

2.15. HYDRAULIC SYSTEM

The hydraulic system consists of a power package, an emergency hand pump, hydraulic lines and valves.

The hydraulic system provides power for the actuation of landing gear, of the nose wheel steering, and of the main wheels brake system.

The modular hydraulic power package, consisting of a variable displacement pump driven by an electrical motor, an integral hydraulic fluid reservoir, one solenoid-operated directional valve, a pressure transducer, and a filter with differential pressure switch, is located in the left main landing gear well just under the wing. Engine compressor bleed air is used for reservoir pressurization. The hydraulic power package is controlled through the HYD-OFF switch and monitored through a pressure gauge, located on the central section of the instrument panel, and an amber caution light operated by a fault detection box. Gauge indication is read in psi.

The hydraulic power package operates in three different modes:

- High Duty Mode
- Low Duty Mode
- Non-operating Mode

When in high duty mode the system delivers a hydraulic pressure in the nominal range from 1800 to 3100 psi for landing gear extension and retraction only. This mode of operation is selected, with the hydraulic system control switch in the HYD position, by moving the landing gear control lever either from the DOWN to the UP or from the UP to the DOWN position: a solenoid-operated depressurizing valve converts the pump from the low to the high duty mode and viceversa, while the solenoid-operated directional valve provides the landing gear extension and retraction. When the landing gear reaches the retracted position the landing gear up stop switch stops the power package. When the landing gear reaches the extended position the landing gear down stop switches allow the power package to be converted to the low duty mode. The landing gear squat switches prevent the directional control valve from delivering high pressure hydraulic fluid to the landing gear actuators if the landing gear control lever is moved to the UP position while the airplane is on the ground.

When in low duty mode of operation the system delivers a hydraulic pressure in the range from 800 to 1200 psi for nose wheel steering and wheel brakes actuation. This is the normal ground operating mode.

The Non-operating mode is automatically selected during the flight after the landing gear has completed the retraction or by setting to the OFF position the hydraulic system control switch.

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The hydraulic pump motor is connected to the right generator bus through a remote control circuit breaker controlled by the hydraulic system control switch through the HYD CONT 0.5-ampere circuit breaker on the pilot circuit breaker panel.

A pressure transducer on the pump delivery line drives the hydraulic pressure gauge via the fault detection box. An electronic circuitry which couples the transducer output signal with the operating mode information allows the HYD PRESS amber caution light on the annunciator panel to come on when the delivery pressure is out of the range corresponding to the selected operating mode or when, with the gear lever set to DN, the HYD switch is set to OFF or the HYD CONT circuit breaker is pulled out.

The correct operation of the fault detection box can be checked by rotating to the HYD position then depressing the SYS TEST knob on the instrument panel. Refer to the Normal Procedures Section for further information about test procedure. Electrical power for operating the hydraulic pressure monitoring system is delivered from the essential bus through the HYD PRESS WARN 3-ampere circuit breaker on the pilot circuit breaker panel.

A differential pressure switch, parallel connected with the hydraulic fluid filter, drives the HYD FILTER red warning light in the Ground Test/Refuel panel: when the light is on the filter element must be replaced to avoid possible filter by-pass.

The HYD LEVEL red warning light in the Ground Test/Refuel panel will come on when the "low level" probe detects an insufficient amount of hydraulic fluid in the system. Refer to Section 3 of this manual for servicing the system if a filter obstruction occurs or the hydraulic fluid reservoir needs to be refilled.

A hand pump through an independent ducting system and a landing gear emergency selector valve allows supplying hydraulic fluid pressure for extending the landing gear if either a power package failure or a severe hydraulic fluid leakage occurs: a sufficient amount of hydraulic fluid remains in the reservoir, below the motor-driven pump suction port, for the hand pump operation.

A service selector valve allows retracting and extending the landing gear using the hand pump during ground maintenance operations with the airplane on jacks. The service selector valve is not accessible during flight.

