

CHAPTER

29

Hydraulic Power

**CHAPTER 29**
HYDRAULIC POWER

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HYDRAULIC POWER - INTRODUCTION

General

Three hydraulic systems supply pressurized hydraulic fluid to supply power to these airplane systems:

- Flight controls
- Landing gear actuation
- Main gear brakes
- Main and nose landing gear steering
- Leading edge slats
- Trailing edge flaps
- Thrust reversers.

These systems make up the hydraulic power system:

- Main hydraulic systems
- Ram air turbine (RAT) system
- Hydraulic indicating systems
- Ground servicing system.

Main Hydraulic Systems

The three hydraulic systems are Left, Center, and Right. The names give the location of their main components.

Ram Air Turbine System

The ram air turbine supplies an emergency source of hydraulic power to operate the flight controls. The RAT also supplies emergency electrical power.

Hydraulic Indicating System

The hydraulic indicating system shows these hydraulic system indications on the flight deck:

- System pressure
- Pump pressure

- Reservoir pressure
- Pump temperature
- Reservoir temperature
- Hydraulic reservoir quantity
- Valve positions.

Ground Servicing System

A central servicing bay permits you to fill the three hydraulic reservoirs from a single location.

Abbreviations and Acronyms

- ACMP - alternating current motor pump
- actr - actuator
- ADIRU - air data inertial reference unit
- ADP - air driven pump
- ADU - air drive unit
- AFDC - autopilot flight director computer
- AIMS - airplane information management system
- ARINC - Aeronautical Radio, Inc.
- APUC - auxiliary power unit controller
- AS - airspeed
- auto - automatic
- ASG - ARINC signal gateway
- ASCPC - air supply and cabin pressure controller
- C - center
- capt - captain
- CCU - computing and communications unit
- CD - case drain
- CHIS - center hydraulic isolation system
- CL - center left
- CR - center right

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HYDRAULIC POWER - INTRODUCTION

- CTC - cabin temperature controller
- depress - depressurization
- disc - disconnect
- EDIU - engine data interface unit
- EDP - engine driven pump
- ELCU - electrical load control unit
- ELMS - electrical load management system
- eng - engine
- FSEU - flap slat electronics unit
- gnd - ground
- HLCS - high lift control system
- hyd - hydraulic
- HYDIM - hydraulic interface module
- isln - isolation
- L - left
- LG - landing gear
- LSCU - logic and speed control unit
- LVDT - linear variable differential transformer
- MAT - maintenance access terminal
- mgmt - management
- MLG - main landing gear
- MSOV - modulating and shutoff valve
- NG - nose gear
- NLG - nose landing gear
- OPAS - overhead panel ARINC 629 system
- PCU - power control unit
- PFC - primary flight computer
- PFCS - primary flight control system
- pnl - panel
- press - pressure
- PSEU - proximity sensor electronics unit
- pwr - power
- qty - quantity
- R - right
- RAT - ram air turbine
- rlf - relief
- RPM - revolutions per minute
- rsv - reserve
- rsrv - reservoir
- rtn - return
- RWW - right wheel well
- SIU - signal interface unit
- sply - supply
- stby - standby
- svce - service
- sys - system
- temp - temperature
- TGA - turbine gearbox assembly
- VIGV - variable inlet guide vanes
- vlv - valve
- xdcr - transducer

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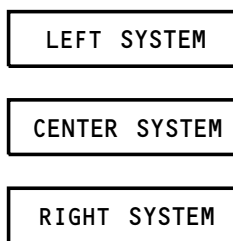
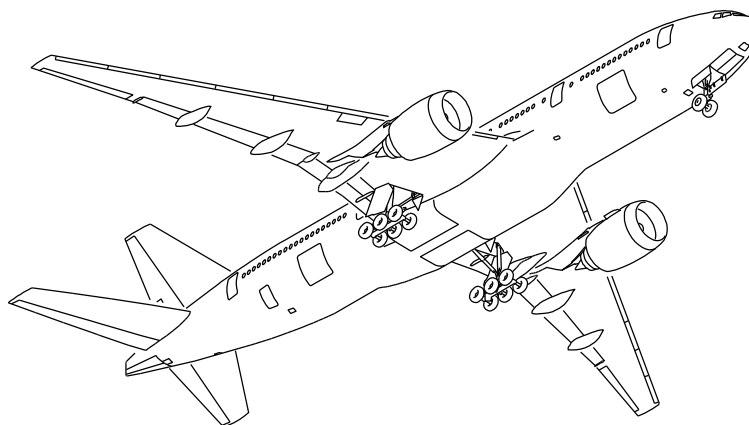
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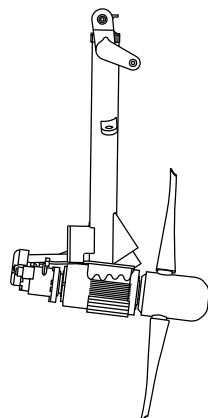
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HYDRAULIC POWER USER SYSTEMS:

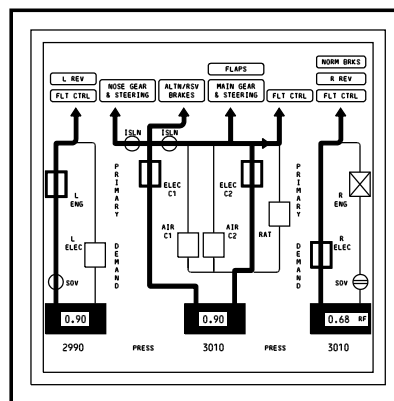
- FLIGHT CONTROLS
- LANDING GEAR ACTUATION
- MAIN GEAR BRAKES
- MLG AND NLG STEERING
- LEADING EDGE SLATS
- TRAILING EDGE FLAPS
- THRUST REVERSERS



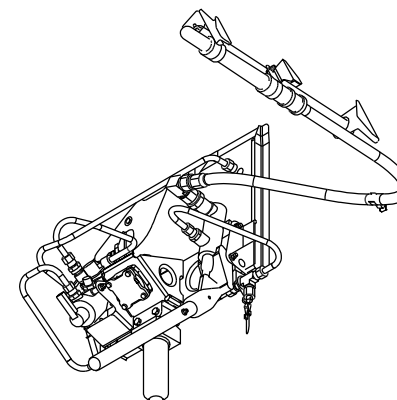
MAIN HYDRAULIC SYSTEMS



RAM AIR TURBINE SYSTEM



HYDRAULIC INDICATING SYSTEM



GROUND SERVICING SYSTEM

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HYDRAULIC POWER - INTRODUCTION

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HYDRAULIC POWER - COMPONENT LOCATIONS

General

Hydraulic system components are in these locations:

- Left and right engine aft strut fairings
- Right wheel well
- Aft wing to body fairings
- Main equipment center
- Stabilizer compartment.

Left and Right Hydraulic Systems

The left and right hydraulic system components are almost the same. Most left system components are in the left engine aft strut fairing. Most right system components are in the right engine aft strut fairing.

The components in each engine aft strut fairing include:

- A hydraulic reservoir
- An alternating current motor pump (ACMP)
- Filter modules (3)
- A reservoir pressurization module.

The left system engine-driven pump (EDP) is on the left engine. The right system EDP is on the right engine.

The system pressure transducers are in the wing structure behind each engine.

Center Hydraulic System

Most center hydraulic system components are in the right wheel well. These components include:

- A hydraulic reservoir
- ACMPs (2)
- Filter modules (3)
- A reservoir pressurization module

- A system pressure transducer
- Isolation valves.

Two air-driven pumps (ADPs) are in the left aft wing to body fairing behind the left wheel well.

The ram air turbine (RAT) is in the right aft wing to body fairing behind the right wheel well.

Other Hydraulic System Components

Four hydraulic interface module (HYDIM) cards are in the cardfiles in the main equipment center.

Heat exchangers are in the left and right main fuel tanks.

Hydraulic ground servicing equipment is in the ground servicing bay. The ground servicing bay is in the right aft wing to body fairing.

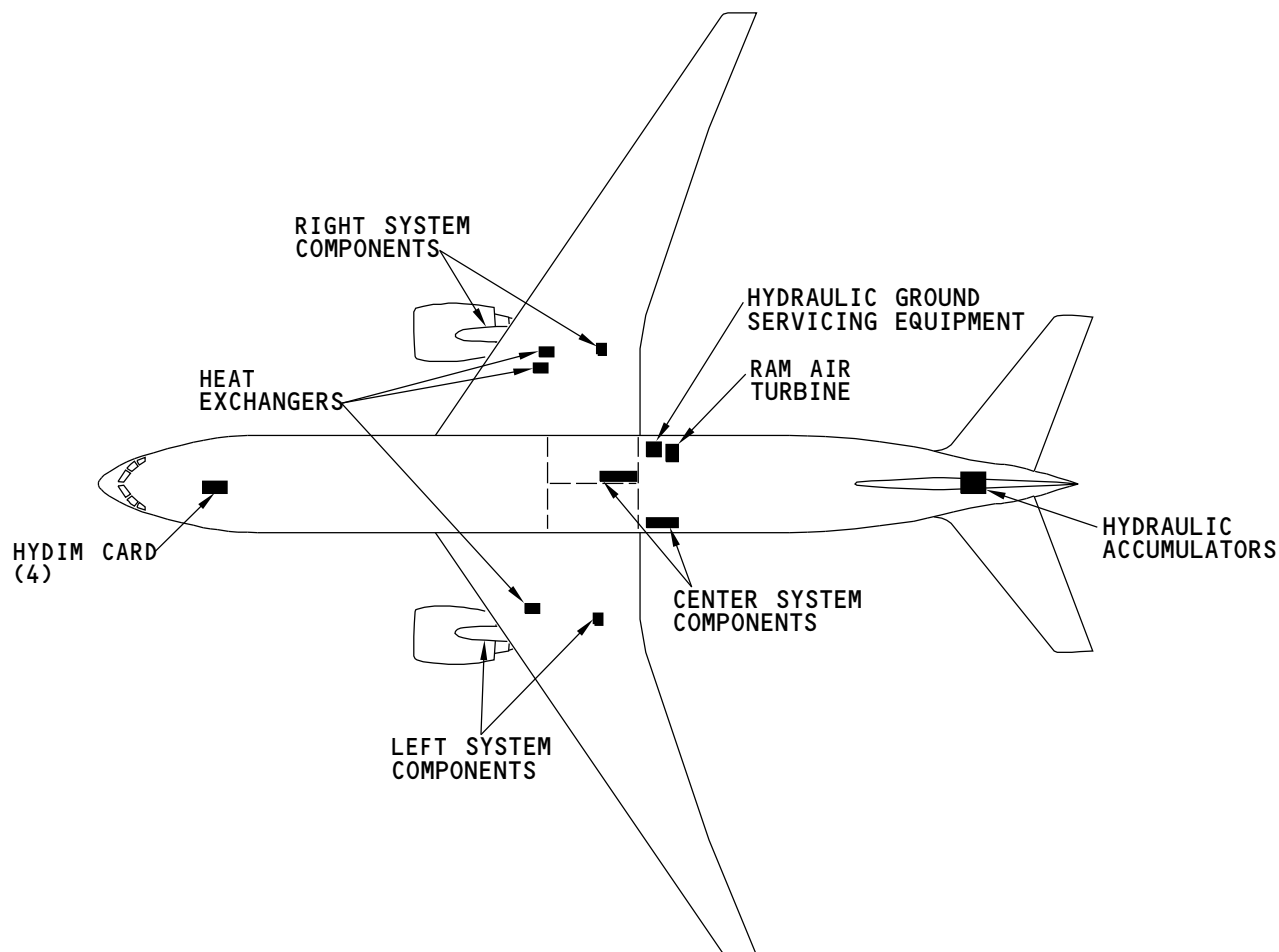
Hydraulic accumulators are in the stabilizer compartment.

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HYDRAULIC POWER - COMPONENT LOCATIONS

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HYDRAULIC POWER - OPERATION

General

You can pressurize the hydraulic systems with a ground service cart or with the hydraulic pumps.

Ground Service Cart Pressurization

The ground pressurization connections for the left system are in the left engine strut.

The ground pressurization connections for the right system are in the right engine strut.

You get access to these connections through the aft strut fairing doors on the right side of each engine strut.

The ground pressurization connections for the center hydraulic system are in the left wing to body fairing behind the left wheel well.

You get access to these connections through the ADP filter module access door.

Hydraulic Pump Pressurization

You use the Hydraulic/RAT panel on the P5 overhead panel to turn on the hydraulic pumps.

Training Information Point

If you pressurize the hydraulic systems with the hydraulic pumps, make sure there is sufficient fuel in the main fuel tanks to cool the heat exchangers. Approximately 740 gallons (2801 liters) (5000 pounds) (2268 kg) of fuel in the left and right main fuel tanks is necessary to cool the heat exchangers in the left and right hydraulic systems. Approximately 1080 gallons (4089 liters) (7303 pounds) (3313 kg) of fuel in the right main tank is necessary to cool the center system heat exchanger.

To pressurize a hydraulic system with a ground service cart, you first need to remove the pressure from the hydraulic reservoir.

The sequence in which you pressurize or remove the pressure from the hydraulic systems can cause fluid to move between the center and right systems. This can cause a high fluid level in one system and a low fluid level in the other system.

If you set the parking brake in one of these conditions:

- The right and center system pressurized
- Only the right pressurized
- No hydraulic system pressurized

and then release the brake with only the center system pressurized, the fluid can move to the center system.

If you set the parking brake with only the center system pressurized, and then release the brake in one of these conditions:

- The right and center system depressurized
- Only the right system pressurized
- No hydraulic system pressurized

the fluid can move to the right system.

To keep the movement of fluid between the right and center hydraulic systems to a minimum, do these steps:

- Pressurize the right hydraulic system first
- Remove the pressure from the right hydraulic system last.



WARNING

KEEP PERSONS AND EQUIPMENT CLEAR OF THE FLIGHT CONTROL SURFACES, THE THRUST REVERSERS, THE LANDING GEAR, AND THE DOORS FOR THE MAIN LANDING GEAR. THESE COMPONENTS CAN MOVE SUDDENLY WHEN YOU SUPPLY HYDRAULIC POWER. THIS CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT.

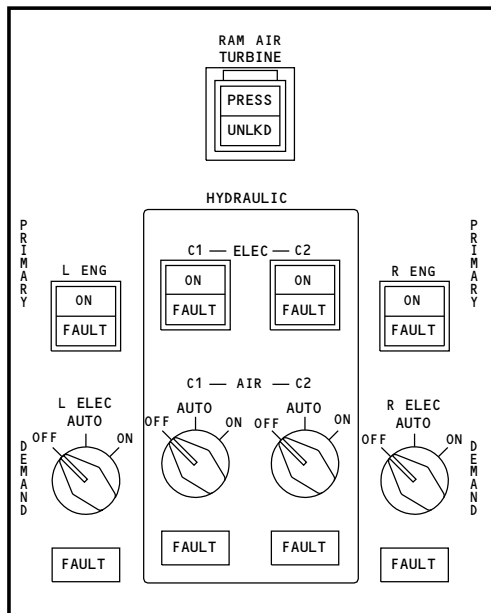
HYDRAULIC POWER - OPERATION

**CAUTION**

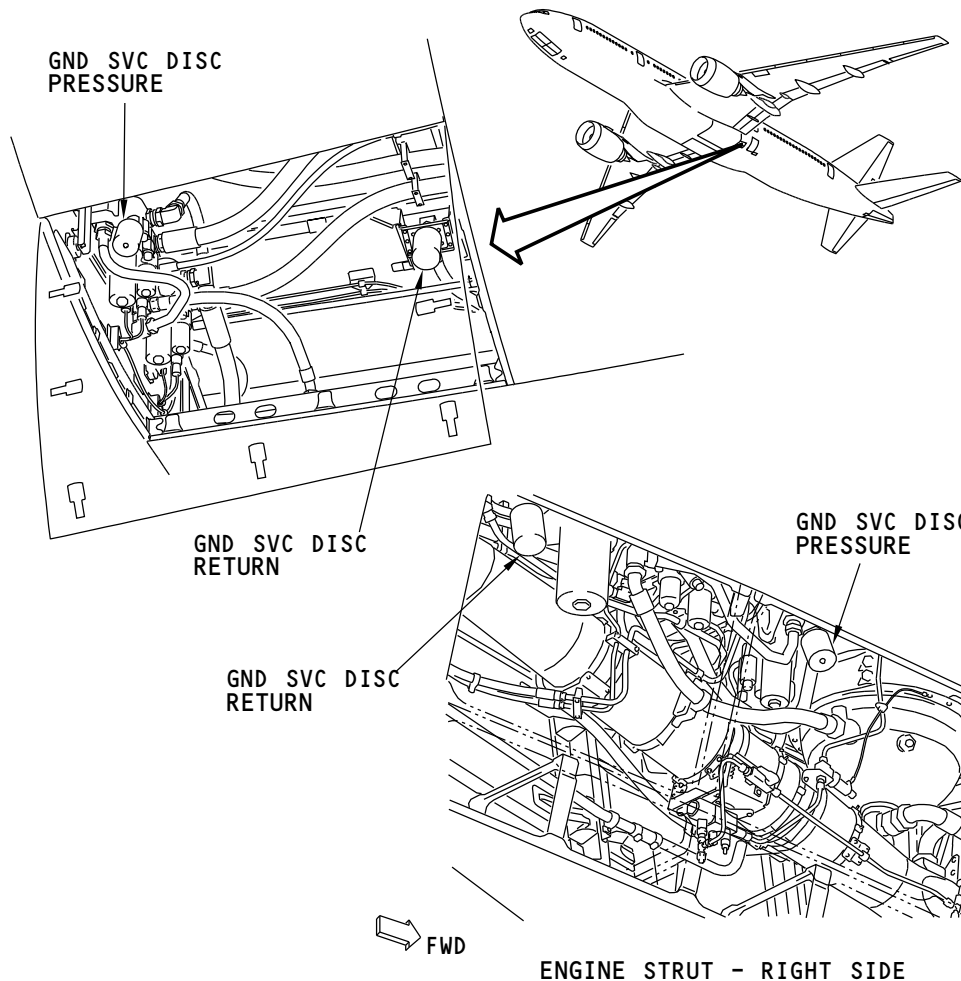
WHEN YOU PRESSURIZE THE MAIN HYDRAULIC SYSTEMS, CAREFULLY MONITOR THE HYDRAULIC INDICATING SYSTEMS IN THE FLIGHT COMPARTMENT TO MAKE SURE THE SYSTEMS OPERATE SATISFACTORILY. IF THE HYDRAULIC FLUID BECOMES TOO HOT, STOP OPERATION OF THE SYSTEM.

**CAUTION**

DO NOT OPERATE THE HYDRAULIC PUMPS AFTER THE HYDRAULIC TEMPERATURE INDICATION IS MORE THAN 100C (212F) OR AFTER THE PUMP FAULT LIGHT COMES ON. IF YOU CONTINUE TO OPERATE THE PUMPS, THE HYDRAULIC FLUID CAN BECOME TOO HOT.



HYDRAULIC/RAT PANEL (P5)



ENGINE STRUT - RIGHT SIDE

HYDRAULIC POWER - OPERATION

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HYDRAULIC POWER - INDICATIONS

General

Hydraulic system data shows on these displays:

- Status display
- Hydraulic synoptic display
- Hydraulic maintenance page.

Status Display

The status display shows the pressure (psi) and the hydraulic reservoir fluid quantity (percent) for each hydraulic system.

The status display also shows EICAS status messages for the hydraulic systems.

The pressures shown at the top of the status display are provided by the system pressure sensors. If a system pressure signal becomes invalid (sensor failed out-of-range), then the highest valid pump pressure for the applicable system will be displayed.

The reservoir quantity fields at the top of the status display also show the suffix OF (overfill), LO (low), or RF (refill) if applicable for the reservoir fluid level. The LO and RF indications are shown in amber and the OF indication is shown in white. The RF and OF indications are shown only when the airplane is on the ground.

Hydraulic Synoptic

The hydraulic synoptic display shows a real time picture of the conditions in the three hydraulic systems.

The hydraulic synoptic display shows these data for normal hydraulic system operation:

- Hydraulic system pressures (psi)
- Hydraulic reservoir fluid quantities (percent)
- Hydraulic pump status (green symbol - pump pressurized, white symbol - pump not pressurized)
- Hydraulic system valve positions (open - green, closed - white).

Green flow lines go from the reservoir symbols through the pump symbols to the airplane systems symbols when the pumps operate.

The synoptic display also shows these non-normal conditions:

- Pump failure (amber symbol)
- Pump pressure sensor failure (low-intensity white symbol)
- Valve failure (amber symbol)
- Valve position sensor failure (low-intensity white symbol)
- Pump overheat condition (amber OVHT).

The pressures shown at the bottom of the synoptic display are provided by the system pressure sensors. If a system pressure signal becomes invalid (sensor failed out-of-range), then the highest valid pump pressure for the applicable system will be displayed. The system pressure is shown with white numerals for pressures greater than 1200 psi in the main part of the center hydraulic system and with amber numerals for pressures less than 1200 psi in the main part of the center hydraulic system.

The change to amber is driven by the appearance of the low system pressure EICAS caution message (amber being the color for caution-level annunciations) and is not driven by the value of the displayed pressure. So, for some operating conditions (center system pressurized only by RAT or center system isolated and pressurized only by ACMP C1), the value displayed is that of the RAT system or the isolated, ACMP C1 pressure instead of the pressure in the main part of the hydraulic system.

The color change of the numerals, however, is still governed by the system low pressure EICAS message.

That EICAS message uses pressure sensors that are not exposed to RAT pressure or isolated, ACMP C1 pressure. For example, when the RAT is the only hydraulic power source for the center system, it may take several minutes (or more) for the residual pressure in the main part of the hydraulic system to bleed down below 1200 psi (due to normal, internal leakage) and cause the system low pressure EICAS message to appear; when the EICAS caution message appears, the pressure numerals will turn amber but the value of the displayed pressure is that of the RAT system, nominally 3000 psi except during transient decreases during maneuvers.

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HYDRAULIC POWER - INDICATIONS

The reservoir quantity fields also show the suffix OF (overfill), LO (low), or RF (refill) if applicable for the reservoir fluid level.

Pressurized hydraulic fluid paths are shown as a wide green line. Unpressurized paths are shown as a thin white line. Flow direction is indicated by an arrowhead.

Each hydraulic pump is shown as a box on the synoptic display. The upper boxes are for the primary pumps and the lower boxes are for the demand pumps. The pump symbol is white with no flow line if the pump is commanded off and green if the pump is commanded on and the pump pressure is normal. The pump symbol is amber with an X in the box if the pump is commanded on and the pump pressure is low. The pump symbol is low-intensity white if the pump pressure sensor is not valid (failed out-of-range).

OVHT will show in amber next to the hydraulic pump symbol if a pump overheat condition is detected.

The flow line through a pump is shown in green if the pump is commanded on and the pump pressure sensor indicates normal pressure. If a pump pressure signal becomes invalid (sensor failed out-of-range), then the default pressure value for the applicable pump is used and the flow line can be green even though the pump symbol is low-intensity white.

The RAT is also shown as a box on the hydraulic synoptic display. The RAT symbol is white with no flow line when it is stowed and green with a flow line when the RAT is activated and the RAT pressure is normal. The RAT symbol is amber with an X in the box if the RAT is activated and the RAT pressure is low. The RAT symbol is low-intensity white if the RAT pressure sensor is not valid.

The hydraulic system valves are shown as circles with flow paths that turn to show the valve open or closed. The valve symbol is white with no flow line if the valve is commanded closed and green with a flow line if it is commanded open. The valve symbol is amber with an X in the circle if the valve position sensor does not match the valve commanded position. The valve symbol is low-intensity white if the valve position sensor is not valid.

Hydraulic Maintenance Page

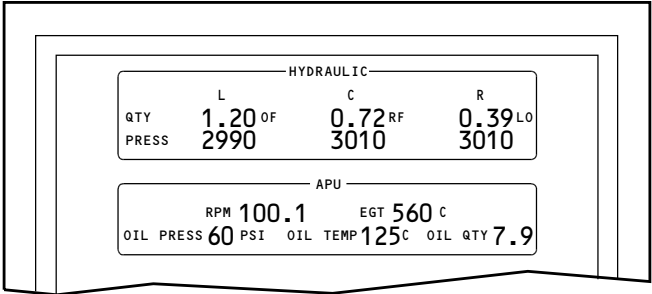
The hydraulic maintenance page shows for each system:

- Hydraulic system pressures (psi)
- Hydraulic primary and demand pump data (pressure in psi, temperature in degrees C, selector position, and run status)
- RAT pump data (pressure in psi, speed in RPM, and position)
- Hydraulic system reservoir data (quantity in percent, pressure in psi, temperature in degrees C)
- Flight control shutoff valve positions
- Reserve and nose gear isolation valve positions.

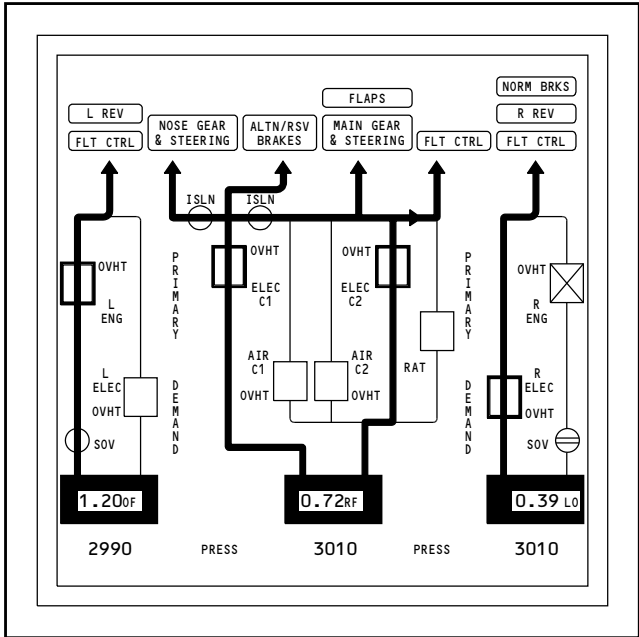
The hydraulic maintenance page displays data in real time if the system sensor signals are valid. If a signal is not valid, then the corresponding maintenance page parameter is blank.

Training Information Point

When the hydraulic pumps are off, the system pressure indication shows the pressure in the hydraulic reservoirs.



STATUS DISPLAY



HYDRAULIC SYNOPTIC DISPLAY

HYDRAULIC					
		L	C	R	
SYSTEM PRESS:		2990	3010	3010	
PRIMARY PUMP:	PRESS	3050	2980	2980	50
	TEMP	103	75	75	55
	SEL	ON	ON	ON	ON
	RUN	---	YES	YES	---
DEMAND PUMP:	S/O VLV	OPEN	---	---	CLOSED
	PRESS	50	50	40	3020
	TEMP	20	20	20	45
	SEL	AUTO	AUTO	AUTO	AUTO
RAT PUMP:	RUN	NO	NO	NO	YES
	PRESS	---	2950	---	---
	RPM	---	4550	---	---
	POS	---	NOT STOWED	---	---
RESERVOIR:	QTY	1.20 OF	0.72 RF	0.39 LO	
	PRESS	NORM	NORM	LOW	
	TEMP	90	55	30	
	TAIL VLV:	NORM	NORM	CLOSED	
RESERVE ISLN:	WING VALVE POS	---	NORM	---	
	NOSE GR ISLN: VALVE POS	---	NORM	---	

HYDRAULIC MAINTENANCE PAGE

HYDRAULIC POWER - INDICATIONS

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HYDRAULIC POWER - OPERATIONAL TESTS

General

These are the operational tests for the hydraulic system:

- Air Driven Pump (ADP) (C1)
- Air Driven Pump (ADP) (C2)
- Center hydraulic isolation system (CHIS) test
- Heaters test
- Landing gear auto-off relay A test
- Landing gear auto-off relay B test.

Air Driven Pump Tests

The ADP tests are interactive tests to test the operation of each ADP. These functions are tested during these tests:

- Overspeed protection
- Secondary speed control
- Reserve power
- Auto/On control
- ADP heater operation
- Pressure and temperature indication.

These tests also reset an ADP after an overspeed shutdown.

Center Hydraulic Isolation System (CHIS) Test

This test makes sure CHIS control and indications operate normally. Both isolation valves close and open during this test.

Heaters Test

The heaters test makes sure that the RAT heater and the ADP heaters operate normally. This test starts the heaters, then stops them again.

Landing Gear Auto-Off Relay Tests

These tests make sure the landing gear auto-off relays operate correctly. The relays are energized and de-energized during the tests.

Training Information Point

Pneumatic power is necessary to do the air driven pump test.

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GROUND TESTS

SELECT ATA SYSTEM

27 PRIMARY FLIGHT CONTROL SYSTEM

27 STALL WARNING MANAGEMENT

27 HIGH LIFT SYSTEM

29 HYDRAULIC SYSTEM

30 AIRFOIL COWL ICE PROTECTION SYSTEM

30 AIR DATA SENSOR ANTI ICE SYSTEM

30 WINDOW HEAT CONTROL SYSTEM

31 AIMS - FLIGHT DATA RECORDER SYSTEM

31 PRINTER

SELECT TEST TYPE

☒ OPERATIONAL TEST

☐ LRU REPLACEMENT TEST

SELECT OPERATIONAL TEST

29 HYDRAULIC SYSTEMS

OPERATIONAL TESTS:

AIR DRIVEN PUMP (ADP) (C1)

AIR DRIVEN PUMP (ADP) (C2)

CENTER HYDRAULIC ISOLATION

HEATERS (RAT GENERATOR, ADP C1, AND ADP C2)

LANDING GEAR AUTO-OFF RELAY A

LANDING GEAR AUTO-OFF RELAY B

CONTINUE

HELP

GO BACK

SELECT OPERATIONAL TEST

(6)

29 HYDRAULIC SYSTEM

OPERATIONAL TESTS:

AIR DRIVEN PUMP (ADP) (C1)

AIR DRIVEN PUMP (ADP) (C2)

CENTER HYDRAULIC ISOLATION

HEATERS (RAT GENERATOR, ADP C1, AND ADP C2)

LANDING GEAR AUTO-OFF RELAY A

LANDING GEAR AUTO-OFF RELAY B

HYDRAULIC POWER - OPERATIONAL TESTS

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**HYDRAULIC POWER - LRU REPLACEMENT TESTS****General**

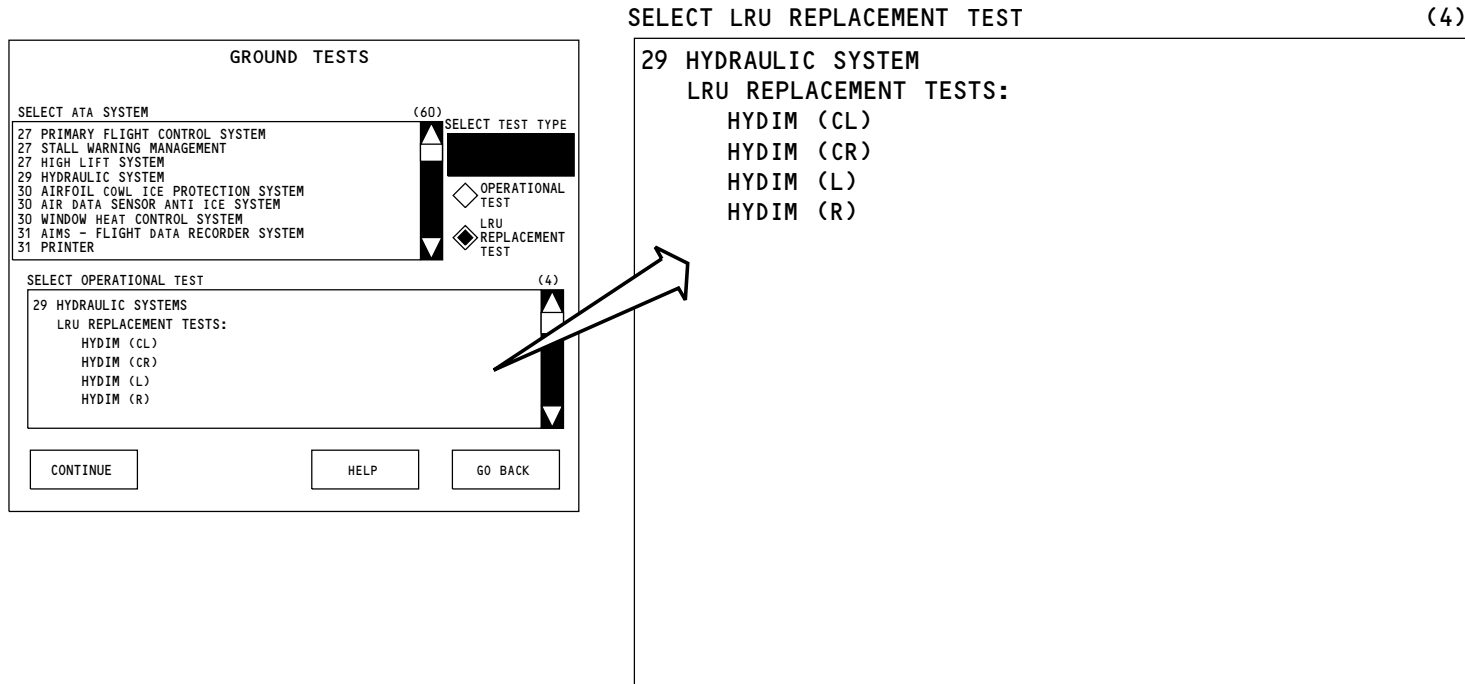
These are the LRU replacement tests for the hydraulic systems:

- HYDIM CL LRU replacement test
- HYDIM CR LRU replacement test
- HYDIM L LRU replacement test
- HYDIM R LRU replacement test.

HYDIM LRU Replacement Tests

A HYDIM LRU replacement test for each of the four HYDIM cards does a test of the HYDIM cards.

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HYDRAULIC POWER - LRU REPLACEMENT TESTS

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MAIN HYDRAULIC SYSTEMS - HYDRAULIC SYSTEM SUMMARY

General

Three independent hydraulic systems supply hydraulic power to airplane systems.

Left Hydraulic System

An EDP is the primary pump for the left hydraulic system. An ACMP is the demand pump for the left hydraulic system.

The left hydraulic system supplies hydraulic power to these systems:

- Flight controls
- Left thrust reverser.

Right Hydraulic System

An EDP is the primary pump for the right hydraulic system. An ACMP is the demand pump for the right hydraulic system.

The right hydraulic system supplies hydraulic power to these systems:

- Flight controls
- Right thrust reverser
- Normal brake system.

Center Hydraulic System

Two ACMPs are the primary pumps for the center hydraulic system. Two ADPs are the demand pumps for the center hydraulic system. A ram air turbine is an emergency source of hydraulic pressure for the center system primary flight controls.

The center hydraulic system supplies hydraulic power to these systems:

- Flight controls
- Leading edge slats
- Trailing edge flaps
- Landing gear actuation
- Alternate and reserve brakes system

- Normal and reserve nose landing gear steering
- Main landing gear steering.

Hydraulic System Servicing

A service bay permits you to fill the three hydraulic systems from a single location.

Hydraulic System Indications

Pressure, temperature, and quantity sensors supply this hydraulic system data:

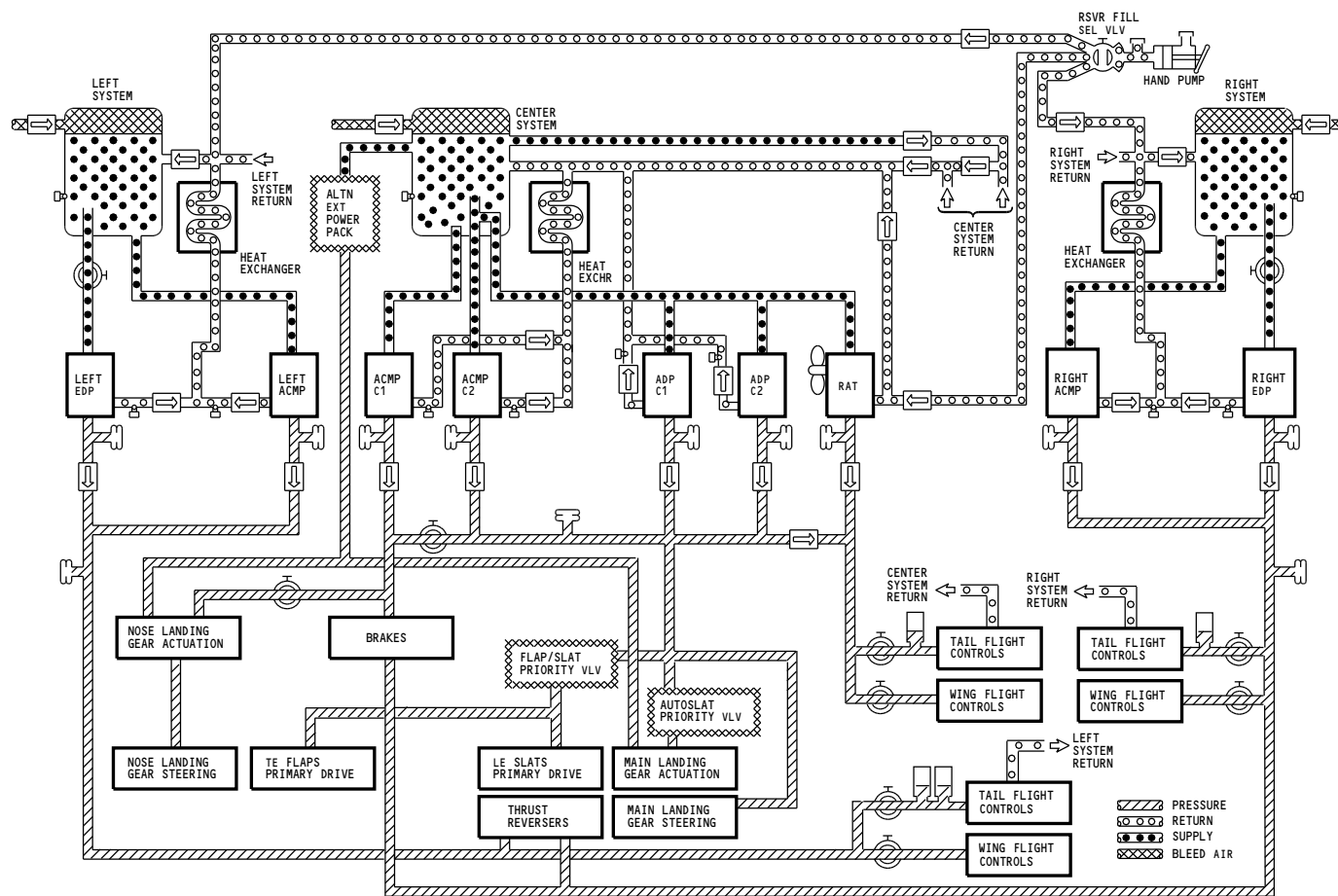
- System pressures
- Pump pressures
- Reservoir pressures
- Pump temperatures
- Reservoir temperatures
- Reservoir quantities.

