SECTION 13

HYDRAULICS

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SECTION 13

HYDRAULICS

1. GENERAL (Figure 1)

Hydraulic power for operation of the flight controls, landing gear, nose wheel steering and brakes is furnished by three independent hydraulic systems, designated No. 1, No. 2 and No. 3.

No. 1 system is pressurized by the left engine-driven pump or by an ac electric motor-driven pump located at the left side of the rear equipment bay.

No. 2 system is similar and is pressurized by the right engine-driven pump or by a second ac electric motor-driven pump located at the right side of the rear equipment bay.

No. 3 system is pressurized by either of two ac electric motor-driven pumps, designated 3A and 3B and located on either side of the fuselage.

2. NO. 1 AND NO. 2 HYDRAULIC SYSTEMS (Figures 2, 3, 4 and 5)

NOTE: No. 1 system is described; No. 2 system is similar except where noted.

A. Engine-Driven Pump

The No. 1 system engine-driven pump (EDP) is mounted on the accessory gearbox of the left engine. The pump automatically varies its displacement to control fluid outlet pressure at a nominal 3000 psi. A motor-driven shutoff valve, located on the engine mounting beam, closes the EDP supply line when the LH ENG FIRE PUSH switch/light on the glareshield is pressed in.

B. AC Electric Pump

An ac electric motor-driven pump is mounted on the left side of the rear fuselage equipment bay and has the same mechanical operation as the EDP. The pump is supplied with electric power from the ac main bus No. 2. The pump is manually controlled by a switch on the hydraulic system control panel in the flight compartment. The No. 2 system ac pump is supplied with electric power from the ac main bus No. 1.

If the left engine fails or is shut down, the left engine-driven pump fails and the normal source of electrical power for ac main bus No. 1 is removed. When this occurs, the right EDP supplies hydraulic pressure to the No. 2 hydraulic system and ac main bus No. 2 powers the No. 1 hydraulic system ac electric pump. Although electric power is automatically distributed from the right engine generator to both ac main busses by the generator transfer contactors, the No. 1 generator line contactor (GLC-1) opens when the left engine generator fails, removing

power from the No. 2 hydraulic system ac electric pump. The failure or shutdown of the right engine causes a similar chain of events involving GLC-2 and the No. 1 hydraulic system ac electric pump.

C. Reservoir

The hydraulic system reservoir is of the self-pressurizing, bootstrap type. A suction pressure of 55 psi is maintained by system pressure acting on a piston within the reservoir. The reservoir has direct reading fluid level indicator, a fluid temperature probe and an overflow line connected to an overflow tank.

D. Accumulator

A piston-type accumulator, located below the reservoir, maintains pressure when rapid increases in demand are made on the system. The accumulator is precharged with nitrogen. A nitrogen pressure gauge is located on the No. 1 system ground service panel inside the aircraft to the left of the rear equipment bay door.

E. Heat Exchanger

A ram air heat exchanger, with separate cores for No. 1 and No. 2 systems, is located aft of the rear equipment bay door. Ram air from the dorsal fin inlet cools the cores in flight. An automatic, temperature-controlled, electric blower cools the cores if an overheat condition occurs.

3. NO. 3 HYDRAULIC SYSTEM (Figure 6)

A. AC Electric Pumps

Two identical ac electric-motor-driven pumps designated 3A and 3B, mounted on either side of the fuselage, supply hydraulic power to the No. 3 hydraulic system. Each pump varies its displacement automatically to control its fluid outlet pressure to a nominal 3000 psi.

B. Reservoir

The No. 3 system reservoir is located between the main wheel bins in the main landing gear bay and is similar to the No. 1 and No. 2 system reservoirs.

C. Accumulator

The No. 3 system accumulator is located forward of the right main landing gear bin in the main landing gear bay and is similar to the No. 1 and No. 2 system accumulators. The accumulator nitrogen pressure gauge is located forward and outboard of the right main landing gear bin. If a double engine failure occurs this accumulator caters for flight control requirements until the air-driven generator comes on line.

D. Fuel/Oil Heat Exchanger

On aircraft that do not incorporate Canadair SB 600-0318, a fuel/oil heat exchanger, located in the right wing root forward of the main landing gear well, ensures adequate heat transfer from the hydraulic fluid to the fuel.

E. Air-Driven Generator

If both primary ac electric systems fail, the air-driven generator (ADG) automatically deploys and the ADG ac emergency transfer contactor, ADG AC ENER TC energizes, connecting ac electric pump 3B directly to the ADG bus, bypassing the pump ON/OFF control switch. Thus, No. 3 hydraulic system continues to operate in the normal manner, powered by the ADG bus, using pump 3B only.

4. LANDING GEAR (Figures 7 and 8)

The main landing gear retracts inward into a recess in the wing and centre fuselage and the nose landing gear retracts forward beneath the flight compartment. Normal extension and retraction is electrically controlled and hydraulically operated. Hydraulic pressure for normal landing gear operation is supplied by No. 3 hydraulic system.

