOVs can be set to the closed position automatically by the Hydraulic Monitoring and Control Application (HMCA) in specific cases.
The FSOV includes a ball valve and an electric motor (28VDC power supply). It is installed out of the engine fire zone. The motor part has limit switches to control and give indications.

Engine Driven Pump

The EDP is a pressure-compensated, variable-displacement axial-piston pump installed and powered by the Accessory Gear Box (AGB) of the engine. Thus, in usual conditions, the EDP operates continuously, when the engine operates. The EDPs will pressurize the hydraulic systems to 5000 psi. There are two EDPs for each engine, one for each hydraulic system.
The primary function of the EDP is to change mechanical energy into hydraulic energy. It is used as the primary source of hydraulic power for the Green and Yellow systems.

High Pressure (HP) Manifold

The EDP HP manifold is identical for the Green and the Yellow system. There are four EDP HP manifolds installed. The delivery flow of each EDP is filtered in the manifold before it goes to the hydraulic consumers. It contains a pressure transducer that senses the system pressure and causes low-pressure alerts. The HP manifold has a non-bypass filter.

Case Drain Manifold

There are four Case Drain (CD) manifolds, one for each EDP. They are installed in the front spar (Yellow system) and the rear spar (Green system) of the wing. The CD manifold includes a thermal bypass valve that sends the fluid to the Hydraulic Heat Exchanger (HHX) or directly to the return line.
The CD filters are non-bypass filters. A temperature sensor is also installed on the CD manifold to sense the hydraulic temperature to give overheat alerts. The CD manifold also contains a pressure transducer for the detection logic of the Uncontained Engine Rotor Failure (UERF).

Hydraulic Heat Exchanger

A cooling system for the Green and Yellow CD systems is necessary to prevent:
- Hydraulic fluid deterioration because of high temperatures that will decrease fluid life,
- Deterioration of hydraulic equipment.

The HHXs decrease the temperature of hydraulic fluid. They use the fuel as a cooling agent. The HHXs are installed in the fuel wing tanks. For full performance, the HHX must be completely covered by the fuel.

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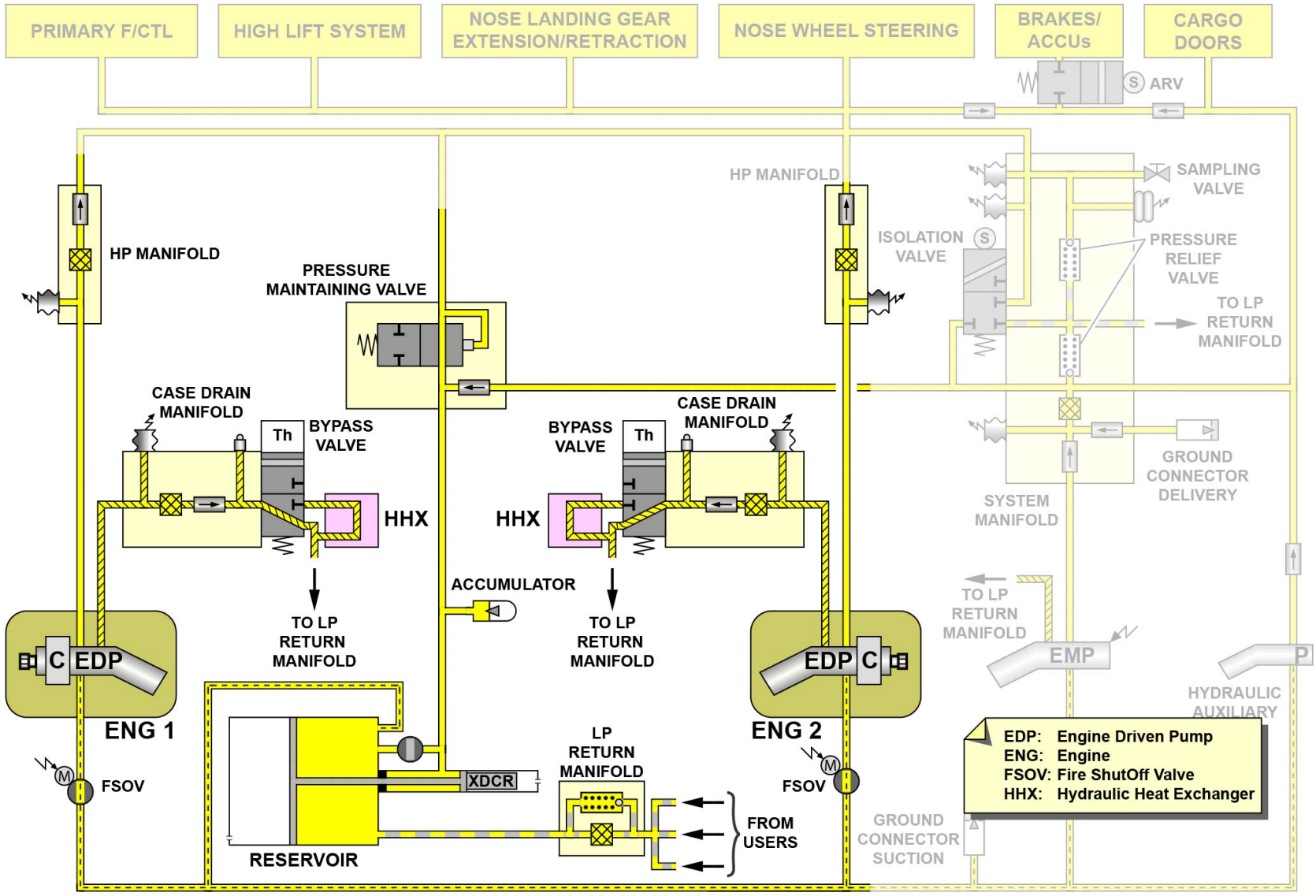

SYSTEM DESCRIPTION - FIRE SHUTOFF VALVE ... HYDRAULIC HEAT EXCHANGER

HYDRAULIC SYSTEM DESCRIPTION (2/3)

System Description (continued)

Electric Motor Pump (EMP)

There are two EMPs, one for each hydraulic system installed in the main landing-gear bay. They change electrical energy into hydraulic energy.
Each EMP has:
- A constant-frequency AC motor (230 VAC, 400Hz)
- A hydraulic pump that is supplied with power by the electrical motor.
On ground only and with the engines not in operation, the EMPs supply hydraulic fluid:
- For cargo door operations (Yellow system only)
- For brake accumulator refill (Green and Yellow systems) through an alternate refill valve (ATA 32)
- For maintenance operations (Green and Yellow systems).

Hydraulic Auxiliary Pump

An hydraulic auxiliary pump can be used for hydraulic power generation for cargo door operation. The hydraulic auxiliary pump installed on the Yellow Ground-Service Panel (GSP) can be used with a power tool (drilling machine) or manually with a handle.

Ground Connectors

Ground Service Cart (5000 psi capacity) through ground connectors can be used to pressurize the hydraulic systems for maintenance operations.

System Manifold

There are two system manifolds installed, one for each hydraulic system.
The system manifold is connected to the system pressure line from the EDPs. It also receives and filters the fluid from the EMP and the GSP and sends it to the system.

An isolation valve isolates the cargo-door supply line from the system. This lets you operate the cargo doors and do the brake accumulator refill without stress on the full hydraulic system with pressure cycles. It also prevents the supply of hydraulic pressure to different flight controls for the safety of the personnel when cargo door is open or close.
The system manifold also has:
- Pressure sensors, to sense the system pressure and give low pressure alerts
- Relief valves that open if the system pressure is higher than a set value
- A sampling valve, to get the samples of hydraulic fluid to monitor for contamination
- A high-pressure filter assembly (no bypass filter).

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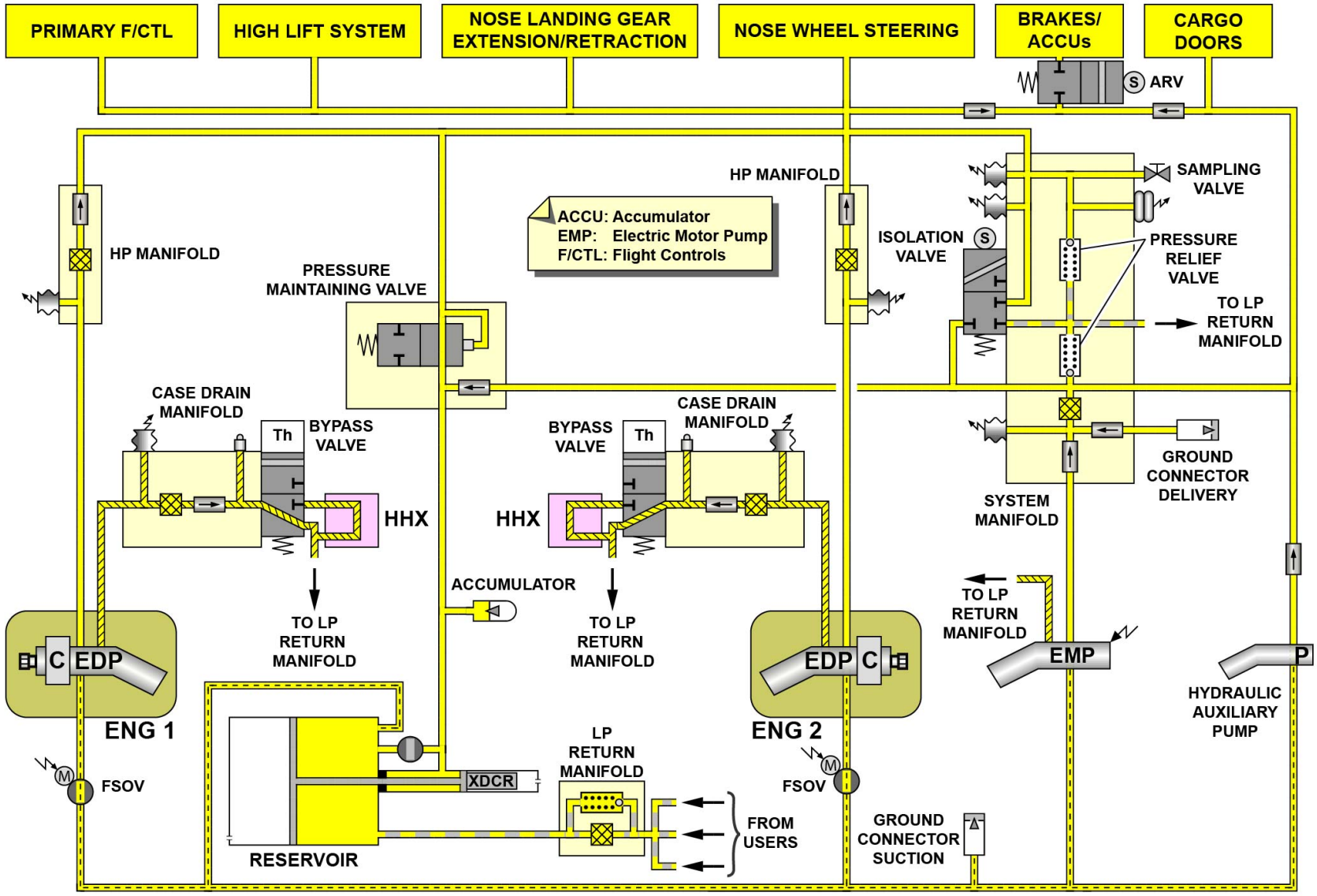
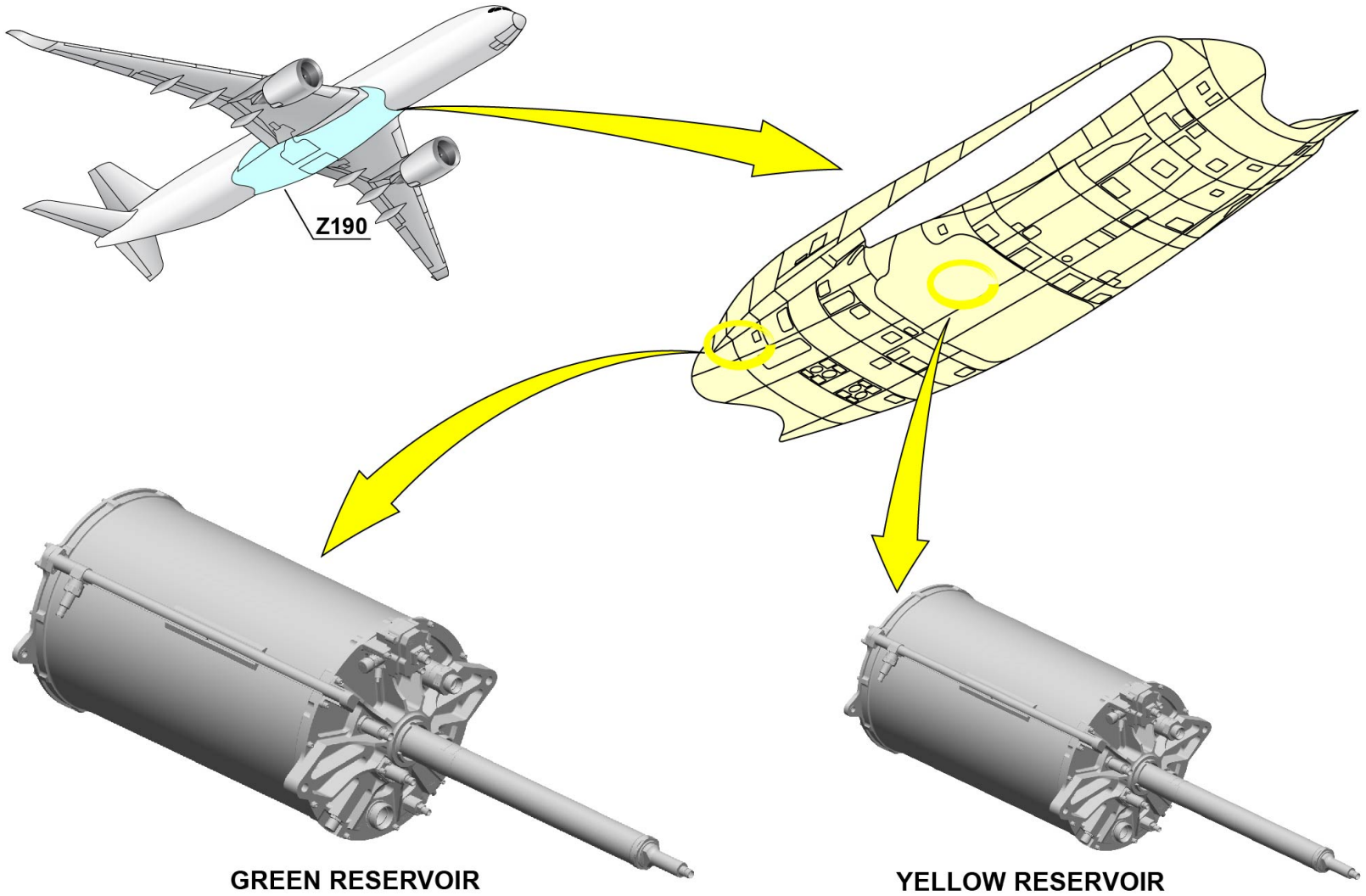


SYSTEM DESCRIPTION - ELECTRIC MOTOR PUMP (EMP) ... SYSTEM MANIFOLD

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Reservoir Description

The Green reservoir is installed on the inner right side of the rear belly fairing. The Yellow reservoir is installed in the MLG bay.



RESERVOIR DESCRIPTION

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Reservoir Description (continued)

Reservoir Pressurization/Depressurization

The reservoirs are the fluid storage devices in the systems. Their function is to supply hydraulic fluid to the EDPs, the EMPs and the cargo door hydraulic auxiliary pump.
Each hydraulic system, Green and Yellow, has its own reservoir and the two are the same type but with different capacities.
The reservoirs are self-pressurized (bootstrap type) to 70 psi (differential) to prevent pump cavitations.
Each reservoir has two pressure relief valves that release air or liquids if there is fluid overflow or overpressure. One relief valve is for the HP side of the reservoir and the other is for the LP side.
A pressure transducer monitors the reservoir pressure and gives a warning if the reservoir pressure is low (below 22 psi).
There is a depressurization switch on the GSP that you can operate manually. This will energize the electrical depressurization valve of the reservoir.
Also, you can use a manual rotating knob on the depressurization valve to release the pressure from the reservoir.

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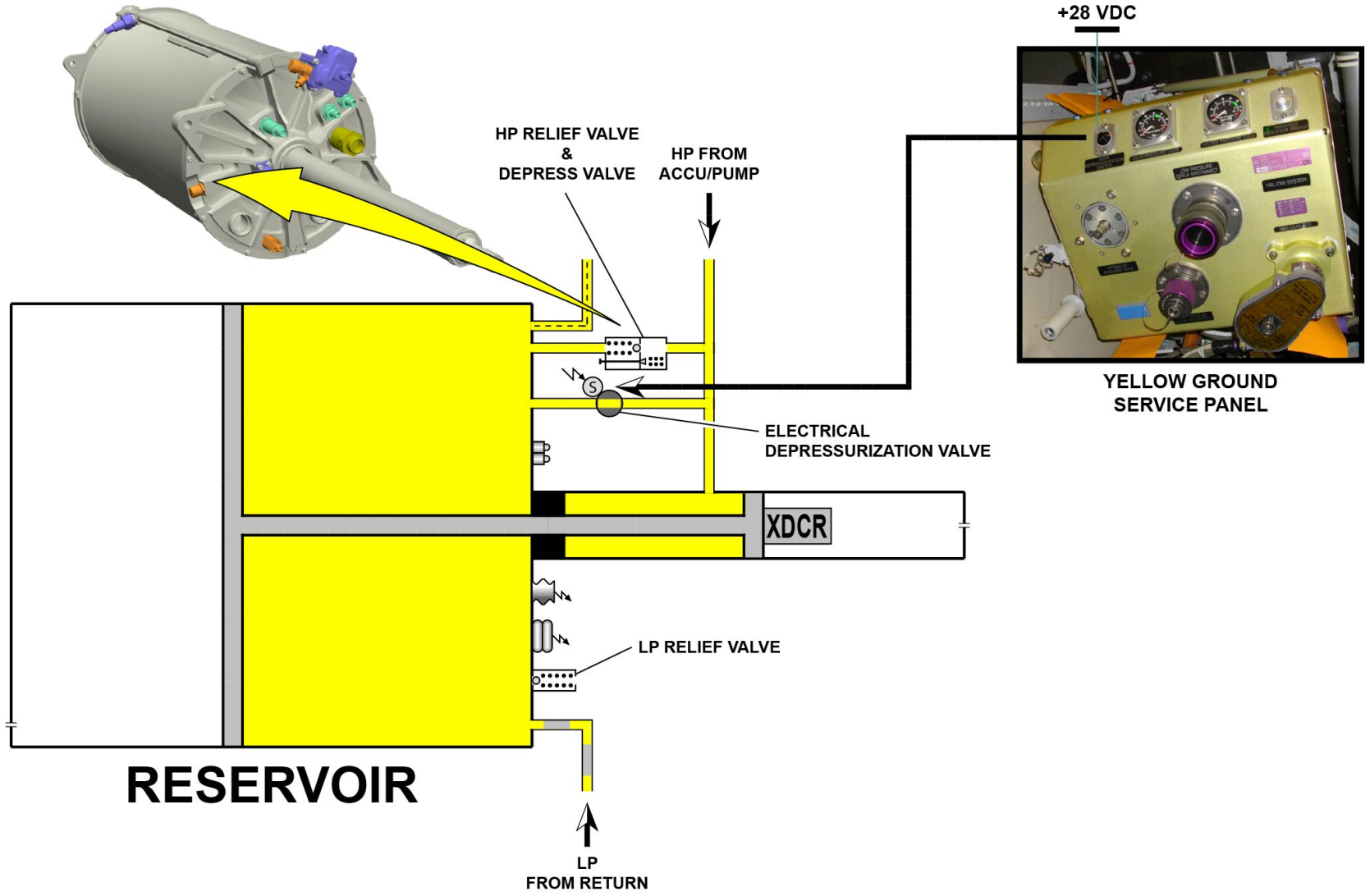

RESERVOIR DESCRIPTION - RESERVOIR PRESSURIZATION/DEPRESSURIZATION

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Reservoir Description (continued)

Reservoir Fluid-Level Indications

The HMCAs in the CPIOMs monitor, with analog signals:
- The hydraulic fluid quantity in the reservoir with a quantity transmitter (level transducer)
- The hydraulic fluid temperature in the reservoir with temperature sensors.