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MAIN HYDRAULIC SYSTEMS - HYDRAULIC SYSTEM SUMMARY

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MAIN HYDRAULIC SYSTEMS - INTRODUCTION

General

The left, center, and right hydraulic systems operate independently to supply hydraulic power to the airplane systems. All three systems operate at 3000 psi nominal pressure.

The hydraulic systems use BMS 3-11 hydraulic fluid.

The components and hydraulic tubing of the three systems are color coded. The left system is red, the center system is blue, and the right system is green.

Each hydraulic system has one or more primary and demand pumps. Primary pumps normally operate continuously. Demand pumps operate only when additional power is necessary.

Left and Right System

The left and right hydraulic systems are similar. These systems each have an engine-driven pump (EDP) as the primary pump and an alternating current motor pump (ACMP) as the demand pump.

The left hydraulic system supplies power for these systems:

- Primary flight control system (PFCS)
- Left thrust reverser.

The right system supplies power for these systems:

- PFCS
- Right thrust reverser
- Normal brake system.

Center System

The center hydraulic system has two ACMPs as the primary pumps. Two air-driven pumps (ADPs) are the center system demand pumps. A ram air turbine (RAT) supplies an emergency source of hydraulic power to the flight controls in the center hydraulic system.

The center system also includes a center hydraulic isolation system (CHIS) for reserve brake and steering operation.

The center system supplies hydraulic power for these systems:

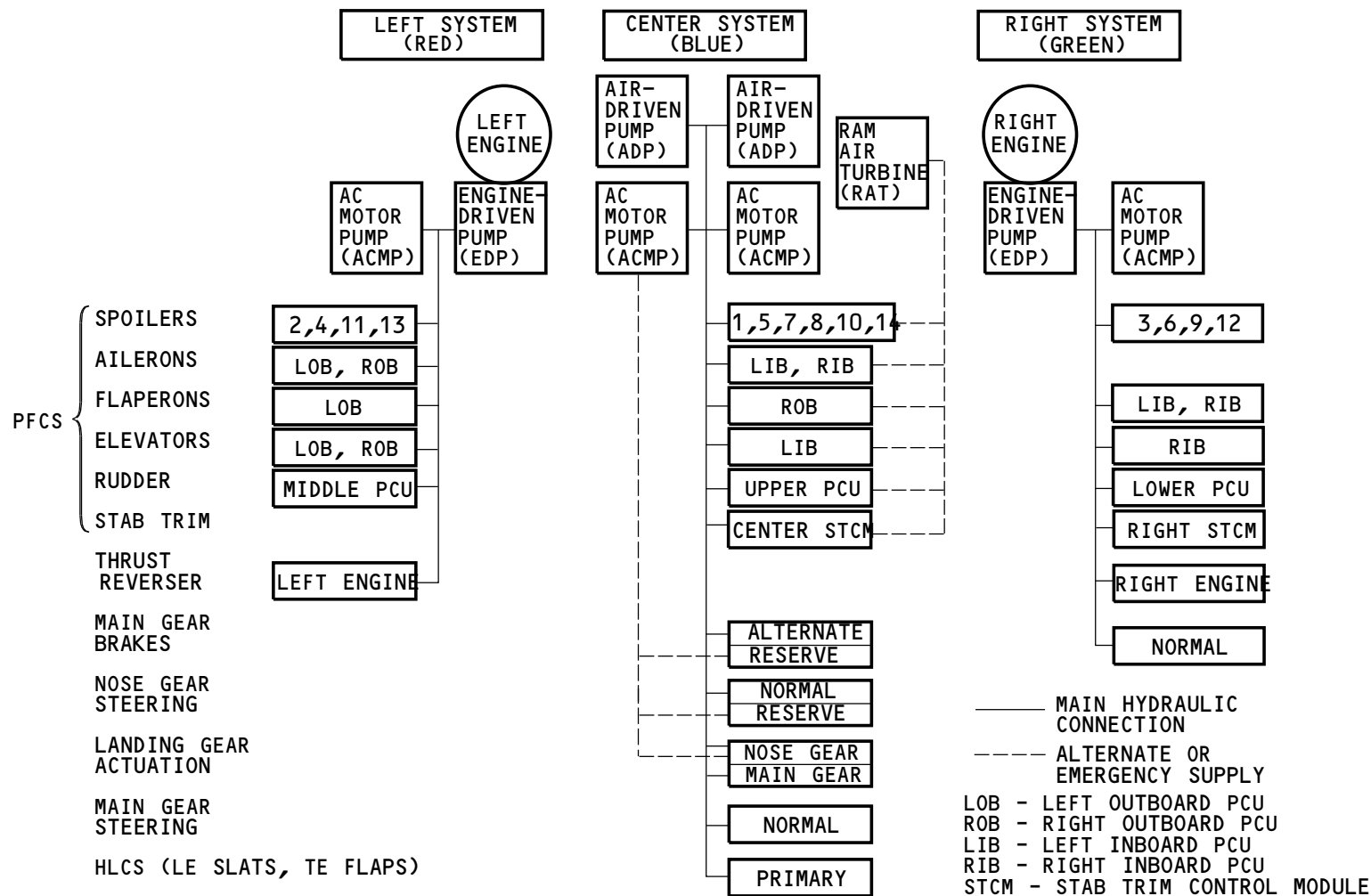
- PFCS
- Alternate and reserve brakes
- Normal and reserve nose gear steering
- Landing gear actuation
- Main gear steering
- High lift control system (HLCS)(LE slats, TE flaps).

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MAIN HYDRAULIC SYSTEMS - INTRODUCTION

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MAIN HYDRAULIC SYSTEMS - INTERFACES

General

Four hydraulic interface module (HYDIM) cards are the interface between the hydraulic systems and other airplane systems.

The HYDIM cards receive and transmit data through the ASG cards and the systems ARINC 629 buses. The HYDIM cards also send and get signals through hard-wires.

ARINC 629 Interfaces

The HYDIM cards have these interfaces through the left and right systems ARINC 629 buses:

- Proximity sensor electronic unit (PSEU) (2)
- Flap/slat electronic unit (FSEU) (2)
- Overhead panel ARINC 629 system (OPAS)
- Electrical load management system (ELMS) power management panels (P110, P210, and P310)
- APU controller (APUC)
- Air supply and cabin pressure controller (ASCPC) (2)
- Cabin temperature controller (CTC) (2)
- Engine data interface unit (EDIU) (2)
- Autopilot flight director computer (AFDC) (3)
- Airplane information management system (AIMS).

The HYDIM cards also send and receive data through AIMS and the flight controls ARINC 629 buses for these components:

- Primary Flight Computers (3)
- Air Data Inertial Reference Unit (ADIRU).

Hard-wire Interfaces

The HYDIM cards also have these interfaces through hard-wires:

- Hydraulic system components
- Flight control shutoff valve (6)

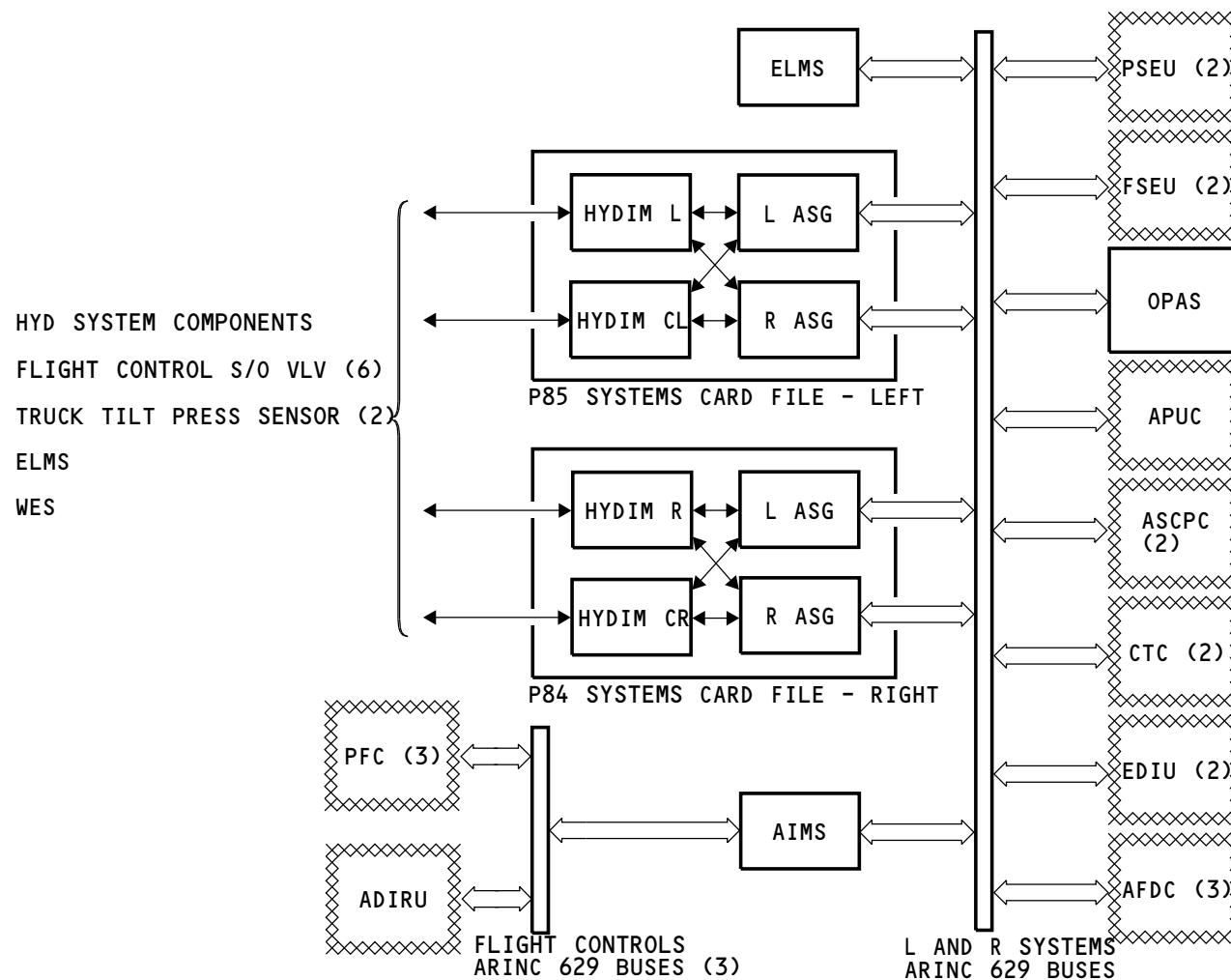
- Truck tilt pressure sensors
- ELMS
- Warning electronic system (WES).

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MAIN HYDRAULIC SYSTEMS - INTERFACES

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MAIN HYDRAULIC SYSTEMS - CONTROLS

General

The controls for the hydraulic system pumps and the RAT manual deployment are on the hydraulic/RAT panel. This panel is on the P5 overhead panel.

The engine fire switches on the P8 aisle stand panel also control EDP operation.

Primary and Demand Pump Controls

Each primary pump has an alternate action switch. You select the pump OFF or ON.

Each demand pump has a rotary selector. You select the pump OFF, AUTO, or ON. When you select AUTO, the pump is in the demand mode and the HYDIM cards control the operation. When you select ON, the pump operates continuously.

Fault lights for each pump turn on if there is a pump overheat or pump low pressure condition.

Rat Deploy Switch

A RAT deploy switch at the top of the panel permits manual deployment of the ram air turbine. The RAT deploy switch is a momentary switch and is guarded.

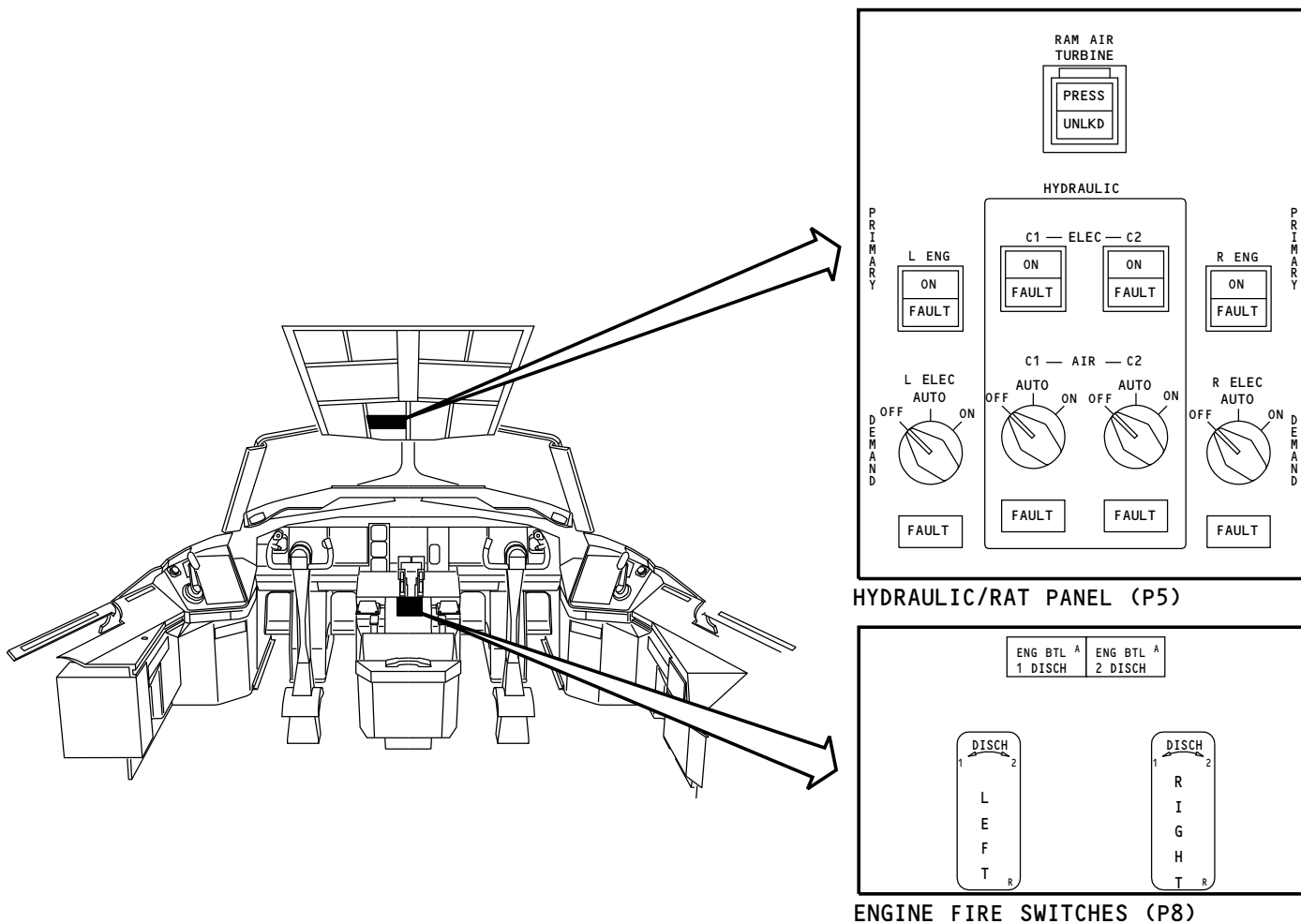
This switch also has an unlocked light and a pressure light. The unlocked light turns on when the RAT is not up and locked. The pressure light turns on when the RAT supplies hydraulic pressure.

Engine Fire Switches

The engine fire switches isolate the engine if there is an engine fire. When you operate one of the fire switches, the hydraulic fluid supply to the related pump shuts off and the pump depressurizes.

Training Information Point

Because the EDP depressurization valve gets electrical power when the EDP control switch is OFF, keep the switch in the ON position. If the switch is in the OFF position for a long period, you should open the circuit breaker for the EDP solenoid.



MAIN HYDRAULIC SYSTEMS - CONTROLS

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**MAIN HYDRAULIC SYSTEMS - HYDRAULIC INTERFACE MODULE CARDS****General**

Four hydraulic interface module (HYDIM) cards supply control, indication, and other functions to the hydraulic system. The HYDIM cards have these names:

- HYDIM left (L)
- HYDIM right (R)
- HYDIM center left (CL)
- HYDIM center right (CR).

HYDIM L controls the functions for the left system. HYDIM R controls the functions for the right system. HYDIM CL and CR control the functions for the center system.

The HYDIM cards are interchangeable. Card position in the card file determines the function of the card.

HYDIM sends and receives some signals directly through hard wires.

HYDIM also sends and receives signals through the left and right systems ARINC 629 buses through the ARINC signal gateway (ASG) cards.

Location

The HYDIM cards are in the P85 left systems card file and the P84 right systems card file.

Training Information Point

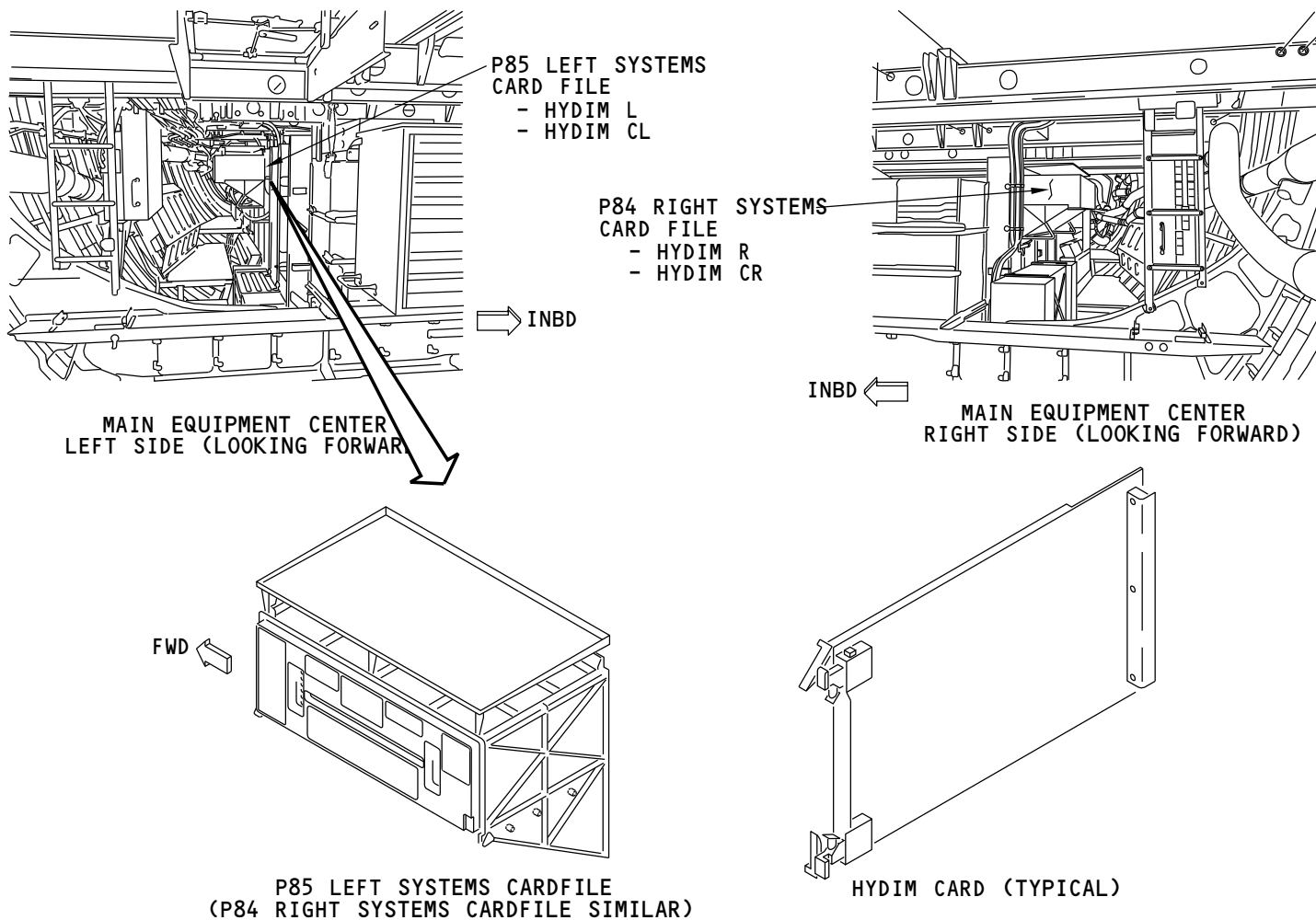
The HYDIM cards are software loadable. See the CMCS section for more information about the data load (SECTION 45-10).

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MAIN HYDRAULIC SYSTEMS - HYDRAULIC INTERFACE MODULE CARDS

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**MAIN HYDRAULIC SYSTEMS - HYDRAULIC INTERFACE MODULE CARDS - FUNCTIONAL DESCRIPTION****General**

Four HYDIM cards in the system card files monitor and control the hydraulic system and do other functions.

The HYDIM cards send and receive some data through ARINC 429 buses to the ARINC signal gateway (ASG) cards. The ASG cards send and receive data through the systems ARINC 629 buses.

The HYDIM cards also send and receive data through hard wires.

- Monitor flight control shutoff valve positions.

Control Functions

The HYDIM cards control these functions:

- Demand pump (L, R ACMP; ADP C1, C2) AUTO operation
- Reserve and NG isolation valve operation
- Landing gear auto-off (MLG and NLG selector/bypass valves)
- RAT auto deploy.

Indications

HYDIM supplies these hydraulic system indications through AIMS:

- System pressures
- Pump pressures
- Reservoir pressures
- Pump temperatures
- Reservoir fluid temperatures
- Reservoir quantities
- RAT locked status
- Valve positions.

HYDIM also does these functions:

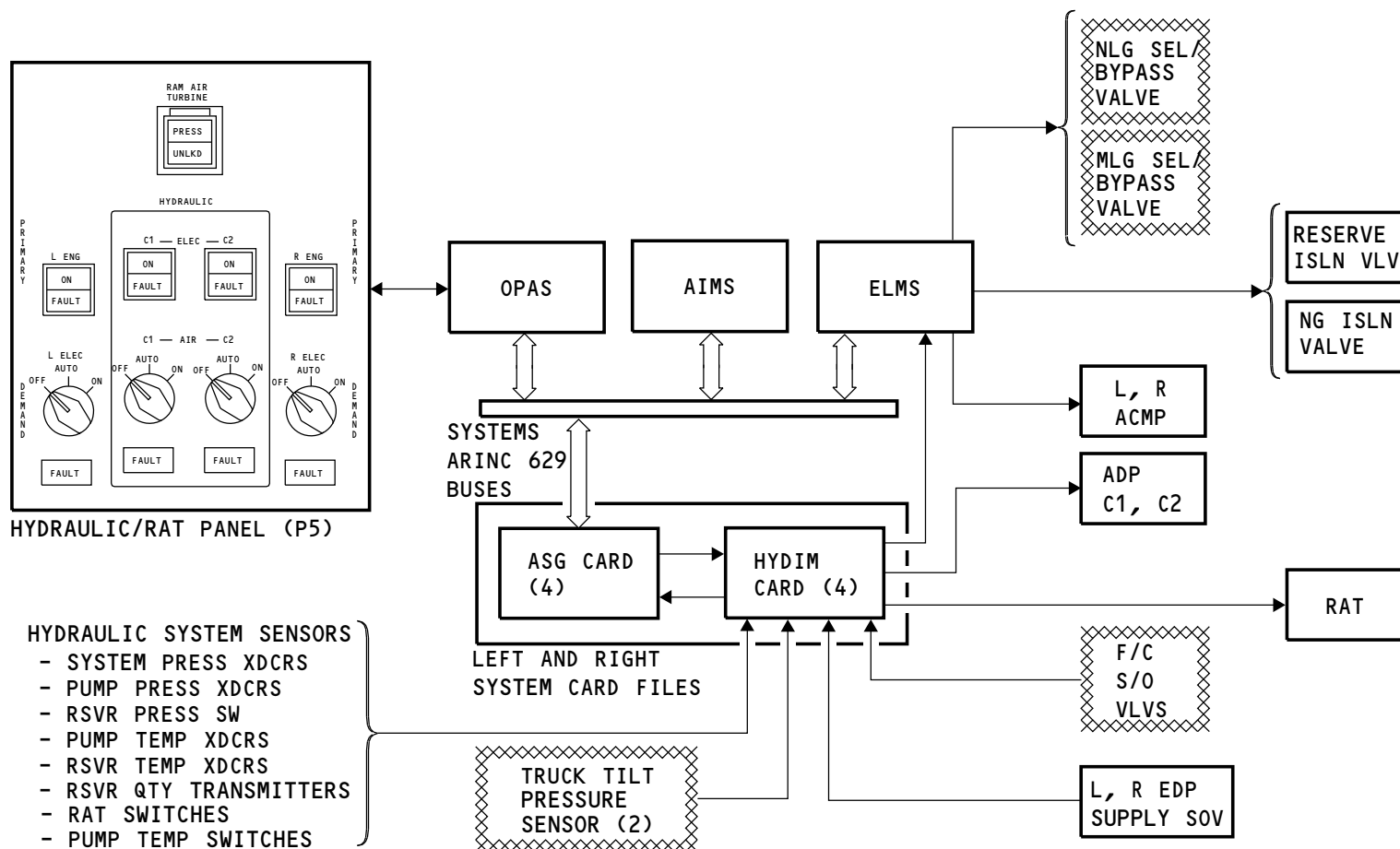
- Hydraulic system fault detection
- Monitor EDP supply shutoff valve positions
- Monitor truck tilt pressures

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MAIN HYDRAULIC SYSTEMS-HYDRAULIC INTERFACE MODULE CARDS -FUNCTIONAL DESCRIPTION

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MAIN HYDRAULIC SYSTEMS - HYDRAULIC SYSTEM RESERVOIRS

Purpose

The hydraulic reservoirs supply hydraulic fluid under pressure to the hydraulic pumps. The reservoirs also get the return hydraulic fluid from the airplane systems that use hydraulic power.

Physical Description

The left and right system reservoirs are the same. Each has a total volume of 12.6 gallons (47.8 liters) and normally contains 7.4 (28 liters) gallons of hydraulic fluid.

The center system reservoir has a total volume of 25.6 gallons (97 liters) and normally contains 11 gallons (41.7 liters) of hydraulic fluid.

Each reservoir has these components:

- Reservoir pressure relief valve
- Sight glasses (low and overfull)
- Reservoir sample valve
- Reservoir drain valve
- Reservoir temperature transducer
- Reservoir quantity transmitter.

Location

The left hydraulic system reservoir is in the left engine aft strut fairing.

The right hydraulic system reservoir is in the right engine aft strut fairing.

The center system reservoir is in the aft part of the right wheel well.

Functional Description

The reservoirs are pressurized by the bleed air system for positive supply to the pumps.

The reservoirs have an internal trap to make sure fluid goes to the pumps during negative-G conditions.

Each reservoir also has a standpipe. For the left and right reservoirs there are 2 gallons (7.6 liters) of fluid below the standpipe. The EDPs get a fluid supply from the standpipe. A port at the bottom of the reservoir supplies fluid to the ACMPs.

For the center hydraulic system, there are 1.2 gallons (4.5 liters) below the standpipe. The standpipe supplies the fluid to ACMP 2, to both ADPs, and to the RAT. ACMP 1 gets fluid from the bottom of the reservoir.

The reservoir pressure relief valve opens between 85 and 90 psi to protect the reservoir against over-pressurization.

Training Information Point

You get access to the left and right reservoirs through the aft strut fairing doors on both sides of the aft engine struts.

When filled to the correct level, the top sight glass shows red and the bottom sight glass shows black.

When the reservoir is in an overfull condition, both sight glasses show black.

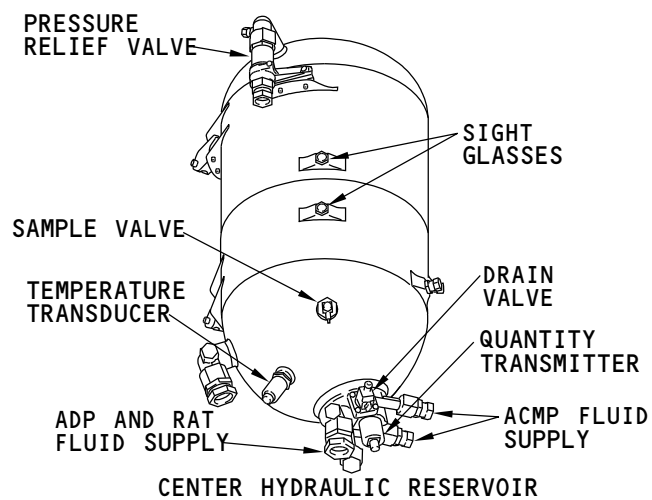
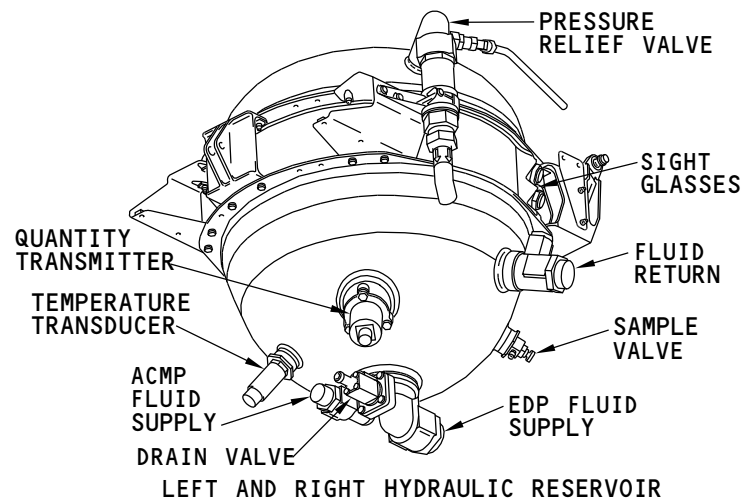
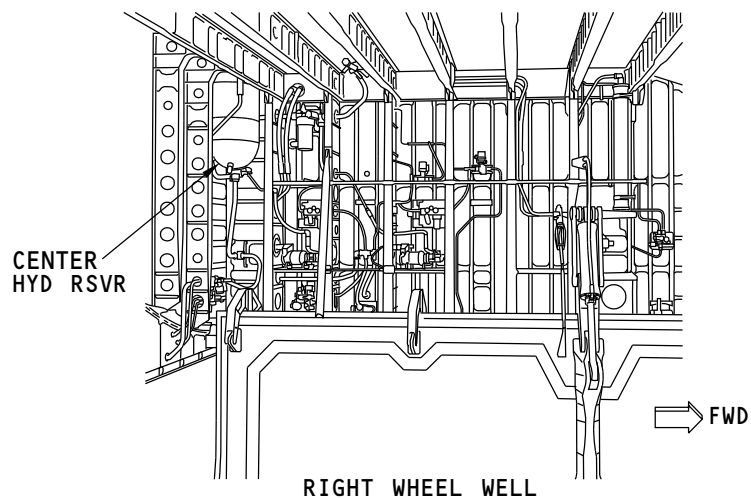
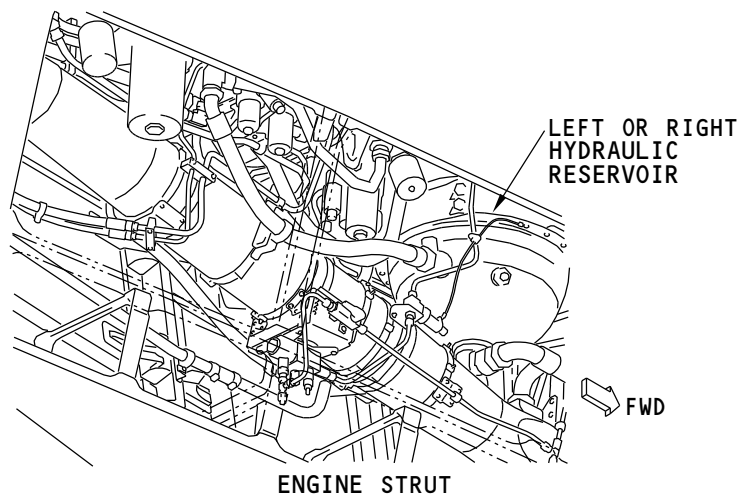
When the reservoir needs to be filled, both sight glasses show red.

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MAIN HYDRAULIC SYSTEMS - HYDRAULIC SYSTEM RESERVOIRS

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MAIN HYDRAULIC SYSTEMS - RESERVOIR PRESSURIZATION MODULE AND SHUTOFF VALVE

General

The reservoir pressurization modules supply airplane bleed air to the reservoirs.

The reservoir pressurization shutoff valves are manually operated valves which permit the shutoff of air pressure to the reservoir.

Each hydraulic system has a reservoir pressurization module, and a reservoir pressurization shutoff valve.

Physical Description

Each reservoir pressurization module has these components:

- Filter (2)
- Check valve (2)
- Test port
- Manual bleed valve
- Gage port.

The reservoir pressurization shutoff valves are simple manual shutoff valves. These shutoff valves are before the pressurization module in the pneumatic line to the reservoir.

Location

The modules for the left and right systems are in the engine aft struts below their reservoir.

The center system module is on the aft bulkhead in the right wheel well.

The shutoff valves are near the pressurization modules.

Operation

To depressurize a reservoir, first turn the shutoff valve to the closed position. Install the lock pin to hold the valve in the closed position.

You depressurize the reservoir with the manual bleed valve on the reservoir pressurization module.


CAUTION

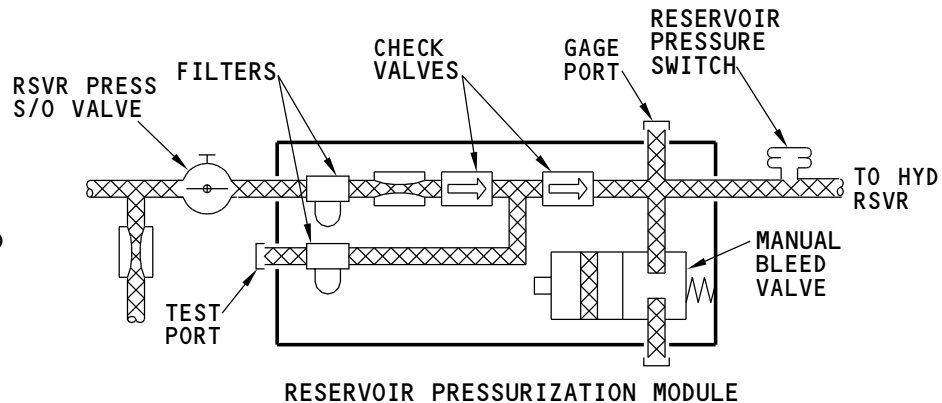
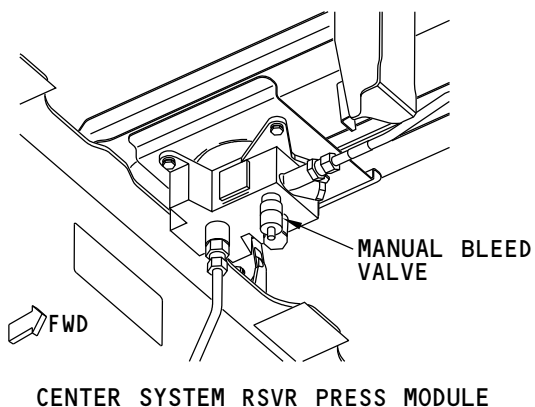
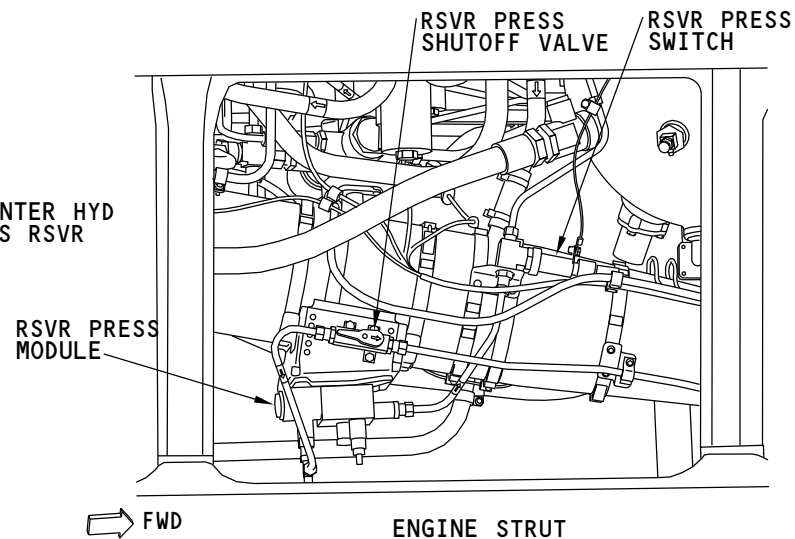
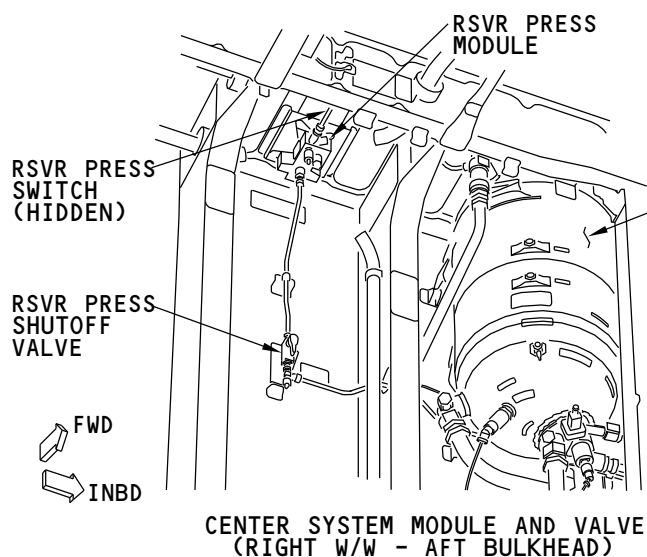
PUT A RAG AROUND THE AIR BLEED VALVE ON THE RESERVOIR PRESSURIZATION MODULE TO CATCH HYDRAULIC FLUID SPRAY. HYDRAULIC FLUID SPRAY CAN CAUSE INJURIES TO PERSONS.