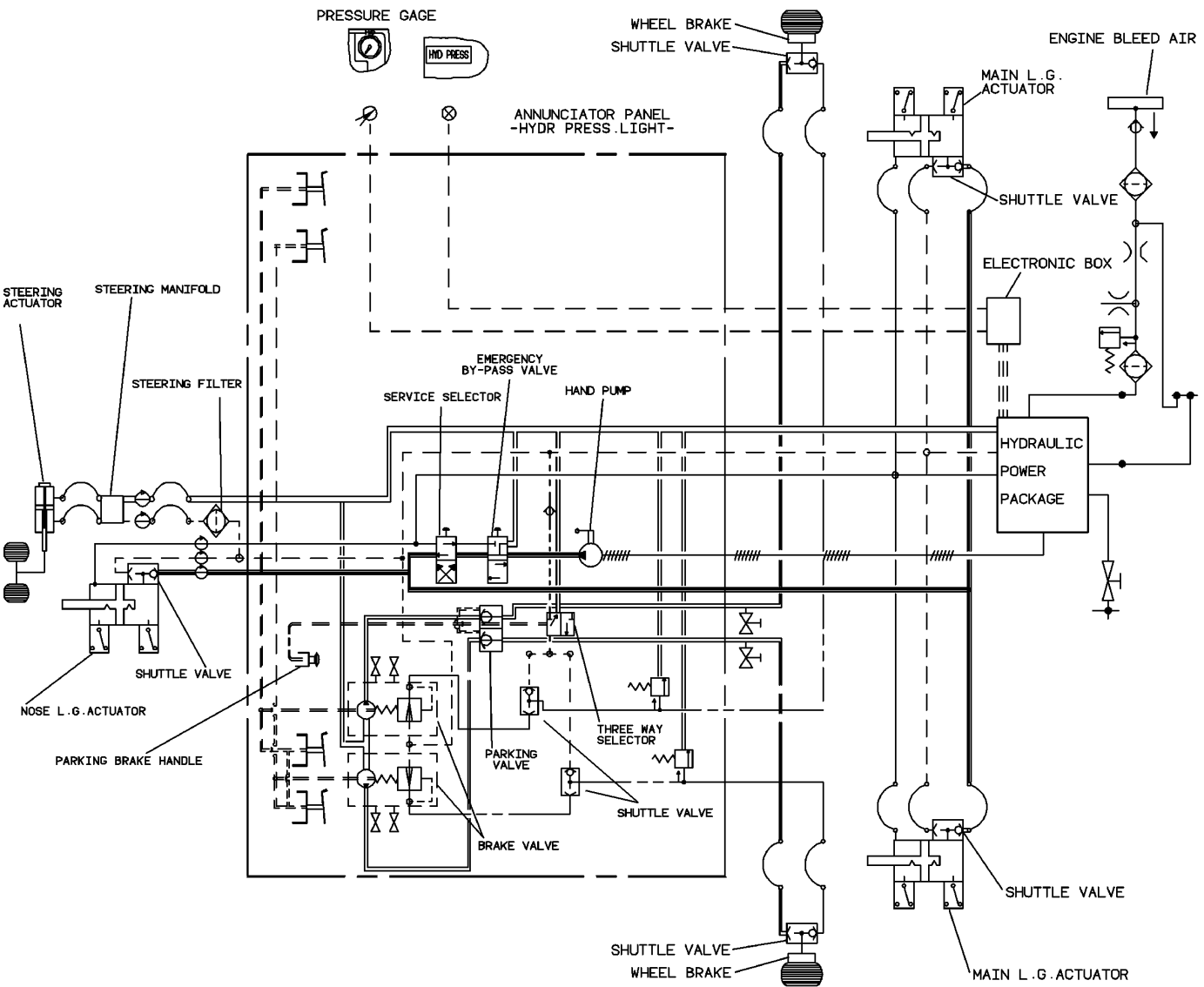


Figure 2.15-1. Hydraulic System

Issued: May 22, 2006

Rev. A0

Rep. 180-MAN-0030-01102

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DESCRIPTION AND OPERATION

HYDRAULIC SYSTEM

2.15.1 LANDING GEAR

The airplane is equipped with hydraulically actuated, fully retractable tricycle landing gear: the double-wheel nose gear retracting forward into the nose section and the main gear retracting rearward into the fuselage. Doors completely cover the retracted gear.

The rear door of the nose gear well and the forward doors of the main gear strut wells are mechanically operated by the gear through connecting linkages and remain open when the gear is extended. The wheel well doors of the nose gear (side hinged doors) and of the main gear (aft doors), that are mechanically operated, open during gear extension and close when the gears are fully extended. All the three landing gear shock absorbers are of the air-oil type.

The nose gear is steerable through 50 degrees left and right when on taxiing and 20 degrees left and right when on takeoff.

To guard against the retraction of the landing gear when the airplane is on the ground or when the nose wheel is not centered, two squat switches (one on the nose gear and one on the right main gear shock absorber) are provided: they inhibit the hydraulic power package from supplying pressure fluid to the "up section" of the gear actuators.