The reservoir quantity indication is available on the Hydraulic ECAM page. This indication is adjusted in relation to the temperature and the position of the landing gear (extended/retracted) and doors (LGERS).
The quantity indicator installed on the Green GSP shows the low or high fluid quantity in each reservoir (after selection of the hydraulic system with the reservoir filling selector valve). When the volume is correct, the pointer is in the center position. When the indicator is not energized, the pointer is in the INOP position. The reservoir quantity is corrected in relation to the fluid return temperature.
On each reservoir, you can use a visual indicator to do a check of the reservoir level. This data is not adjusted in relation to the temperature.

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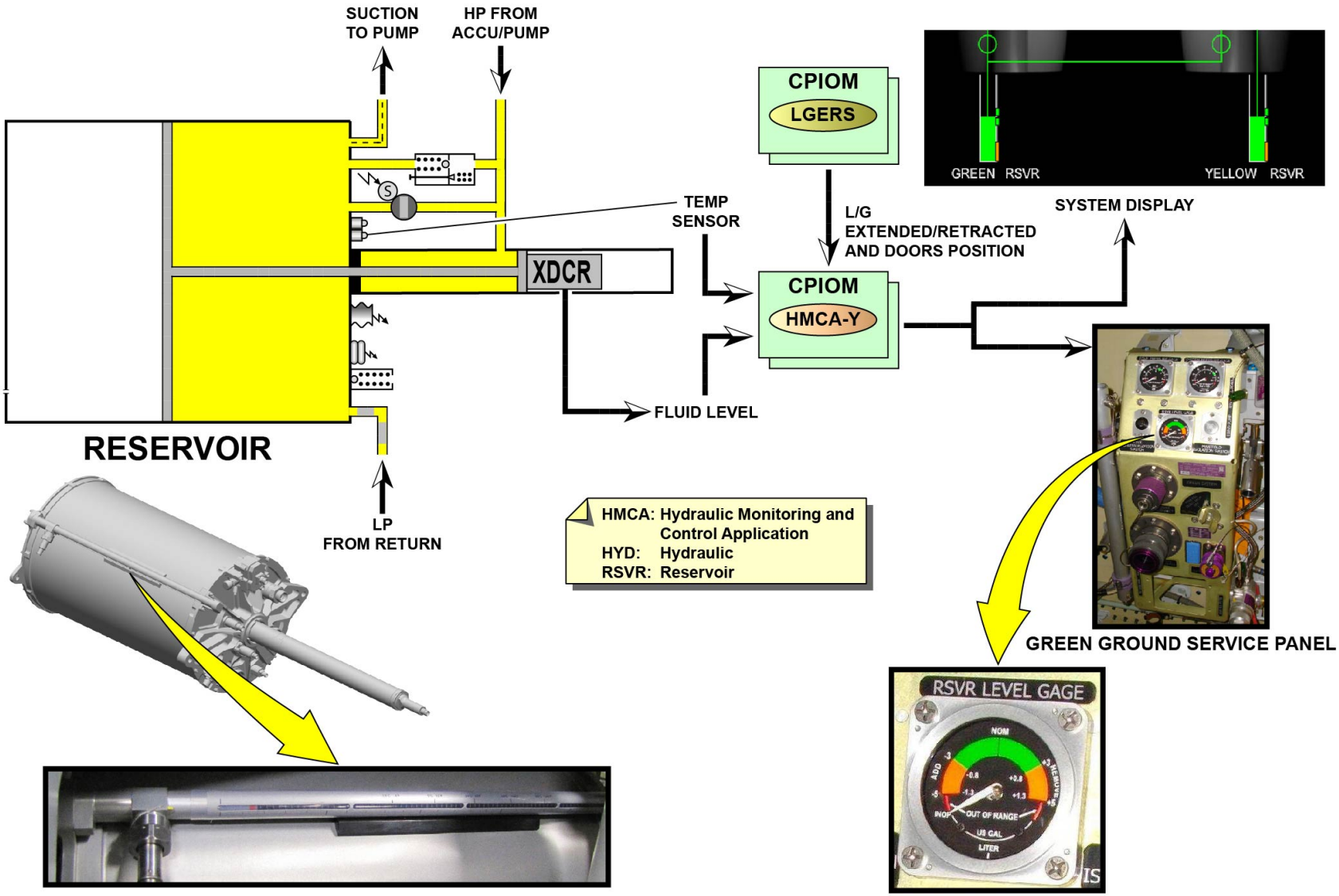


RESERVOIR DESCRIPTION - RESERVOIR FLUID-LEVEL INDICATIONS

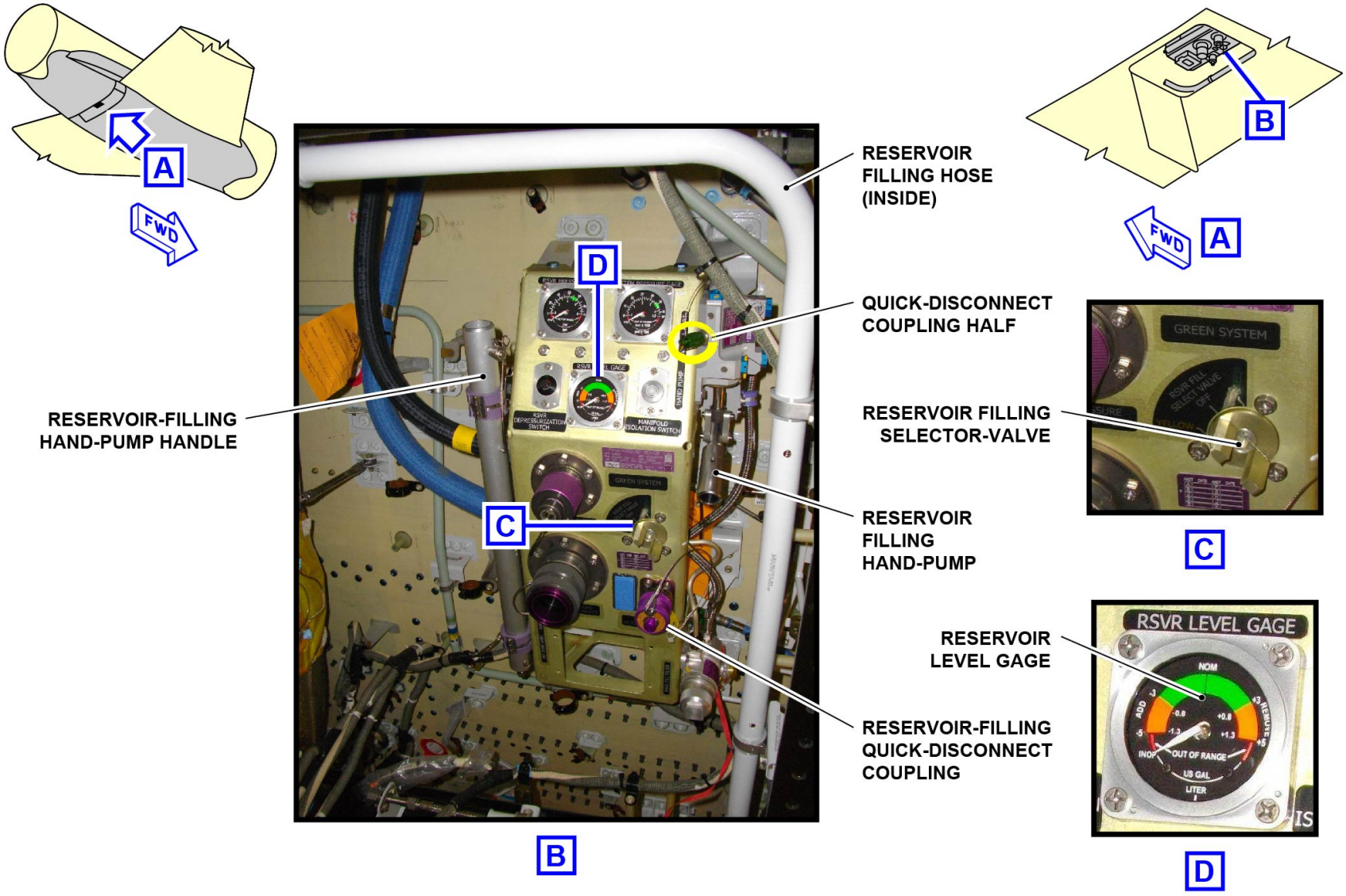
HYDRAULIC SYSTEM DESCRIPTION (2/3)

Reservoir Description (continued)

Reservoir Filling

The primary components of the reservoir filling system are installed on the Green GSP:
- Filling selector valve which is used for manual selection of the reservoir you will fill
- Filling level gage which shows the fluid level of the reservoir
- Ground self-sealing coupling which is used to fill the reservoir from a ground hydraulic cart
- Filling hand pump, with its lever and a flexible hose, which is used to manually fill the hydraulic reservoirs from a can
- Filling filter to give protection from contamination.

There are two possible filling procedures:
- From a hydraulic ground cart connected to the coupling socket
- From a hydraulic fluid container with the A/C hand pump.



RESERVOIR DESCRIPTION - RESERVOIR FILLING

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Reservoir Description (continued)

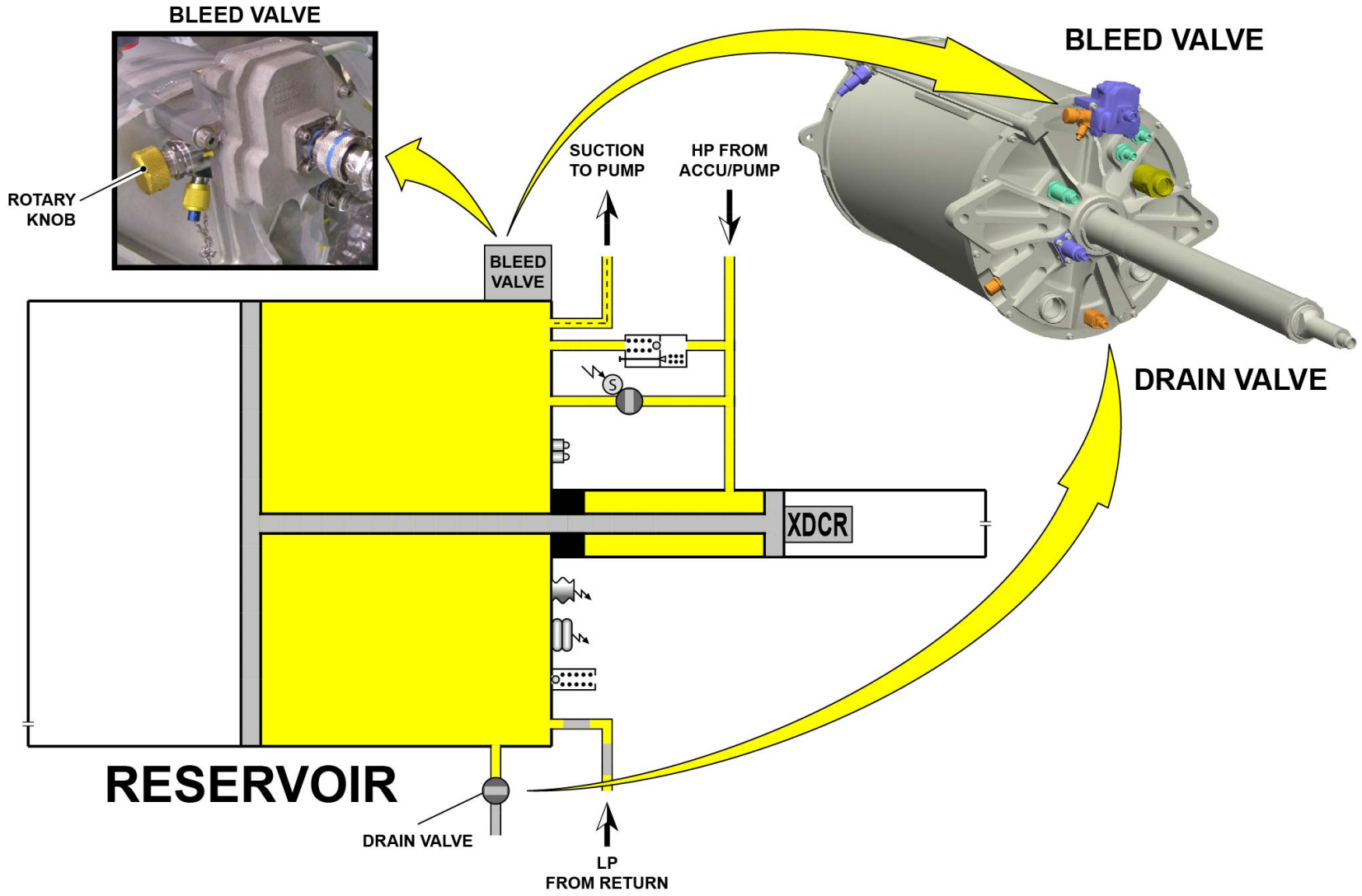
Reservoir Air Bleeding

On bootstrap reservoirs, it is necessary to bleed the air that goes into the system and that is held in the reservoir. A special bleed device does this task automatically, with no input from the maintenance or flight crew.

The reservoir automatic bleed-device is controlled by the HMCAs on the ground if the reservoir is pressurized and the bleed device senses air. Manual bleed is also possible. You must turn a knob on the side valve installed on the body of the automatic bleed-device.

Reservoir Drainage

The manually operated reservoir drain-valve lets you easily remove the hydraulic fluid from the reservoir.



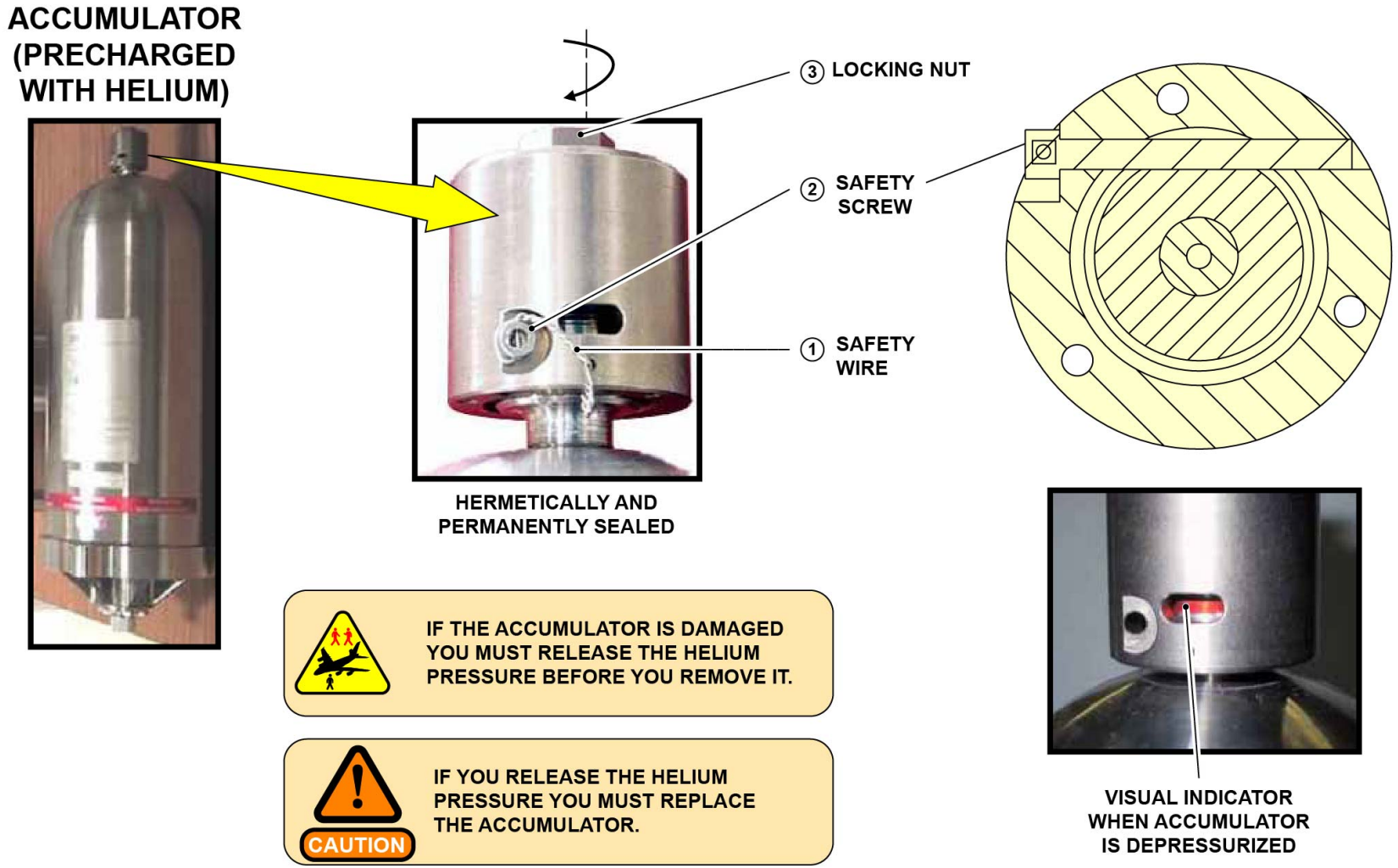
RESERVOIR DESCRIPTION - RESERVOIR AIR BLEEDING & RESERVOIR DRAINAGE

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Accumulator Depressurization

The high-pressure hydraulic accumulator is a metal bellow accumulator pre-charged with helium. Maintenance is not necessary for the accumulator thus, it is not necessary and not possible to do a refill of the gas charge of this equipment.
If an accumulator gas discharge is necessary you must do it manually. There is a safety screw to prevent unwanted operation of the emergency discharge device. This safety screw is safetied with a safety wire. The maintenance operator must remove this protection system before he can install the locking nut. This will cause the depressurization of the accumulator. A visual indication shows that the accumulator is depressurized.