Training Information Point

A reservoir pressure switch near each of the reservoirs send reservoir pressure low or reservoir pressure not-low signals to the HYDIM cards.

See the hydraulic indicating section for more information about the reservoir sensors (SECTION 29-30).

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MAIN HYDRAULIC SYSTEMS - RESERVOIR PRESSURIZATION MODULE AND SHUTOFF VALVE

29-10-00

MAIN HYDRAULIC SYSTEMS - ENGINE DRIVEN PUMP

Purpose

The engine driven pump (EDP) is the primary pump for the left and right hydraulic systems.

Physical Description

The EDP is an axial-piston, variable displacement, hydraulic pump assembly.

An internal pressure compensator controls the output pressure of the pump to approximately 3000 psi.

A depressurization solenoid valve blocks the pump output flow when you turn off the pump.

Case drain hydraulic flow cools and lubricates the engine driven pump.

A ripple damper smooths the pump pressure output.

The pump is rated at 48 gpm at 2850 psi and 3900 rpm.

The dry weight of the pump is 38 pounds (17 kg).

Location

The EDP is on the front face of the engine main gearbox on the left side of each engine.

Functional Description

The engine main gearbox turns the EDP when the engine turns. When the depressurization solenoid valve is not energized, pump pressure output goes to the hydraulic system.

When you turn off the pump, the depressurization solenoid valve gets electrical power. This permits pressurized hydraulic fluid from the pump output line to move the blocking valve. This causes a blockage and removes the pressure from the EDP.

Training Information Point

You get access to the EDPs through the left thrust reverser half.


CAUTION

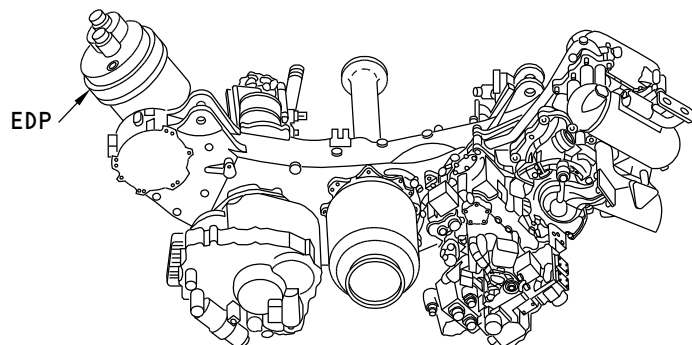
MAKE SURE YOU INSTALL THE O-RING IN THE SPLINE GROOVE ON THE DRIVE SHAFT OF THE ENGINE DRIVEN PUMP. THE O-RING PREVENTS LEAKAGE OF OIL FROM THE ENGINE GEARBOX.

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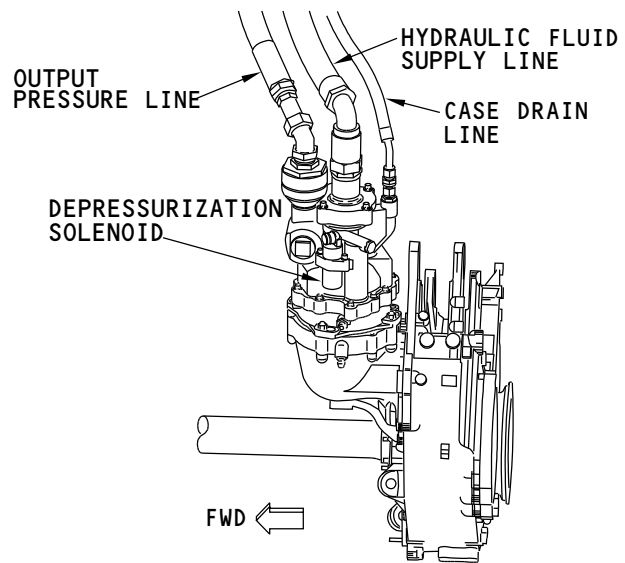
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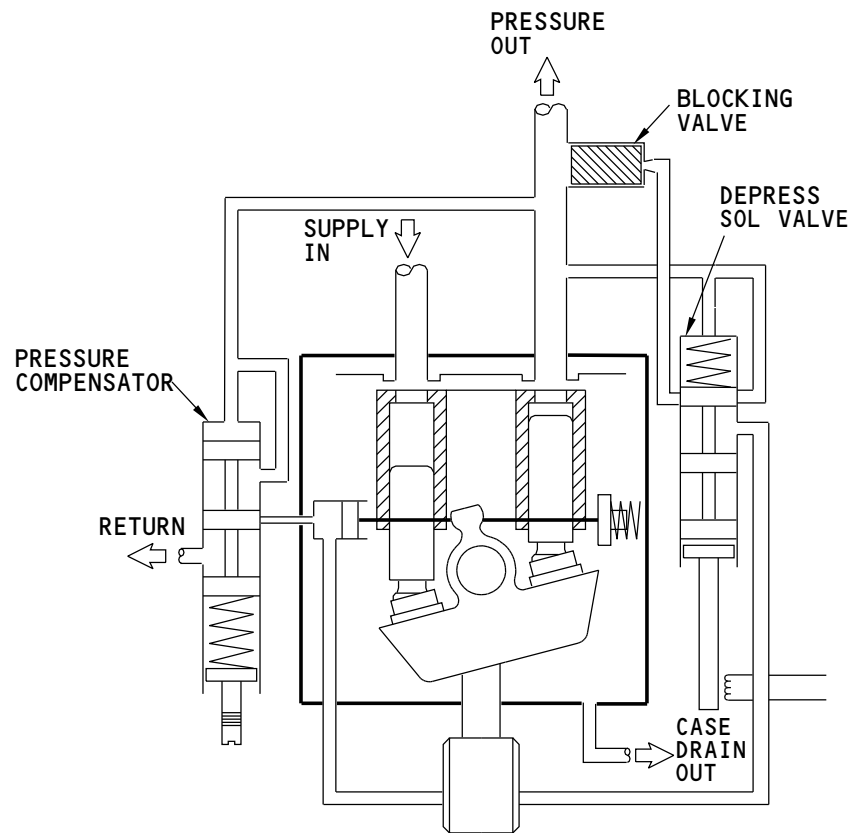
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ENGINE MAIN GEARBOX (LOOKING FORWARD)



ENGINE DRIVEN PUMP



EDP - SCHEMATIC

MAIN HYDRAULIC SYSTEMS - ENGINE DRIVEN PUMP

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**MAIN HYDRAULIC SYSTEMS - ENGINE DRIVEN PUMP - SUPPLY SHUTOFF VALVE****Purpose**

The EDP supply shutoff valve stops hydraulic supply from the reservoir to the EDP when the engine fire switch is in the up position.

Physical Description

The supply shutoff valve is a two-position valve operated by a 28v dc motor. A position indicator shows the position of the valve.

Location

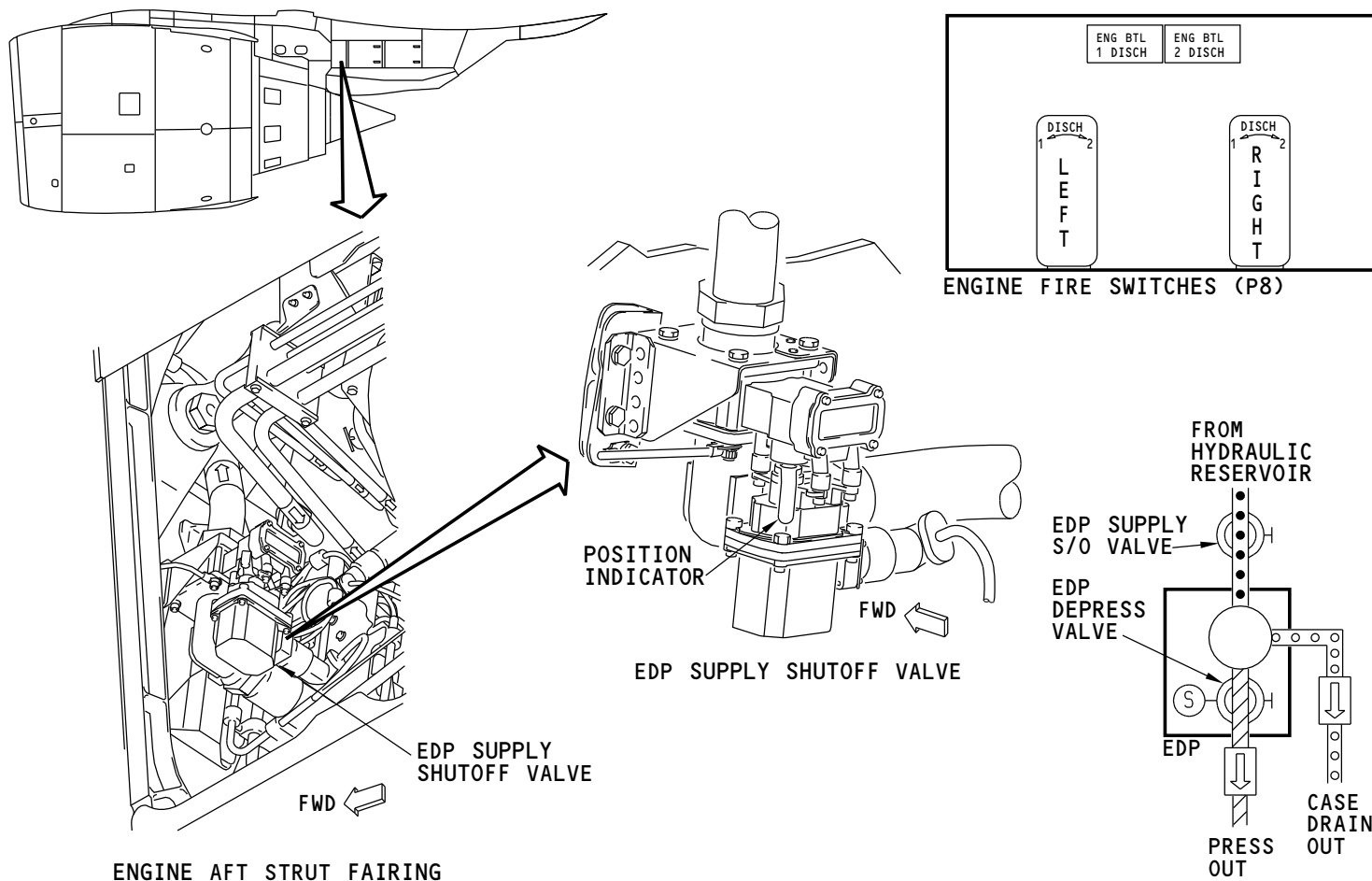
There is a supply shutoff valve in the left side of each engine aft strut fairing near the hydraulic reservoir.

Training Information Point

Because the supply of hydraulic fluid to the pump stops when the fire switch is up, there is no pump case drain flow.

If the engine continues to turn (windmill) with the valve in the OFF position, the EDP may be damaged. You must do an inspection of the EDP filter module.

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MAIN HYDRAULIC SYSTEMS - ENGINE DRIVEN PUMP - SUPPLY SHUTOFF VALVE

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**MAIN HYDRAULIC SYSTEMS - ALTERNATING CURRENT MOTOR PUMP****Purpose**

The ACMPs are the primary pumps in the center hydraulic system and the demand pumps in the left and right hydraulic systems.

Physical Description

The ACMP has an electric motor that mechanically connects to a hydraulic pump. The motor operates with three-phase, 400 Hz, 115/200v ac power. The pump is a nine piston variable-displacement hydraulic pump.

Case drain flow cools the electric motor and cools and lubricates the pump.

A ripple damper smooths the pump pressure output.

The ACMPs are rated at 6 gpm at 2850 psi.

Each ACMP has a temperature switch that is a part of the pump. The temperature switch closes to indicate a pump overheat condition.

The ACMP temperature switch is connected in parallel with the ACMP temperature transducer.

All ACMPs are the same and weigh 47 pounds (21 Kg).

Location

The ACMPs for the left and right hydraulic systems are in the engine struts aft of the reservoirs.

The center system ACMPs are on the keel beam in the right wheel well.

Training Information Point

The center system ACMPs attach to airplane structure through four vibration isolators.

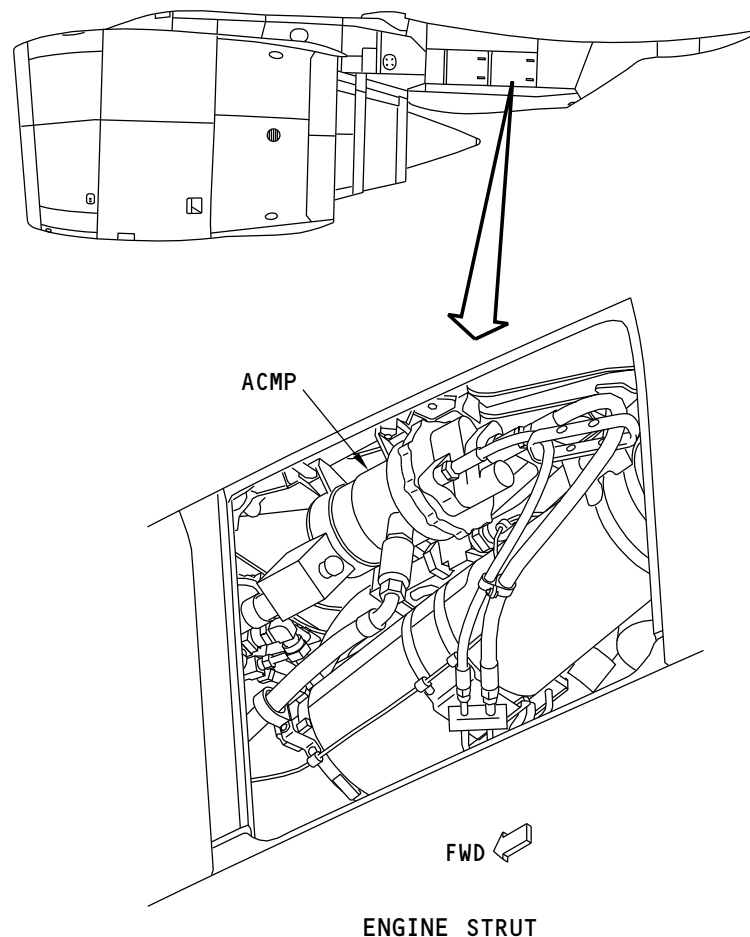
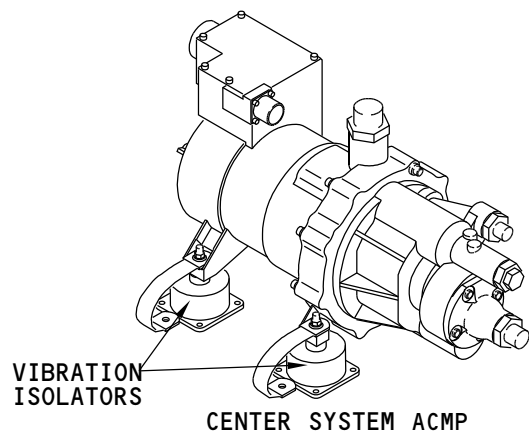
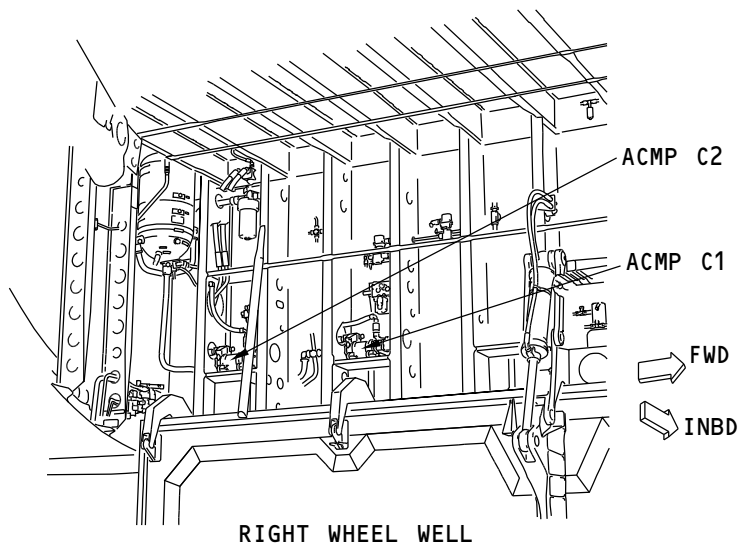
The left and right ACMPs attach to a mounting bracket (not shown) before installation.

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MAIN HYDRAULIC SYSTEMS - ALTERNATING CURRENT MOTOR PUMP

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MAIN HYDRAULIC SYSTEMS - ADP ASSEMBLY - INTRODUCTION

Purpose

Two air driven pump (ADP) pumps are the demand pumps for the center hydraulic system.

General Description

Each ADP pump is part of an ADP assembly. The ADP assembly also has an air drive unit (ADU). The ADU contains these components:

- Turbine gearbox assembly (TGA)
- Modulating shutoff valve (MSOV)
- Air drive unit (ADU) heater.

A mount truss assembly attaches each ADP assembly to the airplane structure. The mount truss assembly for ADP assembly C1 is not the same as the one for ADP assembly C2.

The ADP assemblies use airplane pneumatic power to operate. An inlet duct supplies air pressure to each ADU. The MSOVs let air flow to the turbine of the TGAs. The gearbox of TGAs reduces the turbine speed and operates the pump. ADU heaters are on the ADUs to prevent ice formation. The pumps connect directly to the TGAs. The airflow from the TGAs exits the airplane through two exhaust ducts and two exhaust vents directly aft of the ADP assemblies.

The two TGAs have the same components. The turbine housing of ADP assembly C1 is different than the turbine housing for ADP assembly C2 to permit the exhaust ducts to be near each other.

Two ADP logic speed control units (LSCU), one for each ADP assembly, control the pump operation. The LSCUs supply speed control and overspeed protection to the TGAs. The LSCUs are circuit card assemblies and are LRUs.

A wiring harness for each ADP assembly connects the LSCU to the MSOV and the TGA.

The ADP pumps are the same as the engine driven pumps.

The ADP pump is rated at 53 gpm at 4315 rpm. A reserve mode permits the pump to supply 63 gpm at 5160 rpm. The pumps are LRUs.

Location

The two ADP assemblies are in the left wing-to-body fairing behind the left wheel well. The LSCUs are also in this compartment.

Training Information Point

The EDPs and the ADP pumps are interchangeable. When the pump operates as an ADP pump, the depressurization solenoid does not operate.



CAUTION

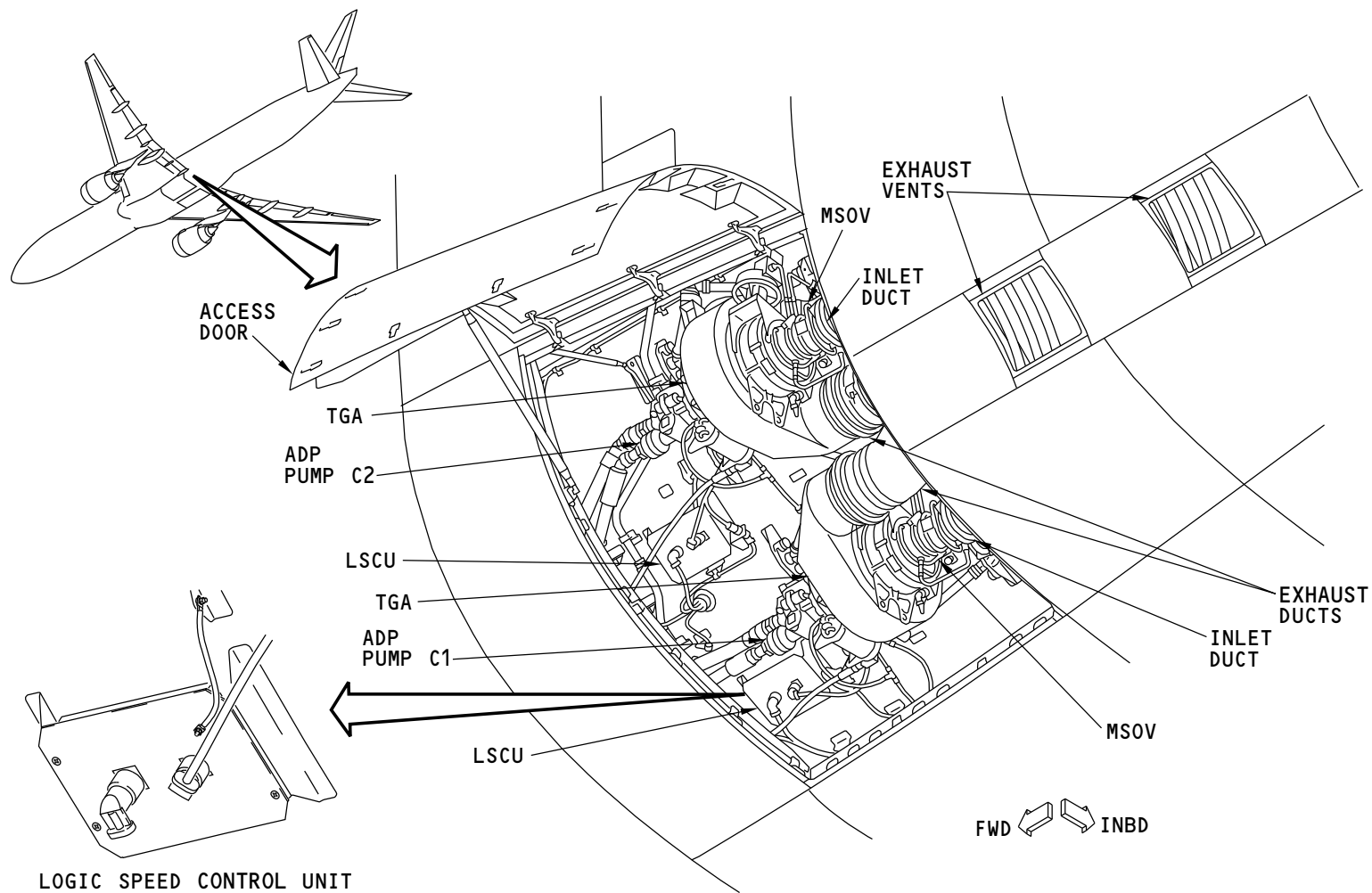
MAKE SURE THE ADP ACCESS DOOR IS FULLY OPEN OR FULLY CLOSED WHEN OPERATING THE TRAILING EDGE FLAPS.

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MAIN HYDRAULIC SYSTEMS - ADP ASSEMBLY - INTRODUCTION

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MAIN HYDRAULIC SYSTEMS - ADP ASSEMBLY- AIR DRIVE UNIT

General

Each ADU has these components:

- Modulating shutoff valve (MSOV)
- Turbine gearbox assembly (TGA)
- ADU heater (not shown).

Modulating Shutoff Valve

The MSOV is a pneumatically-operated butterfly valve that controls airflow to the TGA. A pneumatic actuator moves the butterfly valve.

The MSOV normally operates as a two position valve, either full open or full closed. When the MSOV is open, it supplies the airflow to the turbine.

The MSOV pneumatic actuator modulates the butterfly valve position during secondary speed control.

A position indicator on the MSOV shows the position of the butterfly valve.

The MSOV attaches to the TGA with a V-band clamp. The MSOV also attaches with a V-band clamp to the inlet isolator. The inlet isolator decreases the vibration and noise from the ADP assembly. The inlet duct attaches to the inlet isolator with a V-band clamp.

Turbine Gearbox Assembly

Pneumatic power goes through the MSOV to the TGA.

The turbine in the TGA turns the gearbox. The gearbox has a planetary gearset to reduce turbine speed to operate the ADP pump.

A pneumatic actuator moves the variable inlet guide vanes (VIGVs) in the TGA assembly. The VIGVs open and close to control the airflow to the turbine. During primary speed control, the VIGVs control the turbine speed.

A position indicator shows the VIGV position.

A TGA lubrication system cools and lubricates the TGA gears, bearings, and seals. An oil filter cleans the TGA oil. The oil filter has a differential pressure indicator to show the condition of the filter.

The heat exchanger on the TGA uses case drain fluid from the ADP pump to cool the TGA oil.

There is an oil sight glass and filler port on the front of the TGA.

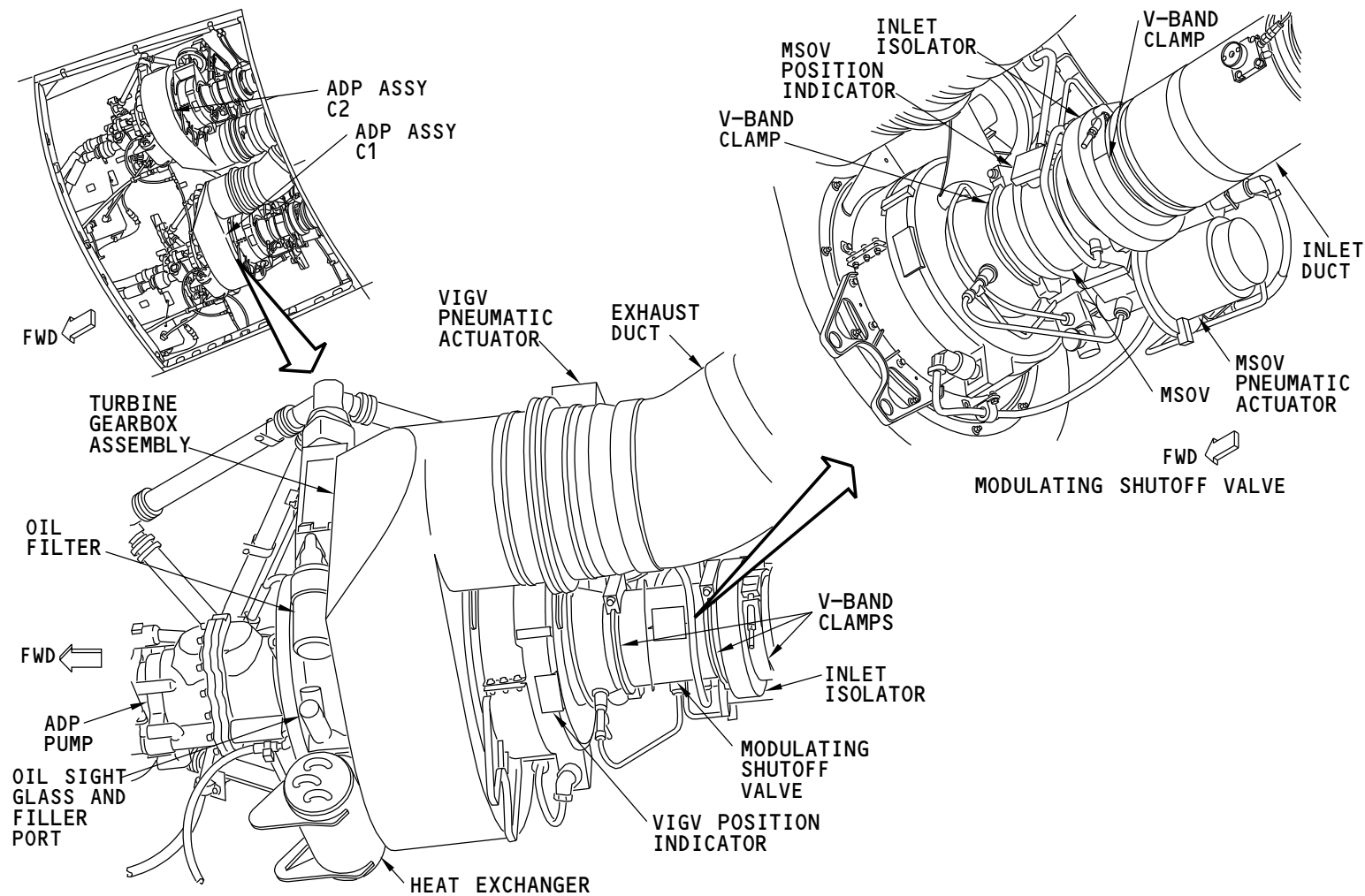
ADU Heater

The ADU heater keeps the temperature of parts of the MSOV and the TGA higher than freezing. This prevents ADU ice formation. The ADU heater is on the ADU and is an LRU.

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MAIN HYDRAULIC SYSTEMS - ADP ASSEMBLY- AIR DRIVE UNIT

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MAIN HYDRAULIC SYSTEMS - ADP ASSEMBLY - FUNCTIONAL DESCRIPTION

General

The ADP assembly gets pressurized air from the airplane pneumatic system.

Air flows through the modulating shutoff valve (MSOV) to the turbine gearbox assembly (TGA). The TGA turns the ADP hydraulic pump. The LSCU supplies primary speed control and overspeed protection.

The MSOV has these components:

- Butterfly valve
- Dual coil solenoid (auto and continuous run coils)
- Pneumatic actuator.

The TGA has these components:

- Variable inlet guide vanes (VIGVs)
- Unison ring
- Pneumatic actuator
- Electro-pneumatic servo-valve
- LVDT
- Turbine wheel
- Gearbox
- Monopole speed sensor (2)
- Pneumatic speed sensor
- Primary reserve solenoid
- Secondary speed control fluidic circuit.

Normal Operation

The signal to operate the ADP assembly comes from the HYDIM cards when the selector is in the AUTO position or from the ADP selector when the selector is in the ON position. These signals go to the LSCU.

The LSCU energizes either the auto run or continuous run coil in the MSOV. This permits air to go to the MSOV pneumatic actuator.

The actuator opens the butterfly valve and air goes through the open VIGVs to turn the turbine.

Speed Control

The ADP assembly has primary and secondary speed control circuits.

The LSCU contains the primary speed control. A monopole speed sensor on the gearbox sends ADP speed signals to the LSCU. The primary speed control circuits control the pneumatic actuator for the VIGVs. The actuator moves the VIGVs through the unison ring. This keeps the turbine within 2.5 percent of the normal operating speed. Normal turbine speed is approximately 32,000 RPM. Normal pump speed is 4315 RPM.

An LVDT supplies actuator position feedback to the LSCU.

The secondary speed control controls the position of the MSOV butterfly valve. The pneumatic speed sensor on the TGA sends a pulsed pneumatic signal in proportion to turbine speed. This signal goes to the secondary speed control fluidic circuit. This pneumatic circuit controls the MSOV pneumatic actuator.

The secondary speed control tries to keep the pump speed approximately 700 RPM higher than the primary speed control. When the system operates on the primary speed control, the secondary speed control gets an underspeed input and keeps the MSOV fully open.

If the primary speed control fails and the speed starts to increase, the MSOV starts to close to keep the pump speed at approximately 5000 RPM.

Reserve Mode

A reserve mode lets the turbine turn at a higher speed to operate the pump at 5160 RPM. This increases pump output for autoslat operation when only one ADP can operate. The HYDIM card commands reserve mode operation for 8 seconds.

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MAIN HYDRAULIC SYSTEMS - ADP ASSEMBLY - FUNCTIONAL DESCRIPTION

For reserve mode operation, the LSCU resets the primary speed control circuit to operate the turbine at the higher RPM. The primary speed control uses the monopole speed sensor input to control the VIGVs. To operate at this higher speed, the secondary speed control must be stopped. The LSCU sends a signal to energize the solenoid in the primary reserve solenoid valve. The valve closes and blocks the pulsed pneumatic signal from the pneumatic speed sensor. Without a speed input, the secondary speed control fluidic circuit does not operate and the butterfly valve in the MSOV fully opens.

Overspeed Protection

Overspeed protection keeps the ADP assembly from turning too fast.

A second monopole speed sensor on the gearbox supplies a speed signal to the LSCU. If the pump speed is more than 6590 RPM, the LSCU opens the control circuits through the overspeed latch. This removes the power from the solenoid in the MSOV and closes the butterfly valve.

Training Information Point

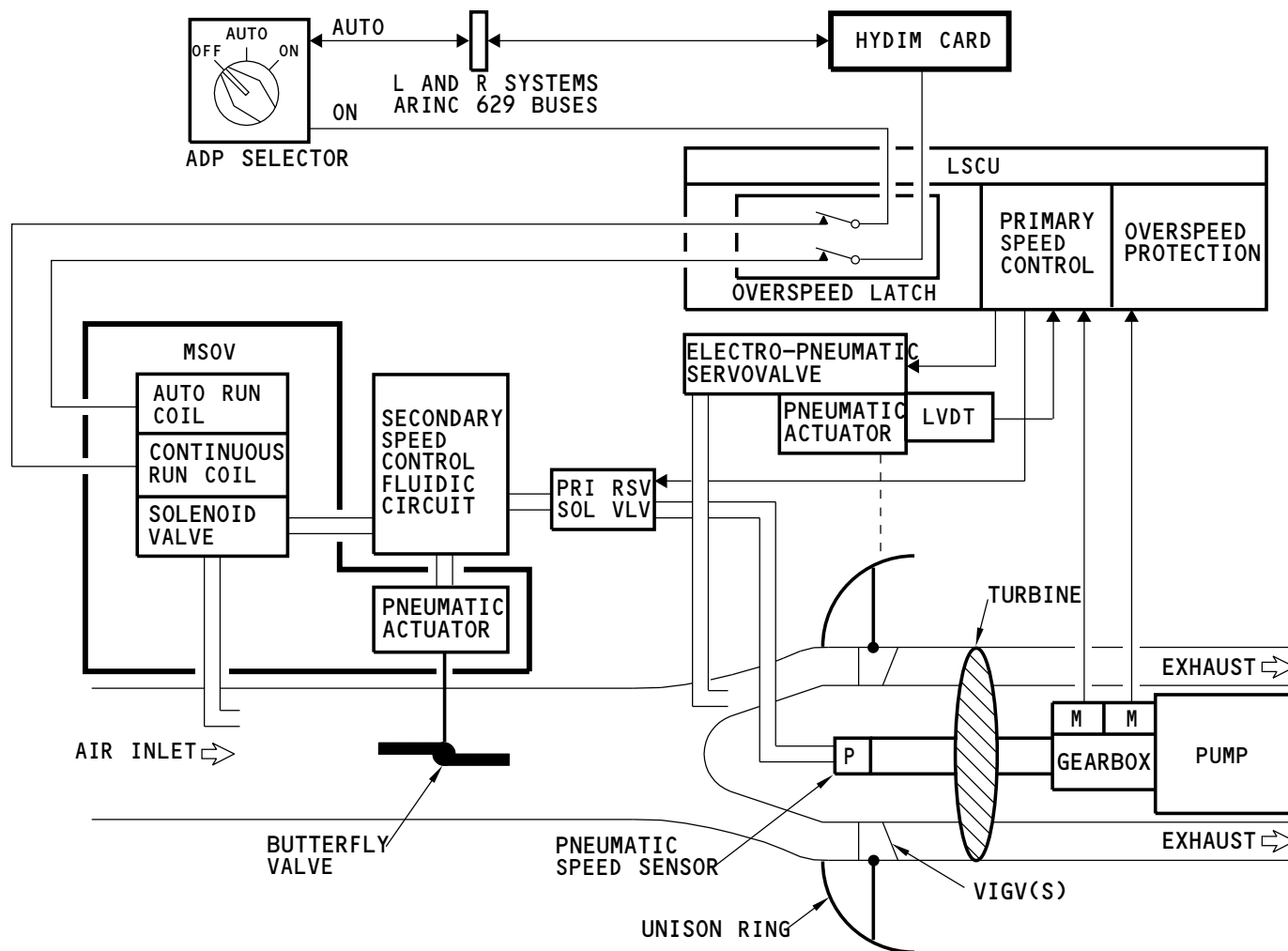
A containment ring protects the airplane from a turbine failure.

The overspeed shutdown system has a latching function that keeps the ADP off until it is reset by a MAT test.

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MAIN HYDRAULIC SYSTEMS - ADP ASSEMBLY - FUNCTIONAL DESCRIPTION

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MAIN HYDRAULIC SYSTEMS - ADU HEATERS

Purpose

The air drive unit (ADU) heaters keep the speed control components of the ADU warm to prevent icing. This increases the ADP reliability after being cold-soaked. The ADU is made of the turbine gearbox assembly (TGA) and the modulating shutoff valve (MSOV).

Physical Description

Each ADU has an electric heater assembly. Each heater assembly has four heater elements. The heater elements warm these parts of the ADU:

- MSOV pneumatic actuator
- VIGV electro-pneumatic servo valve
- Secondary speed control assembly
- MSOV solenoid.

The secondary speed control and the VIGV electro-pneumatic servo valve have cartridge heater elements. The MSOV pneumatic actuator and the MSOV solenoid have conformal heater elements.

The heater assembly has separate connections for the two cartridge heater elements and a third connection for the two conformal heaters. Jumpers in the heater assembly connector are used to connect all four heater elements in series.

Location

You get access to the ADUs through the ADP access door. The ADU heaters are on the aft part of the ADP assemblies.