All the nose and main gear actuators are fully extended when the landing gear is down and retracted when the landing gear is up. Each actuating cylinder is provided with internal up and down locks. Each lock directly actuates the switches controlling the landing gear position indicating lights. The locks are normally closed type and can be opened only by applying positive pressure. An internal shuttle valve in each actuating cylinder allows operating the landing gear extension either on the main or on the emergency hydraulic lines. The landing gear controls and indicators are located on the LANDING GEAR panel in the center of instrument subpanel.

The two position (UP and DN) landing gear control lever is just to the right of the indicator lights assemblies:

- three UNSAFE red warning lights (NOSE, LH and RH)
- three LOCKED DN green advisory lights (NOSE, LH and RH)

Each red word readout type light indicates that the corresponding gear is in motion between the "up locked" and the "down locked" position. Each green word readout type light indicates that the corresponding gear is down and locked. When the gear is up and locked, there is no light illuminated.

CAUTION

A red LH or RH light illuminated after gear extension or retraction may indicate that the corresponding side main gear rear door is not positively closed and locked. In this event the positive lock of the landing gear leg can be checked through the hydraulic pressure indication.

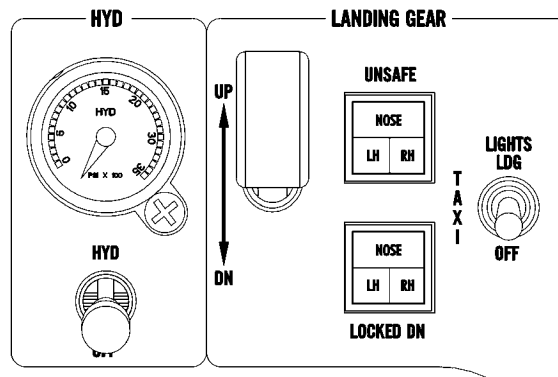


Figure 2.15-2. Hydraulic System / Landing Gear Controls and Indication

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A 326 Hz GEAR WARNING acoustic tone will be generated when:

- the power on one or both of the engines is reduced below a setting sufficient to maintain flight while the landing gear is not locked down. The GEAR WARNING can be silenced by means of the GEAR MUTE switch on the right power lever.
- the flaps are lowered to the DN position and the landing gear is not locked down. The GEAR WARNING cannot be silenced and will continue until either the landing gear is extended or the flaps are retracted to the clean (UP) setting.
- the flaps are in MID position, the landing gear is not locked down and the left power lever is retarded approximately below the half travel position. The GEAR WARNING cannot be silenced and will continue until either the landing gear is extended or the flaps are retracted to the clean (UP) setting.

The correct operation of the landing gear indicating system can be checked selecting on the SYS TEST panel the LND GR position and pressing the central button: the UNSAFE red and the LOCKED DN green lights should illuminate while the GEAR WARNING tone should be generated.

For the emergency extension of the landing gear, in the event of an hydraulic system failure due to a line breakage or a power package malfunction, a hydraulic hand pump and an emergency selector valve are provided with independent emergency lines from the fluid reservoir to the gear actuators. The emergency extension of the landing gear requires that hydraulic system control switch is set to OFF, the landing control lever is set to the DN position and the emergency selector is pulled up: the "UP section" of the gear actuators will be connected to a separated return line while the "DOWN section" will be connected to the hand pump emergency line. About 60 hand pump strokes are required for a positive lock of the gear (the three LOCKED DN green lights on).

The electrical power for the landing gear control and indication is supplied from the essential bus through the 3-ampere LDG GEAR CONT circuit breaker on the pilot circuit breaker panel.

The main gear wheels are 6.50 x 10 units fitted with 6.50 x 10 tubeless type, 12 ply rating tires. The nose gear is equipped with two 5.00 x 5 wheels fitted with 5.00 x 5 tubeless type, 8 ply rating tires.

2.15.2 BRAKE SYSTEM

The main wheels brakes are hydraulically actuated by depressing the toe portion of either the pilot's or copilot's rudder pedals. Each carbon brake receives pressure from the corresponding metering valve which delivers hydraulic fluid pressure to the brake actuating pistons. Each brake valve, mechanically operated by the pedals, allows delivering metered pressure fluid from the hydraulic system to the brake unit proportionally to the load applied on the pedals: a compensating spring inside each brake valve contrasts the pilot action on the pedals simulating the brakes reaction.