GAS DEPRESSURIZATION (MANUALLY ACTIVATED)



ACCUMULATOR DEPRESSURIZATION

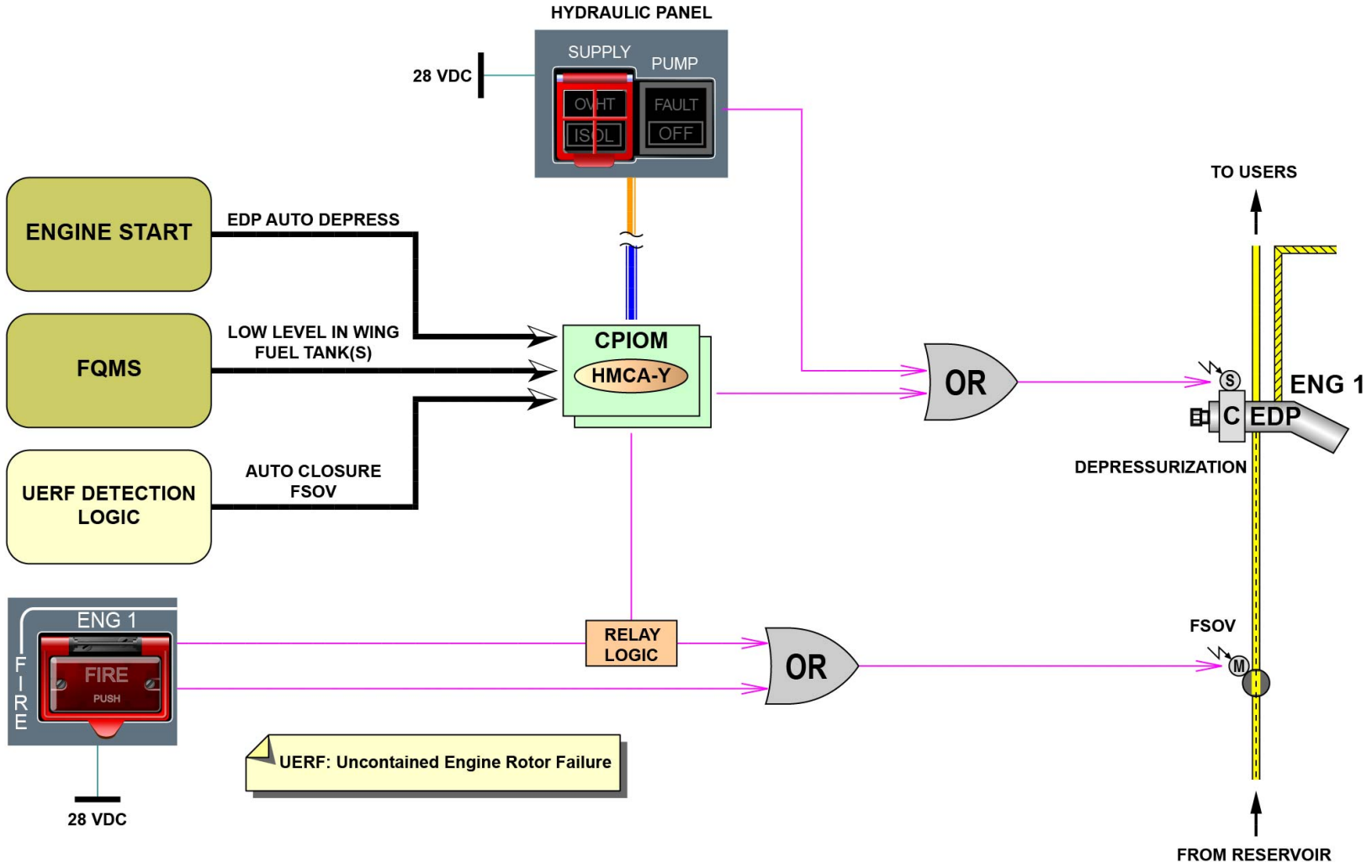
HYDRAULIC SYSTEM DESCRIPTION (2/3)

FSOV and EDP Logic Operation

Each FSOV can be controlled:
- Manually with the ENG FIRE pushbutton of the related engine on the overhead panel. This procedure is reversible. You can open the FSOV again if you push the ENG FIRE pushbutton.
- Manually with the SUPPLY OVHT/ISOL pushbutton in the hydraulic (HYD) section on the overhead panel. The signal from the pushbutton is transmitted from the Integrated Control Panel (ICP) to the HMCAs through AFDX. This activation is non-reversible. You cannot open the FSOV in flight again when you push the SUPPLY OVHT/ISOL pushbutton.
- Automatically by each HMCA of the related hydraulic system if there is UERF Detection Logic.

To put each EDP in the depressurized mode, you must energize the EDP solenoid valve.
This solenoid valve can be energized:
- Manually by a pump OFF pushbutton switch (direct wiring)
- Automatically when the related engine FIRE pushbutton is pulled (because a FSOV is closed)
- Automatically by the Propulsion Control System (PCS) in case of engine start. The EDPs will then be pressurized again after the engine is correctly started.
- Automatically by the FQMS if there is a fuel low level and a hydraulic temperature (from the reservoir temperature sensors) of more than a certain threshold (80 degrees). Automatic depressurization is only done if the second EDP of the hydraulic system, which is on the opposite engine, supplies pressure (pressure is measured at the EDP HP manifold). If a high demand from the hydraulic consumers is received (such as landing gear or slat/flap operation), the logic is inhibited and the two EDPs in the hydraulic system are still operating. This high demand is sensed through the two pressure monitoring sensors at the system manifold if the pressure decreases to less than a set limit (which is higher than the low pressure limit).

If there is a fuel low-level auto-depress, no FAULT light on the PUMP FAULT/OFF pushbutton comes on and there is no Flight Warning System (FWS) alert.



FSOV AND EDP LOGIC OPERATION

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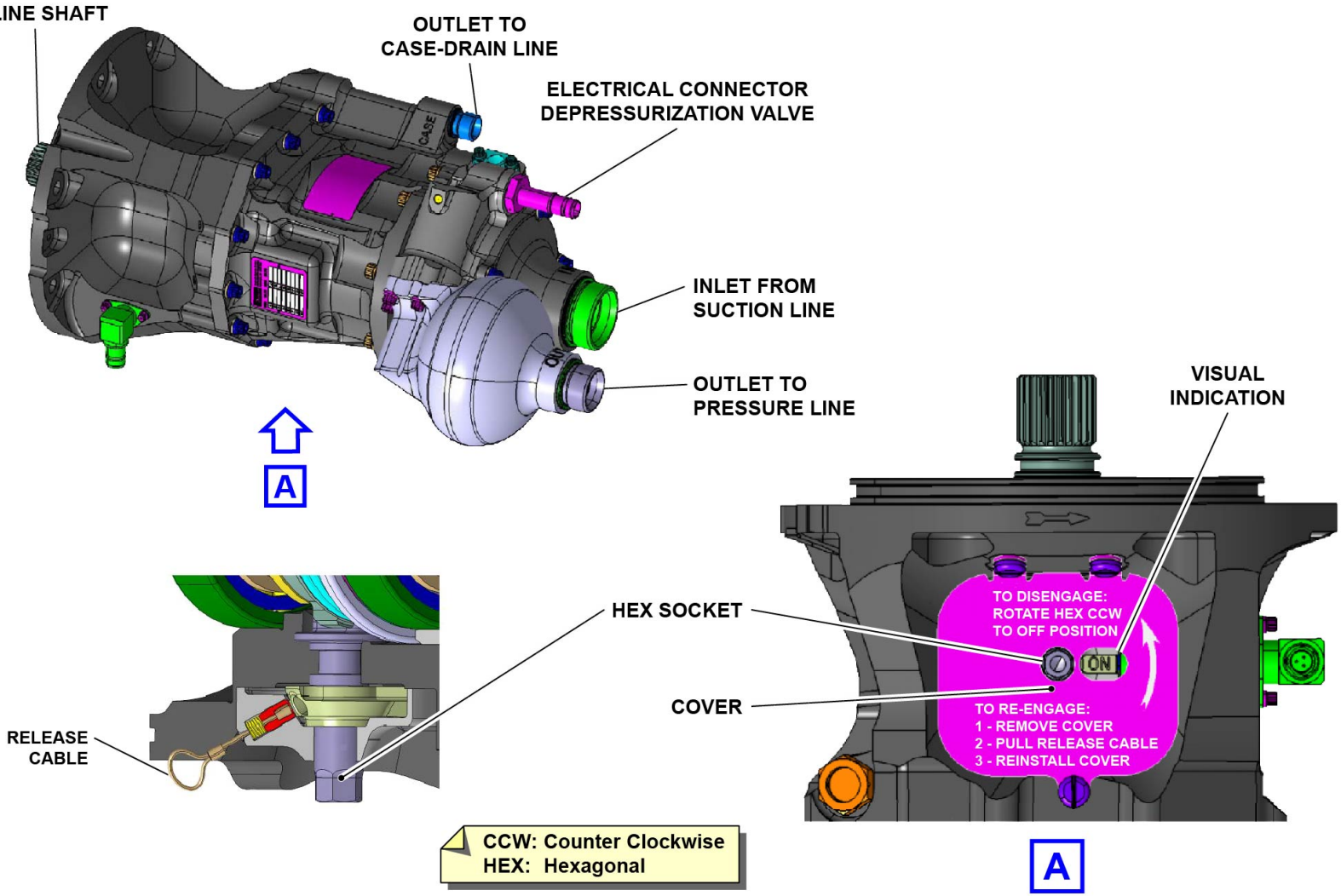
HYDRAULIC SYSTEM DESCRIPTION (2/3)

Engine-Driven-Pump Disengagement

For deactivation, a declutch mechanism is used to disconnect the EDP from the engine AGB. If you operate the declutch mechanism, the rotation/torque from the engine cannot be transmitted to the EDP. Thus, the EDP cannot turn and the supply of hydraulic power is stopped. This mechanism is a fully mechanical mechanism, which is manually operated on the ground.
To engage the EDP, again it is necessary to pull the release cable.



ENGINE-DRIVEN-PUMP DISENGAGEMENT

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Electric-Motor-Pump Logic Operation

Electric-Motor-Pump Logic Operation

The EMP can only be activated on the ground (LGERS, WOW) with a constant frequency (400Hz) of 230VAC with all the engines off (engines not running) and no fault sensed by the Motor Control and Protection Unit (MCPU). The EMP can be started automatically when the consumer sends a signal for cargo door operation (Yellow system) or brake accumulator refill (Green & Yellow systems). If this occurs, only the related consumer systems will have a hydraulic supply. If the signal stops, the EMP stops automatically.
The EMP can also be started manually with the "ON" pushbutton on the cockpit overhead panel (GND hydraulic panel). If this occurs, the full hydraulic system is pressurized and the isolation valve opens.
The EMP of the related hydraulic system is controlled and monitored by the HMCA with the Motor Control and Protection Unit (MCPU), the CRDC and the Remote Control Circuit Breaker (RCCB).
The MCPU controls and protects the EMP. It gives start/stop commands and monitors different parameters.
To operate an EMP, the aircraft RCCB must be closed and the MCPU must be energized and there must be a "NO FAULTS DETECTED" indication.
The HMCA starts the Yellow (Green) EMP (command signal sent to the MCPU) if:
- The engines are not in operation (data from the Propulsion Control System (PCS)).
- The aircraft is on the ground (data from the LGERS applications: Weight on Wheels (WOW)).
- No faults are found by the MCPU.
- Electrical Supply: 230 VAC at a constant frequency (400Hz).

There are 2 MCPUs, one for each pump.
The MCPU controls and monitors the EMP. This is to make sure that the EMP is not energized in dangerous conditions and to send data about dangerous operation to the HMCA. The MCPU can start the EMP with an EMP start command signal from the HMCA. The MCPU can stop the EMP if it finds unusual EMP operation.
The MCPU is usually de-energized. It becomes energized if an EMP request is sent to the HMCA while the aircraft is on the ground and if no EMP fault is latched in the HMCA.
The RCCB is usually "open". It closes if the command inputs from the CRDC and the HMCA are both true. The CRDC command is true if all the engines are off and no EMP motor overheat is sensed. The HMCA command is true if all the engines are off and if either "Weight on wheels" or "Low speed" is true. After correct power-up of the MCPU, the HMCA sends a command to the related RCCB to "close" so that 230 VAC power is now available at the MCPU.
Then the HMCA sends an EMP ON command to the MCPU after correct closure of the RCCB. The EMP ON command is activated if the HMCA sends a command to the related SSPC to "close".
The MCPU monitors and gives protection to the EMP for all of the faults that follow:
- An overspeed fault
- An EMP overheat fault
- An unbalanced current fault
- Unusual current consumption of the EMP
- A frequency fault.

If one of these parameters is more than/less than a specified level, the EMP will be stopped. When a failure is sensed, the MCPU will send an output signal to the CRDC. The CRDC will then open the RCCB, and will also transmit the fault signal to the CPIOM (HMCA) with AFDX. When the CPIOM (HMCA) receives a fault, it will send a command to the MCPU and to the RCCB to stop the EMP.
The MCPU also supplies a discrete EMP fault-signal directly to the CPIOM (HMCA) if a critical EMP fault (overheat, current fault, unbalance fault, ground fault, speed fault) occurs. This signal sends

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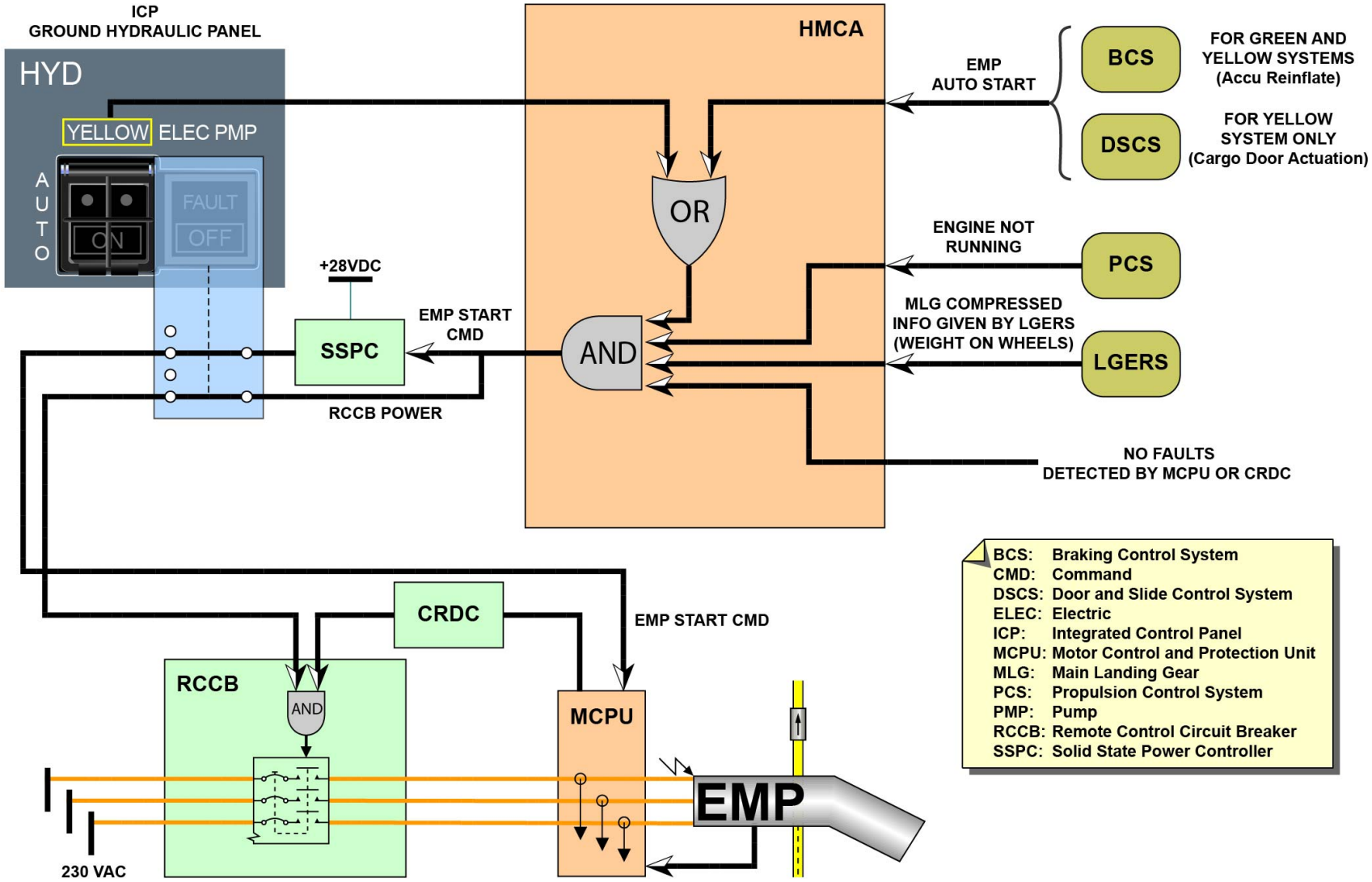
the EMP faults directly to the CPIOM (HMCA) if the usual communication from the CRDC/AFDX is not possible.



ELECTRIC-MOTOR-PUMP LOGIC OPERATION - ELECTRIC-MOTOR-PUMP LOGIC OPERATION

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HYDRAULIC SYSTEM DESCRIPTION (2/3)

Electric-Motor-Pump Logic Operation (continued)

System Manifold: Isolation Valve Control

The normal position of the system manifold isolation-valve is de-energized in the closed position. The hydraulic fluid is moved from the EMP or the GSP to the auxiliary hydraulic system (cargo door or braking). When the EMP is started for cargo door operation or accumulator reinflation, the isolation valve stays de-energized. It will not be possible to energize it to the open position (even by pushing in the isolation switch on the yellow ground service panel).
The isolation valve will supply the hydraulic power to all the users if the EMP ON pushbutton is pushed (ground hydraulic panel on the overhead panel). In this configuration the isolation valve will be energized. It will also do this if the manifold isolation switch is pushed on the GSP when the hydraulic system is pressurized by the Ground Service Cart.