Indications

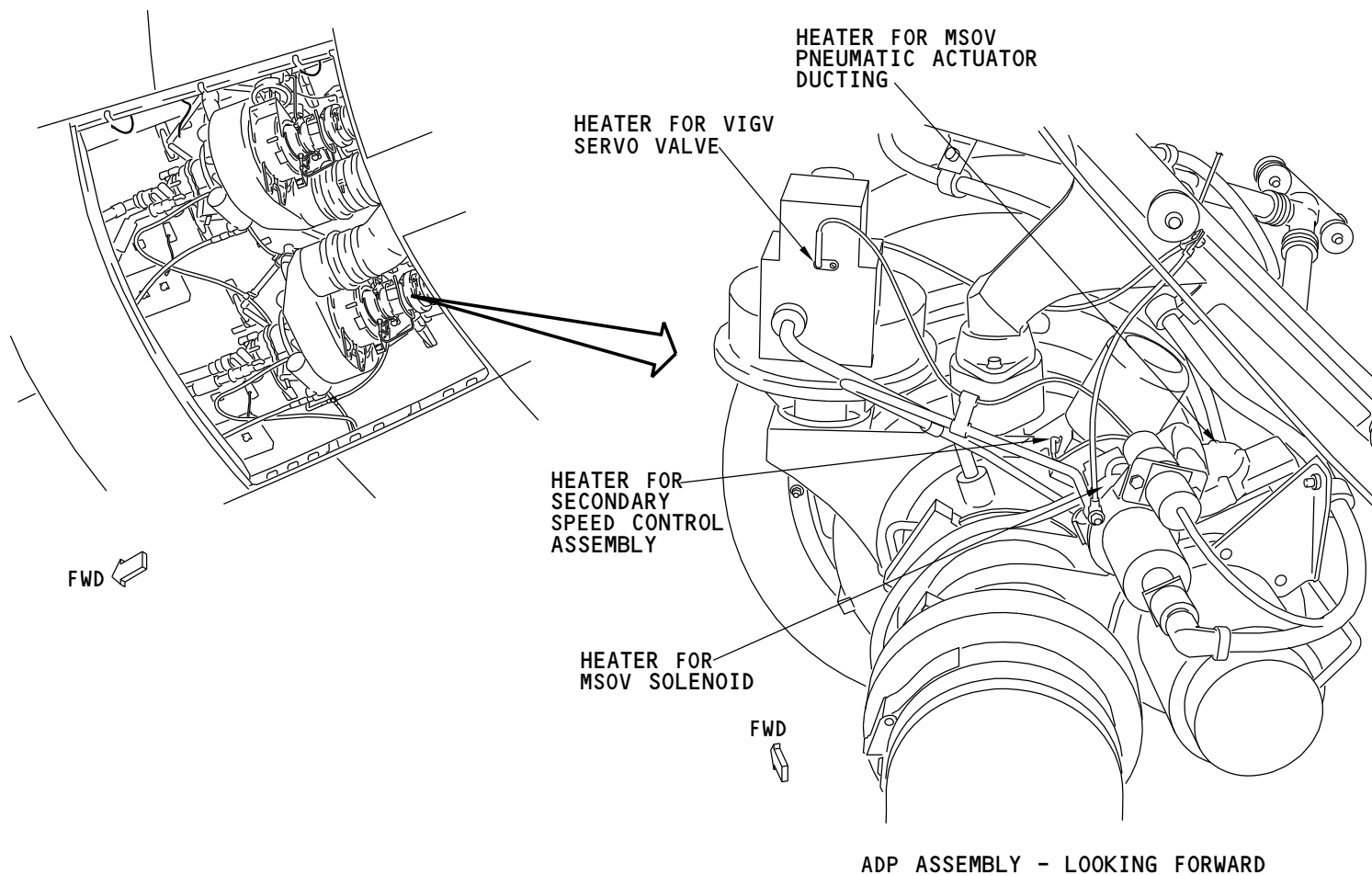
There is no indication that the ADU heaters are on.

The AIMS shows the status message HYD PUMP DEM C1 or HYD PUMP DEM C2 if there is a failure in an ADU heater element.

Training Information Point

Each ADU heater assembly is an LRU.

You can do a test of the two ADU heaters with the HEATERS operational test. You can also do a test of each of the heaters with the ADP C1 or ADP C2 operational tests.



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MAIN HYDRAULIC SYSTEMS - ADU HEATERS

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MAIN HYDRAULIC SYSTEMS - ADU HEATERS - FUNCTIONAL DESCRIPTION**General**

The air drive unit (ADU) heaters operate automatically to keep the temperature of the ADU speed control components higher than freezing. This prevents icing in the ADU.

The HYDIM CL card controls the heaters for both ADUs. The P210 right power management panel supplies the electrical power to operate the heaters.

Functional Description

The HYDIM CL card sends a signal to the ELMS to operate the ADU heaters for any of these conditions:

- Total air temperature is less than 2C (ADIRU input through the AIMS)
- ADP C1 case drain temperature is less than 10C
- ADP C2 case drain temperature is less than 10C
- ADP C1 operational test (MAT test)
- ADP C2 operational test (MAT test)
- Heaters operational test (MAT test).

The ON signal goes to the ELMS computing and communications unit (CCU) in the P210 right power management panel. The CCU energizes heater relays to supply power to the ADU heaters and also to the RAT heater.

The heaters go off 30 minutes after the total air temperature goes above 2C and both ADP case drain temperatures are more than 10C. The heaters also go off 5 seconds after a RAT deployment.

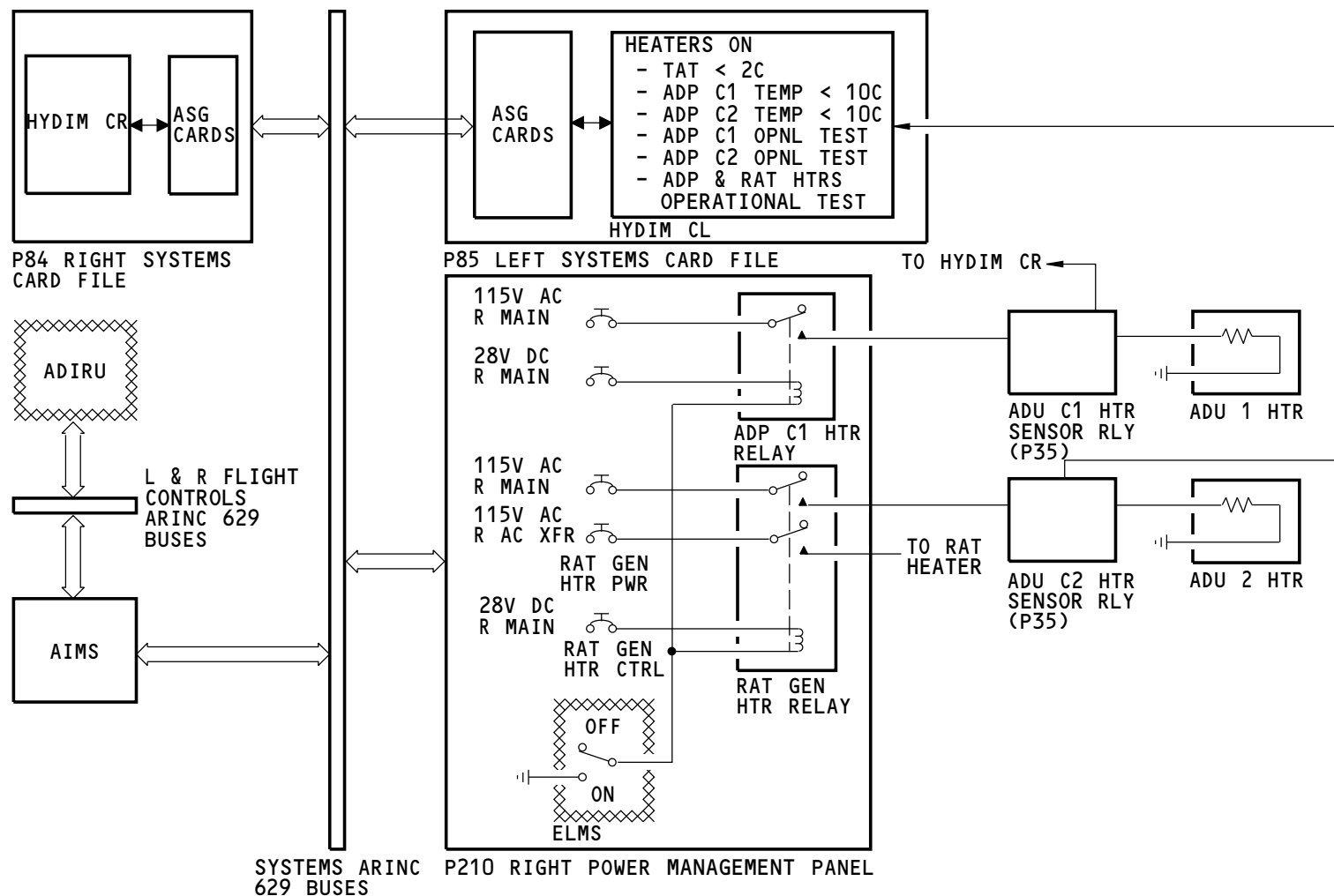
ADU heater sensor relays send the ADU heater on/off condition to the HYDIM cards. The HYDIM cards use this to monitor for correct heater operation.

The ADU heater elements connect in series. A failure of a single element will prevent all of the elements in the heater assembly from operating.

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MAIN HYDRAULIC SYSTEMS - ADU HEATERS - FUNCTIONAL DESCRIPTION

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**MAIN HYDRAULIC SYSTEMS - AC MOTOR PUMP (ACMP) PRESSURE AND CASE DRAIN FILTER MODULE****Purpose**

The ACMP pressure and case drain filter module removes particles from the hydraulic fluid after the fluid leaves the ACMP. Transducers on or near the filter module send pressure and temperature signals to the HYDIM cards.

Physical Description

Each of the four ACMPs has its own pressure and case drain filter module. All of these modules are interchangeable.

Each filter module has these components:

- Case drain filter
- Pressure filter
- Automatic filter bowl removal shutoff valve (not shown) (2)
- Differential pressure indicators (red pop-up indicator)(2)
- Check valves (2)
- Pressure transducer (center system filter modules)
- Temperature transducer.

Location

The filter module for the left hydraulic system is in the left aft engine strut fairing. The filter module for the right hydraulic system is in the right engine strut. You get access to these filter modules through the aft strut fairing doors on the right side of each engine strut.

The filter modules for the two center system ACMPs are in the right wheel well on the keelbeam.

Functional Description

Hydraulic pressure and case drain flow goes through the filters in the filter modules.

A temperature transducer in the case drain line sends temperature signals to the HYDIM cards. A pressure transducer in the pressure line sends pressure signals to the HYDIM cards.

Check valves prevent hydraulic backflow through the filter module.

Training Information Point

You can not clean the filters and use them again.

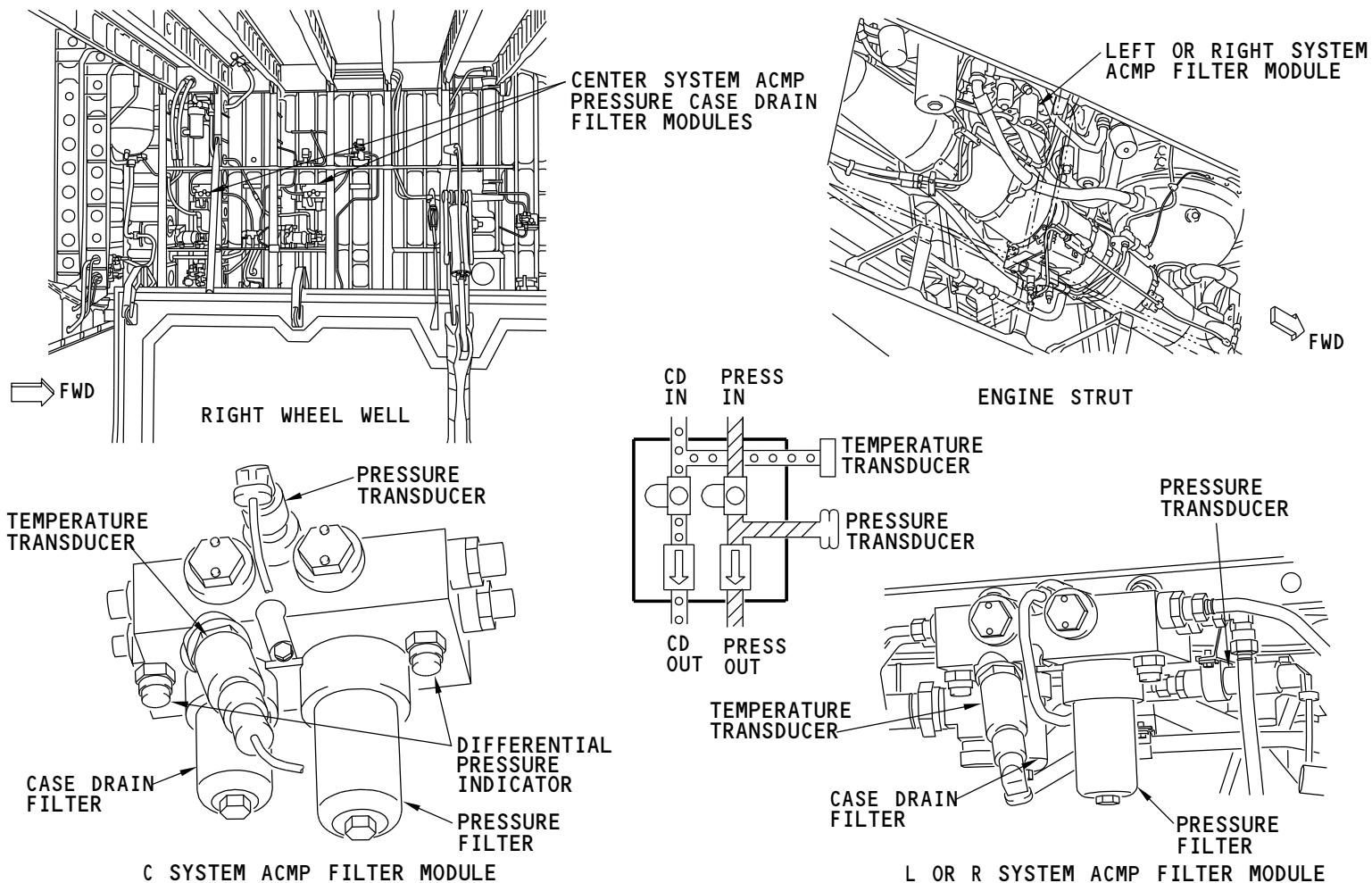
The red differential pressure indicator extends to show a clogged filter. Replace the filter and manually reset the indicator.

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MAIN HYDRAULIC SYSTEMS - AC MOTOR PUMP (ACMP) PRESSURE AND CASE DRAIN FILTER MODULE

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MAIN HYDRAULIC SYSTEMS - ADP AND EDP PRESSURE AND CASE DRAIN FILTER MODULES

Purpose

The pressure and case drain filter modules for the EDPs and the ADPs remove the particles from the hydraulic fluid after the fluid leaves the pumps. A pressure relief valve in the modules supplies system protection if pressure gets too high.

Transducers on the filter modules send pressure and temperature signals to the HYDIM cards.

Physical Description

The ADP filter module and the EDP filter module are interchangeable.

Each module has these components:

- Pressure filter
- Case drain filter
- Automatic filter bowl removal shutoff valve (2)
- Differential pressure indicator (red pop-up indicator) (2)
- Check valve (3)
- Pressure transducer
- Temperature transducer
- Relief valve.

The EDP filter modules and the filter module for ADP C2 also have a ground service disconnect.

Location

The filter module for the left system EDP is in the left engine aft strut fairing. The filter module for the right system EDP is in the right engine aft strut fairing.

You get access to these filter modules through the aft strut fairing doors on the left and right sides of each engine strut.

The ADP filter modules are in the left wing to body fairing forward of the ADPs. An access panel permits you to get access to the filter modules.

Functional Description

Hydraulic pressure and case drain flow go through the filters in the filter modules.

A temperature transducer in the case drain line sends temperature signals to the HYDIM cards. A pressure transducer in the pressure line sends pressure signals to the HYDIM cards.

The check valves prevent hydraulic backflow. The check valve in the pressure line also isolates the pressure transducer from system pressure.

The relief valve starts to open at 3400 psid to protect the system from over-pressure. Full flow occurs at 4100 psi. The relief valve sends the hydraulic fluid back to the reservoir through the system return lines.

Training Information Point

You can not clean the filters and use them again.

The red differential pressure indicator extends to show a clogged filter. Replace the filter and manually reset the indicator.

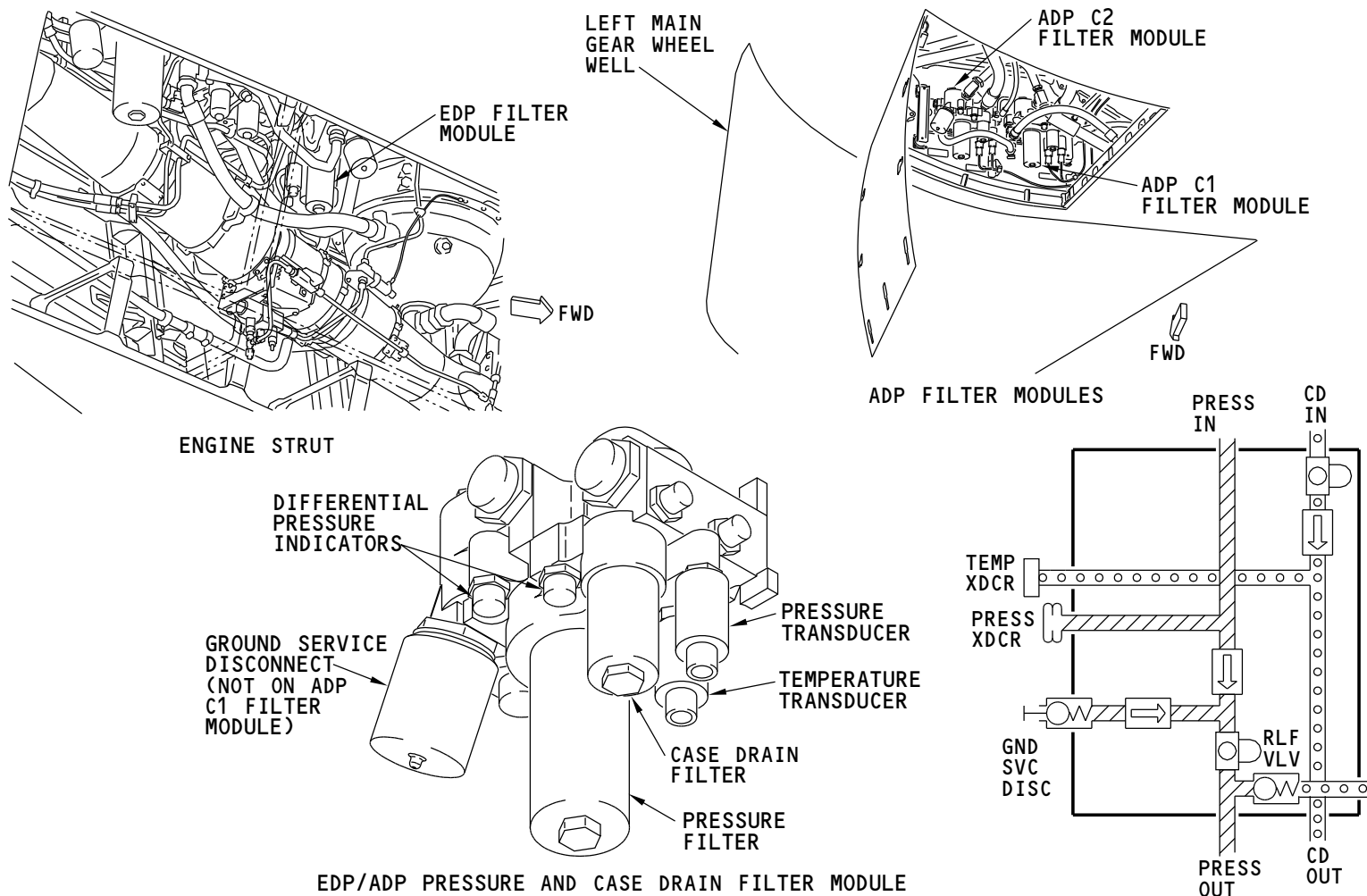
You can pressurize the hydraulic system with a ground pressure source through the ground service disconnect.

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MAIN HYDRAULIC SYSTEMS - ADP AND EDP PRESSURE AND CASE DRAIN FILTER MODULES

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MAIN HYDRAULIC SYSTEMS - RETURN FILTER MODULES

Purpose

The return filter modules remove particles from the hydraulic fluid before the fluid returns to the reservoirs.

Physical Description

The left and right return filter modules are the same. The center return filter module is different than the left and right modules.

Each module has these components:

- Replaceable filter
- Automatic filter bowl removal shutoff valve
- Differential pressure indicator (red pop-up indicator)
- Check valve (2) (left and right modules only)
- Bypass relief valve with indicator
- Ground service disconnect (Left and right modules only).

Location

The return filter module for the left system is in the left engine aft strut fairing. The return filter module for the right system is in the right engine aft strut fairing. You get access to these filter modules through the aft strut fairing doors on the right side of each engine strut.

The center system return filter module is on the keelbeam in the right wheel well.

Functional Description

Return fluid from airplane hydraulic systems and the heat exchangers goes through the return filter modules before it goes into the hydraulic reservoirs again.

The left and right return filter modules have a negative pressure loop.

The negative pressure loop and the check valves permit backwards flow of fluid from the reservoir to the system without backflush of the filter.

The center hydraulic system has a negative pressure loop outside the return filter module.

Bypass relief valves open to permit continued hydraulic flow if the filter clogs. The relief valve starts to open at approximately 165 psid.

Training Information Point

You can not clean the filters and use them again.

The red differential pressure indicator extends if the pressure difference across the filter is 48 - 62 psi. This shows a clogged filter. Replace the filter and manually reset the indicator.

A red indicator on the bypass relief valve extends to show the bypass valve is open.

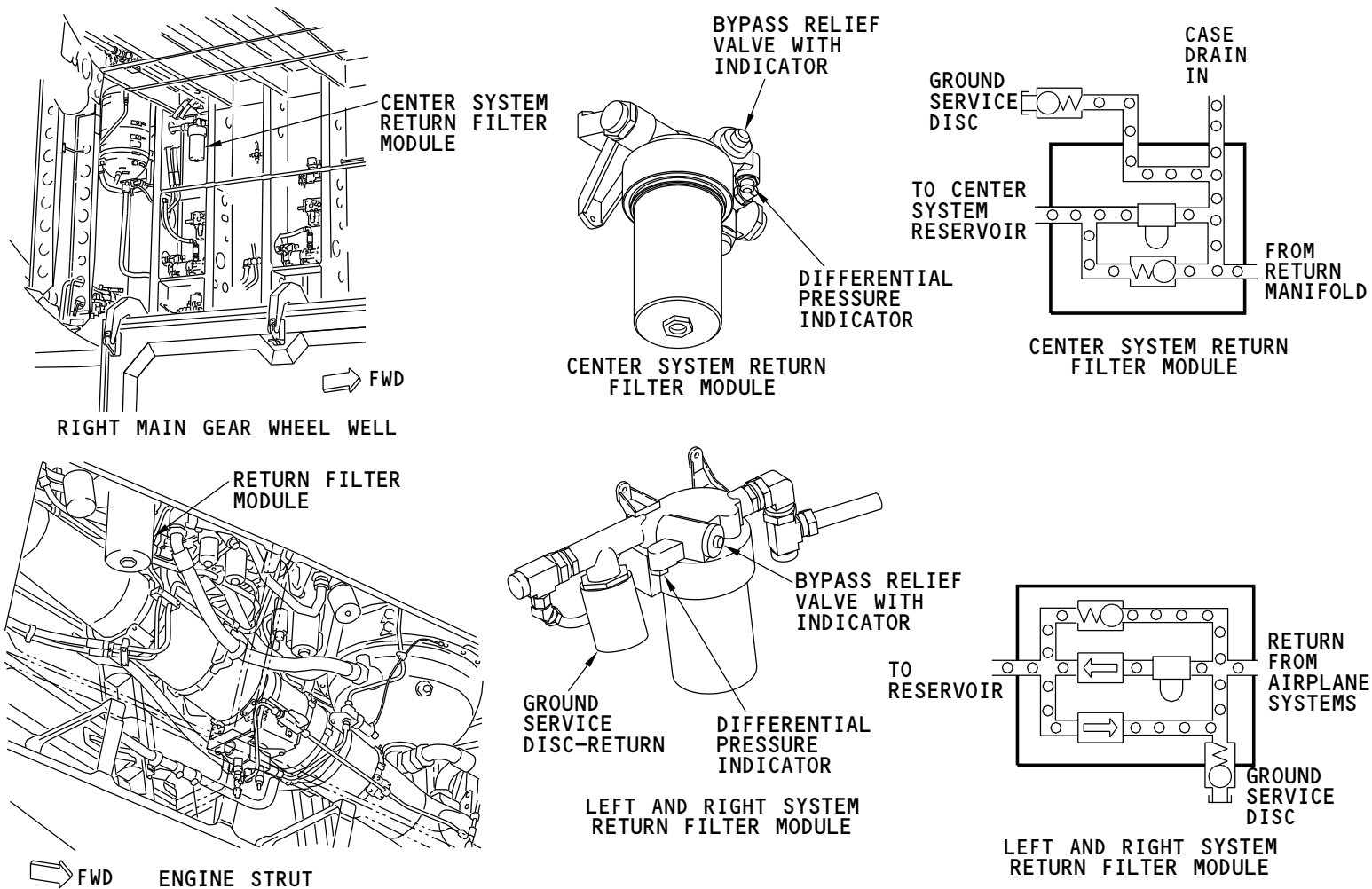
You use the ground service disconnect as the return port during ground hydraulic pressure cart operation. The center system ground service disconnect is not on the return filter module. A hydraulic tube connects the disconnect to the module.

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MAIN HYDRAULIC SYSTEMS - RETURN FILTER MODULES

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MAIN HYDRAULIC SYSTEMS - HEAT EXCHANGERS

Purpose

A heat exchanger in each hydraulic system cools the case drain hydraulic fluid from the EDPs and the ACMPs. This extends the service life of the fluid and the hydraulic pumps.

Physical Description

The heat exchangers use aluminum finned tubes to transfer heat from the fluid to the fuel. Fuel in the left and right main tanks cools the hydraulic fluid.

Location

The heat exchanger for the left hydraulic system is in the left main fuel tank between ribs 10 and 11.

The heat exchangers for the right hydraulic system is in the right main fuel tank between ribs 10 and 11.

The heat exchangers for the center hydraulic system is in the right main fuel tank between ribs 11 and 12.

Training Information Point

NOTE: The heat exchangers in the hydraulic system use the fuel to remove heat from the hydraulic system.

When pressurizing a hydraulic system with an ACMP use the following minimum fuel levels:

Approximately 739 gallons (2797 liters) (5000 pounds) (2267 kg) of fuel in the left main fuel tank is necessary to cool the case drain flow from the left hydraulic system.

Approximately 1035 gallons (3918 liters) (7000 pounds) (3175 kg) of fuel in the right main fuel tank is necessary to cool the case drain flow from the right hydraulic system.

Approximately 1080 gallons (4088 liters) (7303 pounds) (3313 kg) of fuel in the right main tank is necessary to cool the case drain flow from the center hydraulic system.

When pressurizing a hydraulic system with an EDP use the following minimum fuel levels:

Approximately 709 gallons (2684 liters) (4794 pounds) (2175 kg) of fuel in the left and right main fuel tanks is necessary to cool the case drain flow from the left and right hydraulic system.

You can operate the hydraulic pumps if fuel goes below these levels if you obey the CAUTION below.



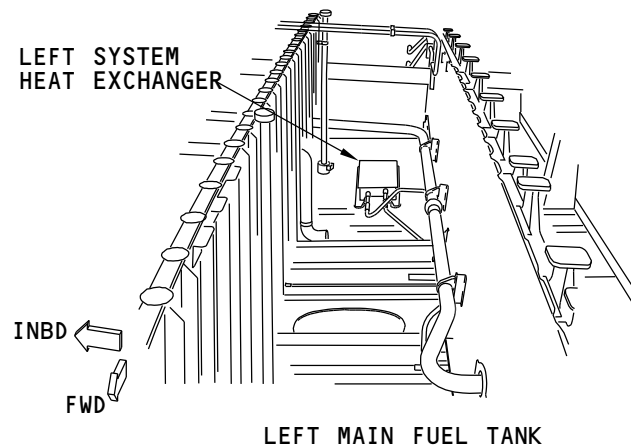
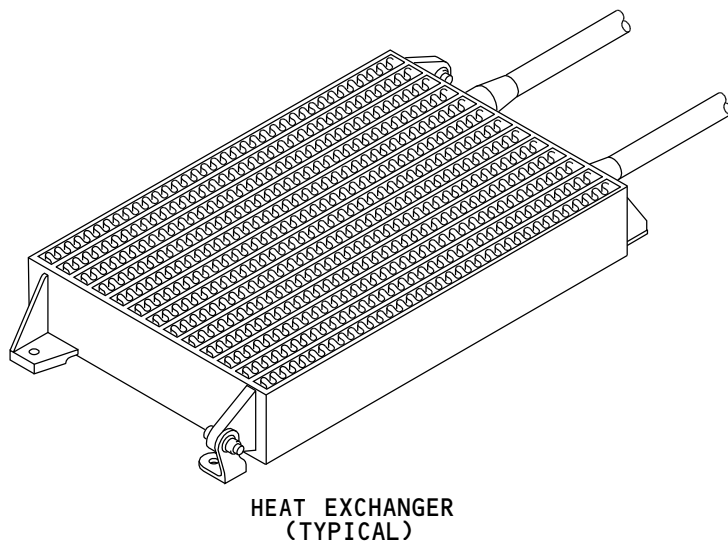
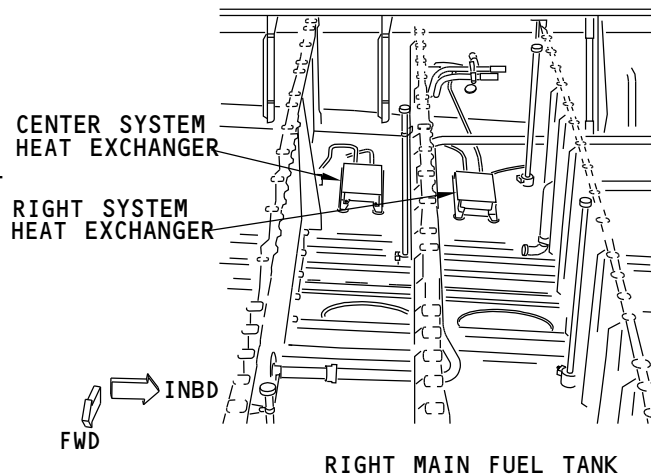
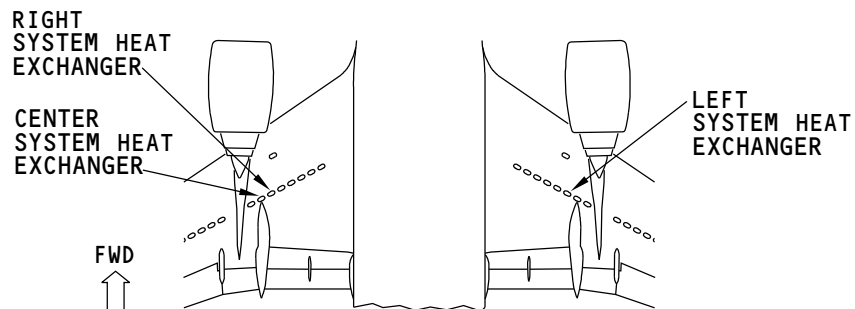
DO NOT OPERATE THE HYDRAULIC PUMPS AFTER THE HYDRAULIC TEMPERATURE INDICATION IS MORE THAN 100C (212F) OR AFTER THE PUMP FAULT LIGHT COMES ON. IF YOU CONTINUE TO OPERATE THE PUMPS, THE HYDRAULIC FLUID CAN BECOME TOO HOT.

29-10-00

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MAIN HYDRAULIC SYSTEMS - HEAT EXCHANGERS

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**MAIN HYDRAULIC SYSTEMS - RESERVE ISOLATION VALVE AND NOSE GEAR ISOLATION VALVE****General**

The reserve isolation valve and the nose gear isolation valve supply engine burst protection to the center hydraulic system to prevent complete loss of center system fluid.

These valves permit a reserve brake and nose gear steering operation if there is a leak in the PFCS or MLG hydraulic lines. The valves also permit PFCS and MLG operation if there is a leak in the NLG or LE slat hydraulic lines.

The reserve isolation valve and the nose gear isolation valve are part of the center hydraulic isolation system (CHIS).

The reserve isolation valve isolates brakes and steering from the center hydraulic system.

The nose gear isolation valve controls ACMP C1 output to nose gear steering.

Physical Description

The reserve isolation valve and nose gear isolation valves are the same.

They are 28v dc motor-powered, two-position valves. They each have a position indication lever which permits you to manually operate the valve.

Location

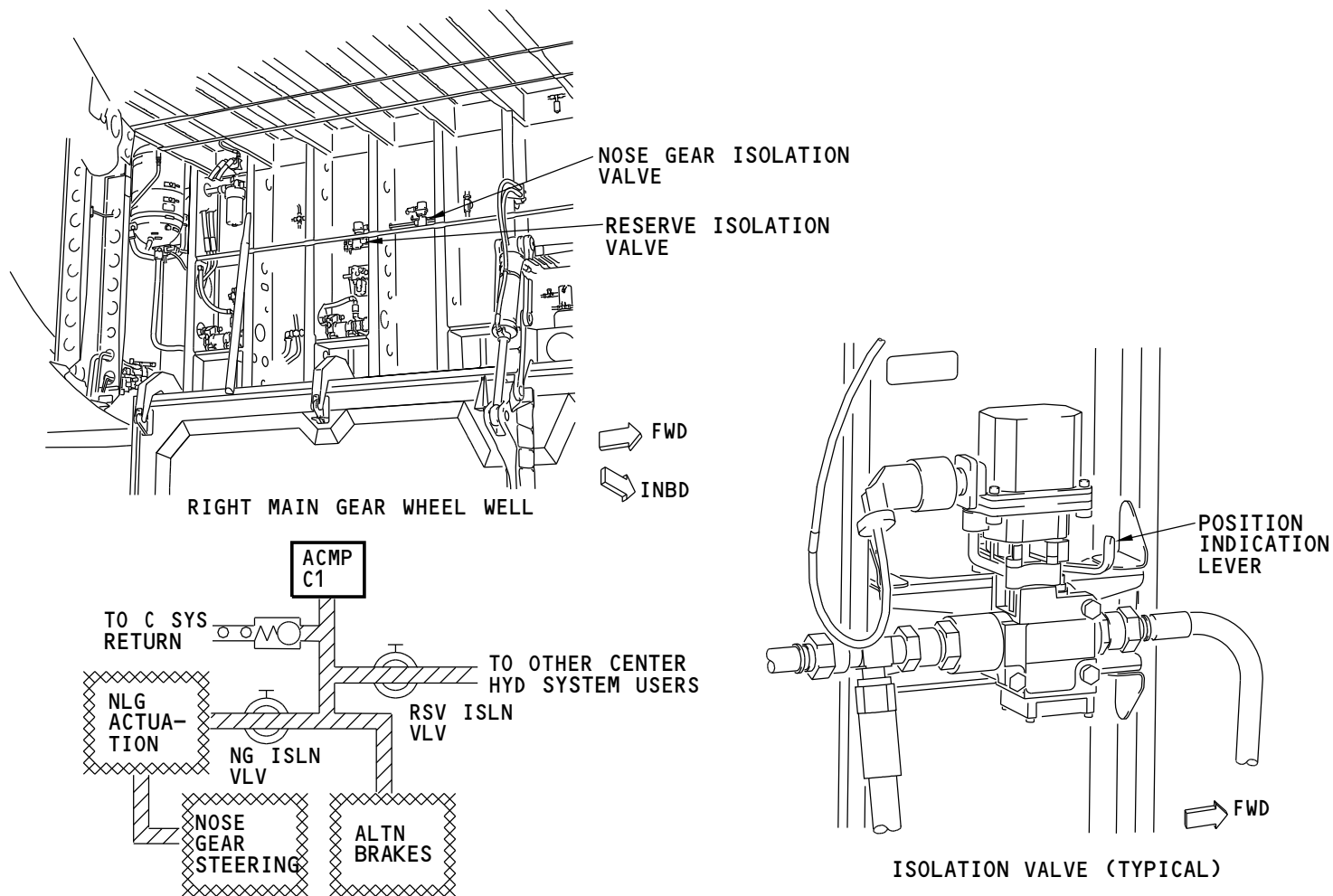
Both valves are in the right wheel well on the keelbeam.

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M36111 S000617769_V1

MAIN HYDRAULIC SYSTEMS - RESERVE ISOLATION VALVE AND NOSE GEAR ISOLATION VALVE

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**MAIN HYDRAULIC SYSTEMS - CENTER SYSTEM RETURN MANIFOLD AND PRESSURE RELIEF VALVE****Return Manifold**

The center system return manifold collects the return hydraulic flows from center hydraulic system components.

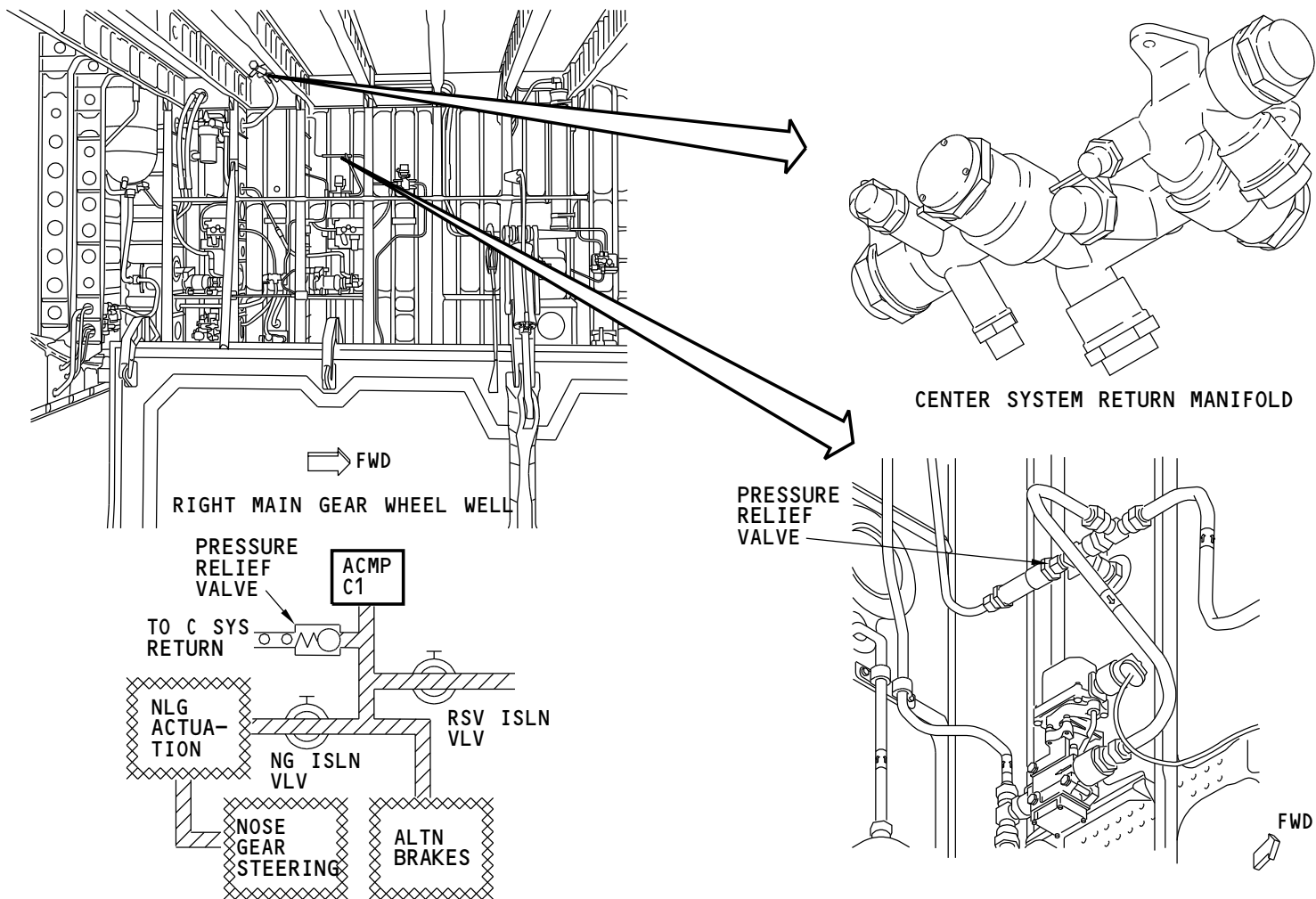
The manifold is on the ceiling in the right wheel well near the keelbeam.