An integral automatic diverter allows the brake valve to operate as a master cylinder when the pressure drops below 500 psi due to a hydraulic power package failure or line breakage. In this event the action on the pedals results in a fluid pressure directly applied to each brake unit through a separate emergency line: a shuttle valve is provided on each brake unit to connect the pistons to the main or to the emergency line.

CAUTION

Emergency brakes operation requires increased load is applied on the pedals.

A safety relief valve is installed on each brake main line for protecting the brake against over pressure.

The parking brake is actuated through the PARKING BRAKE handle located just below the instrument panel on the left side of the control pedestal. The handle simultaneously operates a three way selector valve and a parking brake valve.

When the hydraulic power package is operating the parking brake can be engaged by pulling out and then rotating clockwise to the vertical position the PARKING BRAKE handle: the three way selector valve connects the landing gear "down" pressure line on the brakes main lines through two shuttle valves. A non-return valve on the inlet line of the three way selector valve maintains trapped the pressure to the brakes, after the parking brake has been engaged, if the hydraulic power package is turned off.

When the hydraulic power package is not operating the parking brake can be engaged by pulling out and then rotating to the vertical position the PARKING BRAKE handle while pressing on the pedals: the parking brake valve on the emergency lines traps the pressure to the brakes: more than one action on the pedals is recommended.

The vertical position of the parking brake handle indicates that the parking brake system is engaged.

The parking brake can be released by rotating to the horizontal position and then pushing in the PARKING BRAKE handle.



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2.15.3 STEERING SYSTEM

The electro-hydraulically operated nose gear steering is controlled by means of the rudder pedals. The system consists of a solenoid operated steering select valve, a servovalve, a hydraulic steering actuator and an electrical circuitry for controlling and monitoring the system in a close loop.

The steering selector valve acts as a shut-off valve. When not-energized the valve disconnects the steering system from the hydraulic system and converts the steering actuator to operate as a "shimmy damper" by connecting the "left" to the "right" section of the actuator through calibrated orifices. When energized the valve connects the hydraulic system to the servovalve which drives the steering actuator. A squat switch on the nose gear leg allows energizing the selector valve only when the airplane is on the ground while a fault monitoring circuit prevents energizing the selector valve in the event of a steering system failure. As additional safety, the electrical power to the steering system is controlled by the nose gear "down" limit switch which prevents power to be delivered to the steering control system if the gear is not locked down. The electrical power voltage which controls the servovalve is a function of the difference between the signals generated by two potentiometers: a COMMAND potentiometer, driven by the rudder pedals, and a FEEDBACK potentiometer, driven by the nose gear leg while steered.

The steering system engages after the STEERING CONTROL push button on the left handle of the pilot control wheel has been actuated. The two-momentary-position button allows selecting to different steering operating modes:

- Low gain mode for TAKEOFF operations
- High gain mode for TAXI operations

After the battery has been switched ON and/or after the control wheel Master Switch has been operated, a pressure on the STEERING CONTROL button up to the first step does not engage the steering system, while pressing up to the second step, the take off mode is operative: the nose gear can be steered up to 20 deg. in both directions. The control circuitry allows a pedal travel corresponding to about 6 deg. of rudder angular travel, with no steering action. This steering delay enables the pilot to operate the rudder on cross wind takeoff or landing maintaining the nose wheel centered.

When the steering operates in take off mode the STEER T-O white advisory annunciation appears on the PFD.

Pressing again the button to the first step, the taxi mode is operative: the nose gear can be steered up to 50 deg. in both directions and the STEER TAXI wight annunciation on the PFD, will flash.

The steering can be disengaged by depressing the control wheel Master Switch (MSW) on the outboard handle of both the pilot and the copilot control wheels.

NOTE

In addition to the steering system disengagement the momentary type MSW pushbutton, when depressed, will disengage the autopilot and will inhibit the primary pitch trim or rudder trim in the event of an actuator runaway.

The STEER FAIL red warning light, on the annunciator panel, will illuminate in the event of a steering system failure. The warning and the feedback circuitry can be checked for proper operation by rotating to the STEER position then depressing the SYS TEST knob on the instrument panel. Refer to the Normal Procedures Section of the Airplane Flight Manual for further information about test procedure.

The electrical power for the steering system control and monitoring is supplied from the essential bus through the 3-ampere NOSE STRG circuit breaker on the pilot circuit breaker panel.