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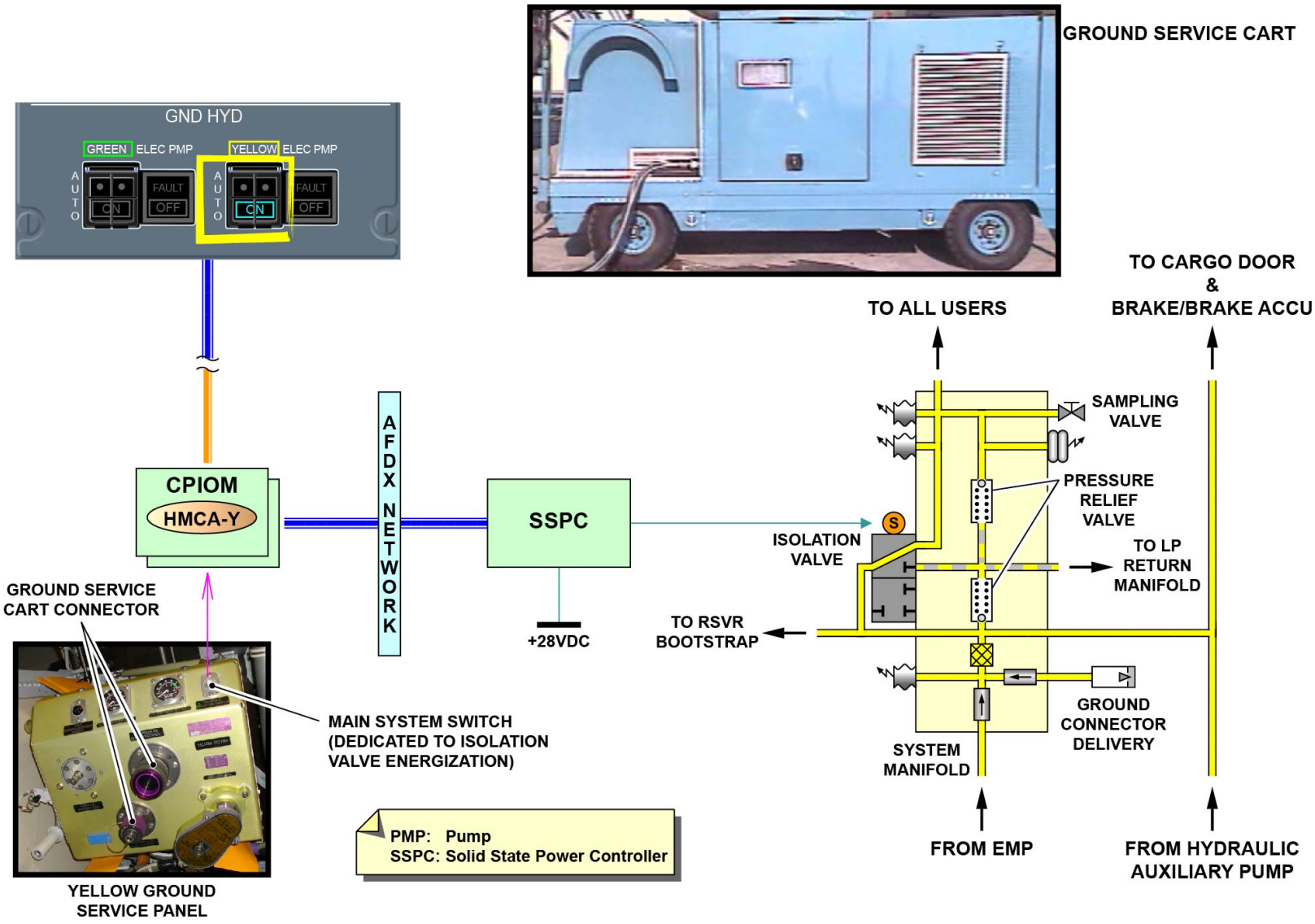

ELECTRIC-MOTOR-PUMP LOGIC OPERATION - SYSTEM MANIFOLD: ISOLATION VALVE CONTROL

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HYDRAULIC SYSTEM DESCRIPTION (2/3)

Temperature Control

The A350 hydraulic system is heat controlled to keep the fluid temperature in a certain range (between 20 deg. C and 95 deg. C) in the reservoir during the flight, in usual conditions. The lower temperature limit decreases the fluid friction loss in the tubing network and gives the best dimension for the tubing. The higher temperature limit is given in relation to maximum fluid life. To get this range of temperature, heating and cooling devices are included in each system.
Each hydraulic system has three temperature control valves, one at each wing tip, upstream of the most remote actuator (outer aileron) and one in the THS compartment. The temperature control valves supply a metered flow from HP to LP if necessary and change the hydraulic power into thermal power and thus increase the temperature of the hydraulic fluid. The temperature control valves are temperature and differential-pressure controlled. A temperature control valve only lets a flow go through the valve if the supply pressure is more than a specified limit (3700 psi, 250 bars). This makes sure hydraulic power is supplied to the downstream Flight Controls (F/CTL) actuators in the correct sequence. The thermal control makes sure that hydraulic fluid goes through the valves if its temperature is too low.

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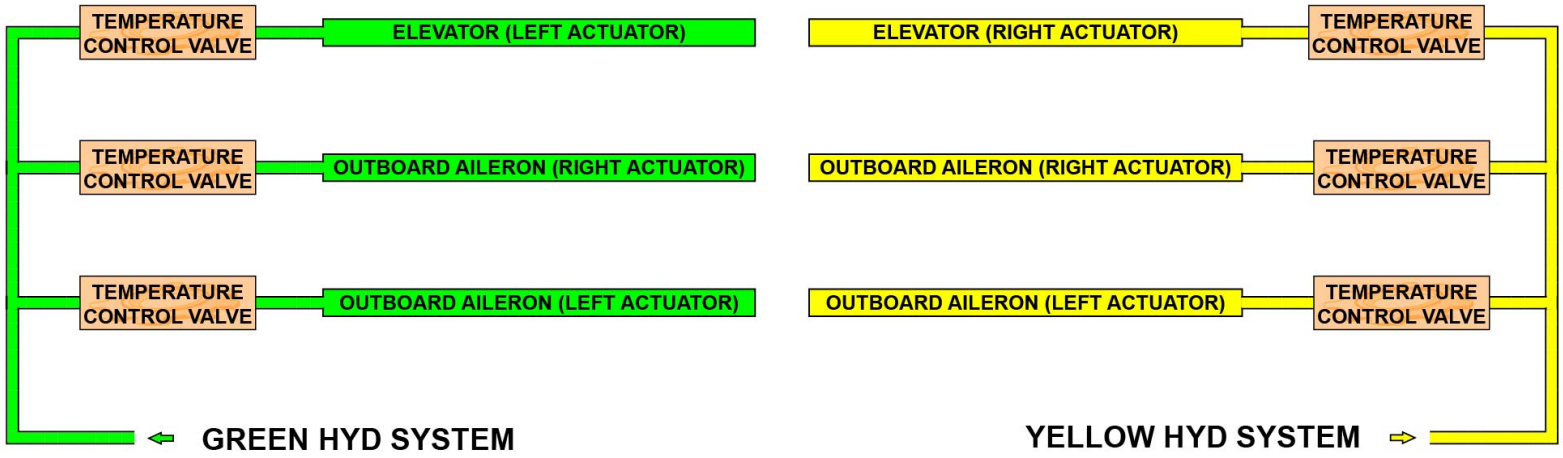
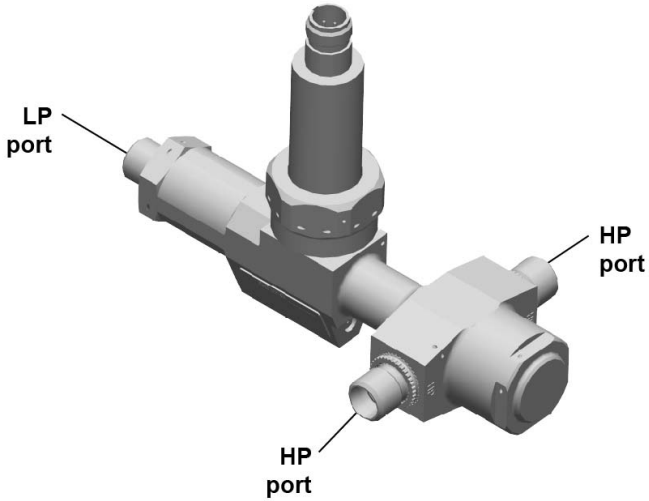


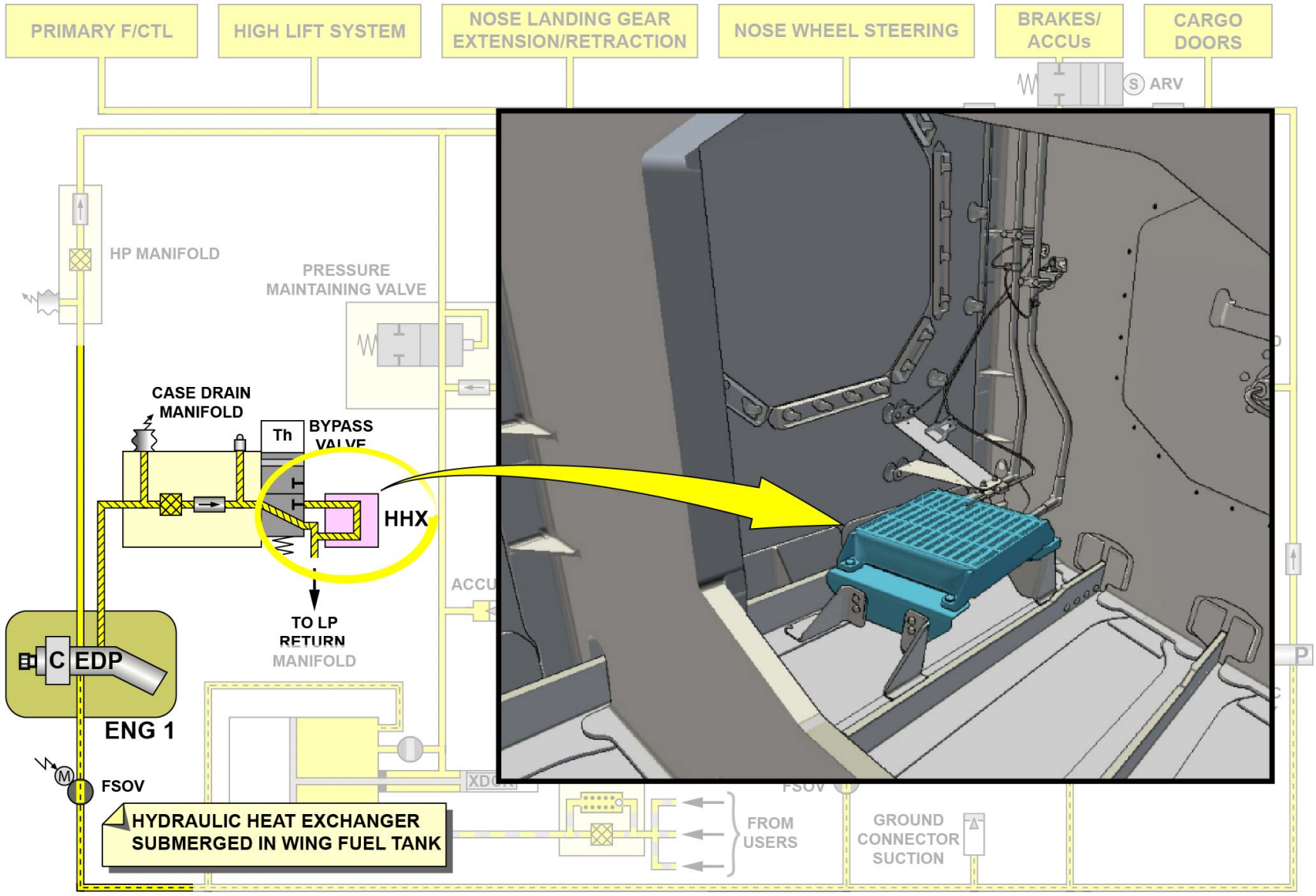


TEMPERATURE CONTROL

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Temperature Control

The hydraulic system cooling uses two fuel-submerged HHXs for each system. The HHXs decrease the temperature of the hydraulic fluid in the EDP CD flow. To do this, they use the colder fuel in the wing tank. The HHXs are installed in the wing tanks. Each of the HHXs is controlled by a special thermal bypass valve. If the fluid temperature changes, the related thermal bypass valve opens or closes the hydraulic flow path through the HHX.
The valve is fully passive and bypasses the HHX for a CD fluid temperature of less than a certain value (60 deg. C). The flow is fully sent through the HHX for a temperature of more than a certain value (80 deg. C). Between these lowest and highest values (60 deg. C and 80 deg. C), there is a linear flow to the HHX in relation to the temperature.



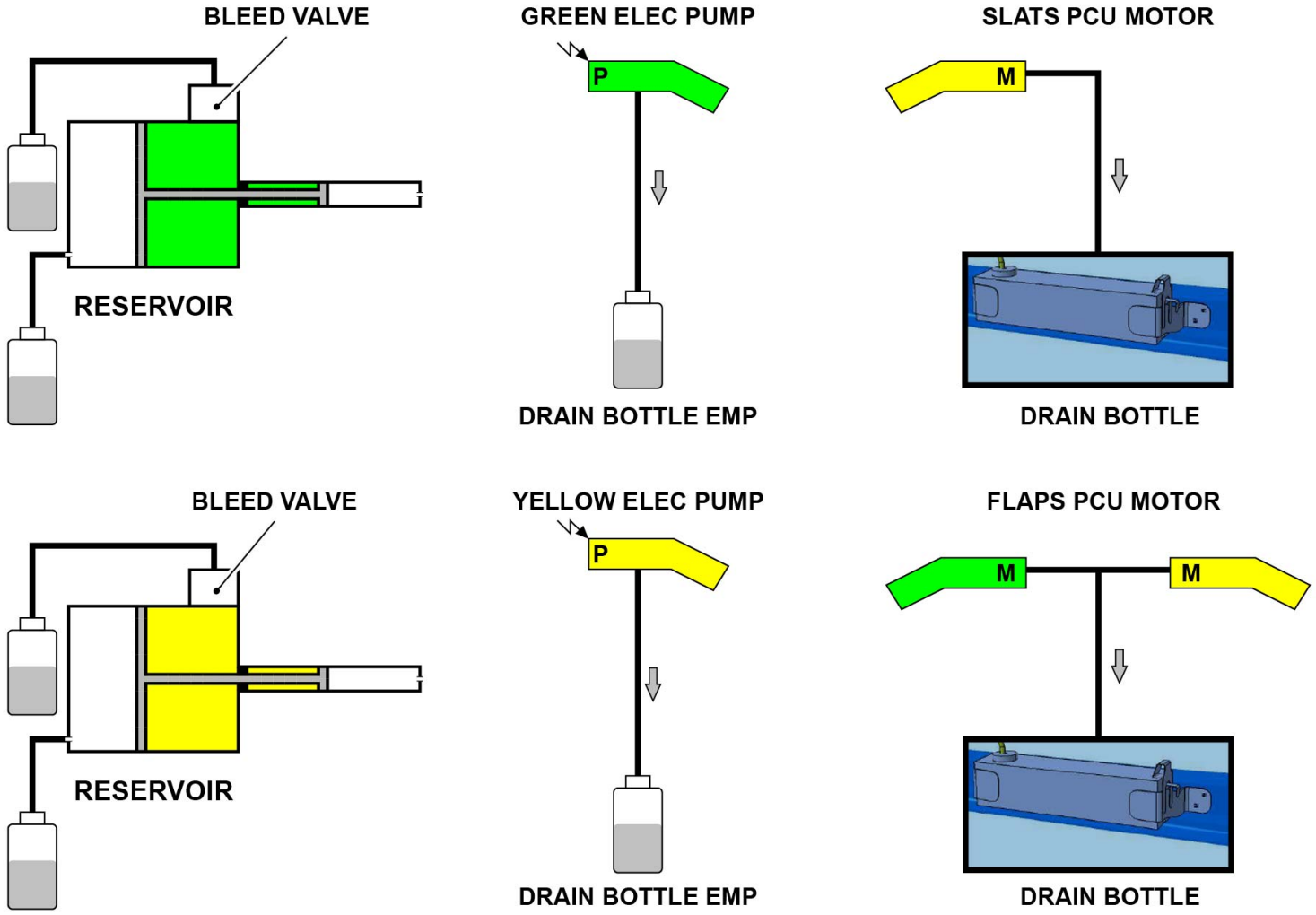
TEMPERATURE CONTROL

V1813401 - V01T0M0 - VM29D1HYDDO3001

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Seal Drain

To keep the hydraulic compartment as clean as possible, the seal drain collects the hydraulic fluid leakage in transparent tanks. In this system, fluid drains into the recovery tanks by the effect of gravity. If a tank is full, an overflow-pipe drains the unwanted fluid into the MLG bay.
CAUTION: WHEN YOU DRAIN THE BOTTLES, YOU CAN SPILL FLUID. FLUID CAN CAUSE CORROSION AFTER A LONG PERIOD OF TIME. THUS, IF YOU SPILL FLUID, YOU MUST CLEAN THE AREA TO PREVENT THIS CORROSION.

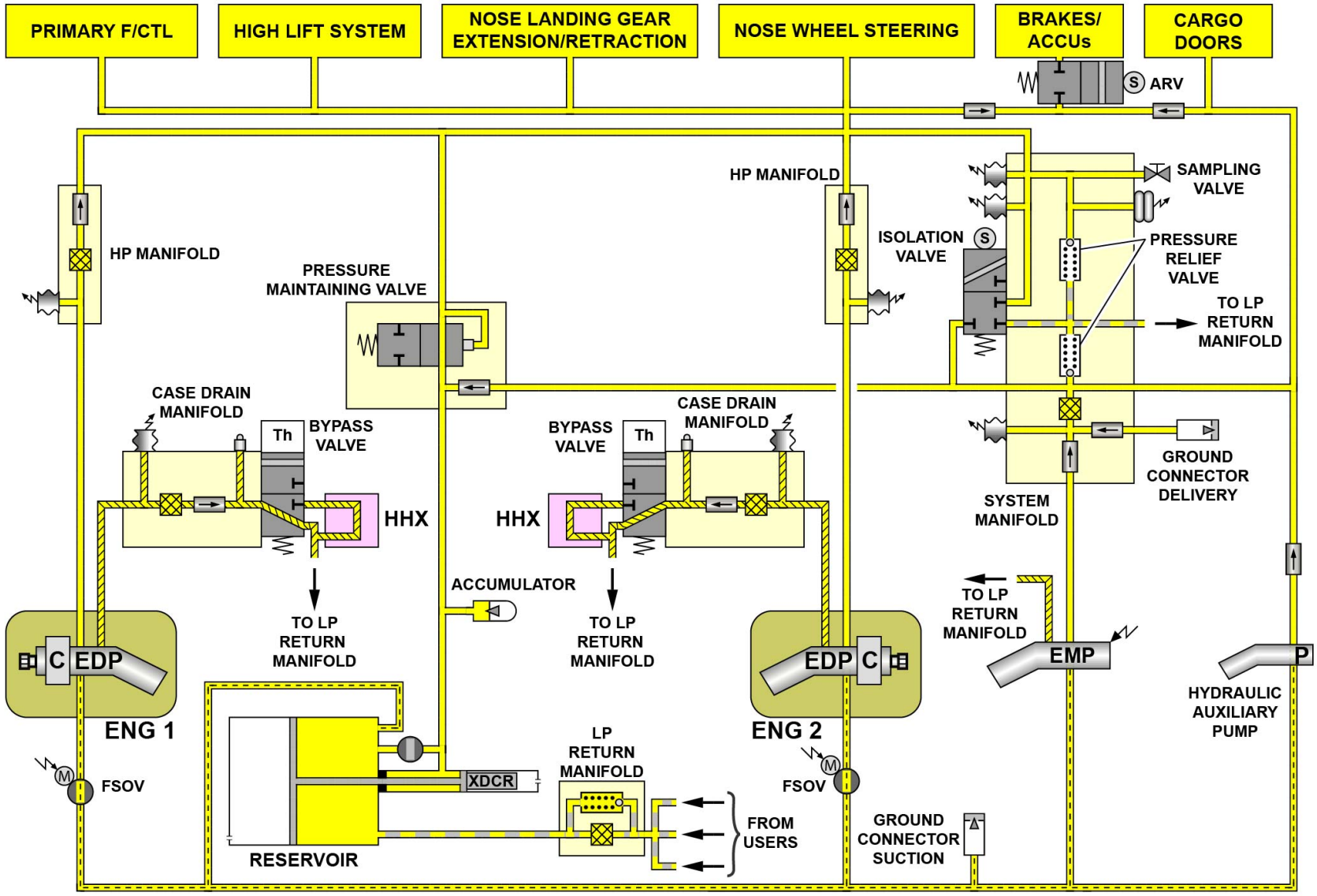

BLEED VALVE
RESERVOIR
GREEN ELEC PUMP
P
DRAIN BOTTLE EMP
SLATS PCU MOTOR
M
DRAIN BOTTLE
BLEED VALVE
RESERVOIR
YELLOW ELEC PUMP
P
DRAIN BOTTLE EMP
FLAPS PCU MOTOR
M
M
DRAIN BOTTLE

SEAL DRAIN

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Yellow Hydraulic System Review

Lets review the Yellow hydraulic system.