Pressure Relief Valve

A center system pressure relief valve supplies overpressure protection to the part of the center system that may be isolated by the CHIS.

The relief valve is on the keelbeam in the right wheel well.

The relief valve starts to open at a pressure of 3700 - 3900 psid.



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MAIN HYDRAULIC SYSTEMS - CENTER SYSTEM RETURN MANIFOLD AND PRESSURE RELIEF VALVE

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MAIN HYDRAULIC SYSTEMS - HYDRAULIC ACCUMULATORS

Purpose

The hydraulic accumulators absorb pressure changes caused by tail flight control PCU operation. This increases the life of the hydraulic system components.

Physical Description

The left, right and center hydraulic systems each have a single hydraulic accumulator in the pressure lines to the tail flight controls. All accumulators are the same and have a volume of 50 cubic inches.

The accumulators have a hydraulic fluid side and a gas side. A fluid port connects the fluid side to the hydraulic line. You service the gas side of the accumulator with nitrogen.

Location

The hydraulic accumulators are on the forward side of the aft bulkhead of the stabilizer compartment. The hydraulic accumulator service panel is on the aft side of the stabilizer compartment aft bulkhead.

Training Information Point

A door forward of the APU compartment gives access to the hydraulic accumulator service panel. Gages on the panel show the gas charge for the accumulators in each system. A chart shows the relation of pressure to temperature, and when servicing is necessary. A charging valve for the accumulators in each system lets you connect a nitrogen supply.



WARNING

DO NOT ENTER THE COMPARTMENT WITHOUT FORCED AIR VENTILATION WHEN YOU SERVICE THE HYDRAULIC ACCUMULATORS. DO NOT RELEASE NITROGEN INTO THE COMPARTMENT WHEN SERVICING THE ACCUMULATORS. NITROGEN WILL DISPLACE AIR AND REDUCE THE OXYGEN LEVEL IN THE COMPARTMENT. LACK OF OXYGEN CAN RESULT IN UNCONSCIOUSNESS OR DEATH. A SECOND MECHANIC WHO CAN OBSERVE THE WORK MUST BE LOCATED OUTSIDE THE COMPARTMENT WHEN NITROGEN IS BEING SERVICED IN A CLOSED COMPARTMENT.



WARNING

DO NOT LOOSEN THE BODY OF THE HYDRAULIC ACCUMULATOR CHARGING VALVE. THE PRESSURE IN THE HYDRAULIC ACCUMULATORS CAN QUICKLY PUSH THE CHARGING VALVE OFF THE MANIFOLD ASSEMBLY. THIS CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.



WARNING

DO NOT RELEASE NITROGEN INTO THE COMPARTMENT WHEN DISCONNECTING THE CHARGING ASSEMBLY FROM THE HYDRAULIC ACCUMULATORS. NITROGEN WILL DISPLACE AIR AND REDUCE THE OXYGEN LEVEL IN THE COMPARTMENT. A LACK OF OXYGEN CAN RESULT IN UNCONSCIOUSNESS OR DEATH.



WARNING

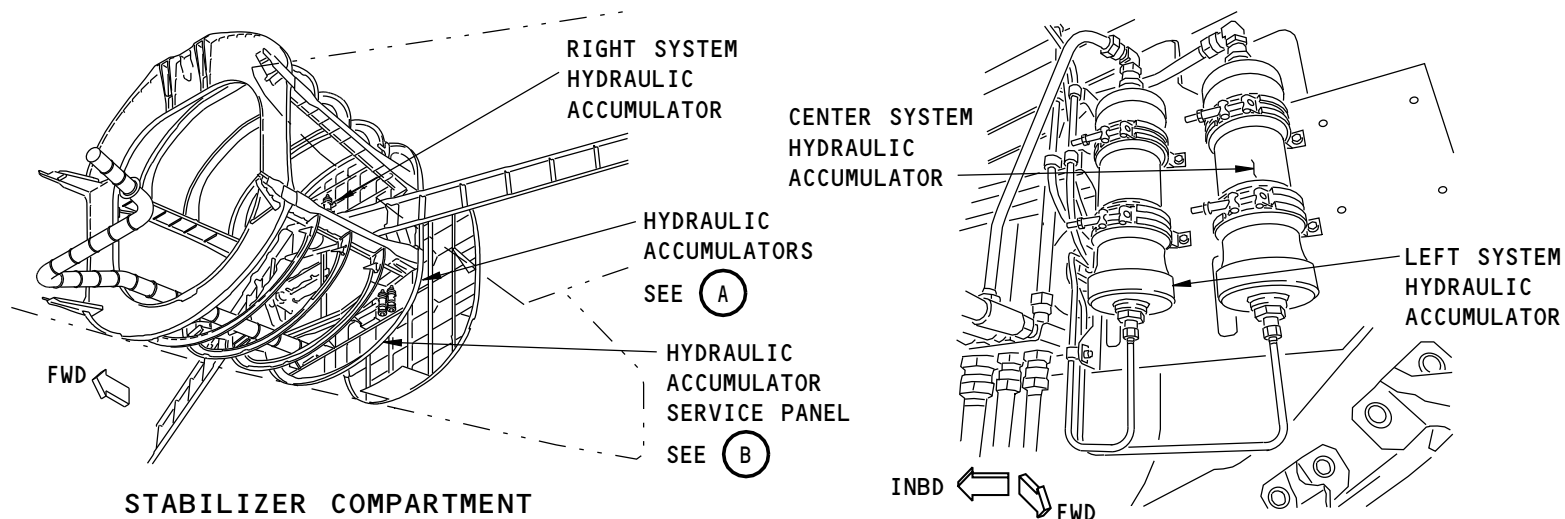
YOU MUST PREVENT ALL POSSIBLE OPERATION OF THE HORIZONTAL STABILIZER WHEN YOU WORK ON OR NEAR IT. THE HORIZONTAL STABILIZER MOVES QUICKLY AND WITH FORCE. IF THE STABILIZER MOVES WHEN PERSONS ARE IN THE TORSION BOX COMPARTMENT OR NEAR THE STABILIZER, IT CAN CAUSE INJURY TO THEM.

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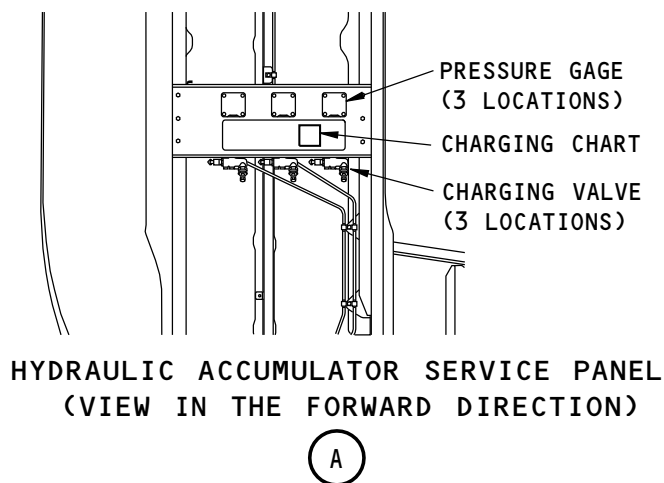
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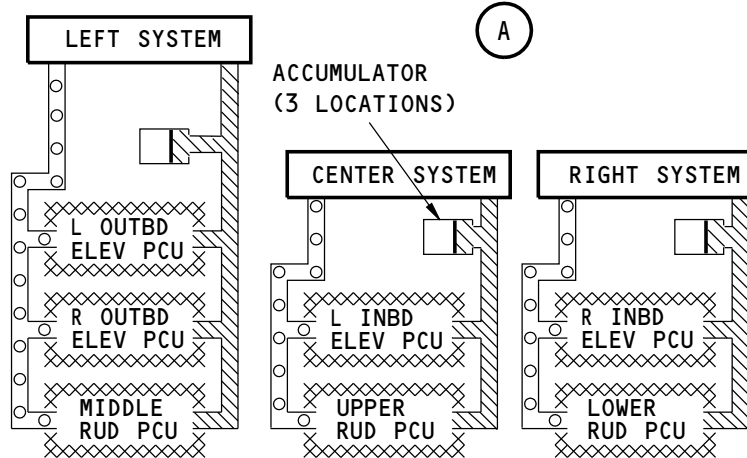


STABILIZER COMPARTMENT

HYDRAULIC ACCUMULATORS



HYDRAULIC ACCUMULATOR SERVICE PANEL
(VIEW IN THE FORWARD DIRECTION)



MAIN HYDRAULIC SYSTEMS - HYDRAULIC ACCUMULATORS

N36549 S0000107104_V2

29-10-00

**MAIN HYDRAULIC SYSTEMS - FUNCTIONAL DESCRIPTION - ENGINE DRIVEN PUMP****General**

The EDPs operate when the related engine turns.

The EDPs can be depressurized by the EDP switch or by the engine fire switch.

HYDIM L monitors the operation of the left EDP. HYDIM R monitors the operation of the right EDP.

EDP Switch Operation

When the EDP switch is in the ON position, the depressurization solenoid valve is not energized. This permits the pressure output of the EDP to go to the hydraulic system.

When the EDP switch is in the OFF position, power from the left 28v dc main bus (left engine) or the right 28v dc main bus (right engine) goes to EDP solenoid valve. This closes the valve to stop the pump output and depressurize the pump.

The case drain flow continues when the switch is in the OFF position.

Supply Shutoff Valve Operation

When you pull the engine fire switch, the supply shutoff valve moves to the CLOSED position. This stops the supply of hydraulic fluid to the EDP. The engine fire switch also energizes the depressurization solenoid valve to remove pressure from the EDP. There is no case drain flow in this condition.

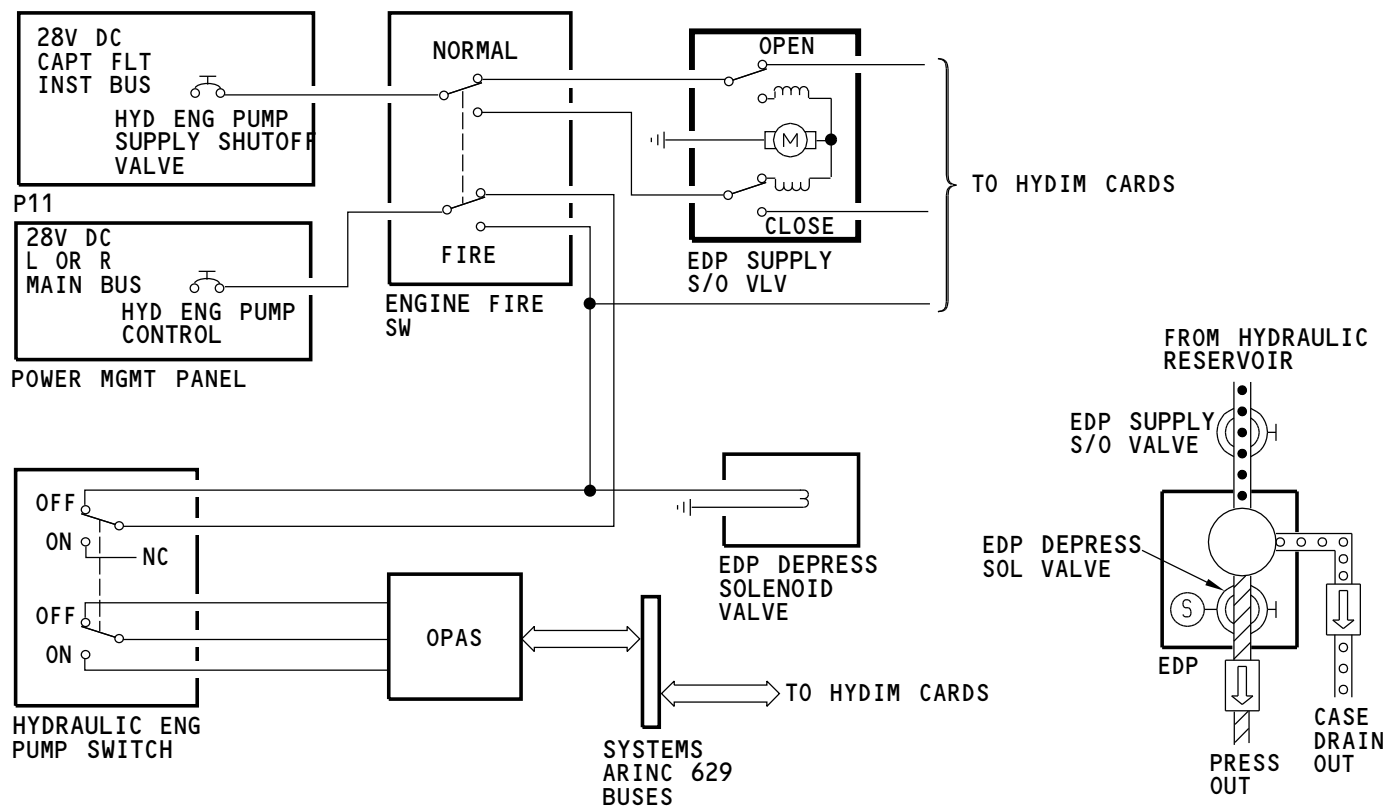
The supply shutoff valve moves to the OPEN position when you move the engine fire switch to the stowed position.

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MAIN HYDRAULIC SYSTEMS - FUNCTIONAL DESCRIPTION - ENGINE DRIVEN PUMP

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MAIN HYDRAULIC SYSTEMS - FUNCTIONAL DESCRIPTION - AIR DRIVEN PUMP

General

The pneumatic system supplies the pressurized air to operate the air driven pumps.

The ADP selectors are on the hydraulic/RAT panel.

The ADP selectors send pump control signals to the overhead panel ARINC 629 system (OPAS). The OPAS sends these control signals through the systems ARINC 629 buses to the HYDIM cards. The HYDIM cards use these signals to operate the pumps in the demand mode. HYDIM CR controls ADP C1 in the demand mode. HYDIM CL controls ADP C2 in the demand mode. The control circuits on each card are equivalent.

The HYDIM cards do not control the ADPs in the continuous run (ON) mode. The ADP selectors send electrical signals directly to the LSCU to operate the pump in the continuous run mode.

An LSCU for each ADP gets the input signals to open the MSOV to permit the ADP to operate.

Demand Mode

With the two ADP selectors in AUTO, the HYDIM cards start one or both of the ADPs when the center hydraulic system must supply a large hydraulic flow rate.

The HYDIM cards get the ADP selector input signal from the ARINC 629 systems buses. The HYDIM cards must also get a hardwire electrical signal from the AUTO position of the ADP selector.

The HYDIM cards prevent or stop demand mode ADP operation during main engine start on the ground.

One ADP operates during any of these conditions:

- Landing gear extension
- Flap/slat operation
- Low pressure (less than 2400 psi) in the center system or in both center system ACMPs
- Touchdown (airspeed more than 80 kts and altitude less than 30 feet)

- Air mode, flaps and slats not up, and one ADP selected OFF or does not operate (in case of autoslat demand)
- Failure of the ADU heaters on both ADPs and groundspeed is more than 80 knots (turns on ADP C1).

When an ADP turns on for low pressure, the pump turns off 15 seconds after the pressure goes above 2700 psi.

The ADP turns on during the touchdown conditions to supply pressure to operate the auto speedbrakes. The pump turns off 5 seconds after the speedbrake lever moves to the stowed position.

The HYDIM cards CL and CR make a selection of one of the two ADPs during single pump operation. They use the other ADP the next time they turn on a single pump. This equalizes the pump wear.

Both ADPs operate for these conditions:

- Autoslat operation
- Landing gear retraction
- Takeoff roll (ground mode, airspeed is more than 80 kts, and the flaps are in the takeoff position).

Both ADPs turn on during the takeoff roll to make sure that at least one of them operates if there is an engine loss. This makes sure that there is sufficient hydraulic flow to operate the rudder for the thrust asymmetry compensation function. The ADPs turn off 10 seconds after the airplane takes off.

Reserve Mode

If one of the two ADPs does not operate and there is an autoslat signal, the HYDIM cards will operate the remaining ADP in the reserve mode. This permits the ADP to operate at a higher speed to make sure sufficient hydraulic flow goes to the leading edge slats. The reserve mode turns off after 8 seconds. The reserve mode operates when the selector is in AUTO or ON.

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MAIN HYDRAULIC SYSTEMS - FUNCTIONAL DESCRIPTION - AIR DRIVEN PUMP

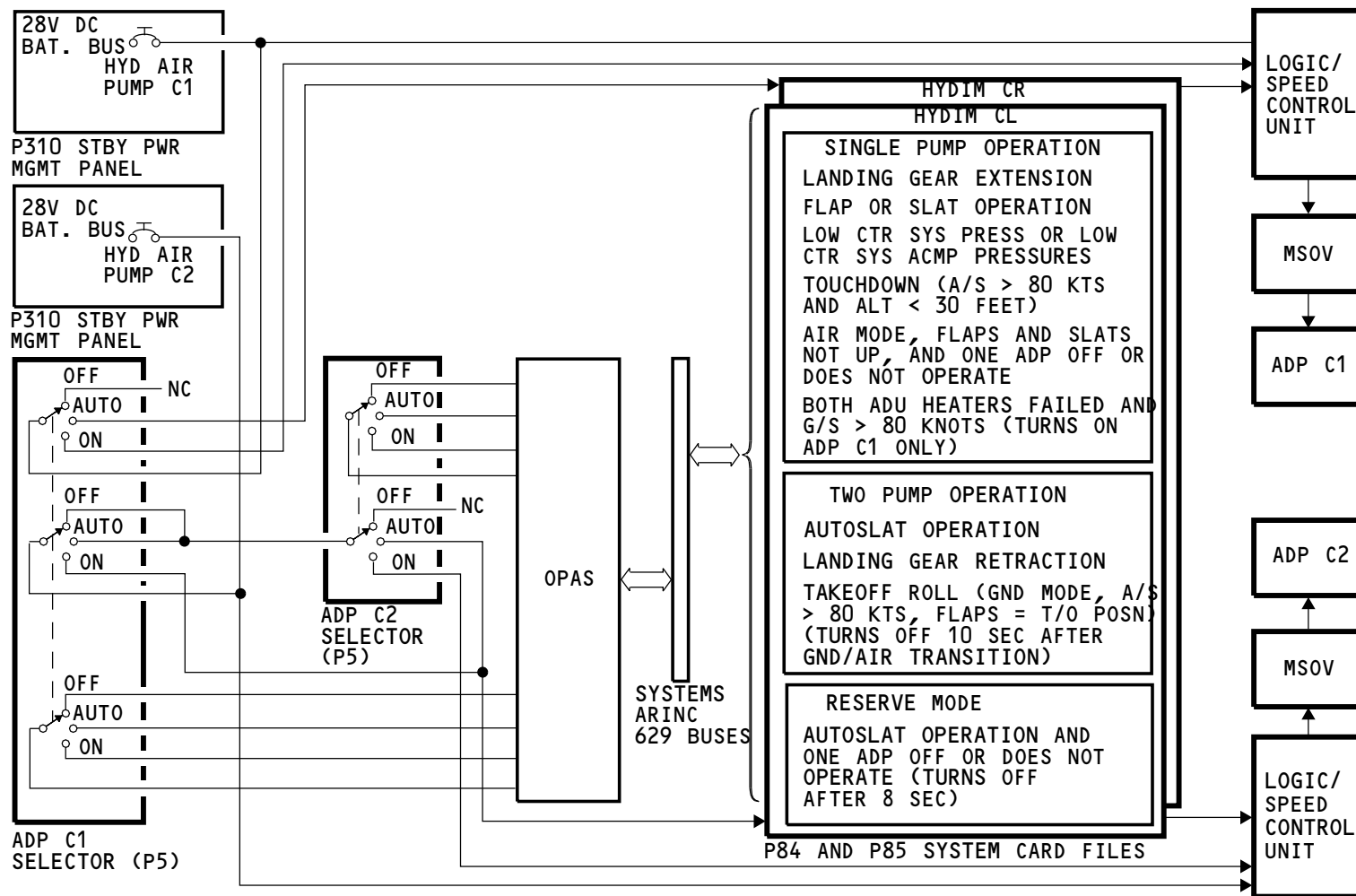
Continuous Operation

An ADP selector in the ON position sends a signal directly to the related LSCU. The LSCU then opens the MSOV to operate the ADP continuously.

Training Information Point

The ADP C1 selector must be in the OFF or AUTO position for ADP C2 to run continuously. If both ADP selectors are in the ON positions, only ADP C1 will operate.

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MAIN HYDRAULIC SYSTEMS - FUNCTIONAL DESCRIPTION - AIR DRIVEN PUMP

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**MAIN HYDRAULIC SYSTEMS - FUNCTIONAL DESCRIPTION - ALTERNATING CURRENT MOTOR PUMP****General**

The control switches and selectors on the hydraulic control panel send pump control signals to the overhead panel ARINC 629 system (OPAS). The OPAS sends these control signals through the left and right systems ARINC 629 buses to the ELMS.

The ELMS contains the logic and electrical relays that controls the ACMPs.

Power management panels and the power panels in the ELMS control electrical power to the ACMPs.

The wiring between the power management panels and the power panels goes through the control switches and selectors. This makes sure that pumps cannot operate when their switch or selector is in the OFF position.

Primary Pump Operation

Signals from the primary pump switches for the center system ACMPs go directly to the ELMS. The HYDIM cards do not control primary pump operation.

Demand Pump Operation

Signals from the demand pump selectors for the left and right system ACMPs go to the HYDIM cards and to the ELMS. When a selector is in the ON position, the signal goes directly to the ELMS. When a selector is in the AUTO position, HYDIM cards control the pump operation signal to the ELMS.

When the left demand pump selector is in AUTO, the left HYDIM card operates the left ACMP for any of these conditions:

- Left engine not running
- Touchdown - CAS is more than 60 kts and altitude is less than 30 feet (to prepare for auto speedbrake operation)
- Left EDP pressure less than 2400 psi (pump turns off 15 seconds after EDP pressure is more than 2800 psi).

When the right demand pump selector is in AUTO, the right HYDIM card operates the right ACMP for any of these conditions:

- Right engine not running
- Altitude is less than 30 feet (prepares for wheel brake and auto speedbrake operation)
- Right EDP pressure less than 2400 psi (pump turns off 15 seconds after EDP pressure is more than 2800 psi).

ELMS Operation

The ELMS computing and communications unit (CCU) in the power management panel gets the pump control signal from the pump switches or HYDIM cards. The computing and communications unit then sends a signal to the electrical load control unit (ELCU) in the power panel. If the switch or selector is in the OFF position, the ELCU does not get the signal. If the selector is in AUTO or ON or if the switch is in ON, the ELCU gets the signal and energizes a relay to supply electrical power to the ACMP.

The ELMS uses time delays of 1.125 seconds between ACMP starts to protect the electrical system from overload.

ELMS Load Shed

The ELMS sheds one or two of the ACMPs during some conditions.

On a single 90 kVA ground power source, the ELMS may shed ACMP C2. For this condition, the ELMS also may shed the left ACMP during engine start.

On a single 120 kVA airplane power source, the ELMS may shed ACMP C2 during fuel jettison when all ACMPs are ON.

Circuit Protection

Ground Fault Protection (GFP) for ACMP is integral to the Power Panel Controller (PPC). The PPC is in the P100 and P200 panels secured by two bolts, and a hand-turn center fastener.

GFP is protection from A to ground downstream from the contactor, and does not include either phase imbalance or overcurrent protection.

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**MAIN HYDRAULIC SYSTEMS - FUNCTIONAL DESCRIPTION - ALTERNATING CURRENT MOTOR PUMP**

ELMS shall trip open and latch contactor when the instantaneous sum of the three phase currents is greater than 8 +/- 1 amps RMS for more than 15 milliseconds.

ELMS shall clear a ground fault condition within 50 milliseconds of the occurrence of the fault (the 50 milliseconds include detection, confirmation, and contactor drop-out times).

For fault currents of 15 amps RMS or more, ELMS shall detect and clear a ground fault condition within 20 milliseconds of the occurrence of the fault (the 20 millisecond include detection, confirmation, and contactor drop-out times).

For fault currents of 100 amps RMS or more, ELMS shall detect faults of 1/2 cycle (400Hz).

The GFP shall not trip as a result of fault currents or transients up to 120 amps RMS and of duration less than or equal to 400 milliseconds.

P100 shall reset the hydraulic pump GFP function in response to a command from the P110 to reset the ACMP GFP trip.

The GFP trip shall not be resettable in-flight. Reset shall not occur as a result of cycling the command line or loss and restoration of aircraft power.

GFP function shall be included in the BIT. If GFP tests fails, a PPC fault shall be indicated.

GFP function shall be powered and enabled when other ELCF functions are enabled.

Electrical power hold up shall be sufficiently long to ensure detection, trip and latch out as a result of a ground fault, prior to loss of function, similar to the ELCF anti-cycling.

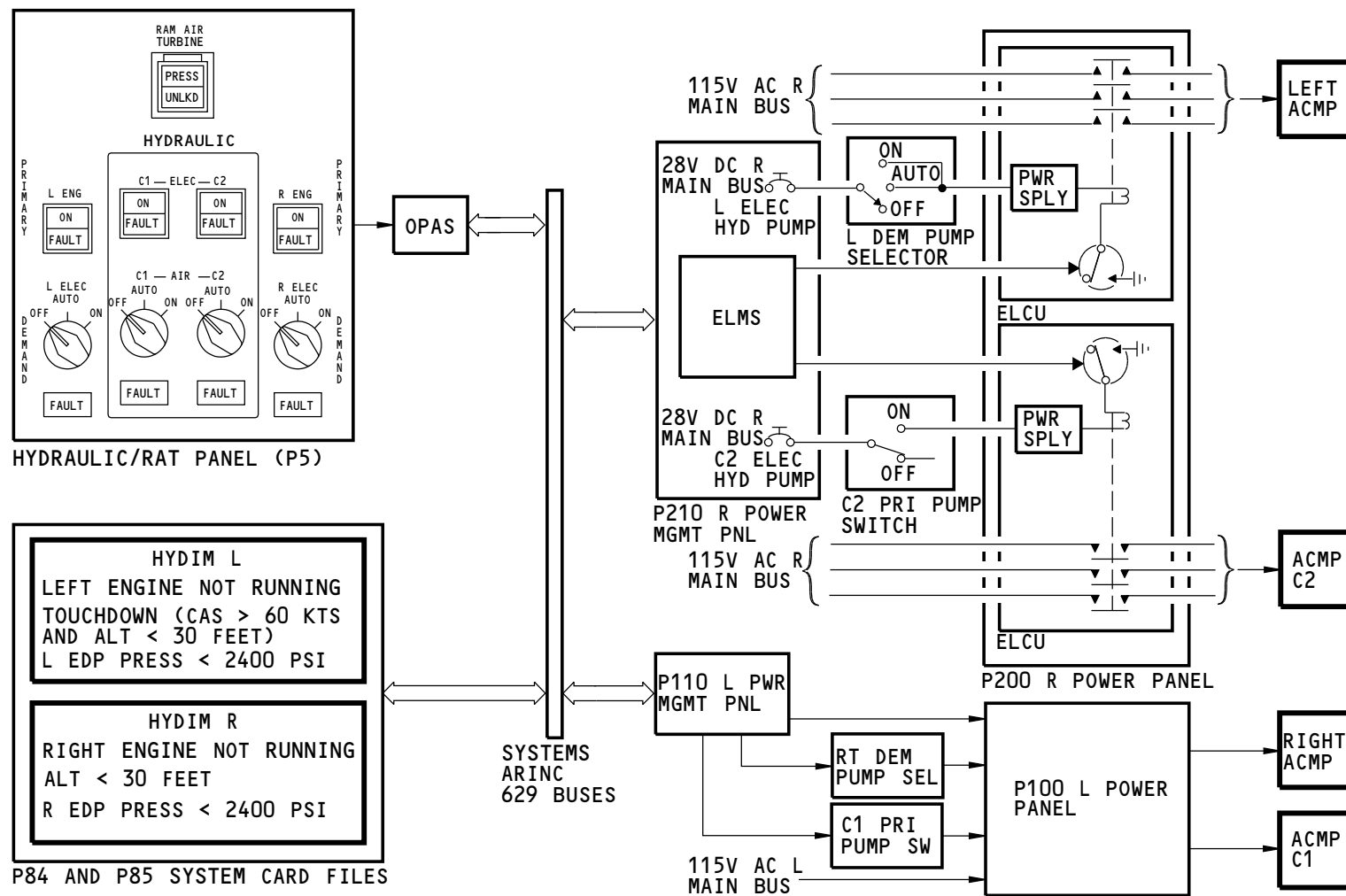
GFP detection shall not interfere with, reduce the reliability of, or be affected by other protective functions in the ELCF.

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MAIN HYDRAULIC SYSTEMS - FUNCTIONAL DESCRIPTION - ALTERNATING CURRENT MOTOR PUMP

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**MAIN HYDRAULIC SYSTEMS - LEFT AND RIGHT SYSTEMS - FUNCTIONAL DESCRIPTION****General**

The left and right hydraulic systems are functionally the same.

The left hydraulic system supplies pressurized hydraulic fluid to operate the left thrust reverser and the PFCS. The right hydraulic system supplies pressurized hydraulic fluid to operate the right thrust reverser, the PFCS, and the normal brake system.

Fluid Supply

The hydraulic system reservoirs contain the hydraulic fluid supply for the hydraulic pumps.

A reservoir pressurization module supplies pressurized air from the pneumatic system to pressurize the reservoir.

The reservoir supplies fluid to the EDP through a standpipe. The ACMP gets fluid from the bottom of the reservoir.

Pressurization

The EDPs are the primary pumps for the left and right hydraulic systems. The EDPs get reservoir fluid through the EDP supply shutoff valves.

The EDPs operate whenever the engines operate. A solenoid valve in each EDP controls the pressurization and depressurization of the pump.

The ACMPs are the demand pumps for the left and right hydraulic systems. The ACMPs normally operate only when there is high hydraulic system demand.

Filtration

Pressure and case drain filter modules clean the pressure flows and the case drain flows of the hydraulic pumps.

A return filter module cleans the return flow of hydraulic fluid from the user systems. The module can be bypassed if the filter clogs.

The heat exchanger cools the hydraulic fluid from ACMP and EDP case drain lines before the fluid goes back to the reservoir.

Hydraulic System Sensors

The hydraulic system sensors send pressure, temperature, and quantity signals to the HYDIM cards.

A reservoir quantity transmitter and temperature transducer are on each of the reservoirs. A hydraulic reservoir pressure switch is on the pneumatic line between the reservoir pressurization module and the reservoir.

The ACMP and EDP filter modules each have a pressure transducer to measure pump output pressure. A temperature transducer in the case drain line of each filter module measures pump case drain fluid temperature.

A system pressure transducer measures hydraulic system pressure.

See the hydraulic pressure indicating section for more information (29-30-00-004).

Each ACMP has a temperature switch that is a part of the pump. The temperature switch closes to indicate a pump overheat condition.

The ACMP temperature switch is wired in parallel with the ACMP case drain temperature transducer. When the temperature switch closes, it simulates a high temperature signal by connecting a fixed resistance to the ACMP temperature transducer input on the HYDIM card.

See the hydraulic temperature indicating section for more information (29-30-00-005).

Pressure Relief

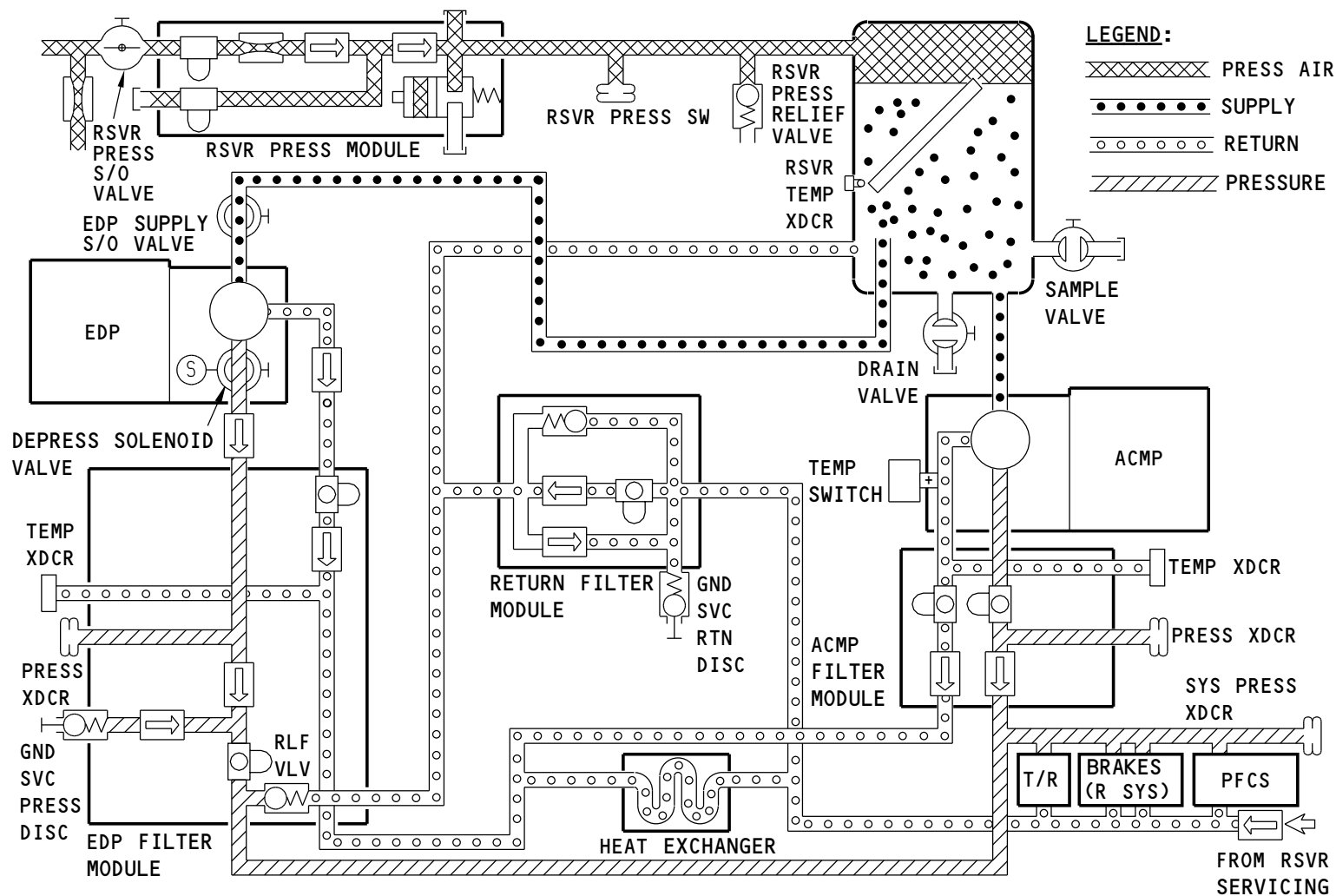
A pressure relief valve on the EDP filter module protects the system against overpressurization.

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MAIN HYDRAULIC SYSTEMS - LEFT AND RIGHT SYSTEMS - FUNCTIONAL DESCRIPTION

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MAIN HYDRAULIC SYSTEMS - CENTER SYSTEM - FUNCTIONAL DESCRIPTION

General

The center hydraulic system supplies pressurized hydraulic fluid to operate these systems:

- Nose landing gear actuation
- Nose landing gear steering
- Alternate brakes
- Main landing gear actuation
- Main landing gear steering
- Trailing edge flaps
- Leading edge slats
- PFCS.

Fluid Supply

The center system reservoir contains the hydraulic fluid supply for the center system hydraulic pumps.

A reservoir pressurization module supplies pressurized air from the pneumatic system to pressurize the reservoir.

The reservoir supplies fluid to the ADPs, the RAT, and one of the ACMPs through a standpipe. The other ACMP gets fluid from the bottom of the reservoir.

The reservoir also supplies hydraulic fluid to the landing gear alternate extension system.

Pressurization

The ACMPs are the primary pumps in the center hydraulic system and are normally on.

The ADPs are the demand pumps in the center system. They normally operate only when the center system needs more hydraulic flow capacity.

The ram air turbine system supplies an emergency source of hydraulic power to the center hydraulic system flight controls.

Filtration

Filter modules clean the pressure and case drain output of the hydraulic pumps.

A return filter module cleans the return flow of hydraulic fluid from the user systems. The module can be bypassed.

The heat exchanger cools the hydraulic fluid from the ACMP case drains before the fluid goes back to the reservoir. ADP case drain fluid does not go through the heat exchangers.

Hydraulic System Sensors

A reservoir quantity transmitter and temperature transducer are on the reservoir. A hydraulic reservoir pressure switch is on the pneumatic line between the reservoir and the reservoir pressurization module.

The ACMP and ADP filter modules each have a pressure transducer to measure pump output pressure. A temperature transducer in each filter module measures pump case drain temperature.

A system pressure transducer measures hydraulic system pressure.

See the hydraulic pressure indicating section for more information (29-30-00-004).

Each ACMP has a temperature switch that is a part of the pump. The temperature switch closes to indicate a pump overheat condition.

The ACMP temperature switch is wired in parallel with the ACMP case drain temperature transducer. When the temperature switch closes, it simulates a high temperature signal by connecting a fixed resistance to the ACMP temperature transducer input on the HYDIM card.

See the hydraulic temperature indicating section for more information (29-30-00-005).

Pressure Relief

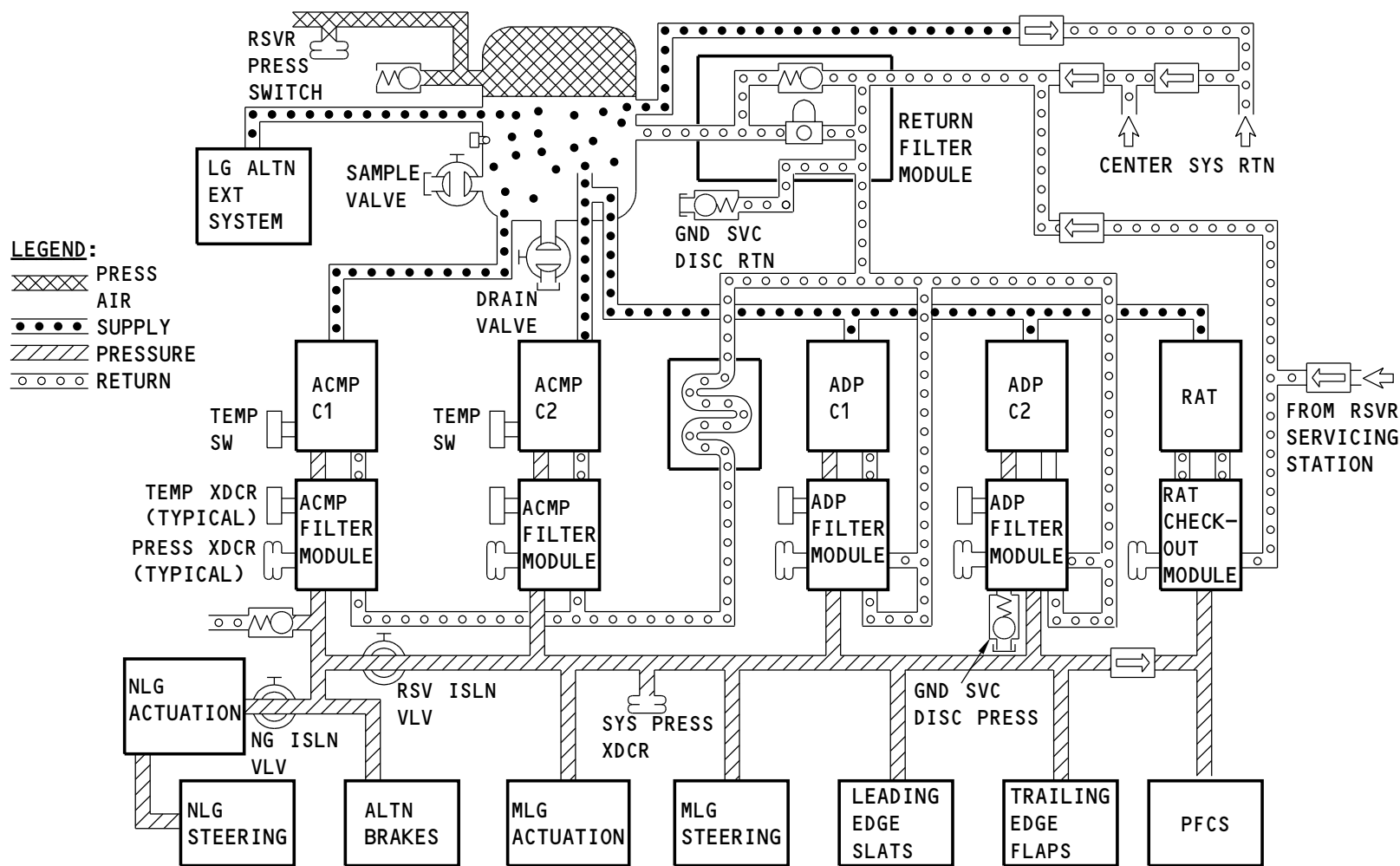
Pressure relief valves in each ADP filter module prevent system overpressurization. A pressure relief valve near ACMP C1 supplies overpressure protection for the CHIS.

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MAIN HYDRAULIC SYSTEMS - CENTER SYSTEM - FUNCTIONAL DESCRIPTION

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**MAIN HYDRAULIC SYSTEMS - CENTER HYDRAULIC ISOLATION SYSTEM - FUNCTIONAL DESCRIPTION****General**

The center hydraulic isolation system (CHIS) supplies engine burst protection and a reserve brakes and steering function.

The HYDIM CL card, in the left systems card file, automatically controls CHIS operation through relays in the ELMS. The relays control the electric motors in the reserve and nose gear isolation valves.

HYDIM CL also sends a signal to the FSEUs to prevent hydraulic operation of the leading edge slats.

Hydraulic Supply

ACMP C1 gets hydraulic fluid from the bottom of the center system reservoir. All other hydraulic pumps in the center system get fluid through a standpipe in the reservoir. This gives ACMP C1 a 1.2 gallon (4.5 liter) reserve supply of hydraulic fluid.

Isolation

The reserve and nose gear isolation valves are normally open.

Both valves close if the quantity in the center system reservoir is low (less than 0.40) and the airspeed is more than 60 knots for more than one second. The HYDIM CL card also sends a signal to the FSEUs. The FSEUs do not send commands to the leading edge slats primary control valve (PCV) for this condition. This prevents hydraulic operation of the slats.

When CHIS is active, this divides the center hydraulic system into different parts. The NLG actuation and steering, and the leading edge slat hydraulic lines are isolated from center system pressure.

The output of ACMP C1 goes only to the alternate brake system.

The output of the other center hydraulic system pumps goes to the trailing edge flaps, the MLG actuation and steering and the PFCS.

If there is a leak in the NLG actuation and steering or LE slat lines, there is no further loss of hydraulic fluid. The alternate brakes, the trailing edge flaps, the MLG actuation and steering, and the PFCS continue to operate normally.

If there is a leak in the trailing edge flaps, the MLG actuation and steering, or the PFCS lines, the reservoir loses fluid down to the standpipe level (0.00 indication). This causes a loss of these systems. But, the alternate brake system continues to get hydraulic power from ACMP C1.

If there is a leak in the lines between ACMP C1 and the alternate brake system, all center hydraulic system fluid is lost.

Nose Gear Isolation Valve

The HYDIM CL reopens the nose gear isolation valve for any of these conditions:

- Airspeed is less than 60 knots
- Pump pressures for ACMP C2, ADP C1, ADP C2, and the RAT is less than 1200 psi for 30 seconds
- Left and right engine RPM is above idle, left and right EDP pressure is more than 2400 psi, and (the NLG is not up, the NLG doors are not closed, or the landing gear lever is not up) for 30 seconds.

The first condition permits the flight crew to operate the NLG steering when airspeed is less than 60 kts (decreased rudder control authority during taxi).

The second condition permits operation of the NLG actuation and steering if the hydraulic leak is in the part of the center hydraulic system isolated by the reserve isolation valve.

The third condition permits operation of the NLG actuation and steering if there has not been an engine burst and the other hydraulic systems are pressurized. The nose gear isolation valve opens when pressure is necessary at the NLG. If the NLG is not fully retracted or the NLG doors are not closed, the nose gear isolation valve opens to let the NLG complete the retraction. When the landing gear lever is moved to the DOWN position, the nose gear isolation valve opens to let the NLG extend with center system pressure.

CHIS Reset

Both valves open again automatically when the center system quantity is more than 0.70 and airspeed is less than 60 knots for five seconds.

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**MAIN HYDRAULIC SYSTEMS - CENTER HYDRAULIC ISOLATION SYSTEM - FUNCTIONAL DESCRIPTION**

Both valves also reset when the center system quantity is more than 0.70 and both engines and both engine driven pumps operate normally for 30 seconds.

Indications

The positions of the nose gear isolation valve and the reserve isolation valve show on the hydraulic synoptic display and the hydraulic maintenance page.

The RESERVE BRAKES/STRG advisory message tells the flight crew that brakes or steering may not be available. This message shows for any of these conditions:

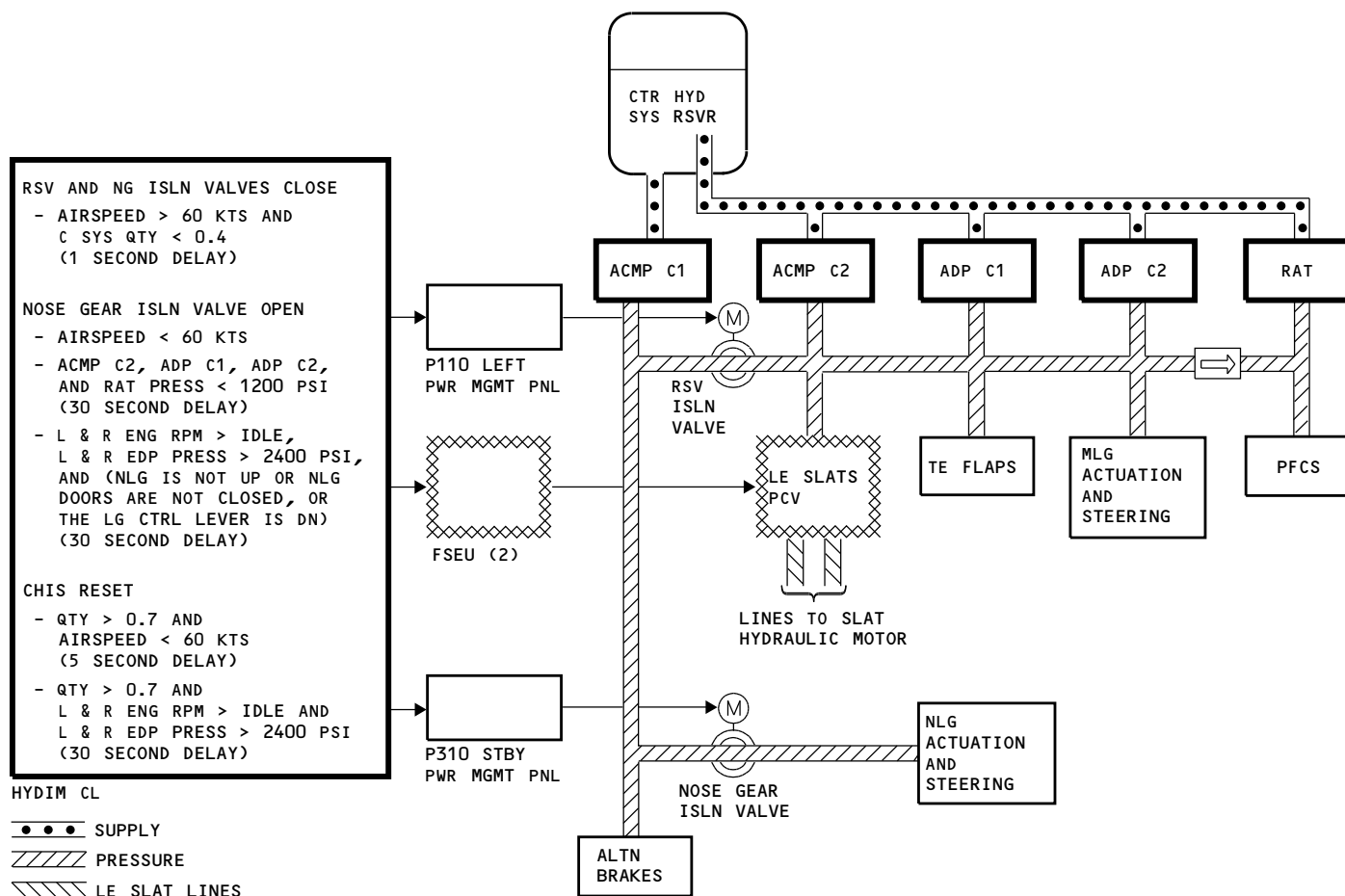
- The center system is isolated and ACMP C1 pressure is less than 1200 psi
- The center system is isolated and the center system pressure is more than 1200 psi
- The reserve isolation valve is not open and ACMP C1 pressure is less than 1200 psi
- The nose gear isolation valve is not open and there is no command to isolate the center system.

The HYD ISLN VALVE status message shows if one or two isolation valves are not in the commanded position.

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MAIN HYDRAULIC SYSTEMS - CENTER HYDRAULIC ISOLATION SYSTEM - FUNCTIONAL DESCRIPTION

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MAIN HYDRAULIC SYSTEMS - TRAINING INFORMATION POINTS - GROUND SERVICING SYSTEM

General

A central fill station in the ground service bay permits you to fill the three hydraulic reservoirs from a single location.

Components

Hydraulic servicing components include:

- Manual pump handle
- Manual pump suction hose
- Pressure fill connection
- Reservoir fill manual pump
- Reservoir fill filter
- Reservoir fill quantity gage
- Reservoir fill selector valve
- Instruction placard.

You set the four-position fill selector valve to send hydraulic fluid to one of the three hydraulic systems. The valve is set to OFF after servicing.

The reservoir fill quantity gage shows the reservoir quantity of the selected hydraulic system.

The reservoir fill filter cleans the fluid that goes into the hydraulic systems.

The reservoir fill manual pump permits you to fill the hydraulic systems manually.

The pressure fill connection permits the connection of a ground service cart to fill the hydraulic systems. A cap covers the connection when not in use.

You use the manual pump suction hose during manual fill operation. One end of the hose connects to the manual pump. The other end of the hose goes in the hydraulic fluid container. When not in use, you put the end of the suction hose in a protective cover.

You use the manual pump handle to operate the manual pump. You put the pump handle next to the suction hose when not in use.

Training Information Point

To get the correct results when you do a check of the hydraulic fluid quantities or fill the reservoirs, the airplane should be in this condition:

- Spoilers retracted
- Landing gear down
- Landing gear doors closed
- Thrust reversers retracted
- Parking brake accumulator pressure at least 2500 psi.



WARNING

DO NOT GET HYDRAULIC FLUID IN YOUR EYES OR ON YOUR SKIN. THE HYDRAULIC FLUID CAN CAUSE INJURY TO PERSONS. IF YOU GET THE HYDRAULIC FLUID ON YOUR SKIN, FLUSH YOUR SKIN WITH WATER. IF YOU GET THE HYDRAULIC FLUID IN YOUR EYES, FLUSH YOUR EYES WITH WATER AND GET MEDICAL AID. IF YOU GET THE HYDRAULIC FLUID IN YOUR MOUTH, GET MEDICAL AID.



CAUTION

USE CLEAN HYDRAULIC FLUID AND CLEAN EQUIPMENT TO FILL THE HYDRAULIC SYSTEM RESERVOIR. IF YOU DO NOT DO THIS YOU CAN CAUSE CONTAMINATION OF THE HYDRAULIC SYSTEM.



CAUTION

DO NOT OPERATE THE PUMP WHILE THE HANDLE OF THE RESERVOIR FILL SELECTOR VALVE IS IN THE OFF POSITION. THIS CAN CAUSE TOO MUCH PRESSURE IN THE RESERVOIR FILL SYSTEM AND CAN CAUSE DAMAGE TO AIRPLANE EQUIPMENT.

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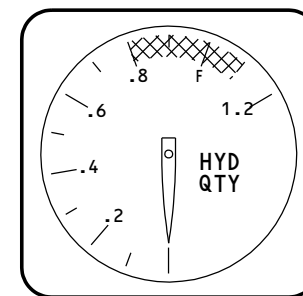
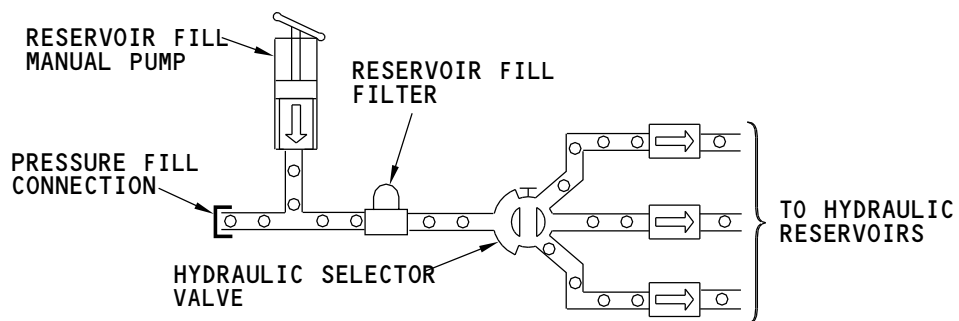
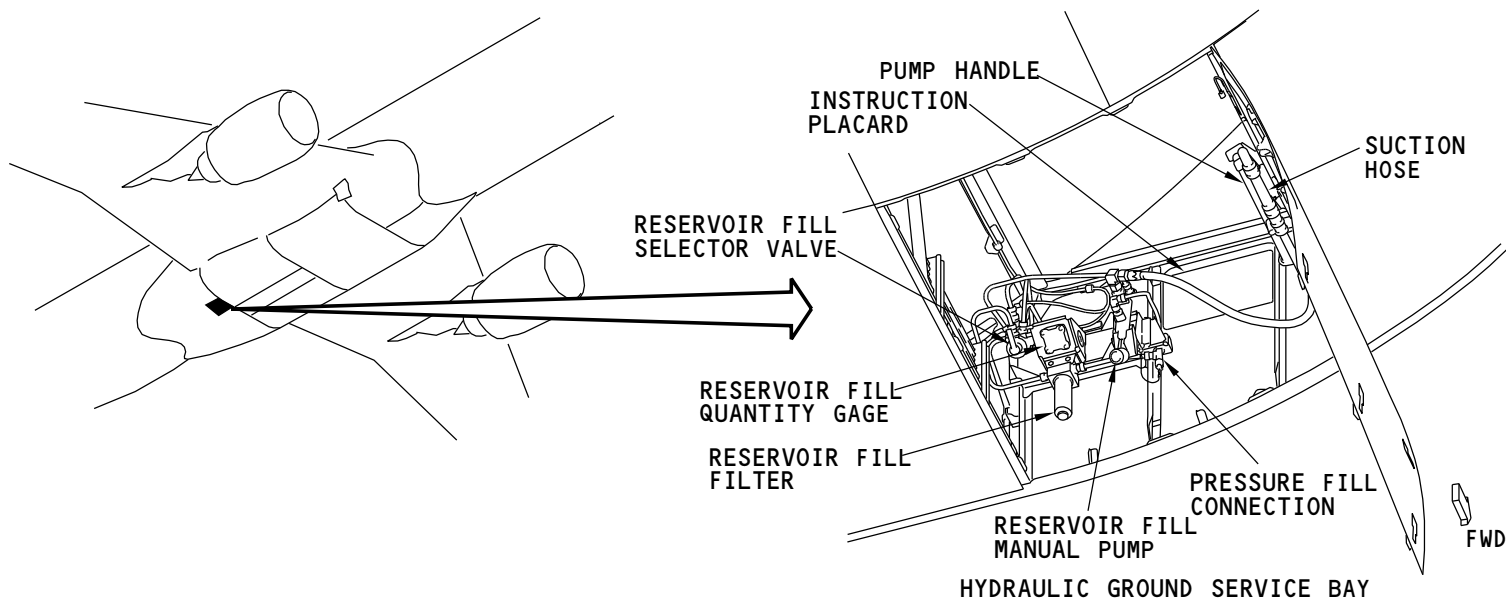
MAIN HYDRAULIC SYSTEMS - TRAINING INFORMATION POINTS - GROUND SERVICING SYSTEM

**CAUTION**

DO NOT FILL THE RESERVOIR TO MORE THAN THE FULL LEVEL. IF YOU PUT TOO MUCH FLUID IN THE RESERVOIR AND THERE IS A CHECK VALVE FAILURE, THE FLUID CAN GO INTO THE DUCTS OF THE PNEUMATIC SYSTEM AND THE AIR CONDITIONING PACKS. IF CONTAMINATION OF THE PNEUMATIC SYSTEM OCCURS MANY TIMES, IT CAN CAUSE DAMAGE TO THE TITANIUM DUCTS. IF YOU PUT TOO MUCH FLUID IN THE RESERVOIR, THE FLUID CAN FLOW OUT OF THE RESERVOIR VENT TUBE, THROUGH THE PRESSURE RELIEF VALVE.

**CAUTION**

USE A MAXIMUM OF 150 PSI WHEN YOU FILL THE RESERVOIR. TOO MUCH PRESSURE CAN CAUSE DAMAGE TO THE HYDRAULIC RESERVOIR.



RESERVOIR FILL QTY GAGE

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MAIN HYDRAULIC SYSTEMS - TRAINING INFORMATION POINTS - GROUND SERVICING SYSTEM

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RAM AIR TURBINE SYSTEM - INTRODUCTION

General

The ram air turbine (RAT) supplies an emergency source of hydraulic power to operate the flight controls. The RAT also is an emergency source of electrical power.

The RAT extends automatically in flight with a loss of hydraulic pressure in the three hydraulic systems. You can manually extend the RAT from the flight deck.

Control of RAT retraction is from the right wheel well.

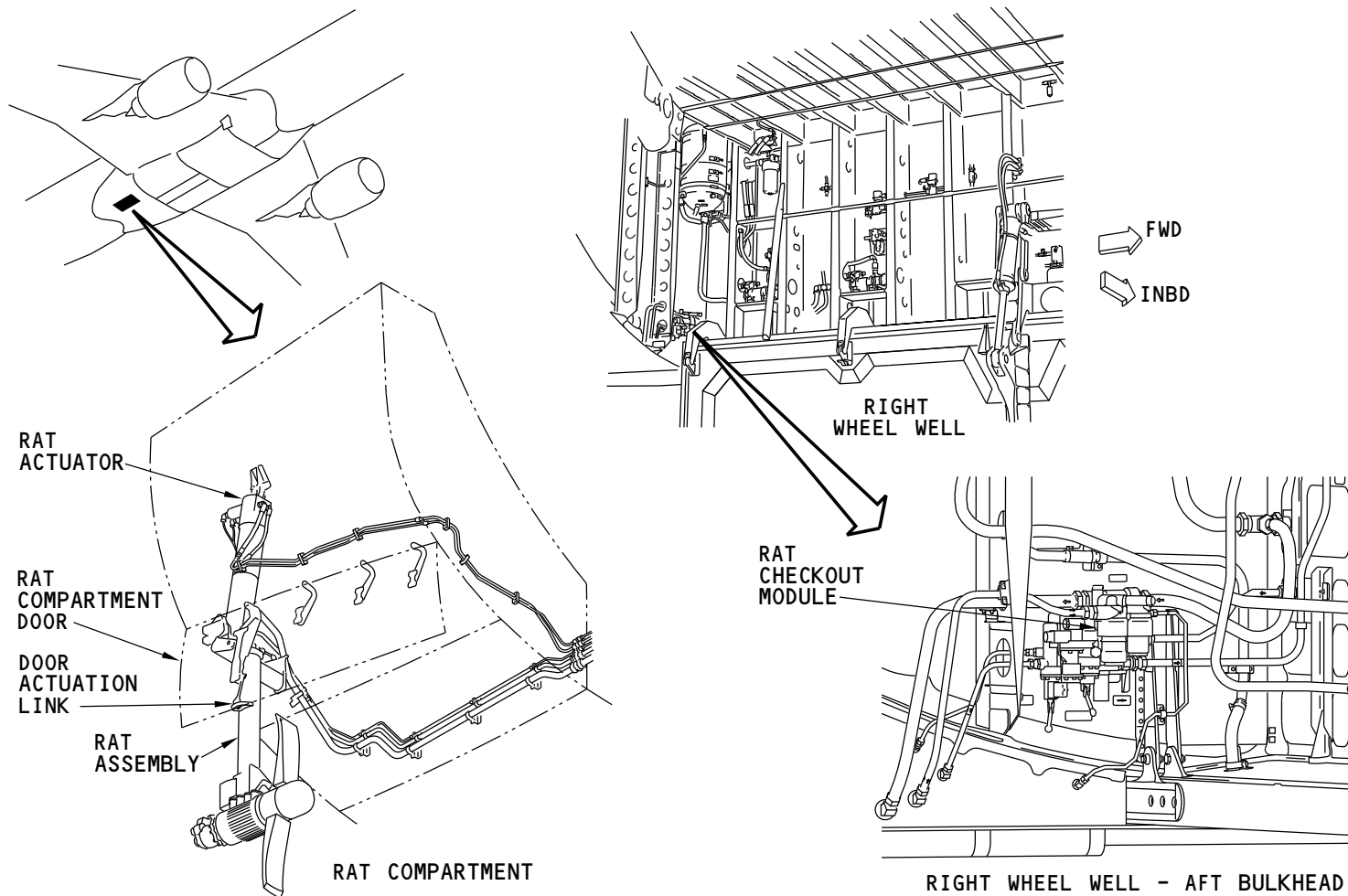
Components

These are the components of the ram air turbine system:

- RAT assembly
- RAT actuator
- RAT compartment door and actuation link
- RAT stowed switch (not shown)
- RAT checkout module.

Most RAT components are in the RAT compartment behind the right wheel well. The RAT checkout module is in the right wheel well.

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RAM AIR TURBINE SYSTEM - INTRODUCTION

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**RAM AIR TURBINE SYSTEM - GENERAL DESCRIPTION****General**

The HYDIM cards or the ELMS control the automatic operation of the RAT.

The RAT manual switch permits manual RAT extension. Indication lights on the RAT manual switch show RAT pressure indication and RAT unlocked condition.

HYDIM Control

The two center HYDIM cards get these inputs to control automatic RAT extension:

- Airspeed (ADIRU through the AIMS)
- Groundspeed (ADIRU through the AIMS)
- Air/ground condition (WOW cards)
- Engines above idle (EDIUs)
- Hydraulic system pressures (HYDIM).

RAT Power Output

The RAT hydraulic pump supplies hydraulic power for some of the center hydraulic system flight controls.

The RAT generator supplies electrical power to the P310 standby power management panel in the ELMS. See the standby power section for more information about the RAT generator (SECTION 24-33).

Indications

The AIMS gets RAT position and pressure data for flight deck indication and fault detection.

RAT pressure indication shows on the hydraulic synoptic display, the hydraulic maintenance page, and the pressure light on the RAT manual switch.

The ELMS calculates RAT speed from the RAT generator frequency. RAT speed shows on the hydraulic maintenance page.

RAT Generator Heater System

A RAT generator heater system keeps moisture from freezing inside the RAT generator. Ice inside the generator could stop RAT spin-up if the RAT is deployed at low airspeeds.

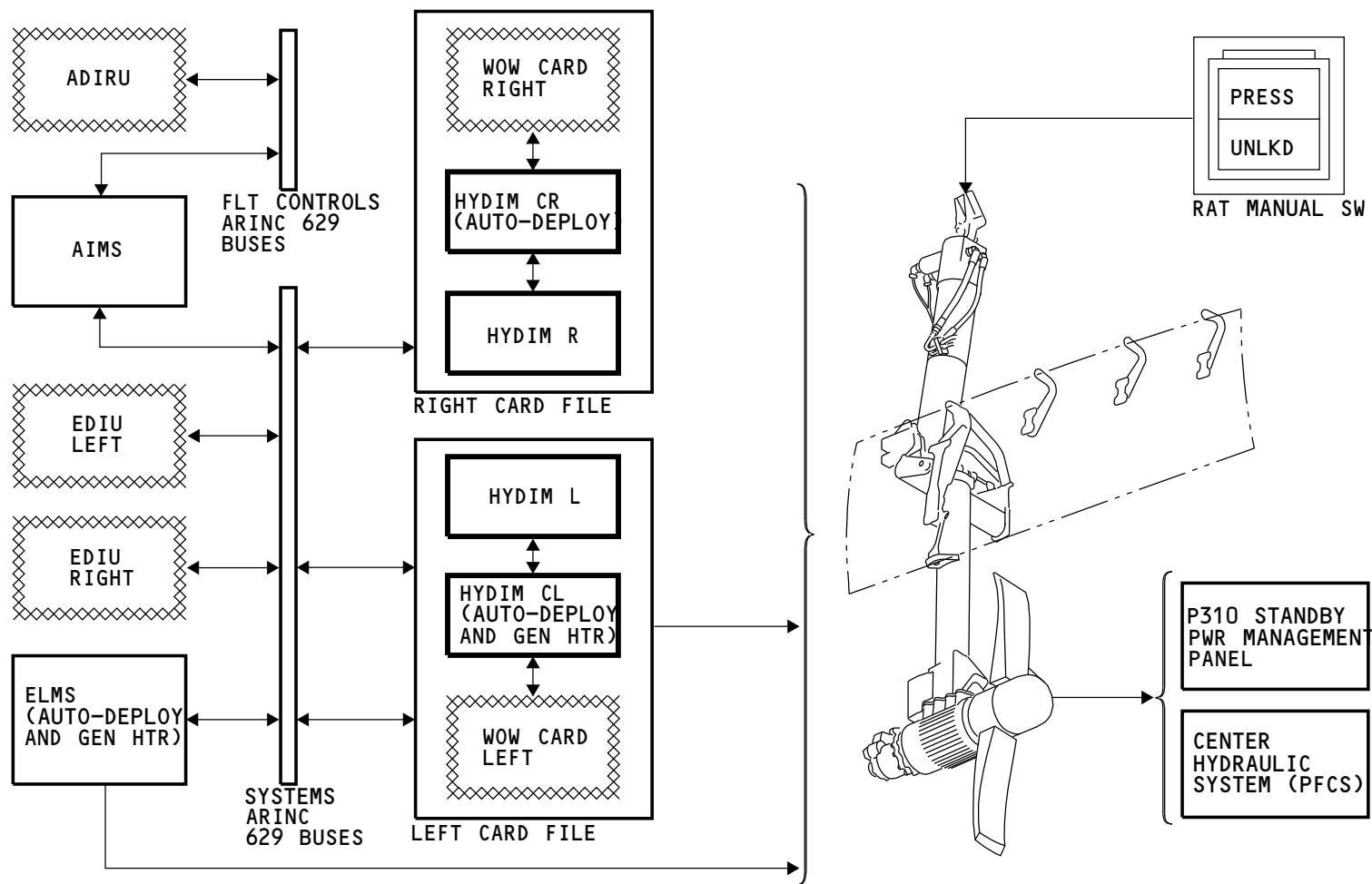
HYDIM controls the RAT generator heater system. The ELMS supplies the electrical power to operate the heaters.

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RAM AIR TURBINE SYSTEM - GENERAL DESCRIPTION

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RAM AIR TURBINE SYSTEM - RAT ASSEMBLY

General

These components are part of the RAT assembly:

- RAT governor-generator assembly
- RAT hydraulic pump
- RAT strut
- RAT blade lock pin
- RAT blade locked switch
- RAT strut angle switch.

RAT Governor-Generator Assembly

The RAT governor-generator assembly has these components:

- Turbine
- Flyweight governor
- Electric generator.

A two-bladed variable pitch turbine turns the shaft of the generator and the pump. Turbine blade diameter is approximately 41.5 inches (105 cm).

The flyweight governor is inside the turbine hub. It controls turbine blade pitch to control turbine speed. Governed speed is approximately 4510 rpm.

The generator is a 115v ac, 3-phase generator rated at 7.5 KVA. A RAT generator heater system keeps ice out of the generator. See the standby power section for more information about the RAT generator (SECTION 24-33).

RAT Hydraulic Pump

The RAT hydraulic pump is a two-stage pressure-compensated pump. It attaches to the aft face of the governor-generator assembly.

The pump flow rate is 10 gpm at 2850 psi.

RAT Strut

The trunnion mounted strut assembly attaches the governor-generator and hydraulic pump to the airplane. Electric and hydraulic lines are in the strut.

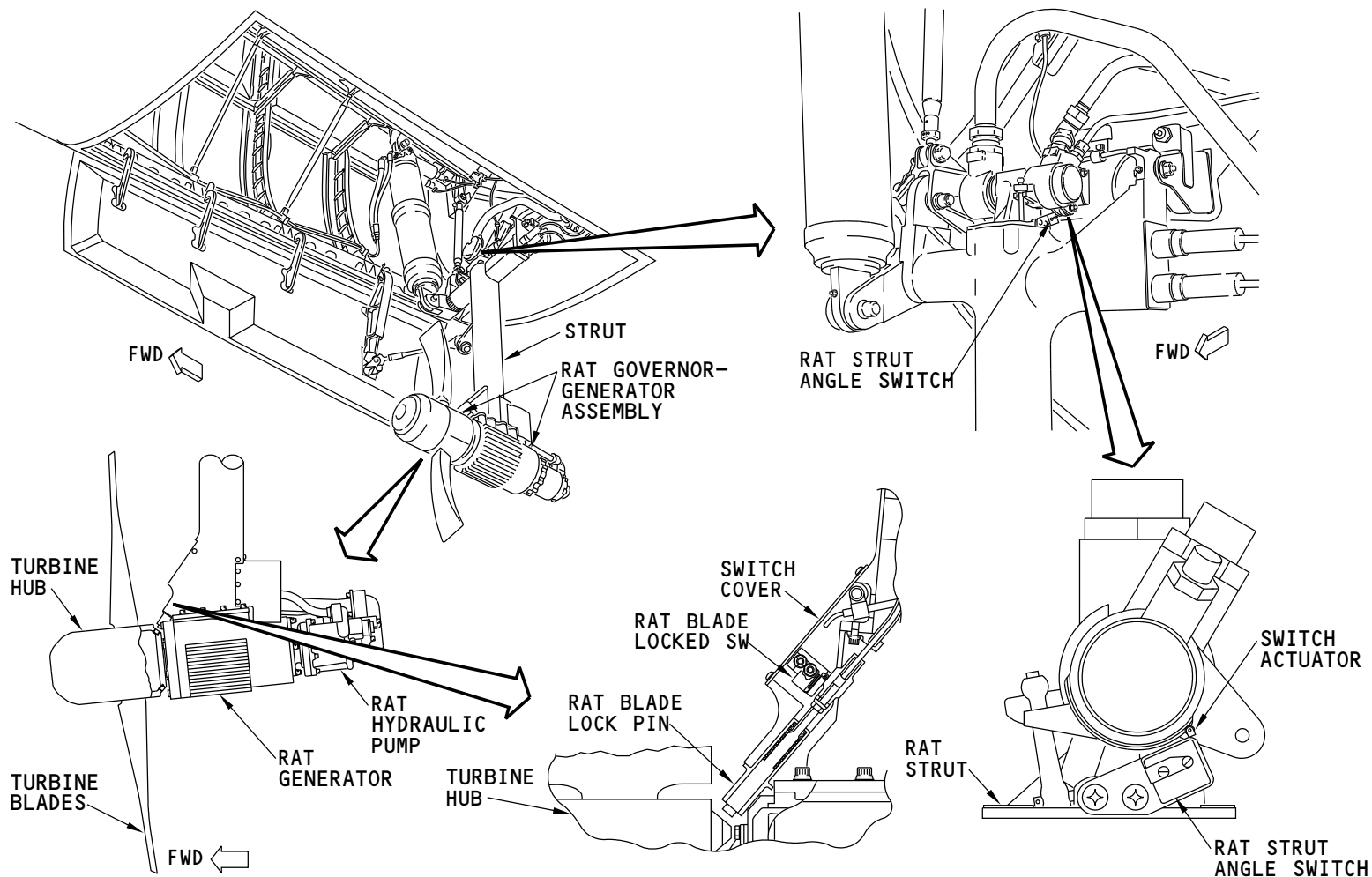
RAT Blade Lock Pin and Blade Locked Switch

The RAT blade lock pin behind the turbine locks the turbine blades in a vertical position when the RAT is more than 9 degrees from the extended position. This keeps the blades from turning until they are clear of the structure of the airplane. It also keeps the blades from causing damage to the airplane during retraction.

The RAT blade locked switch closes when the blade lock pin locks the turbine. This switch keeps the RAT from retracting more than 15 degrees unless the blades are locked by the blade index pin.

RAT Strut Angle Switch

The RAT strut angle switch at the top of the RAT strut permits initial RAT retraction. The switch is closed between 0 and 15 degrees of the RAT extended position. It opens when the RAT is 15 degrees from the extended position to change retraction control to the RAT blade locked switch.



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RAM AIR TURBINE SYSTEM - RAT ASSEMBLY

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**RAM AIR TURBINE SYSTEM - RAT ACTUATOR AND STOWED SWITCH****Purpose**

The RAT actuator extends and retracts the ram air turbine assembly.

The RAT stowed switch gets RAT stowed position input for flight deck indication.

Physical Description

The RAT actuator is a spring-loaded hydraulic actuator. An internal spring extends the RAT. Hydraulic pressure retracts the RAT.

An internal mechanical lock keeps the actuator in the retracted position.

Two solenoids on the actuator unlock the actuator to extend the RAT.

Location

The RAT actuator and RAT stowed switch are in the RAT compartment aft of the right wheel well.