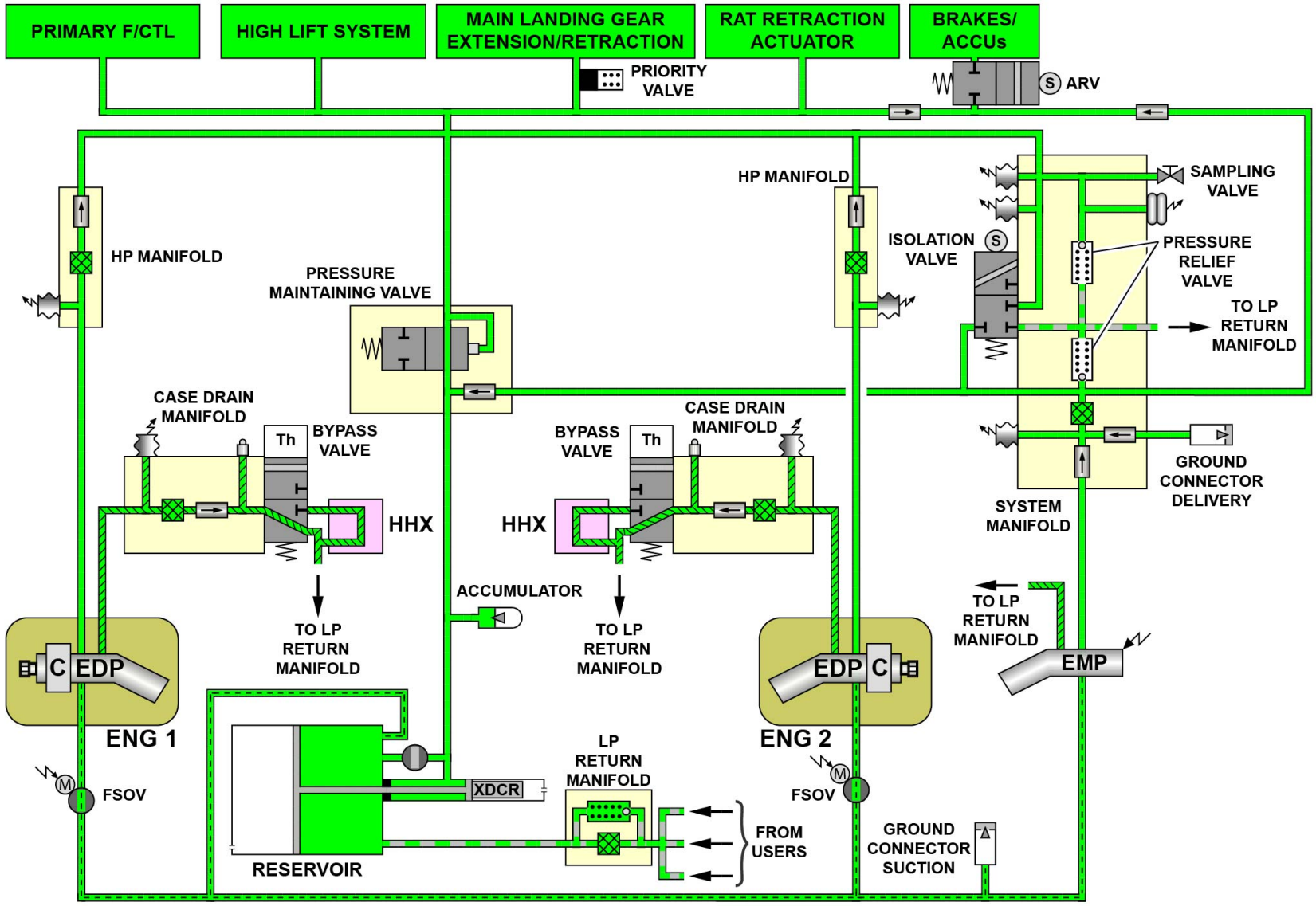
YELLOW HYDRAULIC SYSTEM REVIEW

V1813401 - V01T0M0 - VM29D1HYDDO3001

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Green Hydraulic System

On the Green system, the priority valve gives priority to the primary flight controls. It isolates the heavy load user (MLG extension/retraction) if there is low hydraulic pressure.



GREEN HYDRAULIC SYSTEM

V1813401 - V01T0M0 - VM29D1HYDDO3001

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Monitoring and Indicating

Reservoir

Each sensor installed on the reservoir sends the related data as analog signals to the HMCRF hosted in CRDC. The HMCRF changes these analog signals into digital signals. The data are transmitted to the HMCA through the AFDX.

The HMCRF also sends these signals to show the hydraulic reservoir indications to the flight crew or maintenance personnel:

- The analog signals related to the hydraulic fluid pressure and the hydraulic fluid level to the GSPs
- The discrete signals related to the hydraulic fluid temperature to the FWS.

The HMCA sends these signals to show the hydraulic reservoir indications to the flight crew or maintenance personnel:

- The digital signals related to the hydraulic fluid pressure and the hydraulic fluid level to the FWS
- The digital signals related to the hydraulic fluid pressure, hydraulic fluid temperature and hydraulic fluid level to the CDS.

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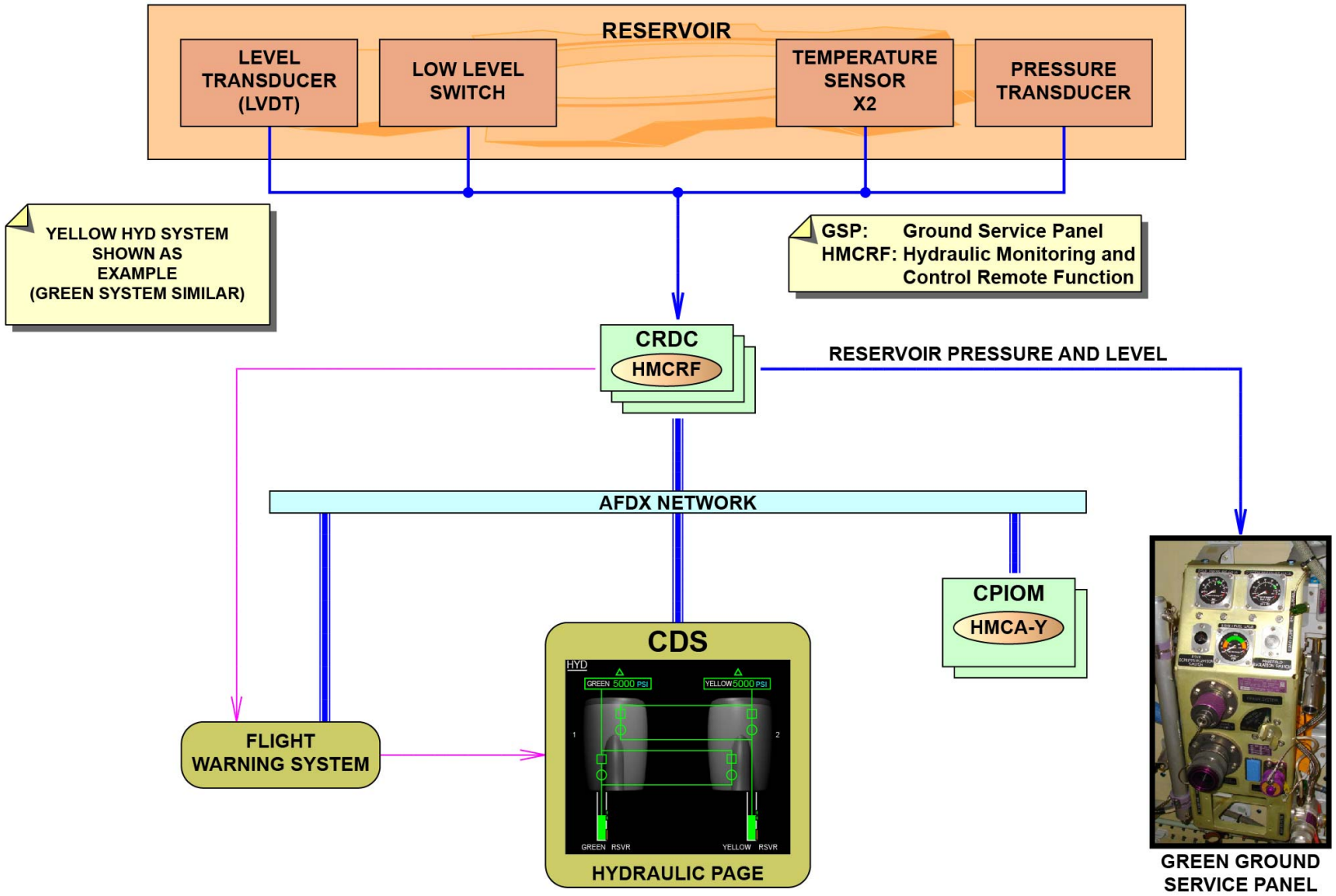


MONITORING AND INDICATING - RESERVOIR

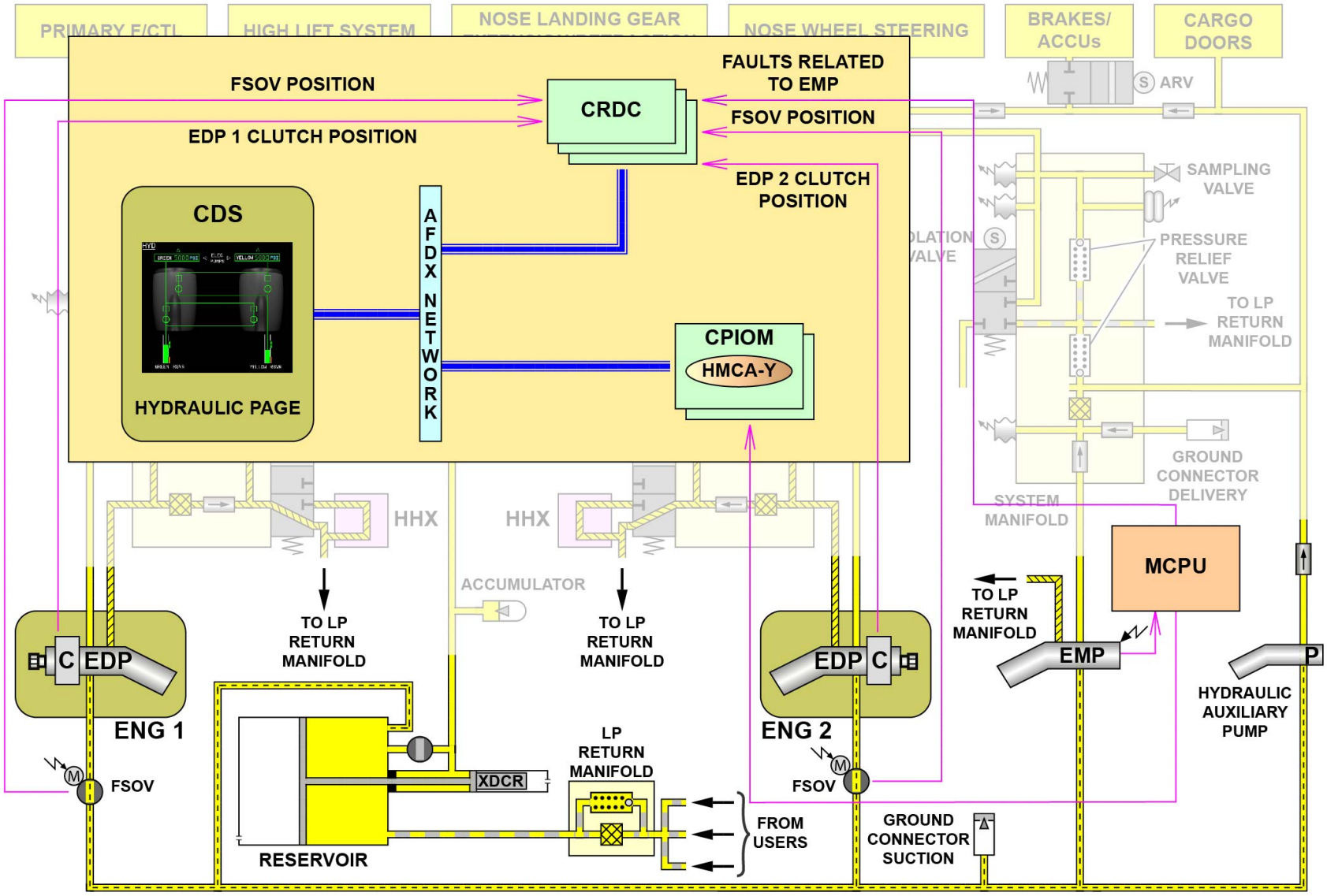
HYDRAULIC SYSTEM DESCRIPTION (2/3)

Monitoring and Indicating (continued)

Supply Part Monitoring

The FSOV position is monitored by the limit switches and is shown on the hydraulic ECAM page.
The EDP can be disengaged on the ground. This is done manually. A switch installed on the EDP will monitor the disengage position. This position is also shown on the hydraulic ECAM page.
The Yellow EMP is controlled and monitored by the MCPU.The MCPU is connected to the CDRCs. The CRDCs are connected to the applications through the Avionics Data Communication Network (ADCN).
The MCPU monitors and gives protection to the EMP for all these faults:
- An overspeed fault
- An EMP overheat fault
- An unbalanced current fault
- Unusual current consumption of the EMP
- A frequency fault.

When a failure is sensed, the MCPU will send an output signal to the CRDC. The CRDC will transfer the fault signal to the CPIOM through the AFDX. As an emergency signal the MCPU will send an EMP fault condition directly to the CPIOM.



MONITORING AND INDICATING - SUPPLY PART MONITORING

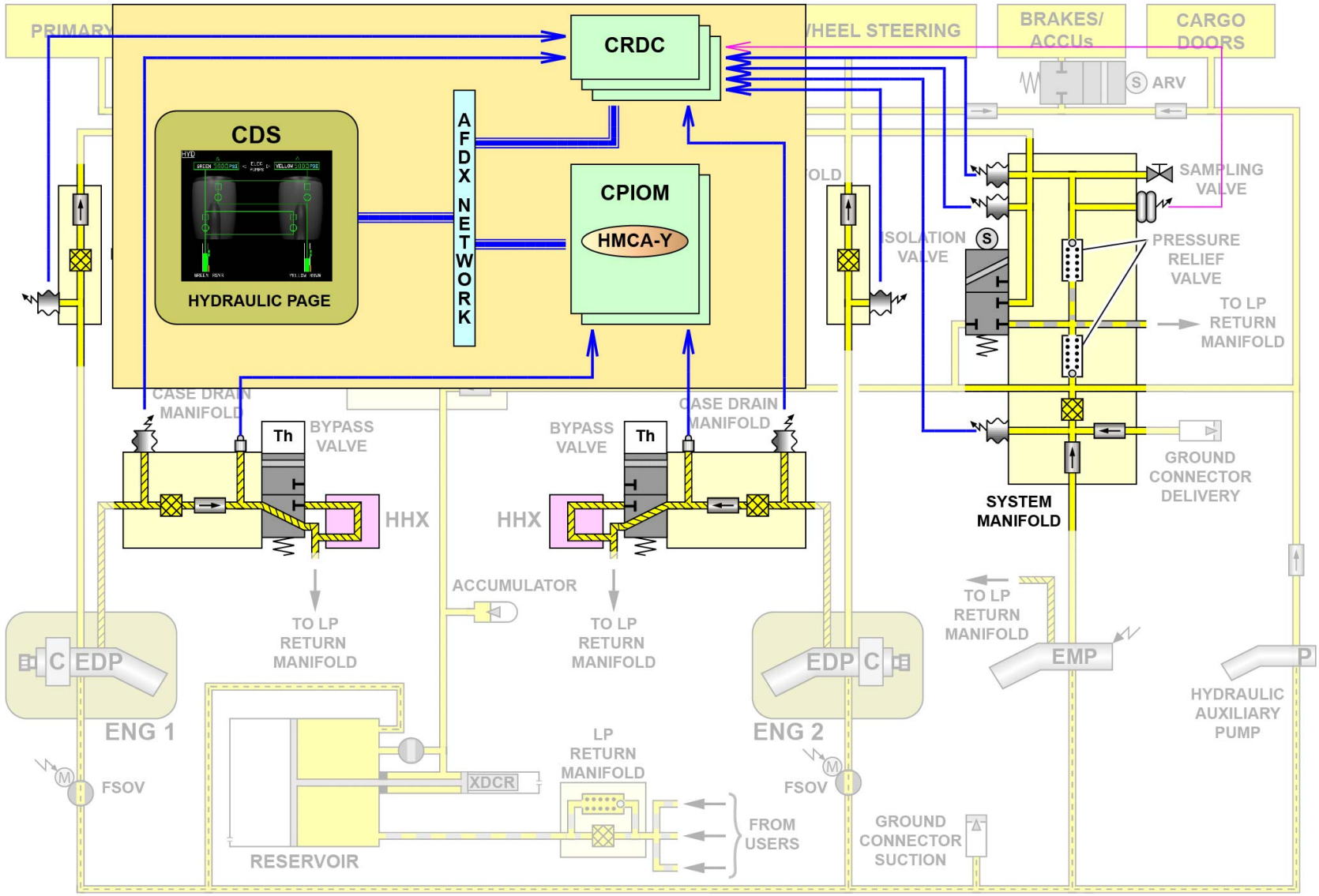
V1813401 - V01T0M0 - VM29D1HYDDO3001

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Monitoring and Indicating (continued)

Distribution Part Monitoring

The different sensors are connected to the CRDCs. This is not applicable to the case-drain temperature sensors which are directly connected to the applications. These sensors are used for indicating but also for the flight controls and the Landing Gear system for example.