Functional Description

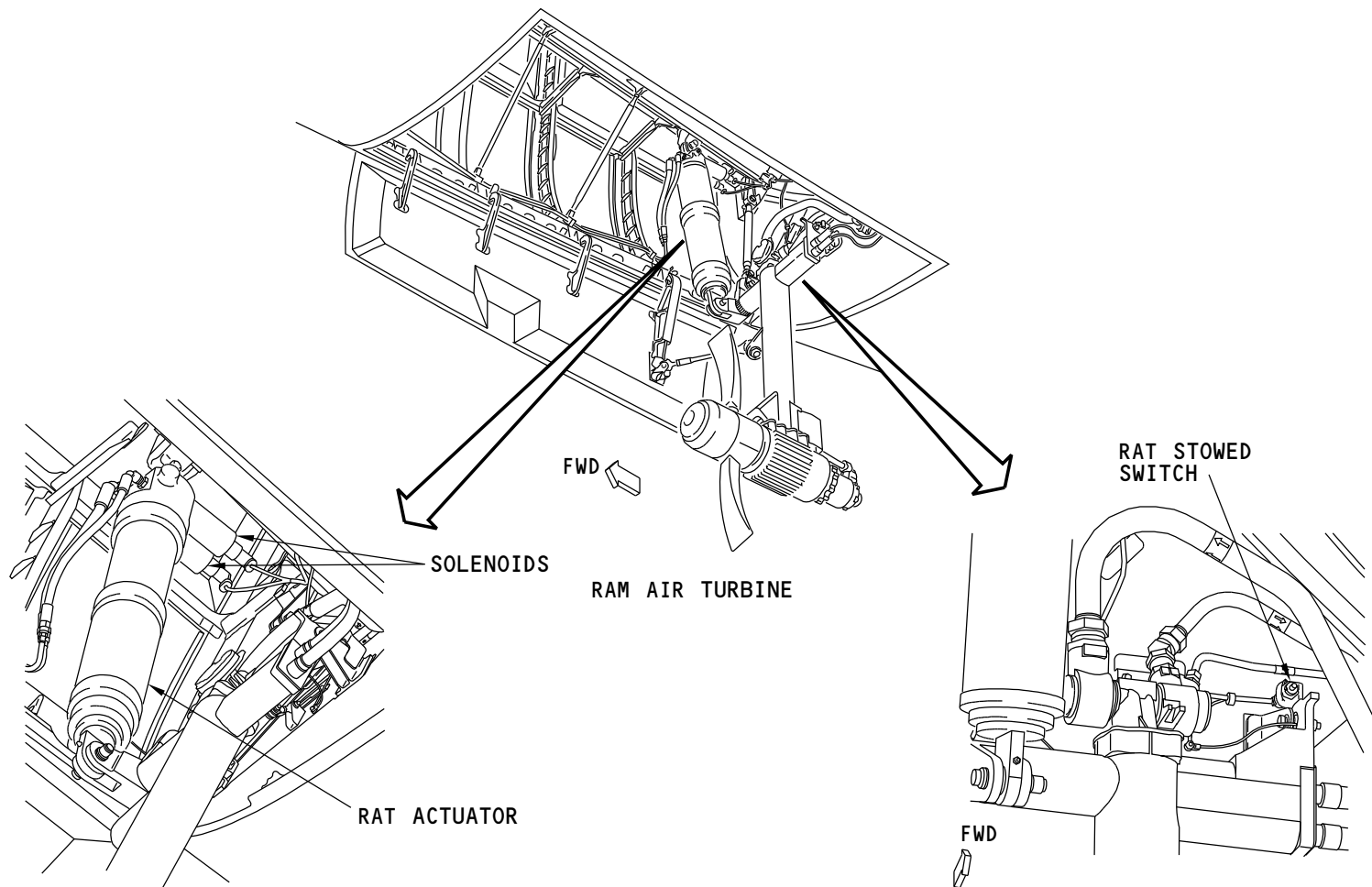
To extend the RAT, one or both solenoids are energized by a signal from any of these:

- HYDIM cards
- ELMS
- RAT manual switch.

This unlocks the actuator and the internal spring extends the RAT.

To retract the RAT, center system hydraulic pressure goes to the retract side of the RAT actuator. The RAT retracts and the internal lock keeps the actuator in the retracted position.

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RAM AIR TURBINE SYSTEM - RAT ACTUATOR AND STOWED SWITCH

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RAM AIR TURBINE SYSTEM - RAT CHECKOUT MODULE - INTRODUCTION

Purpose

The RAT checkout module controls the flow of hydraulic fluid to and from the RAT pump during RAT operation and during ground operational tests.

The RAT checkout module also controls the hydraulic flow to and from the RAT actuator during the RAT retraction.

Location

The RAT checkout module is on the aft bulkhead of the right wheel well. You access the RAT checkout module on the ground with the main landing gear doors open.

Physical Description

Eight hydraulic tubes of different sizes and locations connect to the RAT checkout module. Three of these are the center hydraulic system supply, pressure and return lines. Three hydraulic lines connect the RAT checkout module to the RAT pump for pump supply, pressure and case drain. Two hydraulic lines connect the RAT checkout module to the RAT actuator for RAT retraction and extension.

Two electrical connectors connect to the RAT checkout module. One connector is for the RAT pressure transducer and the other for the RAT stow valve switch and RAT module solenoid valve.

The RAT checkout module components visible from outside the module (some of which are LRUs) are these:

- Pressure transducer (LRU)
- Pressure and case drain filters (LRUs)
- Start-up quantity bypass fuse (LRU)
- RAT module solenoid valve (LRU)
- RAT stow valve
- RAT motoring valve.

Pressure Transducer

The pressure transducer measures the RAT pump output pressure and sends the data to a HYDIM card.

Pressure and Case Drain Filters

The two filters clean the RAT case drain and pressure hydraulic flow from the RAT pump. The filters are different sizes and replaceable cartridge type.

Start-up Quantity Bypass Fuse

The start-up quantity bypass fuse lets some hydraulic fluid from the RAT pump go to the system return during RAT start-up. This keeps the RAT unloaded during start-up to permit a faster RAT spin-up.

RAT Module Solenoid Valve

The RAT module solenoid valve controls hydraulic system pressure to the stow valve during retraction of the RAT actuator. The valve permits the RAT to fully retract only when the turbine blades are locked.

RAT Stow Valve

The RAT stow valve is a manually operated valve which has three positions:

- STOW
- STOP
- FLIGHT.

A manual lever controls the valve position. The RAT stow valve controls center hydraulic system pressure to the RAT actuator during RAT retraction.

To operate the RAT stow valve, it is first necessary to remove the lever lockwire. You pull on the lever T-handle and move the lever up to unlock the lever from the FLIGHT position. You can then move the lever fully up, with the T-handle released, to the STOW position to retract the RAT.

To stop the RAT retraction, you move the lever down, with the T-handle released, until the lever lock touches the stop. In the STOP position the RAT stow valve stops the hydraulic flow to retract the actuator.

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RAM AIR TURBINE SYSTEM - RAT CHECKOUT MODULE - INTRODUCTION

When the RAT retraction is complete, you move the lever fully down, with the T-handle pulled, to the FLIGHT position and release the T-handle to lock the lever. You then install a lockwire on the lever. In the FLIGHT position, the valve connects both sides of the RAT actuator to the center hydraulic system return to permit extension.

The RAT stow valve has a switch that monitors the position of the valve.

RAT Motoring Valve

The RAT motoring valve is a manually operated valve which has two-positions:

- FLIGHT
- MOTOR.

The valve permits center hydraulic system pressure to backdrive the RAT during ground operational tests.

To operate the RAT motoring valve it is first necessary to remove the lever lockwire. You then turn the lever handle 90 degrees counterclockwise so when you move the lever up, the lever tab slides between the fork on the RAT checkout module. When the lever is fully up, the valve is in the MOTOR position and permits hydraulic flow to the RAT pump.

When the RAT motoring is complete, you move the lever fully down to the FLIGHT position and release the handle. The handle internal spring turns the handle. It is then necessary to install a lockwire on the lever.

Training Information Point

The RAT extension time is approximately two seconds. The RAT retraction time is approximately 45 seconds.

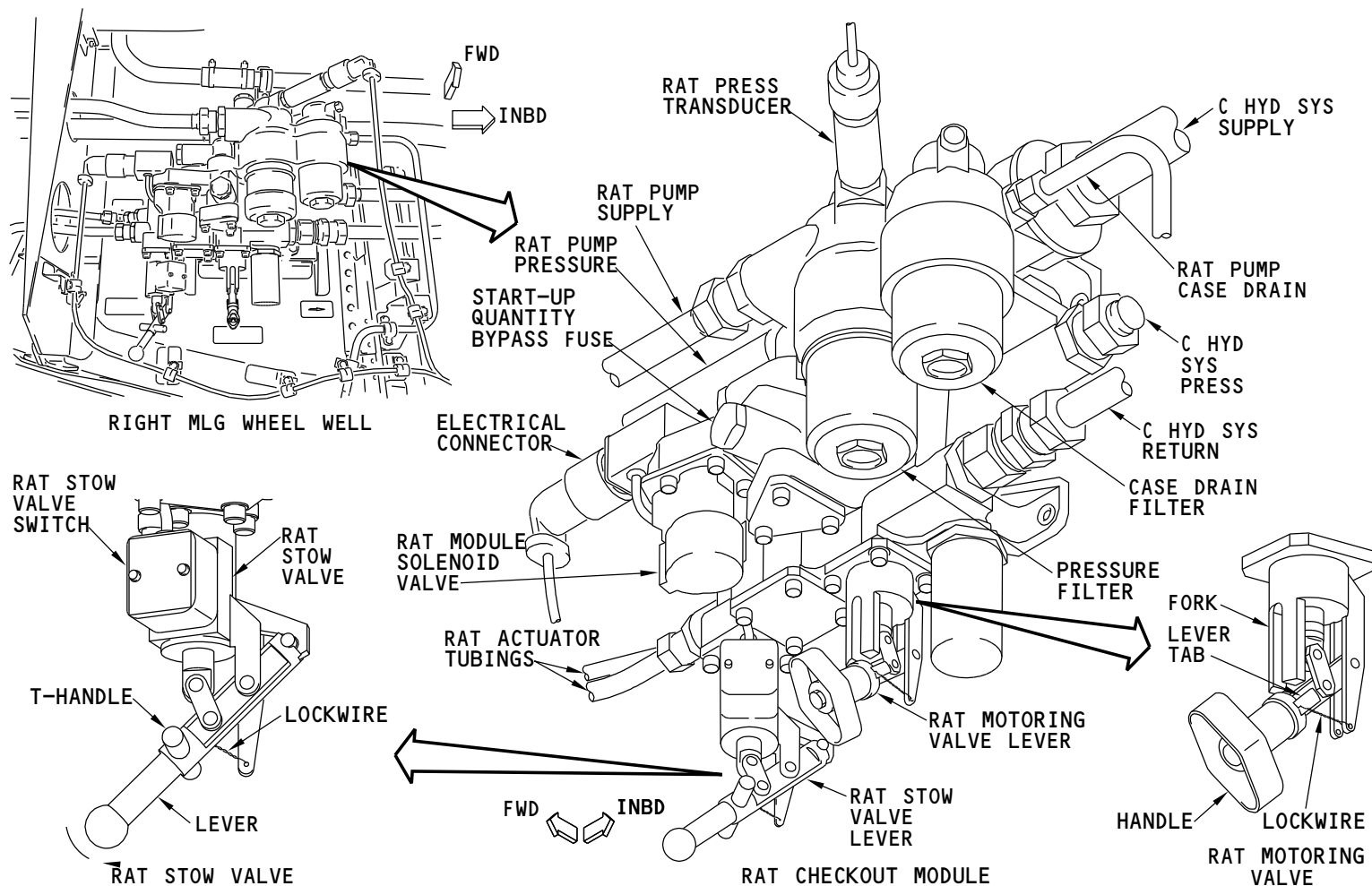
It is necessary to install a protection cage around the RAT when you do the backdrive operational test of the RAT.

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RAM AIR TURBINE SYSTEM - RAT CHECKOUT MODULE - INTRODUCTION

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RAM AIR TURBINE SYSTEM - RAT CHECKOUT MODULE - PHYSICAL DESCRIPTION

General

The RAT checkout module has these components (some of which are LRUs):

- RAT stow valve
- RAT stow valve position switch
- RAT module solenoid valve (LRU)
- RAT motoring valve
- Start-up quantity bypass fuse (LRU)
- Pressure and case drain filters (LRU)
- Check valve (5)
- Pressure relief valve
- Pressure transducer (LRU)
- Thermal bleed orifice.

RAT Stow Valve

The RAT stow valve is manually operated and has three positions:

- STOW
- STOP
- FLIGHT.

A lever controls the valve position. The valve is spring-loaded to the FLIGHT position.

In the STOW position, the RAT stow valve permits center hydraulic system pressure to the RAT actuator for RAT retraction. In the STOP position, the valve stops hydraulic pressure to the RAT actuator. In the FLIGHT position, the valve connects both sides of the actuator to the center hydraulic system return to permit extension.

RAT Stow Valve Position Switch

The RAT stow valve position switch actuates when the RAT stow valve leaves the FLIGHT position. When the RAT stow valve is in the FLIGHT position, the switch sends a ground signal to the HYDIM card. When the RAT stow valve is not in the FLIGHT position, the switch closes to supply a ground to the solenoid of the RAT module solenoid valve.

RAT Module Solenoid Valve

The RAT module solenoid valve is a solenoid operated two-position valve. When the solenoid is not energized, an internal spring holds the valve to stop center hydraulic system pressure to the RAT stow valve. When the solenoid is energized, the valve permits center hydraulic system pressure to the RAT stow valve for retraction of the actuator.

RAT Motoring Valve

The RAT motoring valve is manually operated and has two positions:

- FLIGHT
- MOTOR.

A lever controls the position of the valve. The valve is spring-loaded to the FLIGHT position.

In the FLIGHT position, the valve lets RAT pump pressure go to the center hydraulic system. In the MOTOR position, the valve permits center hydraulic system pressure to backdrive the RAT during ground operational tests.

Start-Up Quantity Bypass Fuse

The start-up quantity bypass fuse lets hydraulic fluid from the RAT pump go to the center system return during RAT start-up. This keeps the RAT unloaded during start-up to permit a faster RAT spin-up.

Filters and Check Valves

Two filters clean RAT case drain and pressure hydraulic flow.

The five check valves control the direction of the hydraulic flow.

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RAM AIR TURBINE SYSTEM - RAT CHECKOUT MODULE - PHYSICAL DESCRIPTION

Pressure Relief Valve

The pressure relief valve supplies over-pressure protection to the RAT system. The pressure relief valve starts to open at 3700-3900 psi.

Pressure Transducer

The pressure transducer sends RAT output pressure data to the HYDIM cards.

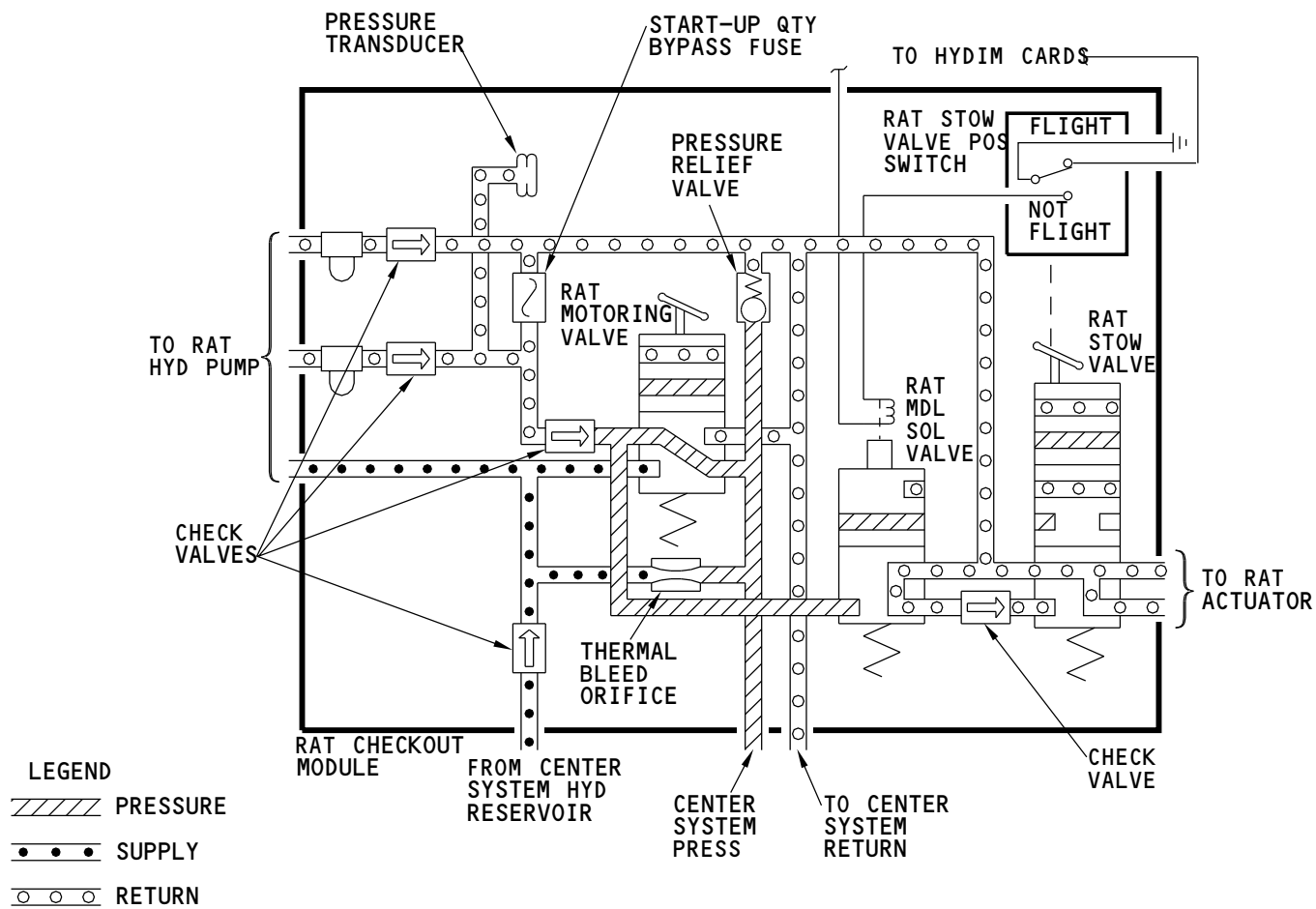
Thermal Bleed Orifice

The thermal bleed orifice lets approximately 0.3 gpm of hydraulic fluid through the RAT pump when the center hydraulic system is pressurized. This keeps the RAT hydraulic pump warm to reduce thermal shock when the RAT is extended.

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RAM AIR TURBINE SYSTEM - RAT CHECKOUT MODULE - PHYSICAL DESCRIPTION

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RAM AIR TURBINE SYSTEM - EXTENSION - FUNCTIONAL DESCRIPTION**General**

A switch on the P5 overhead panel permits manual RAT extension. The HYDIM cards or the ELMS can automatically extend the RAT.

The extend signal supplies power to either or both of the solenoids on the RAT actuator. This unlocks the RAT and permits the spring in the actuator to extend the RAT.

As the RAT gets near the fully extended position, the blade lock pin releases the turbine. The airstream turns the RAT.

Power Sources

These sources can energize the RAT actuator solenoids:

- APU battery bus
- Hot battery bus
- Captain's flight instrument bus.

HYDIM Auto-Extension

The HYDIM cards CL and CR independently control the automatic RAT extension.

CR extends the RAT for these conditions:

- Airplane is in the air mode
- Airspeed or ground speed is more than 80 knots
- Both engines are below idle rpm and center hydraulic system pressure is low or (L,C, and R hydraulic system pressures are low).

CL automatic extension conditions are almost the same as CR. CL extends the RAT for these conditions:

- Airplane is in the air mode
- Airspeed or ground speed is more than 80 knots
- Both engines are below idle rpm and center hydraulic system pump pressures are low or (left and right systems and center system pump pressures are low).

Both CL and CR energize one of the solenoids to unlock the RAT actuator.

ELMS Auto-Extension

The ELMS energizes the other solenoid on the RAT actuator to extend the RAT for these conditions:

- Airplane in the air mode
- Airplane not in the ground mode
- Left and right transfer buses have lost electrical power for 15 seconds.

Manual Extension

The RAT manual switch on the hydraulic/RAT panel energizes both the solenoids on the RAT actuator to extend the RAT.

Indication

The RAT stowed switch in the RAT compartment sends a not-stowed signal to HYDIM CL when the RAT is not in the stowed position.

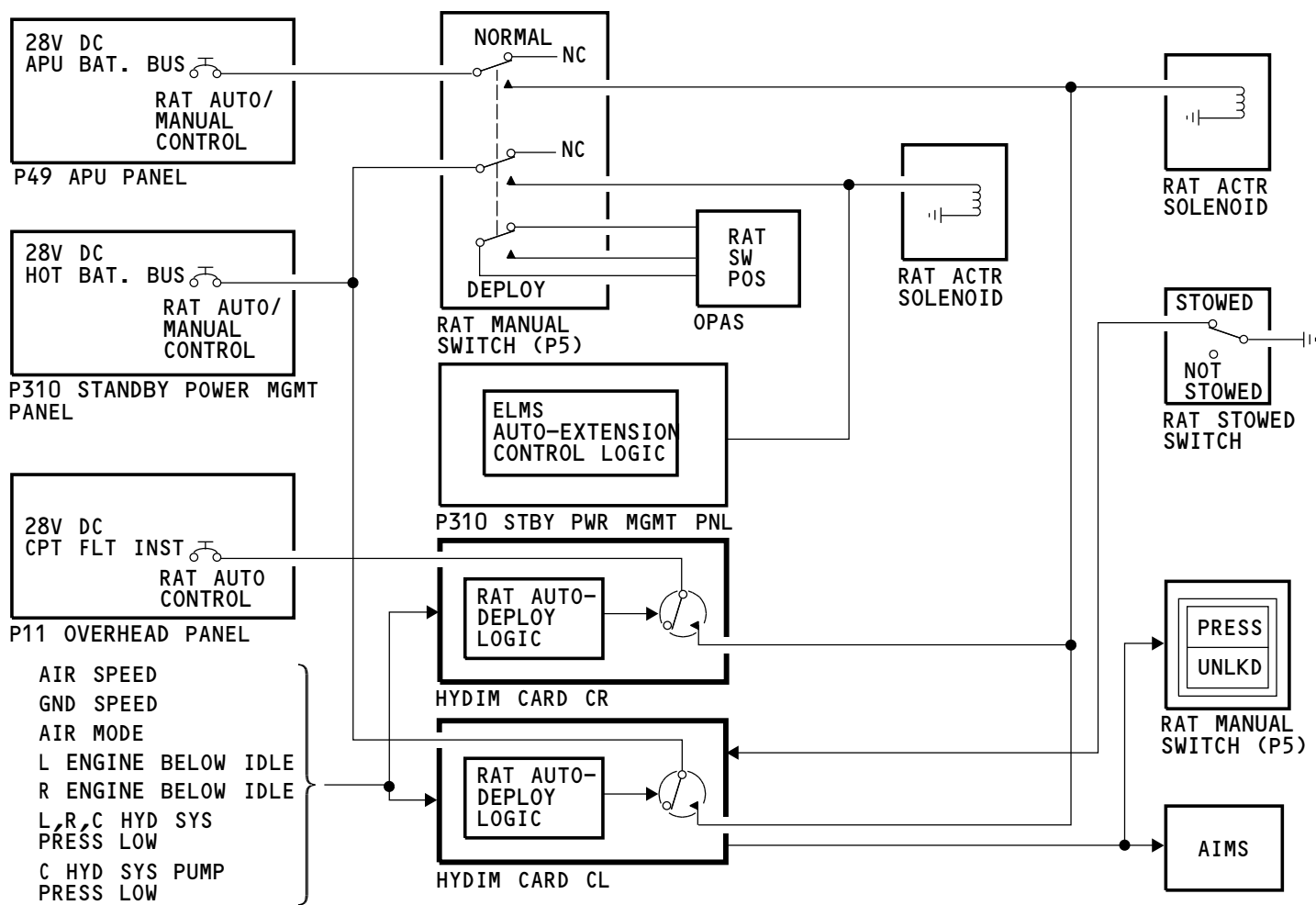
HYDIM CL turns on the RAT switch UNLKD light and sends a signal to the AIMS to show the RAT UNLOCKED advisory message.

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RAM AIR TURBINE SYSTEM - EXTENSION - FUNCTIONAL DESCRIPTION

RAM AIR TURBINE SYSTEM - FUNCTIONAL DESCRIPTION - RETRACTION**General**

You use the stow lever on the RAT checkout module to retract the RAT.

The center hydraulic system supplies the pressure to retract the RAT.

Hydraulic Control

The RAT stow valve and the RAT module solenoid valve both control the retract pressure to the RAT actuator.

The RAT stow lever manually controls the RAT stow valve. A solenoid automatically controls the solenoid valve.

Electrical Control

The RAT strut angle switch and the RAT blade locked switch control electrical power to the solenoid valve.

The strut angle switch is closed when the RAT is between the full down and the 15 degrees from full down position. The switch opens when the RAT is more than 15 degrees from full down.

The RAT blade locked switch is closed when the blade lock pin engages one of the holes on the turbine to lock the blades. This occurs when the RAT is 9 degrees or more from the full down position.

The RAT stow valve position switch supplies the ground for the RAT module solenoid valve when the stow valve is in the STOW position.

Retraction Sequence

When you move the stow lever to the STOW position, electrical power goes through the strut angle switch to energize the solenoid valve.

The solenoid valve moves to permit hydraulic pressure to go to the stow valve.

The stow valve sends pressure to the retract side of the RAT actuator to start retraction.

If the RAT blades are aligned, the blade lock pin engages the hole in the turbine when the RAT has retracted 9 degrees. This closes the RAT blade locked switch and lets the RAT move to the stowed position. Mechanical locks in the RAT actuator lock the RAT in this position.

If the blades are not aligned, the blade locked switch does not close. The RAT stops when the strut angle switch opens at 15 degrees and closes the RAT module solenoid valve.

Training Information Point

You must manually align the RAT turbine blades before RAT retraction.

If you release the RAT stow lever during retraction, the lever moves to the STOP position and the RAT retraction stops.

RAT retraction time is approximately 45 seconds.

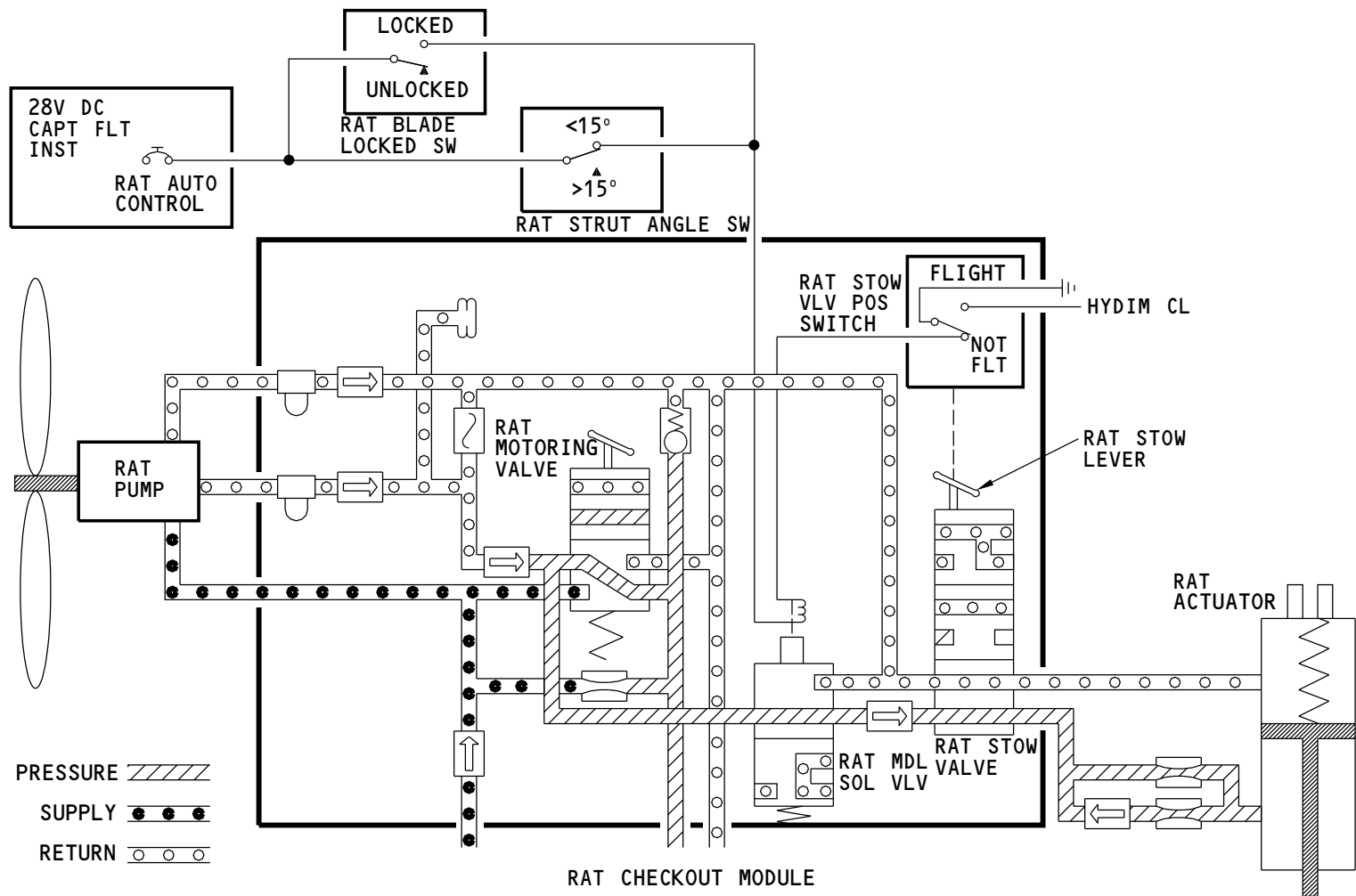
HYDIM CL monitors the position of the RAT stow valve through the RAT stow valve position switch. If the stow valve is not in the FLIGHT position, HYDIM CL sends a signal to the AIMS to show the RAT DEPLOY INOP status message.

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RAM AIR TURBINE SYSTEM - FUNCTIONAL DESCRIPTION - RETRACTION

29-20-00-007

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**RAM AIR TURBINE SYSTEM - FUNCTIONAL DESCRIPTION - IN-FLIGHT OPERATION****Hydraulic Operation**

After in-flight extension, the RAT turbine turns. The start-up quantity bypass fuse lets the initial RAT output go to return. This unloads the hydraulic pump to permit the RAT to spin-up faster.

After spin-up, the start-up quantity bypass fuse closes and RAT pressure goes to the center hydraulic system flight controls.

Speed Control

The governor in the governor-generator assembly changes the blade angle to keep the RAT speed constant.

Indication

The RAT pressure transducer sends RAT pressure data to the HYDIM card CL. HYDIM CL sends this data to the AIMS. The hydraulic maintenance page format shows RAT data.

HYDIM also turns on the pressure light on the RAT switch when RAT pressure is more than 1500 psi.

Training Information Point

The minimum airspeed of 115 knots is necessary for the RAT to supply rated capacity.

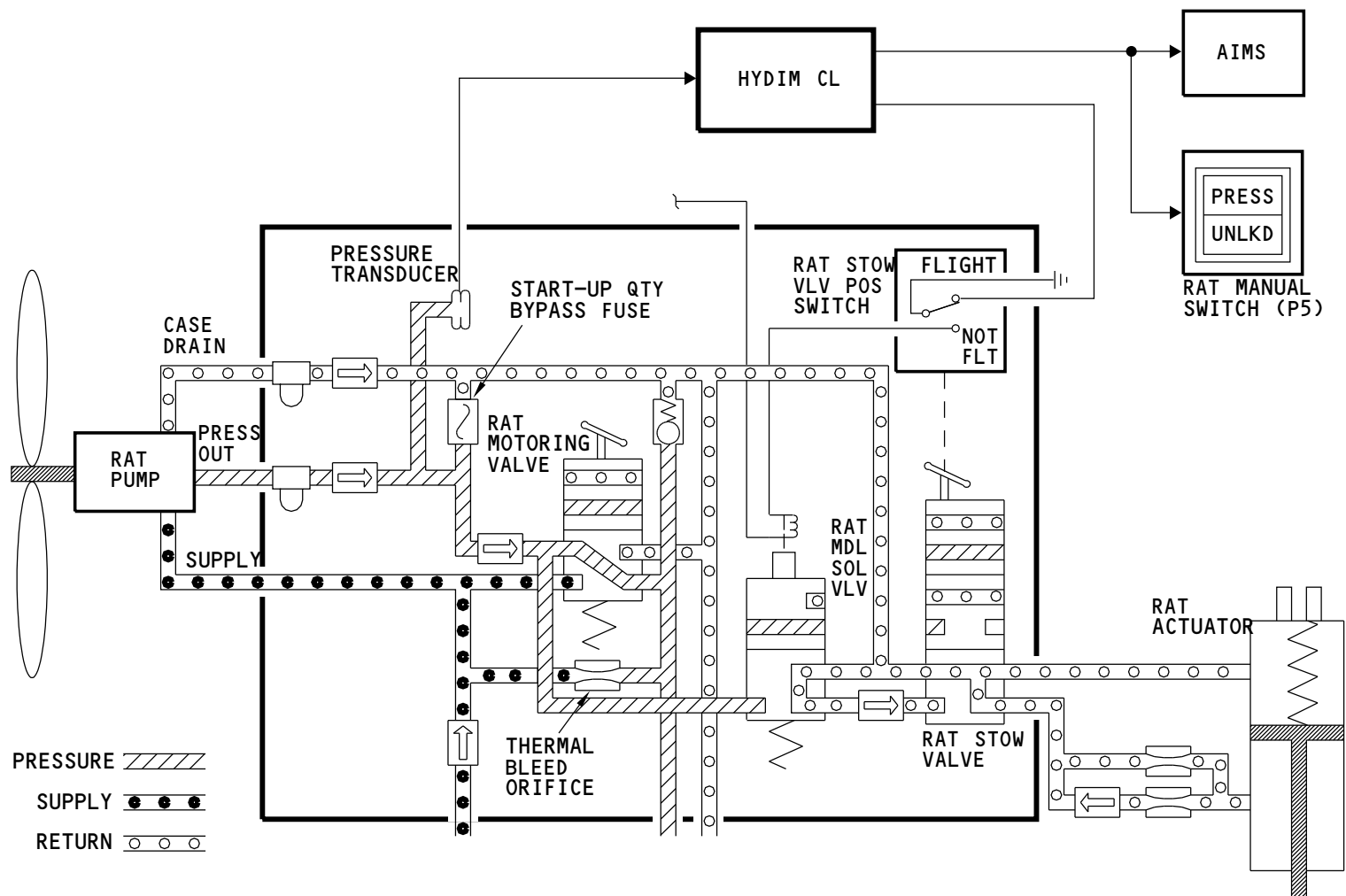
When the RAT is extended and hydraulics off, the airplane rolls left. Two to three units of right control wheel rotation are necessary to hold the wings level.

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M36133 S000617793_V1

RAM AIR TURBINE SYSTEM - FUNCTIONAL DESCRIPTION - IN-FLIGHT OPERATION

29-20-00

**RAM AIR TURBINE SYSTEM - FUNCTIONAL DESCRIPTION - MOTORING****General**

A functional test of the RAT may be done with the RAT checkout module. This test uses center hydraulic system pressure to operate the RAT pump as a motor to turn the turbine.

Operation

The motoring valve lever controls the motoring valve. When you hold the lever in the MOTOR position, center hydraulic system pressure goes to the inlet side of the RAT hydraulic pump. This causes the pump to operate as a motor and turns the turbine.

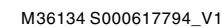
The RAT governor controls the RAT speed to the normal RAT RPM.

The RAT requires a minimum of 45 gpm flow in the center hydraulic system to operate the RAT at full speed.

The ELMS calculates RAT speed from the RAT generator frequency. The hydraulic maintenance page shows RAT speed.

Training Information Point

When you release the motoring valve lever, the RAT motoring valve goes back to the FLIGHT position. The RAT then becomes a pump as it slows down. This pressurizes the hydraulic fluid to the RAT pressure transducer and turns on the RAT PRESS light. The RAT pressure indication stays on until internal leakage in the RAT module causes the pressure to decrease.



RAM AIR TURBINE SYSTEM - FUNCTIONAL DESCRIPTION - MOTORING

29-20-00

**RAM AIR TURBINE SYSTEM - RAT GENERATOR HEATER SYSTEM****General**

The RAT generator heater system operates automatically to heat the RAT generator. This prevents icing in the generator that could prevent RAT spin-up at low airspeed. The icing could be caused by moisture that gets into the RAT generator through many humid air/cold air cycles during normal airplane operation.

There are two heater elements in the generator. Only one element operates at a time. The other element is a spare.

The HYDIM CL card controls the RAT generator heater system. The P210 right power management panel supplies the electrical power to operate the heater system.

Functional Description

The HYDIM CL card sends a signal to the ELMS to operate the RAT heater for any of these conditions:

- Total air temperature is less than 36F (2C) (ADIRU input through the AIMS)
- ADP C1 case drain temperature is less than 50F (10C)
- ADP C2 case drain temperature is less than 50F (10C)
- ADP C1 operational test (MAT test)
- ADP C2 operational test (MAT test)
- Heaters operational test (MAT test).

The ON signal goes to the ELMS computing and communications unit (CCU) in the P210 power management panel. The CCU energizes relays to supply power to the RAT heater and to the ADU heaters.

The heaters go off 30 minutes after the total air temperature increases to more than 36F (2C) and both ADP case drain temperatures are more than 50F (10C). The heaters also go off 5 seconds after a RAT deployment.

A current monitor in the ELMS sends heater operation feedback to the CCU. The CCU sends this data to HYDIM CL to find RAT heater faults.

Indication

There is no indication that the RAT generator heater system is on. A RAT GEN HEAT status message shows for these conditions:

- RAT generator heat is not on when commanded on
- RAT generator heat is on when not commanded on.

Training Information Point

If one of the RAT heater elements fails, you can select the other element with the RAT generator heater switch on the E6-2 shelf.

You can do a test of the operation of the RAT generator heater system with a ground test through the MAT.

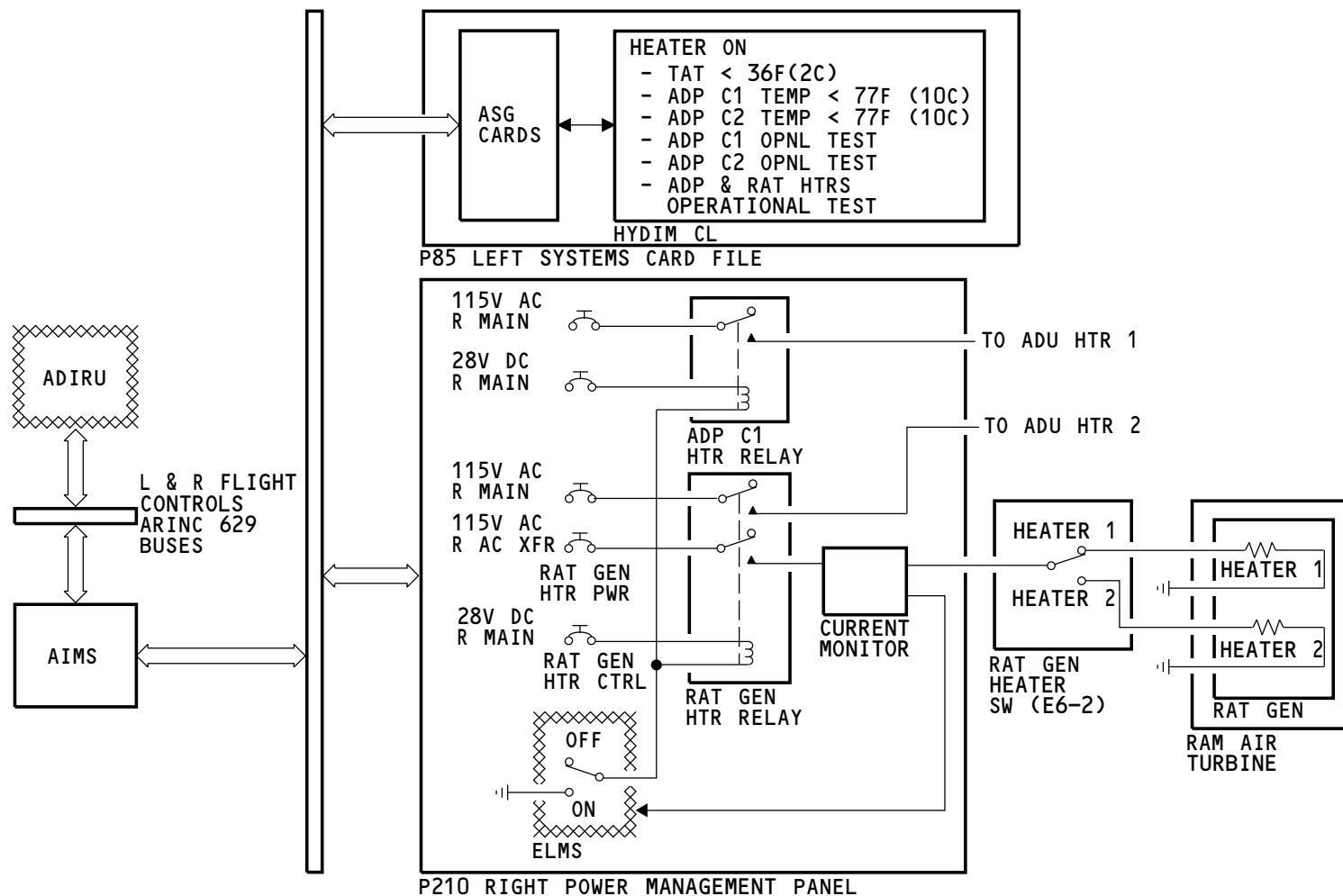
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RAM AIR TURBINE SYSTEM - RAT GENERATOR HEATER SYSTEM

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HYDRAULIC INDICATING SYSTEM - INTRODUCTION

General

The hydraulic indicating system monitors these values:

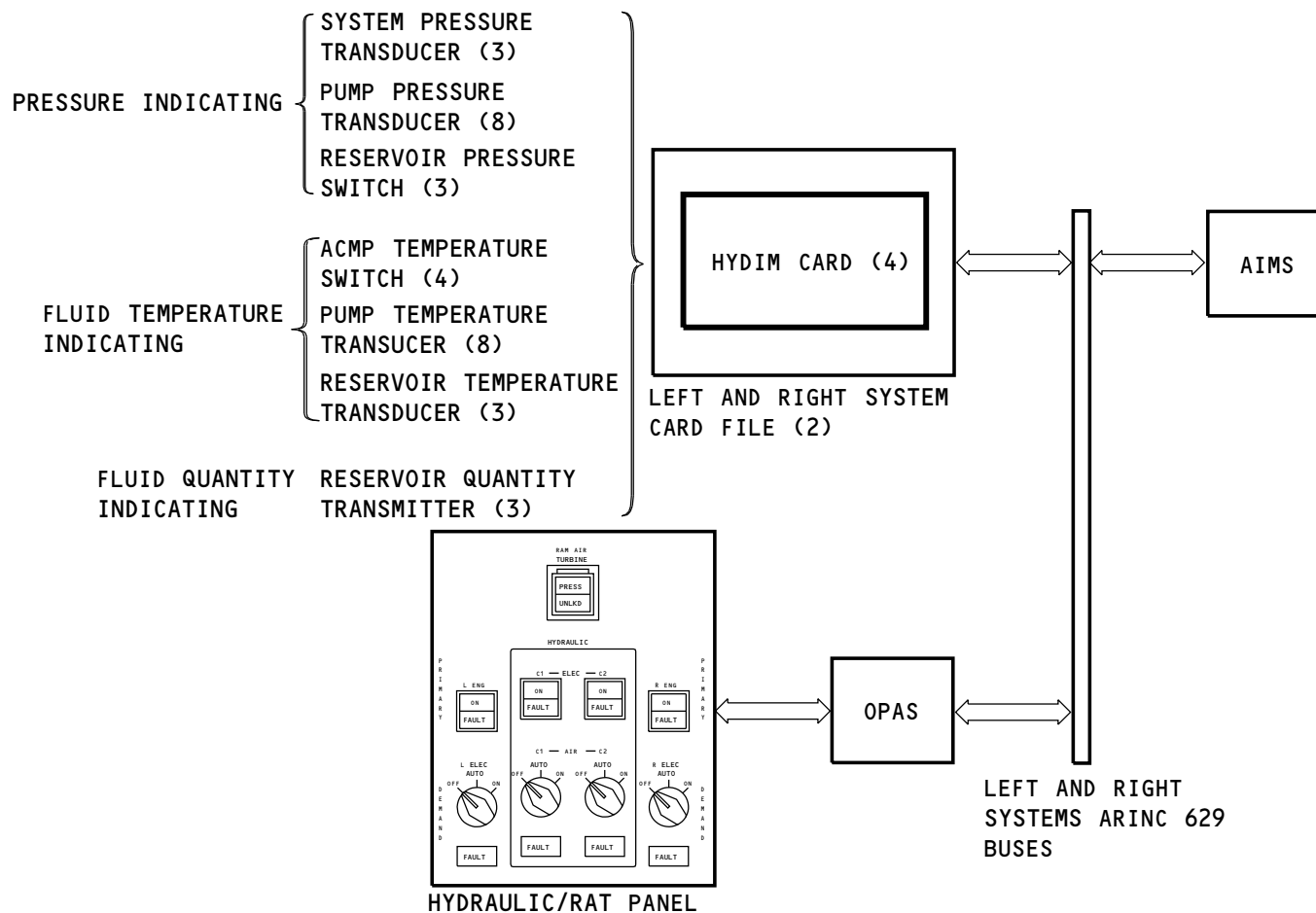
- Fluid and reservoir pressures
- Fluid temperature
- Fluid quantity.

The indicating systems get input from these sensors:

- Hydraulic pump pressure transducer (8)
- Hydraulic system pressure transducer (3)
- Hydraulic reservoir pressure switch (3)
- Hydraulic pump temperature transducer (8)
- ACMP temperature switch (4)
- Hydraulic reservoir temperature transducer (3)
- Hydraulic reservoir quantity transmitter (3)

Interface

The indicating systems sensors send data to the HYDIM cards. The HYDIM cards send the data to the AIMS for flight deck indication. The HYDIM cards also control the fault lights and the RAT indication lights on the hydraulic/RAT panel.



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HYDRAULIC INDICATING SYSTEM - INTRODUCTION

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**HYDRAULIC INDICATING SYSTEM - PUMP AND RESERVOIR SENSORS - COMPONENT LOCATIONS****Pump Sensors**

Each pump has two transducers:

- One pressure transducer
- One temperature transducer.

These transducers are on or near the ACMP, ADP, and EDP filter modules. The pressure transducers are in the pressure line and the temperature transducers are in the case drain line.

Each ACMP has one temperature switch:

- The ACMP temperature switch is a part of the pump.
- The temperature switch closes at 105 degrees C and reopens at 75 degrees C.
- The temperature switch provides an overheat signal that is independent of the temperature transducer.

Reservoir Sensors

Each reservoir has these sensors:

- Reservoir quantity transmitter
- Reservoir temperature transducer
- Reservoir pressure switch.

The reservoir quantity transmitters are in each hydraulic reservoir.

The reservoir temperature transducers are on each hydraulic reservoir.

The reservoir pressure switches are on the pneumatic lines to each reservoir.

Training Information Point

All the pump temperature transducers are interchangeable.

The pump pressure transducers are interchangeable with each other and are also interchangeable with the system pressure transducers.

The left and right quantity transmitters are interchangeable. The center system quantity transmitter is different from the left and right system quantity transmitters.

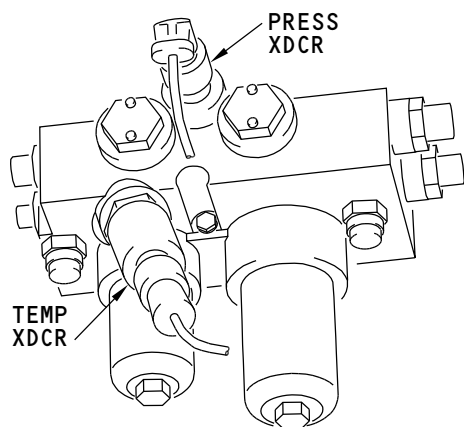
The reservoir temperature transducers are interchangeable. The reservoir pressure switches are interchangeable.

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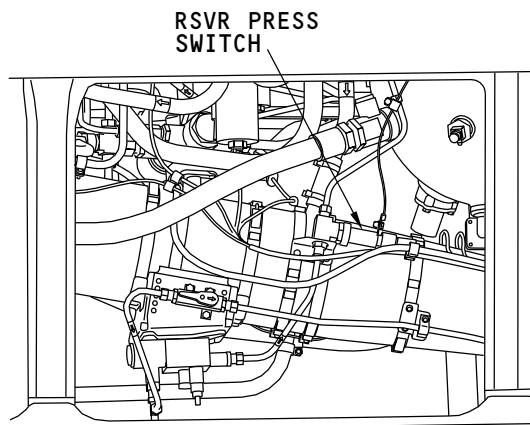
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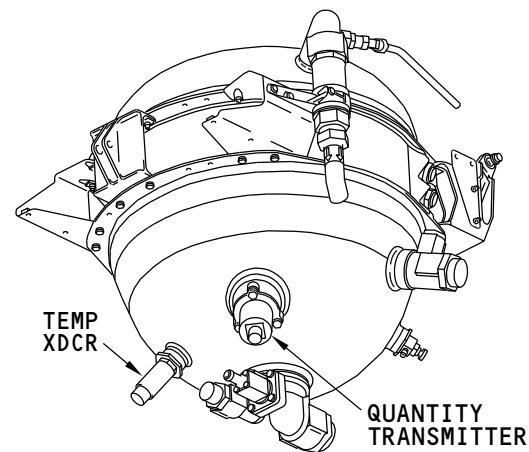
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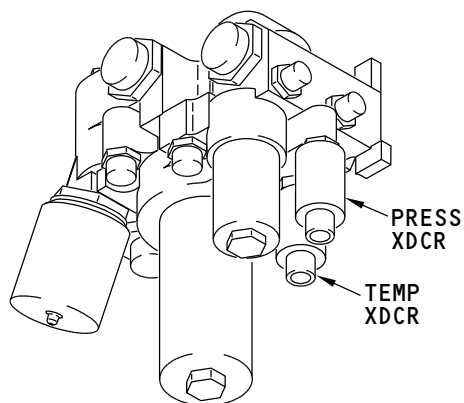
ACMP FILTER MODULE
(CENTER SYSTEM)



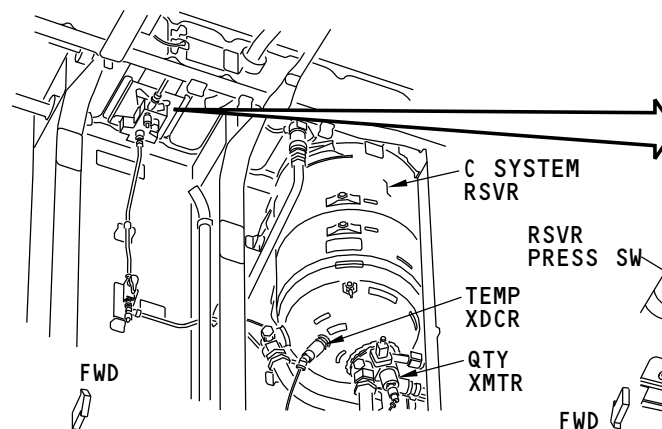
ENGINE STRUT - RIGHT SIDE → FWD



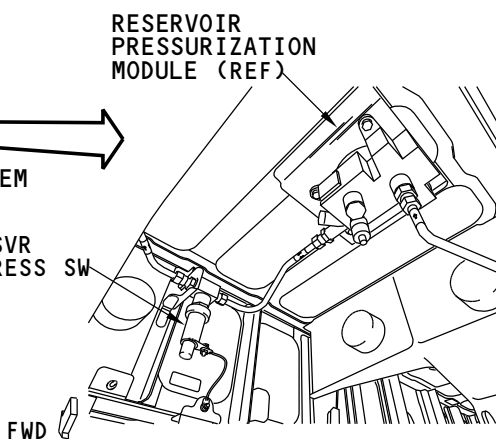
LEFT/RIGHT HYD SYS RSVR



EDP/ADP FILTER MODULE



RIGHT WHEEL WELL - AFT BULKHEAD



RIGHT WHEEL WELL

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HYDRAULIC INDICATING SYSTEM - PUMP AND RESERVOIR SENSORS - COMPONENT LOCATIONS

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HYDRAULIC INDICATING SYSTEM - HYDRAULIC SYSTEM PRESSURE TRANSDUCER - COMPONENT LOCATIONS

General

The left and right hydraulic system pressure transducers are on the rear wing spar of the left and right wings.

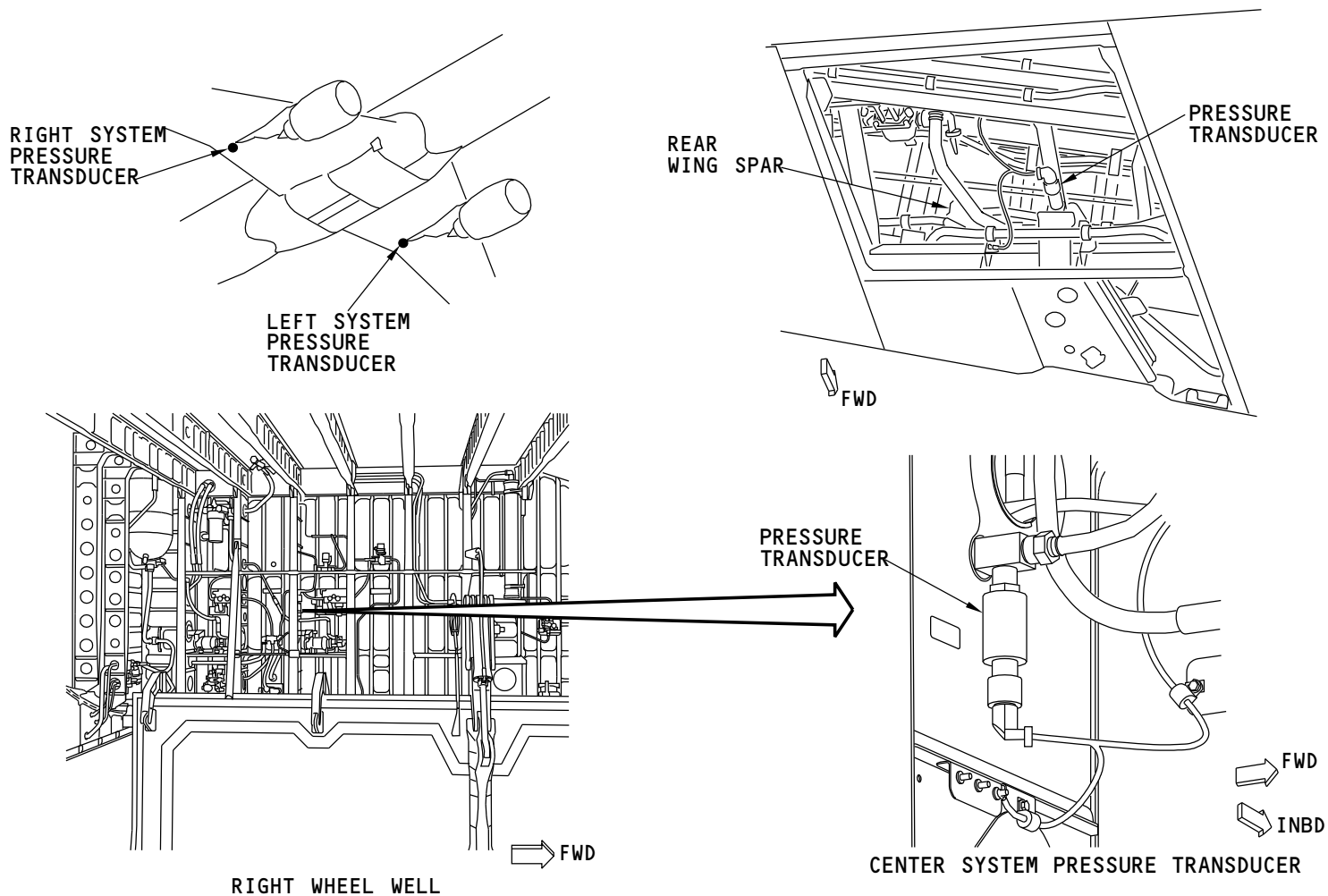
The center system pressure transducer is near the keelbeam in the right wheel well.

Training Information Point

The hydraulic system pressure transducers are interchangeable with the pump pressure transducers.

Access panels (552LB - left system, 652LB - right system) on the bottom of the wings give access to the pressure transducers.

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HYDRAULIC INDICATING SYSTEM - HYDRAULIC SYSTEM PRESSURE TRANSDUCER - COMPONENT LOCATIONS

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HYDRAULIC INDICATING SYSTEM - PRESSURE INDICATING

General

These sensors in the hydraulic systems send hydraulic pressure data to the HYDIM cards:

- System pressure transducer (3)
- Pump pressure transducer (8)
- Reservoir pressure switches (3).

The HYDIM cards control the pressure indications.

Functional Description

The pressure transducers send signals in proportion to pressure between 0 and 4000 psi. The transducers make allowance for temperature changes.

The reservoir pressure switches send a reservoir low pressure signal when the reservoir pressure is 21 psia or less. They send a reservoir not low signal when reservoir pressure is 25 psia or more.

Hydraulic System Pressure Indications

Hydraulic system pressure shows on these displays:

- The status display
- The hydraulic synoptic display
- The hydraulic maintenance page.

For more information about the hydraulic system displays, see 29-00-00-004.

These caution messages show if hydraulic system pressure is below 1200 psi:

- HYD PRESS SYS L
- HYD PRESS SYS C
- HYD PRESS SYS R
- HYD PRESS SYS L+C
- HYD PRESS SYS R+C

- HYD PRESS SYS L+R
- HYD PRESS SYS L+C+R.

Hydraulic Pump Pressure Indications

The maintenance page shows hydraulic pump pressure in psi.

Advisory messages show if hydraulic pump pressure is less than 1200 psi for ACMPs or 1800 psi for ADPs and EDPs. These are the advisory messages:

- HYD PRESS PRI L
- HYD PRESS PRI C1
- HYD PRESS PRI C2
- HYD PRESS PRI R
- HYD PRESS DEM L
- HYD PRESS DEM C1
- HYD PRESS DEM C2
- HYD PRESS DEM R.

These advisory messages do not show for a demand pump when the demand pump selector is in AUTO and there is no control signal from HYDIM to operate the pump.

Also, these advisory messages do not show if the system pressure is low.

Status messages show if there is a signal for a pump to operate and the pump pressure is less than 1200 psi for ACMPs or 1800 psi for ADPs and EDPs. These are the status messages:

- HYD PUMP PRI L
- HYD PUMP PRI C1
- HYD PUMP PRI C2
- HYD PUMP PRI R
- HYD PUMP DEM L
- HYD PUMP DEM C1
- HYD PUMP DEM C2

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**HYDRAULIC INDICATING SYSTEM - PRESSURE INDICATING**

- HYD PUMP DEM R.

These status messages also show if there is a pump overheat condition.

The status and advisory low pressure messages for the EDPs do not show if the related engine speed for the EDP is less than idle.

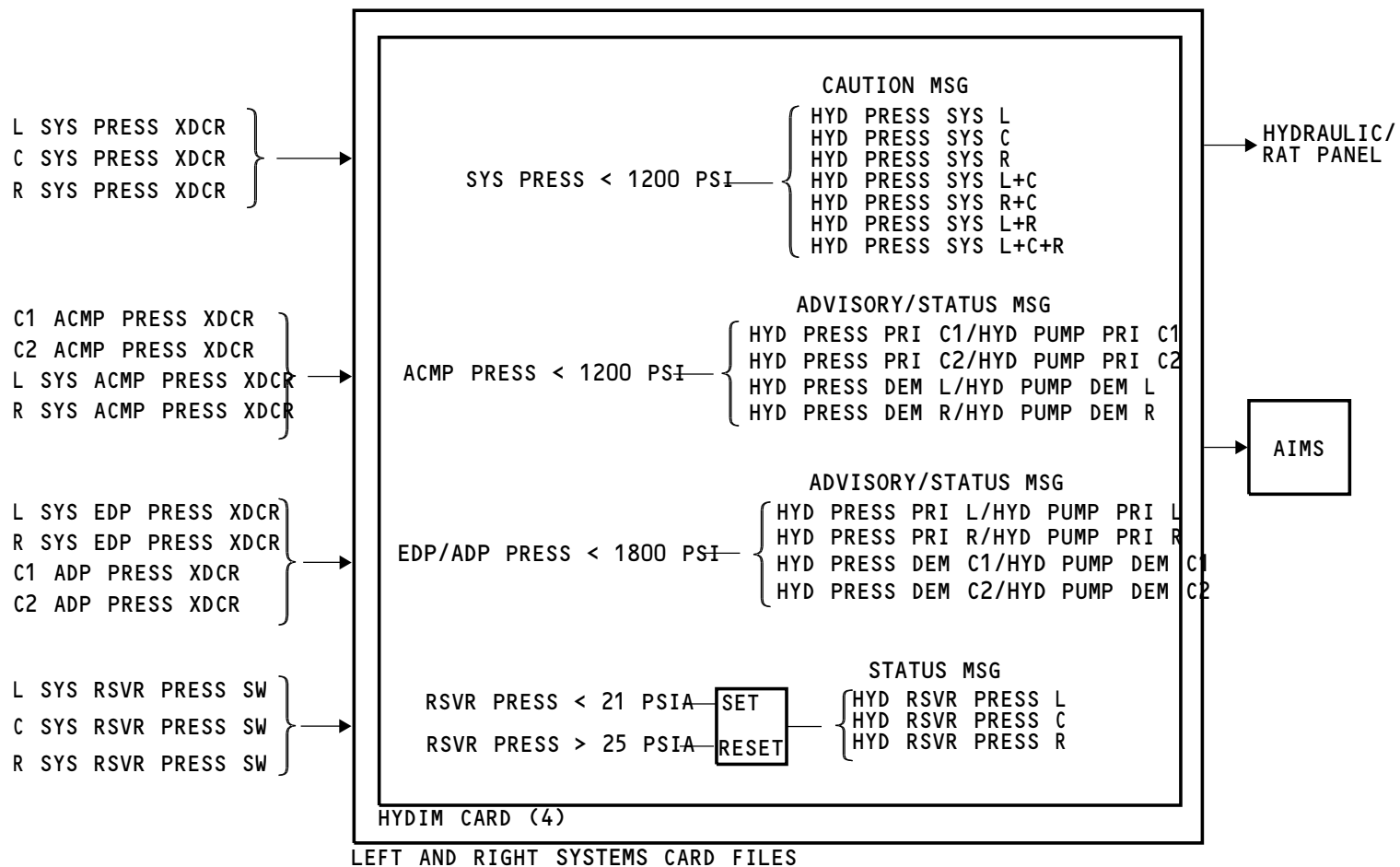
Low pump pressure also makes the pump fault light on the hydraulic control panel come on. The pump fault light does not come on for a demand pump when the demand pump selector is in AUTO and there is no control signal from HYDIM to operate the pump.

Reservoir Pressure Indications

Hydraulic reservoir pressure (LO or NORM) shows on the hydraulic maintenance page. LO shows when the pressure is 21 psia or less. NORM shows when the pressure is 25 psia or more.

These status messages show if the hydraulic reservoir pressure is low:

- HYD RSVR PRESS L
- HYD RSVR PRESS C
- HYD RSVR PRESS R.



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HYDRAULIC INDICATING SYSTEM - PRESSURE INDICATING

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HYDRAULIC INDICATING SYSTEM - TEMPERATURE INDICATING

General

Temperature transducers for each hydraulic reservoir and each hydraulic pump send analog temperature signals to the HYDIM cards. The HYDIM cards convert the analog signals to digital values and detect overheat conditions. The temperature and fault data are sent over the ARINC 429/629 bus to the EICAS, the AIMS, and the CMCS for flight deck display and maintenance support.

Each ACMP has a temperature switch that is a part of the pump.

The ACMP temperature switch provides an overheat signal that is independent of the temperature transducer.

NOTE: The ACMP temperature transducer is located in the ACMP pressure/case drain filter module, approximately 15 inches from the ACMP. Some ACMP failure modes can stop the flow of hydraulic fluid from the case drain and cause a pump overheat condition that is not detected by the case drain temperature transducer.

Sensor Functional Description

The temperature transducers are RTD (resistance temperature detector) type transducers. The transducer provides an electrical signal to the HYDIM card that varies from 4 to 20 milliamperes to indicate temperatures between -54C and 149C (-63.6F to 300F).

The HYDIM temperature value is fixed at -54C for an electrical signal that is less than or equal to 4 milliamperes.

For the EDP and ADP, the HYDIM temperature value is fixed at 149C for an electrical signal that is equal to or greater than 20 milliamperes.

For the ACMP, the HYDIM temperature value is fixed at 111.6C for an electrical signal that is equal to or greater than 17 milliamperes.

For the EDP and ADP temperature transducers, an electrical signal of less than 1 milliampere or more than 23 millamperes indicates a transducer fault.

For the ACMP temperature transducers, an electrical signal of less than 1 milliampere or more than 40 millamperes indicates a transducer fault.

The ACMP temperature switch closes at approximately 105C and reopens at approximately 75C. When the temperature switch closes, it connects a fixed resistor between structure ground and the ACMP temperature transducer input on the HYDIM card. The fixed resistor provides an electrical signal of approximately 17 milliamperes to the HYDIM card. This electrical signal will cause the HYDIM card to detect an ACMP overheat condition independent of the signal provided by the case drain temperature transducer. If the transducer and the switch detect an overheat at the same time, then the total signal provided to the HYDIM card will be between 33 and 40 milliamperes.

These advisory messages show if a transducer fault is detected continuously for 30 seconds:

- HYD TEMP IND PRI L
- HYD TEMP IND PRI C1
- HYD TEMP IND PRI C2
- HYD TEMP IND PRI R
- HYD TEMP IND DEM L
- HYD TEMP IND DEM C1
- HYD TEMP IND DEM C2
- HYD TEMP IND DEM R

The messages go away if the fault is not detected for 3 seconds.

Hydraulic Pump Temperature Indication

Hydraulic pump temperatures are shown on the hydraulic maintenance page in degrees C.

The applicable hydraulic pump temperature display will be blank if a temperature transducer fault is detected.

These advisory messages show if a pump temperature is more than 105C for 2 seconds:

- HYD OVERHEAT PRI L
- HYD OVERHEAT PRI C1

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HYDRAULIC INDICATING SYSTEM - TEMPERATURE INDICATING

- HYD OVERHEAT PRI C2
- HYD OVERHEAT PRI R
- HYD OVERHEAT DEM L
- HYD OVERHEAT DEM C1
- HYD OVERHEAT DEM C2
- HYD OVERHEAT DEM R

The messages go away when the pump temperature is less than 75C for 1 second.

These status messages also show for a pump overheat condition:

- HYD PUMP PRI L
- HYD PUMP PRI C1
- HYD PUMP PRI C2
- HYD PUMP PRI R
- HYD PUMP DEM L
- HYD PUMP DEM C1
- HYD PUMP DEM C2
- HYD PUMP DEM R

The status message faults are latched in the HYDIM card and are reset when the pump operating conditions return to normal. The messages go away when the pump temperature is less than 100C with normal pump pressure for 10 seconds (for the EDPs) or 60 seconds (for the ACMPs and ADPs).

These indications also show for a pump overheat:

- Fault light on P5 hydraulic/RAT panel
- OVHT next to the pump symbol on the hydraulic synoptic display.

For more information about the hydraulic system displays, see 29-00-00-004.

Training Information Point

For some operating conditions, an ACMP temperature transducer fault can be reported as an ACMP overheat message.

The HYDIM cards allow a larger range of valid ACMP temperature signals because of the ACMP temperature switch circuit. A closed temperature switch must be reported as an overheat condition because an overheated hydraulic pump can prevent dispatch. The electrical signal from the switch circuit, added to the electrical signal from an operational temperature transducer, is still considered a valid signal.

If the ACMP temperature transducer has a fault that results in an electrical signal larger than the actual temperature but not large enough to be considered invalid, then an ACMP overheat message can show instead of an ACMP transducer message.

Hydraulic Reservoir Temperature Indication

Reservoir temperature in degrees C shows on the hydraulic maintenance page. There are no reservoir overheat indications.



CAUTION

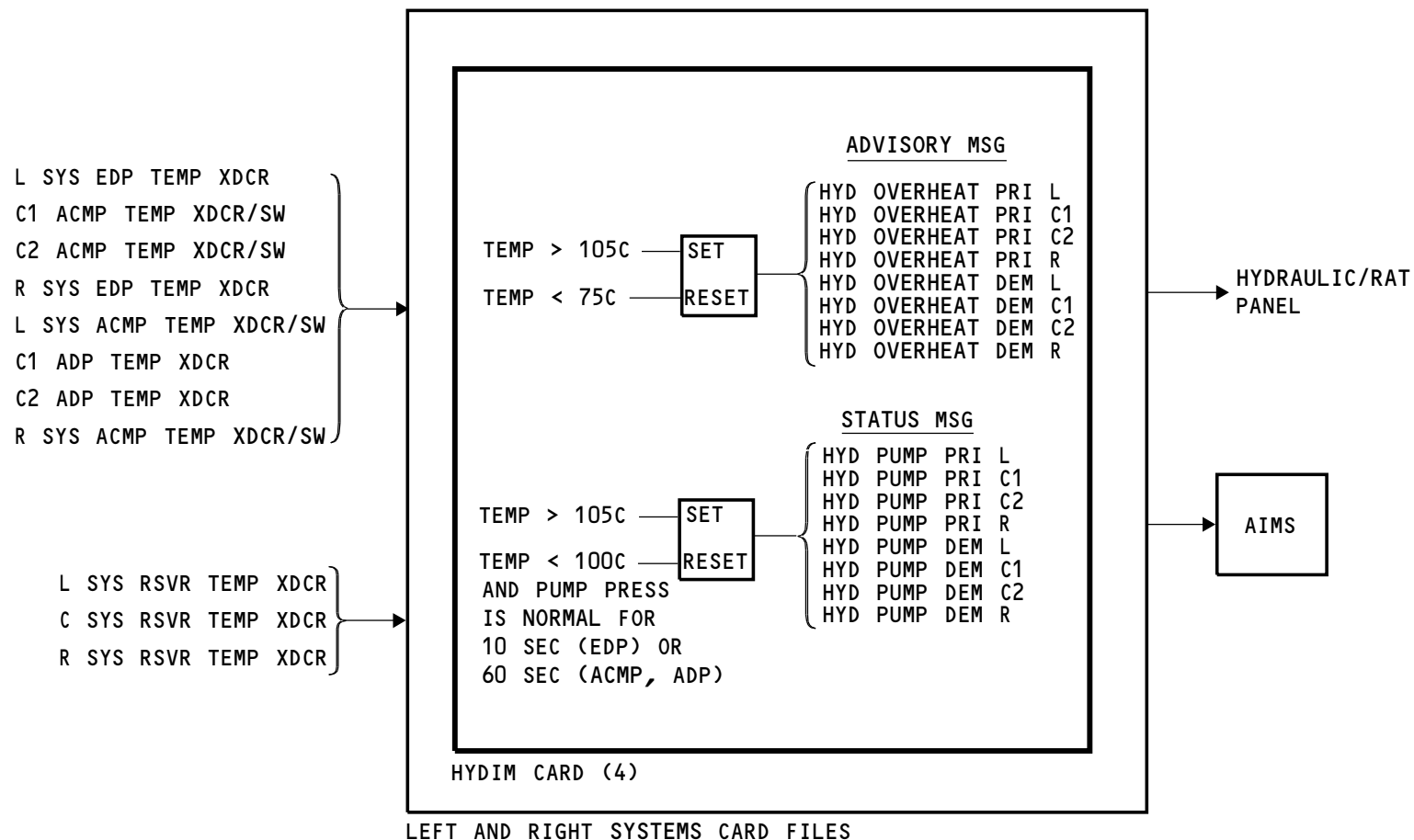
DO NOT OPERATE THE HYDRAULIC PUMPS AFTER THE TEMPERATURE INDICATION ON EICAS IS MORE THAN 100C (212F) OR AFTER THE PUMP FAULT LIGHT COMES ON. IF YOU CONTINUE TO OPERATE THE PUMPS, THE HYDRAULIC FLUID CAN BECOME TOO HOT.

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HYDRAULIC INDICATING SYSTEM - TEMPERATURE INDICATING

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**HYDRAULIC INDICATING SYSTEM - FLUID QUANTITY INDICATING****General**

A quantity transmitter in each of the hydraulic reservoirs measures fluid quantity. Reservoir quantity data goes to the HYDIM cards.

Functional Description

The reservoir quantity transmitters are capacitance-type transmitters. They send a signal to the HYDIM cards in proportion to reservoir fluid quantity. The HYDIM cards send reservoir quantity signals to the AIMS and to the reservoir quantity gage in the hydraulic service bay.

The reservoir quantity indication makes allowance for temperature changes to prevent nuisance refill and overfill indications.

Indication

Reservoir quantities show on these MFD formats:

- Status display
- Hydraulic synoptic display
- Maintenance page.

Quantity indication shows as a decimal number. The reservoir full level shows as 1.00.

If the reservoir quantity is 1.20 or more, an OF (overfill) shows next to the quantity indication on the status display, the hydraulic synoptic display and the hydraulic maintenance page. The OF shows only when the airplane is on the ground.

If reservoir quantity is 0.75 or less, an RF (refill) shows next to the quantity indication on the status display, the hydraulic synoptic display, and the hydraulic maintenance page. The RF shows only when the airplane is on the ground.

If reservoir quantity is 0.40 or less, a LO shows next to the quantity indication on the status display, the hydraulic synoptic display, and the hydraulic maintenance page.

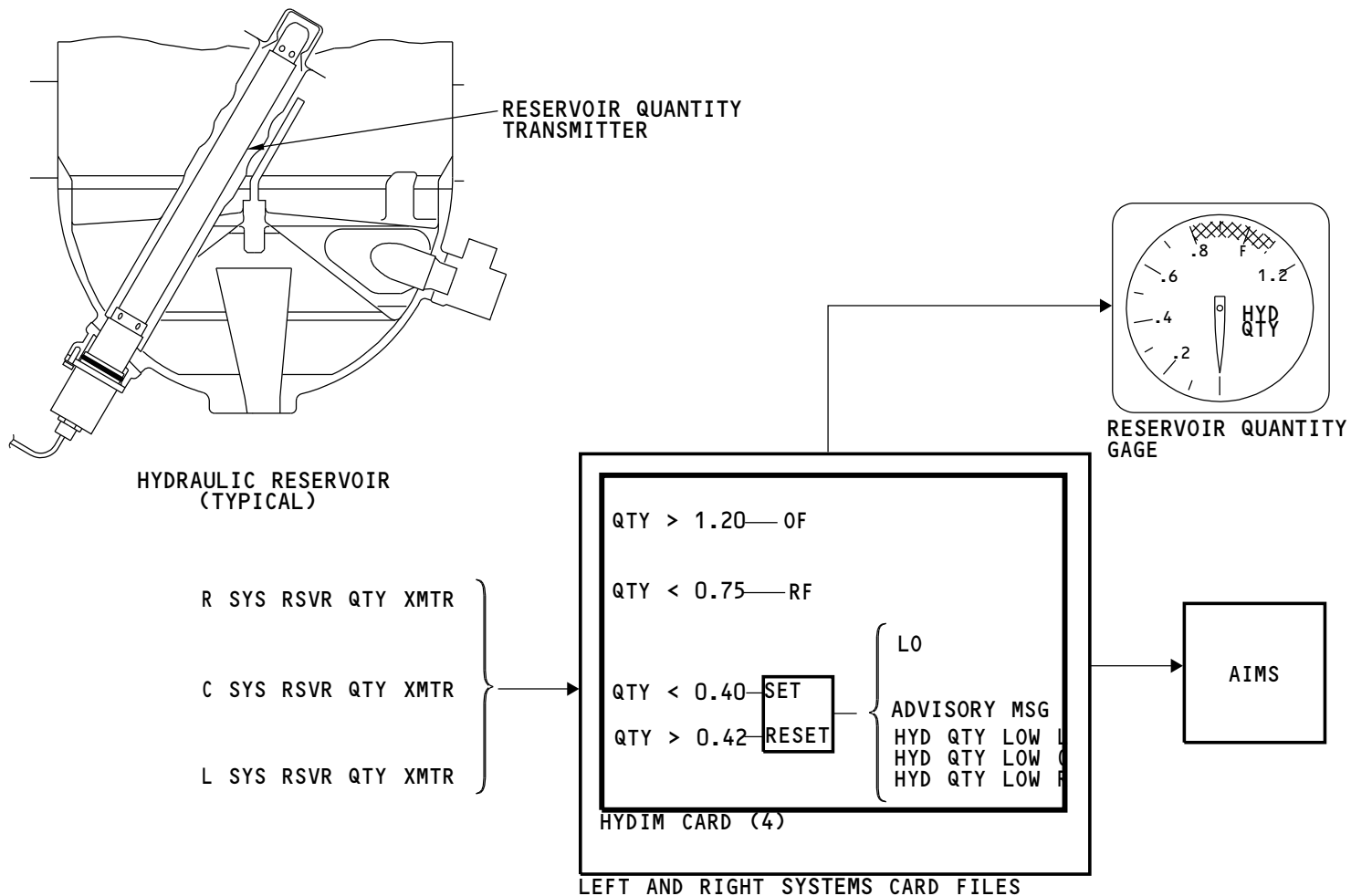
These advisory messages show if reservoir quantity is 0.40 or less:

- HYD QTY LOW L
- HYD QTY LOW C
- HYD QTY LOW R.

The advisory messages and the LO indication reset when the quantity is more than 0.42.

Training Information Point

If the reservoir fluid level is at the top of the standpipe, the quantity indication shows 0.00.



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HYDRAULIC INDICATING SYSTEM - FLUID QUANTITY INDICATING

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