MONITORING AND INDICATING - DISTRIBUTION PART MONITORING

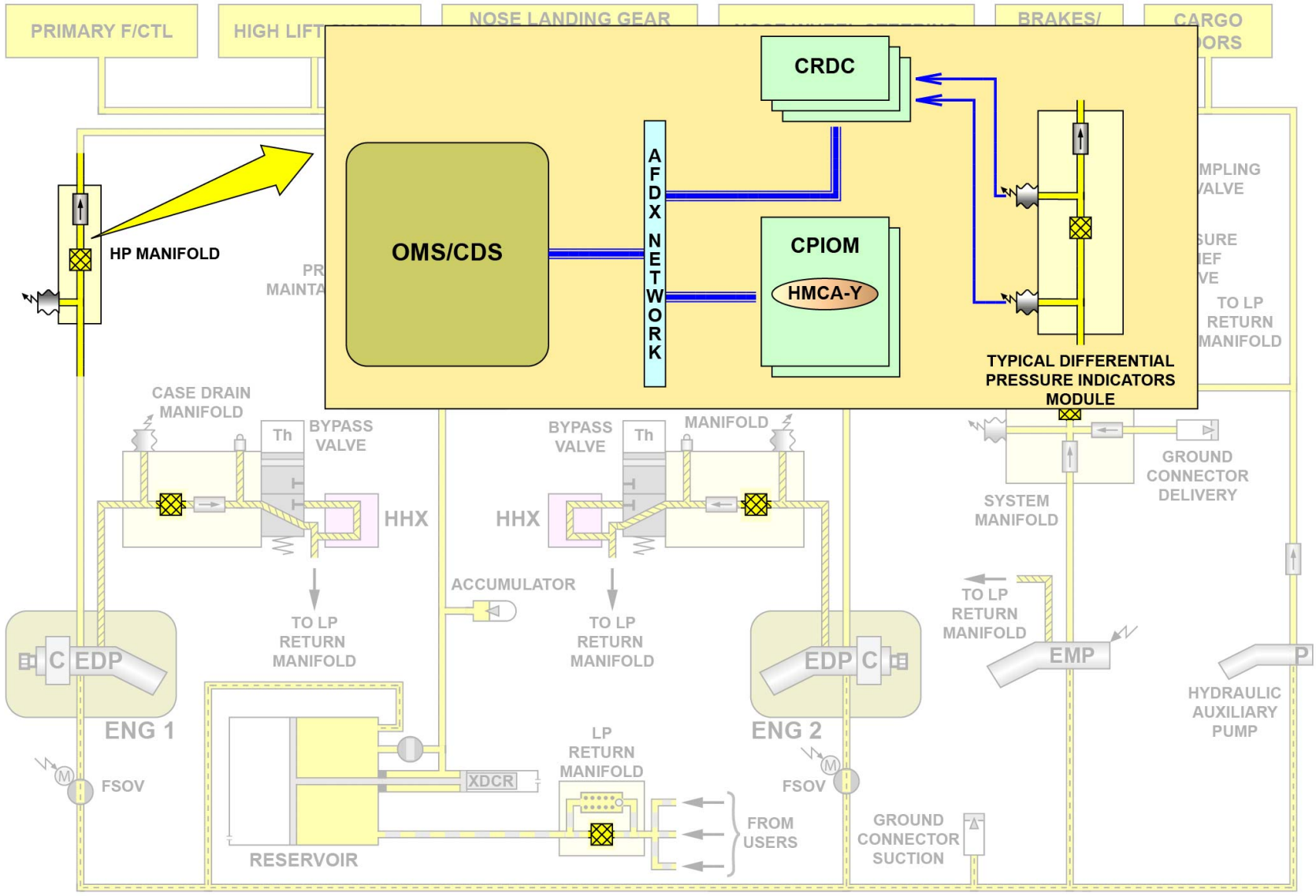
V1813401 - V01T0M0 - VM29D1HYDDO3001

HYDRAULIC SYSTEM DESCRIPTION (2/3)

Monitoring and Indicating (continued)

Filter Clogging Monitoring

There are many filters installed in the hydraulic system.
Each HP, return and CD filter has electrical clogging indicators (differential pressure indicators). For each filter, the pressure is monitored upstream and downstream of the filter.
The return filter includes a bypass device. The clogging status will be supplied in dispatch messages and will be printed on the Post Flight Report.



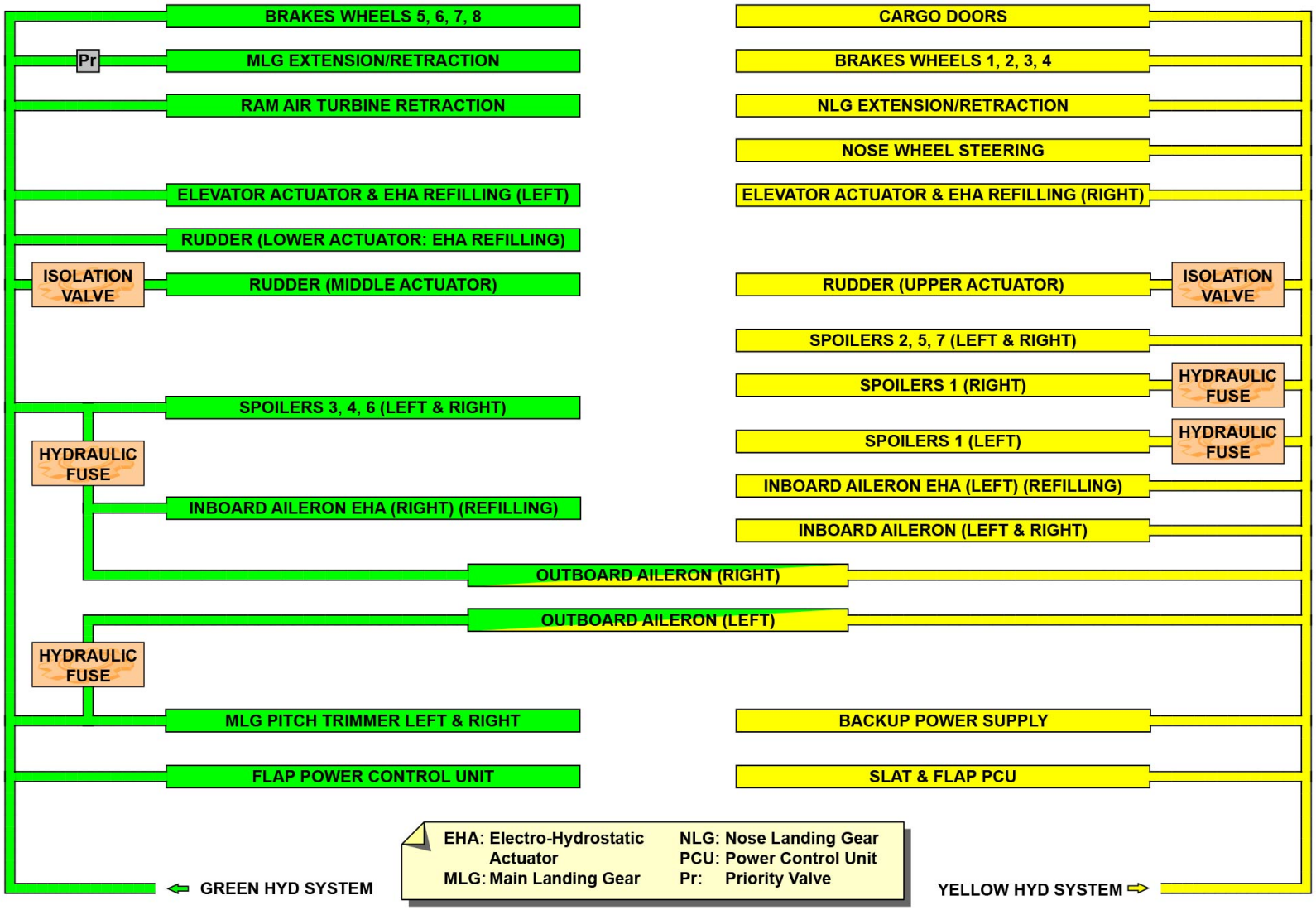
MONITORING AND INDICATING - FILTER CLOGGING MONITORING

V1813401 - V01T0M0 - VM29D1HYDDO3001

HYDRAULIC SYSTEM MAINTENANCE (3)

Hydraulic Fuses

The hydraulic fuses isolate the hydraulic system if there is high leakage, to prevent a hydraulic system loss. The hydraulic-rated fuses will start to close at a specified flow and will stay closed while the pressure on the upstream side is higher (30 psi) than on the downstream side.
It is not possible to set the fuse again in flight. It is necessary to depressurize of the hydraulic system on the ground to set the fuse.
The fuse will set itself when the pressure difference between the inlet and the outlet port is less than 30 psi.
Hydraulic fuses are installed upstream of the outer aileron (left), the inner aileron EHA (right) and spoiler 1 (left and right).



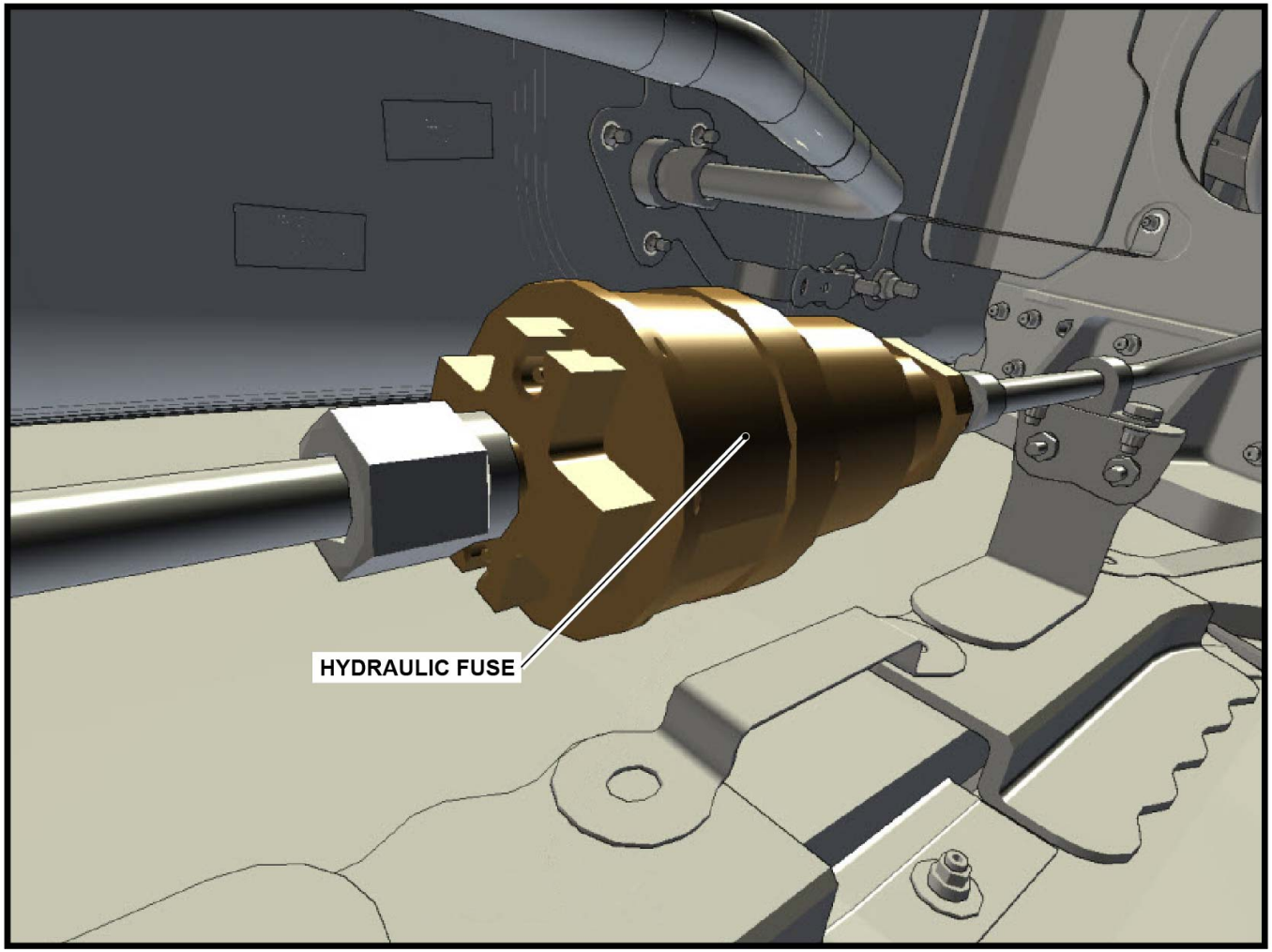
HYDRAULIC FUSES

V1813401 - V01T0M0 - VM29M1HYDMX3001

HYDRAULIC SYSTEM MAINTENANCE (3)

Hydraulic Fuses

The fuse is flow-rated, thus it closes at a specified flow. Ground Support Equipment (GSE) is used to do a check of the closing mechanism of the fuse.
With the hydraulic system pressurized, when the GSE is used and the flow is at the permitted limit, the fuse closes. When the GSE is used the necessary flow will be lower (10 lpm) than in normal operation. It is then possible to do the test with an EMP to pressurize the hydraulic system.



HYDRAULIC FUSES

HYDRAULIC SYSTEM MAINTENANCE (3)

Kevlar Hoses

Kevlar-braided (Aramid fibers) hoses are used for high and low pressure lines.
Kevlar-braided hoses include:
- 1) An inner tube (Teflon: PTFE) which contains the hydraulic fluid,
- 2) A reinforcement (Kevlar: aramid) which gives the inner tube protection from internal system pressures,
- 3) A cover (PBI/polyester protective layer) which gives the reinforcement protection from the external environment.

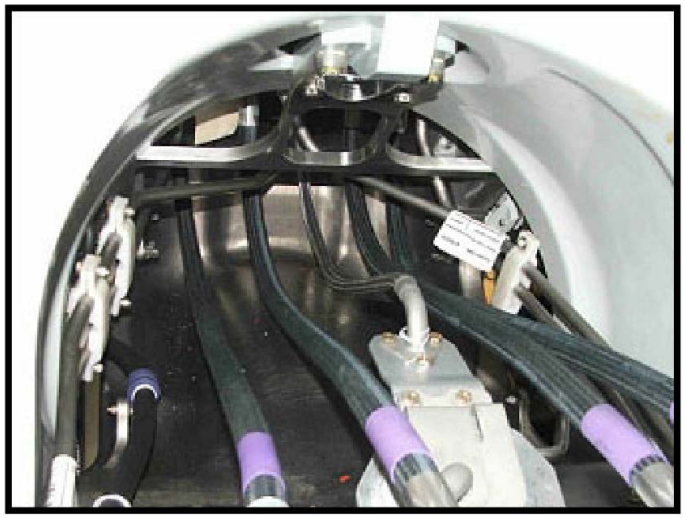
Different precautions are necessary for installation:
- 1) Kevlar hydraulic-hose minimum bend-radius:

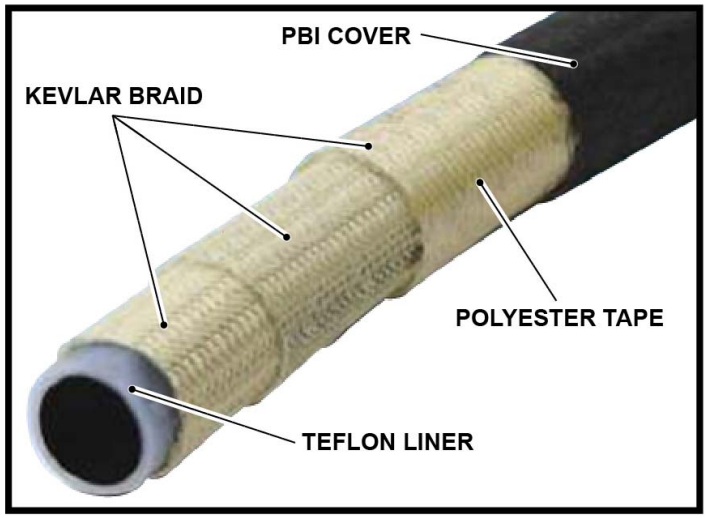
During the handling, storage or installation of kevlar hoses, you must make sure that the bend radius of the Kevlar hose is not less than the minimum bend radius.
CAUTION: YOU MUST OBEY THE SPECIFIED BEND RADIUS IF THE BEND RADIUS IS LOWER THAN THE SPECIFIED BEND RADIUS, KINKING AND LARGE LEAK CAN OCCUR.
- 2) During installation:

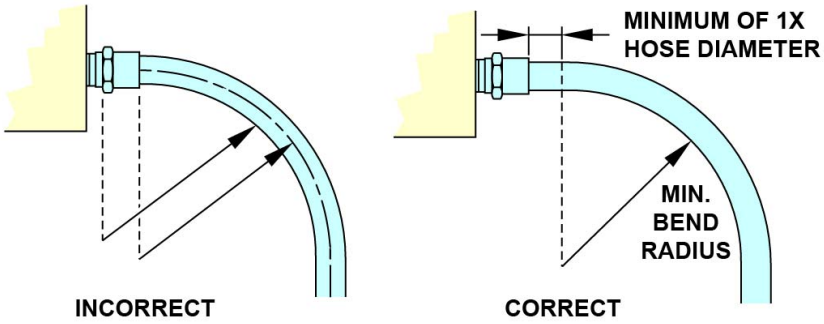
(a) Attach (tighten by hand) the Kevlar hose end-connectors to the related connections, then torque them.
(b) Pre-form the hose manually:
- Use your hands to carefully move the Kevlar hose into the necessary position as you install it. Do not twist the Kevlar hose.

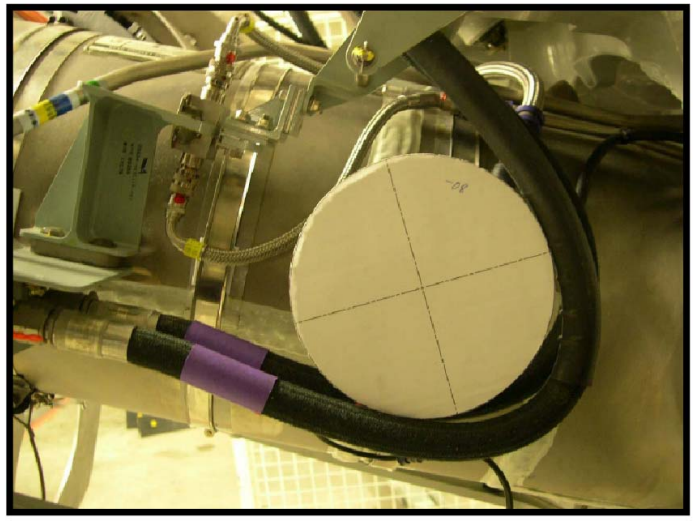
(c) Torque-tighten the other end-connector of the Kevlar hose.
(d) Additional precautions
- Do not put your foot on a Kevlar hose.
- Do not install Kevlar hoses near sources of heat of more than 135 deg.C (275 deg.F).

Hydraulic fluid seepage for the Kevlar hoses is determined by a wet area on the outer surface of the length of the Kevlar hose (not adjacent to the end fittings). For the dispatch, the seepage tolerances are given in the Maintenance Procedure (Table: ATA 20-23-00). These allowances in the Flight Cycle are related to the area where the Kevlar hose is installed.









KEVLAR HOSES

HYDRAULIC SYSTEM CONTROL AND INDICATING (2/3)

Hydraulic System - General (2)

The hydraulic system is controlled from different panels:
-The main hydraulic panel is used to control the Engine Driven Pumps (EDPs) operation, Fire Shut Off Valves (FSOV) closure and to monitor some indications depending on the failures.
-The ground hydraulic panel is used to control the electrical motor pumps (EMPs) operation and has some indications depending on the failures.
-The Hydraulic Ground Servicing panels (Green and Yellow) at the belly fairing of the A/C where are located the connections and switches to perform different maintenance tasks like hydraulic servicing, hydraulic reservoir pressurization and depressurization or manual cargo door operation.
The Hydraulic system parameters are displayed on the ECAM Hydraulic page that can be manually selected using the HYD key of the ECP.

Electric Motor Pump (EMP) Operation (3)

The electrical motor pumps (EMPs) are used on ground to operate the cargo doors (yellow system), to refill the brake accumulators (green and yellow systems) and to do different maintenance tasks.
They can be started manually or automatically. The EMPs operation is inhibited when the engines are running.
There is one EMP per hydraulic system, their control and indications appear at the Ground Hydraulic Panel.
At this panel there are two different pushbutton switches per EMP. One of them is used to select the manual EMP starting (Pulse pushbutton switch), and the second one (Master pushbutton switch) is used to inhibit its operation.
The EMP's indications are available at the ECAM hydraulic page.
At the ECAM Hydraulic page the EMP indication appear between the two hydraulic circuit boxes. The indication consists on a triangle per EMP, both of them appear in white color when the pumps are ready to operate but still in stand by condition.
The EMPs indication on the ECAM Hydraulic page will disappear when the engines are confirmed running (To be checked).
The triangle will change to filled green when the pump is started from the cockpit and green not filled when the EMP is started automatically.
Light will change to filled amber triangle when the pump operation is commanded from the cockpit and amber not filled when the pump is not started from the cockpit.
If the EMP has been manually started, the triangle is linked to the circuit box by a green line.
When the electrical motor pumps are started from the cockpit, the isolation valve installed on each system manifold is energized and all users (except cargo door actuator, yellow system) are hydraulically supplied.
On each ground service panel there is an isolation switch used to operate the isolation valve. This switch will be used when pressurization is done with the ground power carts in order to give hydraulic pressure to all the users. When the pump is started from the cockpit there is no repercussion if the mechanics uses this switch, the isolation valve will not be de-energized.

Engine Driven Pump (EDP) Operation (3)

The hydraulic system can be pressurized by the Engine Driven Pumps (EDPs). There are two EDPs per engine so two per hydraulic system.
The Engine Driven Pumps (EDPs) can be in three different states: pressurized, depressurized and declutch (declutch covered in Theoretical course).
The pressurization and depressurization modes are controlled from the P/Bs installed on the Main Hydraulic Panel. One P/B per EDP is used to select its depressurized mode.
The normal state of the EDP P/B is pushed, at this situation there is no indication at the P/B and when the engines are running the system is pressurized automatically.

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As soon as one P/B is pushed the related EDP will be put in depressurized mode.
At the Hydraulic ECAM page there is a square to indicate the status of each EDP. The indication can be:
- Green in normal configuration when the pump operate to pressurize the hydraulic system and the pressure is higher than a certain threshold (3700 psi),
- Amber when the pump is depressurized,
- Amber with a LO indication inside when the respective pressure switch detects a low pressure,
- Amber XX when the data is not available,
- Amber with an amber DISC indication when the pumps are declutched.

Fire Shut Off Valves (FSOVs) (3)

There is one FSOV for each EDP. The closure of the FSOV will stop the hydraulic supply to the related EDP.
The FSOV can be closed manually using the Engine Fire P/B switch or by using the red guarded SUPPLY "OVHT/ISOL" P/B on Main hydraulic Panel.

Green and Yellow Ground Service Panels Description (2)

The Yellow GSP lets maintenance personnel:
. Pressurize the Yellow hydraulic system
. Monitor the Yellow system pressure and Yellow hydraulic reservoir pressure
. Operate the cargo doors
. De-pressurize the Yellow hydraulic reservoir.
The Yellow GSP has these components:
. The reservoir depressurization switch
. The reservoir pressure gage
. The system pressure gage
. The manifold isolation switch (used to control the isolation valve on the system manifold)
. The low-pressure quick-disconnect coupling for GSP return
. The crank operated drive attachment
. The high-pressure quick-disconnect coupling for GSP delivery
. The hydraulic auxiliary pump.
The Green GSP lets maintenance personnel:
. Pressurize the Green hydraulic system
. Monitor the Green hydraulic system pressure and Green hydraulic reservoir pressure
. Monitor the level of hydraulic fluid in the Green and Yellow hydraulic reservoirs
. Fill the Green and Yellow hydraulic reservoirs
. De-pressurize the Green hydraulic reservoir.
The Green GSP has these components:
. The reservoir pressure gage
. The system pressure gage
. An inlet filling hose
. The manifold isolation switch
. The reservoir filling hand-pump
. The reservoir filling selector-valve
. The reservoir-fillIing quick-disconnect coupling
. The low-pressure quick-disconnect coupling for GSP return
. The high-pressure quick-disconnect coupling for GSP delivery
. The reservoir quantity gage
. The reservoir-filling hand-pump handle
. The reservoir depressurization switch
. The reservoir filling hose
. The reservoir filling filter.
The reservoir level can be monitored using different possibilities. The reservoir quantity indicator gage on the Green Ground Service Panel allows to check the level of the reservoir which has been selected with the manual selector valve. This indication is temperature compensated.
The reservoir quantity can be checked also on the HYD SD page, the indication is also temperature compensated.
The reservoir quantity can be monitored on the reservoir itself but the indication is not temperature compensated.

Reservoir refilling (Green Reservoir) (2)

The connections to refill the hydraulic reservoirs are located at the Green Ground Service Panel.
The refilling is made by the hydraulic return lines and can be done by using a ground cart or with a hand pump.
The level of hydraulic at the reservoir can be checked at the ECAM hydraulic page or at the Ground Service Panel.
To perform the refilling is necessary previously to select the system; that is made by operating the manual selector valve at the center of the ground service panel.
Under the manual selector valve there is a gage where is possible to check if the level of hydraulic at the reservoir is the right one.
At this gage there is a needle and three different color bands: one green and two ambers. If the needle is in front of the green area, it's not necessary to refill, if the needle is in the amber area where is written ADD, it's necessary to add hydraulic fluid to the reservoir, if the needle is in the red area where is written REMOVE, the system is in overfilling condition and some hydraulic fluid should be removed.

RSVR Press./Depress. from Ground Service Panel (2)

To depressurize each reservoir, it is necessary to open the depressurization valve located on the reservoir. This valve can be opened electrically by energizing the solenoid via a switch on the GSP.
On the HYD ECAM Page, in case of reservoir low pressure condition, the amber "RSVR PRESS LO" indication will be displayed close to the reservoir (green reservoir in this example).
This condition is detected for each hydraulic system by a respective low pressure switch installed on the reservoir.
Associated to this air low pressure condition, all FAULT lights on the possible sources (except if inhibited) illuminate on the related P/B switches.
At the Ground Hydraulic Service panel, there is one gage to show the reservoir pressure.
At the E/WD the warning HYD G (Y) RSVR PRESS LO appears with the respective message asking to switch off the EDPs and/or EMPs when the reservoir pressure is below a certain threshold (22psi).
In flight the reservoirs are pressurized by the EDP's
On ground, in order to repressurize the reservoir the electric pumps can be used if the engines are not running.
If the RSVR had low pressure before starting the Engine this might lead to Engine Pump cavitation.
The EMP has to be started in order to pressurize the system by ELEC PMP ON P/B (pulse P/B), before the Engines are started, to avoid pump cavitation.

RSVR Press./Depress. from the Reservoir (2)

To depressurize each reservoir, it is necessary to open the depressurization valve located on the reservoir. This valve is opened manually by operating a knob directly on the valve.
At the Hydraulic Ground Service panel, there is one gage to show the reservoir pressure.
On the HYD ECAM Page, in case of reservoir low pressure condition, the amber "RSVR PRESS LO" indication will be displayed close to the reservoir (green reservoir in this example).
This condition is detected for each hydraulic system by a respective low pressure switch installed on the reservoir.
Associated to this air low pressure condition, all FAULT lights on the possible sources (except if inhibited) illuminate on the related P/B switches.
At the Ground Hydraulic Service panel, there is one gage to show the reservoir pressure.
At the E/WD the warning HYD G (Y) RSVR PRESS LO appears with the respective message asking to switch off the EDPs and/or EMPs when the reservoir pressure is below a certain threshold (22psi).
In flight the reservoirs are self pressurized by the EDP's
On ground, in order to repressurize the reservoir the electric pumps can be used if the engines are not running.

If the RSVR had low pressure before starting the Engine this might lead to Engine Pump cavitation.
The EMP has to be started in order to pressurize the system by ELEC PMP ON P/B (pulse P/B), before the Engines are started, to avoid pump cavitation.

Yellow HYD system pressurized by Hydraulic Ground Cart (3)

The hydraulic ground carts are connected at the green and yellow ground service panels. Due to the High pressure 5000psi a specific hydraulic ground carts have to be used.
When the isolation valve is not energized only the yellow cargo door actuators and yellow brake accumulator are hydraulically supplied.
The hydraulic pressure can be checked on the Hydraulic ECAM page or on the system pressure gage on the related ground service panel.
The hydraulic status of each hydraulic circuit is shown at the HYD SD Page.
When the isolation valve is energized all the yellow users are hydraulically supplied.
The hydraulic status of each hydraulic circuit is shown at the ECAM hydraulic page by a triangle and a circuit box.

EMP: Abnormal Operation (3)

If the Electric Motor Pump (EMP) is faulty, the hydraulic system cannot be powered on ground when engines are not running, unless ground cart is used. Recharge capability of Brake Accumulators will be lost.
For some maintenance issues both green and yellow systems have to be powered by the EMP. Ground performance can therefore be affected.
EMPS Faults are sent by MCPU / EMP as discrete signals to one CRDC which forwards these on AFDX network to one HMCA. As a backup function the MCPU additionally sends the general "EMP Fault" discrete signal directly to the HMCA if Overheat, Current, Unbalance, Ground or Speed faults is true.

The EMP operation is protected by the Motor Control and Protection Unit (MCPU), this unit protects the electric motor pump against overheat, over speed, abnormal current consumption and phase current unbalance.
A low pressure condition can be also detected by the low pressure switch located at the system manifold.
In case of malfunction an amber FAULT light illuminates on the respective EMP switch and a warning message appears at the WD area.
In case of overheat, over speed or current unbalance, the MCPU stops automatically the EMP operation, the WD area shows the message to switch the pump manually OFF to confirm the automatic disconnection.
In case of over speed or current unbalance the FAULT light disappears when the pump is disconnected. In case of overheat, the FAULT light stays on as long as the overheat condition is detected.
In case of low pressure it's necessary to switch off the EMP manually, and once the amber FAULT light disappears.
All EMP Faults are latched by HMCA. To reset the EMP, the maintenance operator has to perform a BITE Interactive Test on the OMT.

Hydraulic Fluid Abnormal Temperature (3)

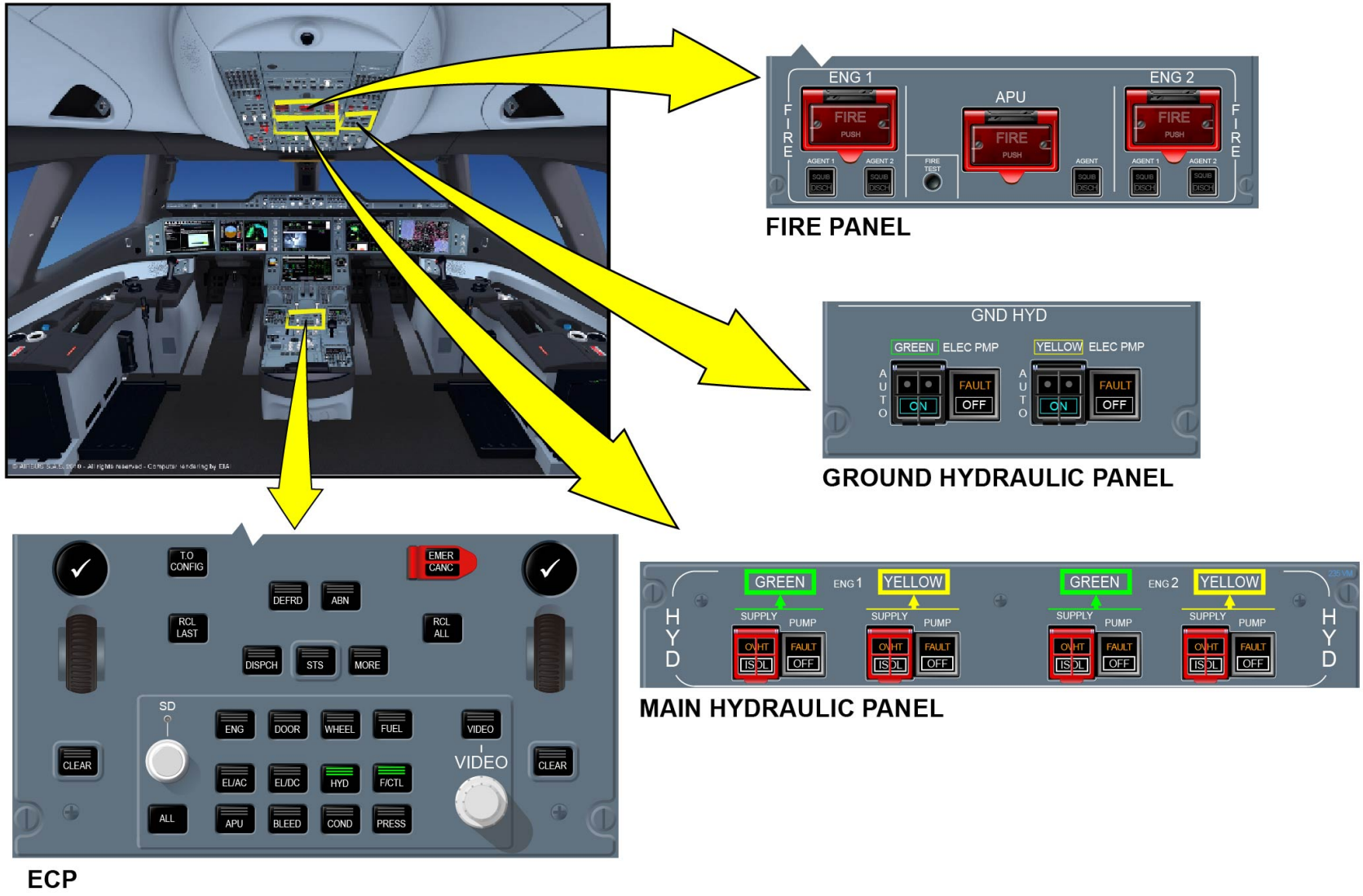
At the hydraulic system there are two levels of fluid overheat depending on the temperature:
- Excessive Temperature High condition,
- System overheat.

The temperature of the hydraulic system is monitored by different temperature sensors:
- Two are located on each reservoir,
- One is located on the related engine case drain manifold of the EDP.

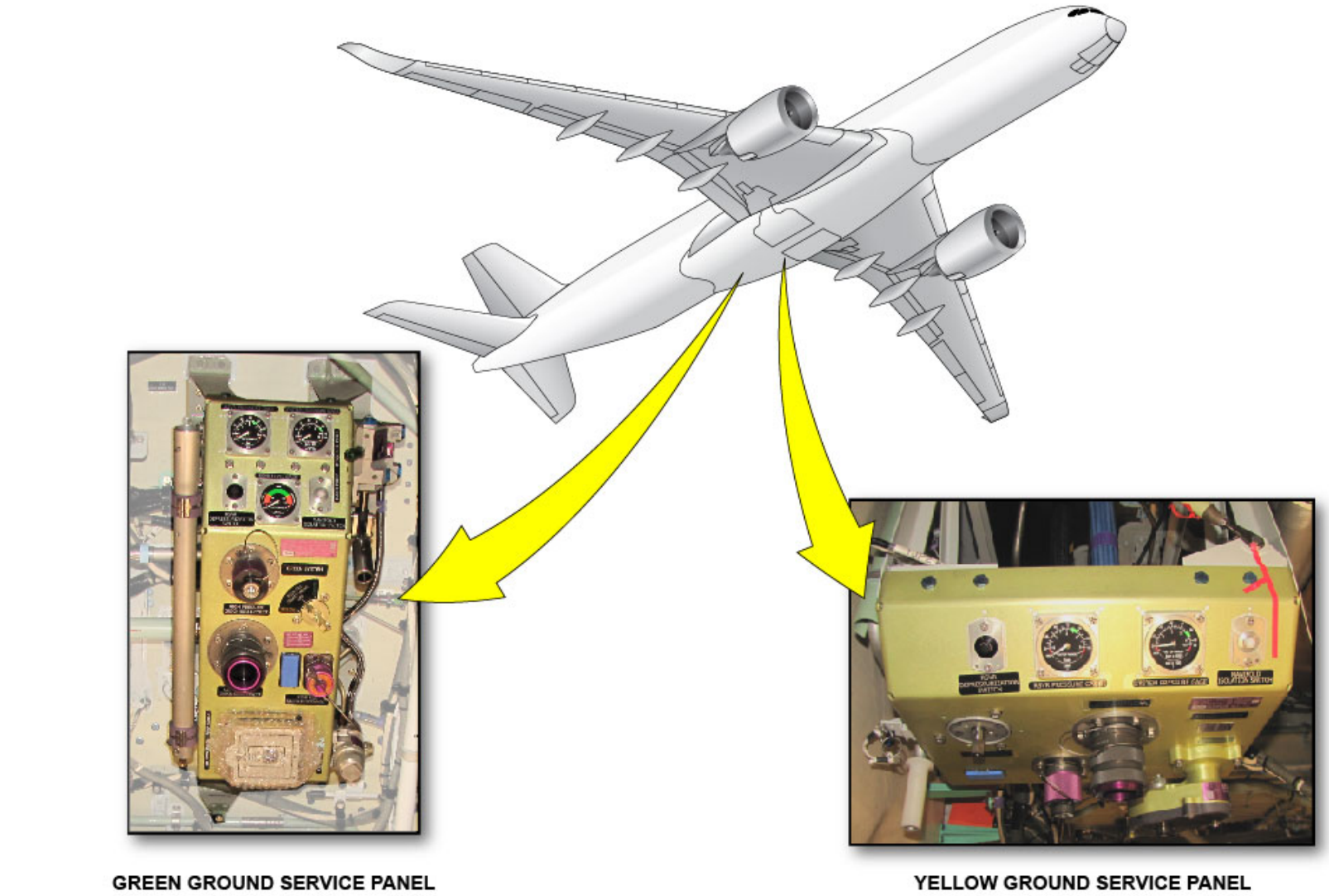
1) Excessive Temperature High (Yellow System):
An overheat temperature condition appears in NORMAL fuel level when:
- The reservoir temperature is more than a certain threshold (95°C),
- The case drain temperature is more than a certain threshold (120°C).

OR
An overheat temperature condition appears in LOW fuel level when:
- The reservoir temperature is more than a certain threshold (115°C),

- The case drain temperature is more than a certain threshold (135°C).
In this case, as there is an overheat in the green hydraulic system the FAULT lights (G EDPs) on the HYD panel and the FAULT light on the GND HYD panel are illuminated.
On the Hydraulic SD page, the amber "OVHT" indication appears near to the related reservoir and on the WD area, the amber "HYD Y SYS TEMP HI" message appears with the related blue messages asking to switch OFF the related EDP's (In this case yellow system) and Yellow EMP.
Once the EDPs are depressurized a white OFF light appears at each P/B switch and in overheat condition the FAULT lights remain amber as long as the overheat condition remains.
2) Overheat Condition (Green System):
The increase of temperature at the hydraulic system can lead to degradation at the hydraulic fluid.
If after an excessive temperature high the temperature of the hydraulic fluid continues to increase, the system will enter in an "Overheat condition":
- The Reservoir temperature is more than a certain threshold (120°C),
- The Case drain temperature is more than a certain threshold (150°C).
At this situation, the amber FAULT light will appear on the EDPs and EMPs depressurization P/Bs, and also the red FAULT light at the ISOL P/Bs (FSOV Closure).
At the WD area a warning will inform about the "OVHT" condition and different blue memos will request the depressurization for the two EDPs connected to the respective hydraulic system and closure of the related FSOVs (via the SUPPLY ISOL red guarded P/B SWs).
After closure of the related FSOVs, the related EDPs will be automatically put in depressurized mode but the pilots will have to confirm it by using the EDPs P/B SWs.
3) Hydraulic Heat Exchanger (Green and Yellow Systems):
To keep the hydraulic fluid at low temperature values there is one fuel/hydraulic heat exchanger installed the fuel tank (one hydraulic heat exchanger for each EDP).
The Hydraulic Heat Exchanger is installed at the case drain line, as they are consider as the hottest point of the system.



HYDRAULIC SYSTEM - GENERAL (2) ... HYDRAULIC FLUID ABNORMAL TEMPERATURE (3)



HYDRAULIC SYSTEM - GENERAL (2) ... HYDRAULIC FLUID ABNORMAL TEMPERATURE (3)

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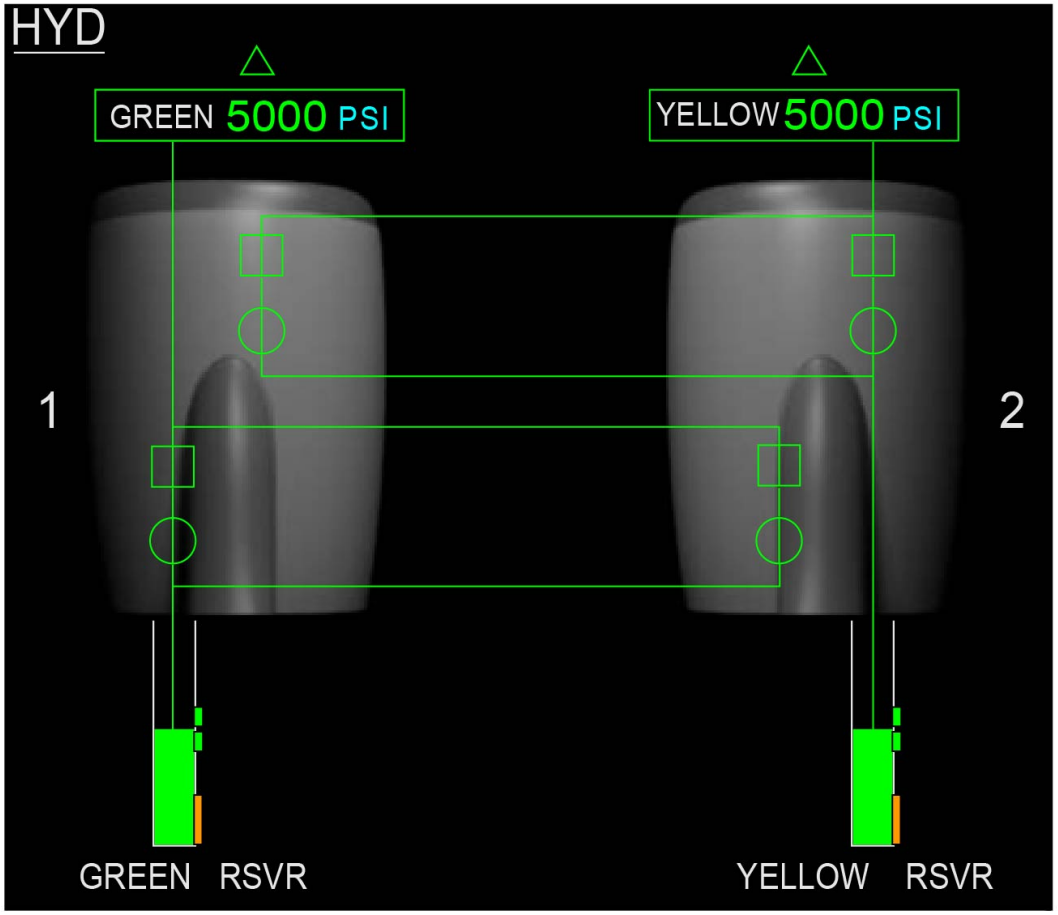
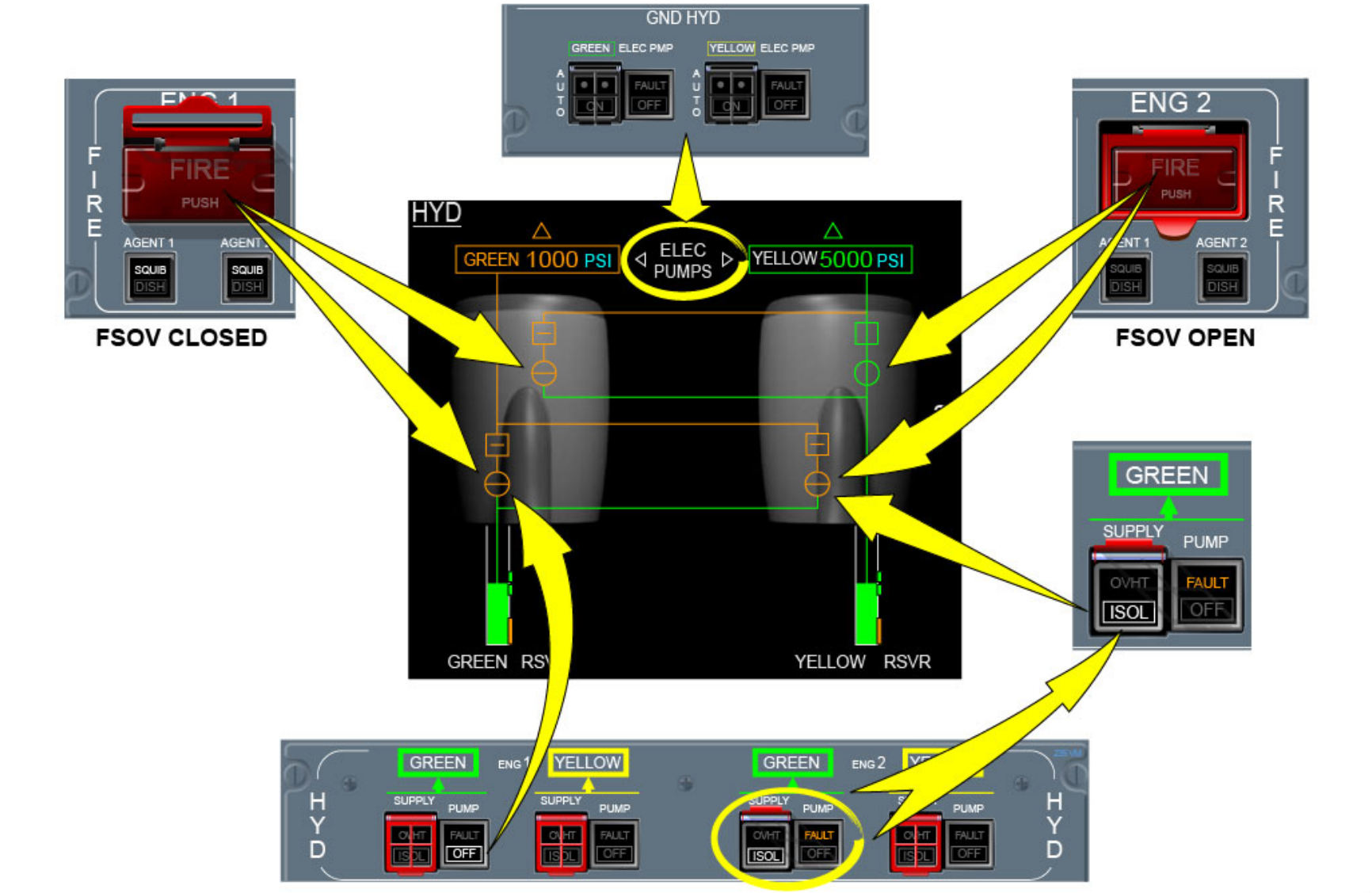
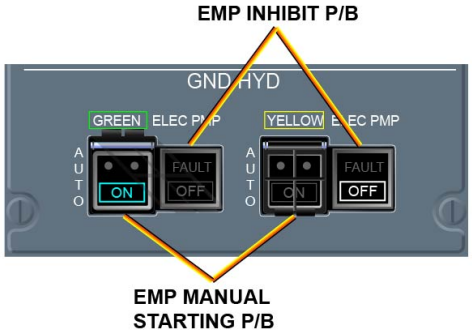


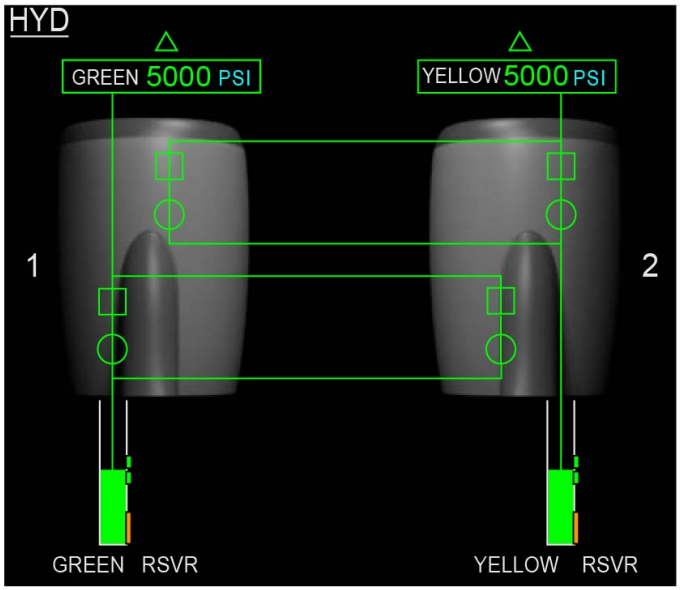
HYDRAULIC ECAM PAGE (NORMAL OPERATION)

HYDRAULIC SYSTEM - GENERAL (2) ... HYDRAULIC FLUID ABNORMAL TEMPERATURE (3)



HYDRAULIC SYSTEM - GENERAL (2) ... HYDRAULIC FLUID ABNORMAL TEMPERATURE (3)





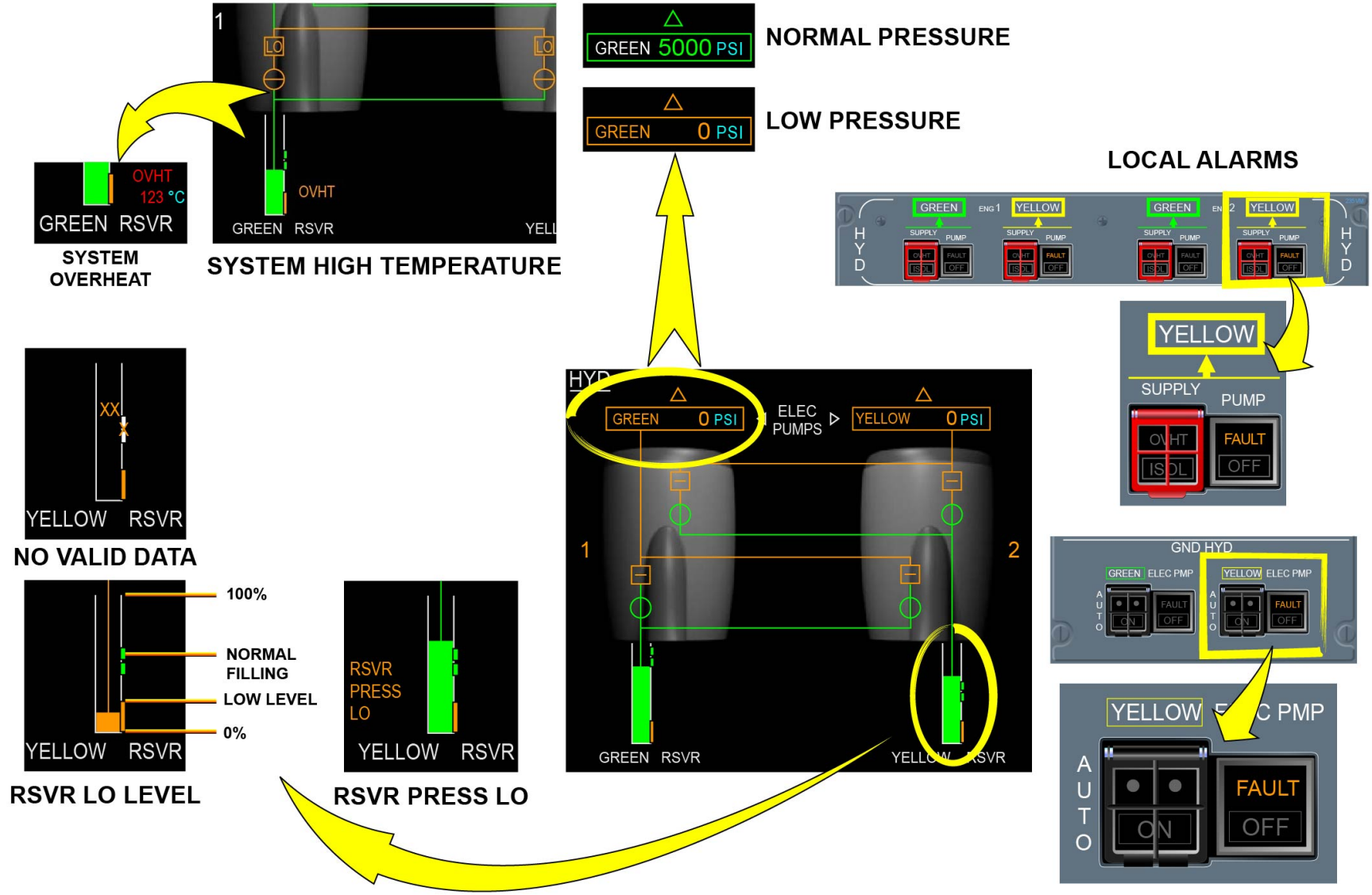
HYDRAULIC NORMAL OPERATION

EMP INDICATING

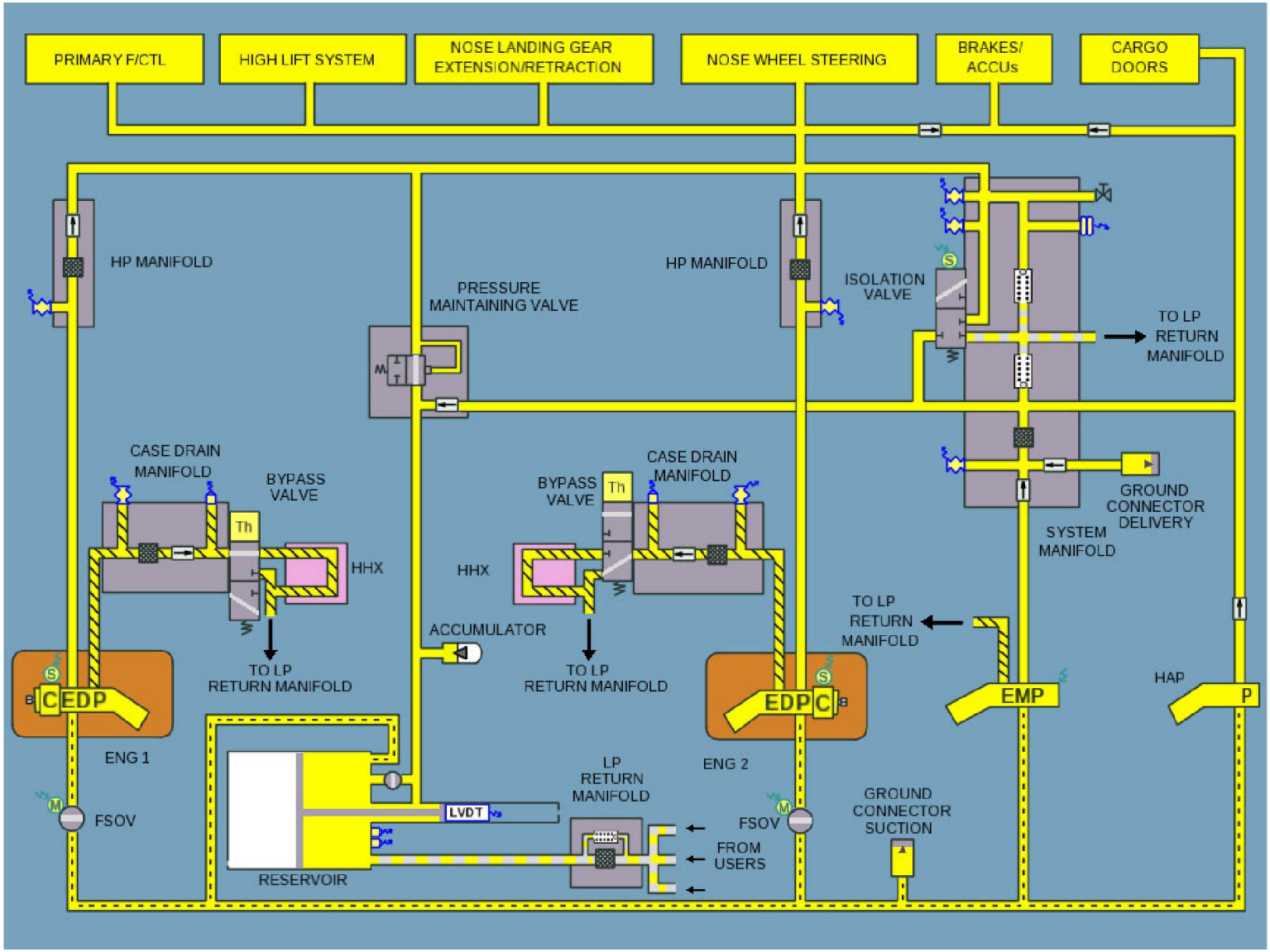
- NORMAL STATE
- EMP RUN BY CONSUMER COMMAND
- EMP RUNNING UPON START-UP FROM COCKPIT «ON» PUSHBUTTON
- EMP FAULT WITH EMP «ON» P/B ACTIVE
- EMP FAULT WITH EMP «ON» P/B INACTIVE
  EMP RUNNING UPON START-UP FROM COCKPIT «ON» PUSHBUTTON
- XX EMP DATA INVALID

EDP INDICATING

- EDP ON
- EDP AUTOMATICALLY DEPRESSURIZED IN FUEL LOW LEVEL CONDITIONS
- EDP COMMANDED «OFF»
- EDP COMMANDED «OFF» AND LOW PRESSURE IS DETECTED
- LO LOW PRESSURE IS DETECTED
- DISC EDP HAS BEEN DECLUTCHED
- XX EDP DATA INVALID



HYDRAULIC SYSTEM - GENERAL (2) ... HYDRAULIC FLUID ABNORMAL TEMPERATURE (3)



HYDRAULIC SYSTEM - GENERAL (2) ... HYDRAULIC FLUID ABNORMAL TEMPERATURE (3)

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