For emergency landing gear operation, the gear may be extended by pulling the landing gear manual release T-handle in the flight compartment. The handle mechanically releases the landing gear uplocks and dumps hydraulic pressure, allowing the gear to free-fall. The gear is assisted by a combination of airflow and spring pressure on the nose gear, and by a down-lock assist actuator, supplied by No. 2 hydraulic system, on the main gear.

The landing gear control lever is positioned on the right side of the centre instrument panel and is normally operated by the copilot, but is within reach of the pilot. Landing gear down and locked indications are given by three green lights on the landing gear selector panel. Landing gear unsafe red lights, in the landing gear handle, flash when the gear is in transit or any landing gear leg is not locked in the selected position. An aural warning occurs if the landing gear is not down and locked and either of the throttles is retarded to HIGH IDLE or the wing flaps are extended more than 30 degrees. The warning horn may be muted, with the throttles retarded, by pushing the MUTE HORN button on the selector panel. The horn, however, cannot be muted when the flaps are extended more than 30 degrees.

A. Landing Gear Control Unit

The landing gear control unit is located in the underfloor avionics bay and contains two circuits: a landing gear control circuit and a weight-on-wheels circuit.

The landing gear control circuit processes landing gear control information using inputs from the landing gear proximity switches, the landing gear control lever and the throttle levers. Outputs from the circuit consist of landing gear command signals, landing gear control lever indicator/interlock signals and aural warning signals.

The weight-on-wheels (WOW) circuit provides two independent outputs designated WOW 1 and WOW 2. Each WOW output circuit receives proximity switch signals and passes either a weight-on-wheels or a weight-off-wheels signal to the other aircraft systems using WOW information. A comparator circuit causes the amber WOW OP FAIL light on the centre instrument panel to come on if a disagreement exists among the various weight-on-wheels outputs or if power is removed from either WOW circuit. A similar circuit causes the amber WOW IP FAIL light on the centre instrument panel to come on if a disagreement exists among the various inputs to either of the WOW channels.

B. Landing Gear Control Lever

The landing gear control lever has a solenoid-operated downlock which prevents inadvertent selection of gear UP with a weight-on-wheels signal input. The downlock may be mechanically overridden by displacing the release button adjacent to the control lever. The override permits the landing gear to be retracted, if the downlocks fail to disengage normally due to a fault in the solenoid circuit or due to a WOW switch giving a weight-on-wheel signal after take-off when a gear UP selection is attempted.

5. MAIN LANDING GEAR BAY OVERHEAT DETECTION SYSTEM (Figure 9)

Overheat and fire detection is provided for the main landing gear bay by fire-sensing cables, which are routed around the top inner surface of each main wheel bin and connected to a detection control unit in the flight compartment. A panel with two switch/lights marked OVHT and OVHT WARN FAIL, is located on the centre instrument panel above the landing gear control panel.

The detection control unit, which has two channels, overheat and short-to-ground, discriminates between an actual overheat condition and a short circuit. If an overheat condition occurs, the resistance change in the sensing cable is detected by the overheat channel and the red OVHT light comes on. The control unit resets automatically when the cable resistance increases above the alarm point, as a result of a temperature decrease in the main wheel bay. A short circuit is detected by the short-to-ground channel, which causes the amber OVHT WARN FAIL light to come on.

Pressing the OVHT switch/light checks the integrity of the circuit and causes the red OVHT light to come on. When the OVHT WARN FAIL switch/light is pressed, the MLG BAY OVHT FAIL light on the annunciator panel comes on, the MASTER CAUTION and WARNING lights flash and the OVHT WARN FAIL light comes on.

6. NOSE WHEEL STEERING (Figure 10)

Airplanes that do not incorporate Canadair SB 600-0380 have a mechanically controlled, hydraulically operated nose wheel steering system electrically armed by the N/W STEER switch on the pilot's facia panel. The pilot's steering quadrant provides 53 to 55 degrees nose wheel steering each side of centre. Normal hydraulic steering is available when the N/W STEER switch, above the steering quadrant, is in the ARMED position, the nose landing gear is down and locked, and one or both weight-on-wheels signals is present. When the N/W STEER switch is set to OFF, hydraulic pressure is removed from the nose wheel steering actuator.

Using the nose wheel steering control wheel, the pilot can turn the aircraft during taxiing without differential braking. However, it is not possible to steer beyond the maximum range of 55 degrees using hydraulic power because the rack and pinion disengages. For towing or taxiing with differential braking, the N/W STEER switch must be set to OFF to shut off the hydraulic supply and permit the nose wheels to castor up to approximately 90 degrees. Hydraulic power must not be used to re-engage the rack and pinion. If the nose wheels are at an angle greater then 55 degrees left or right, they must be brought to a lesser angle by towing or by differential braking before arming the hydraulic nose wheel steering system.

Airplanes that incorporate Canadair SB 600-0380 have an electro-mechanical nose wheel steering system, (also described as a steer-by-wire system), controlled by an electronic control module (ECM). With the nose gear down and locked, weight on wheels and the N/W STEER switch set to ARMED, nose wheel steering is available through the steering quadrant or the pilot's and copilot's rudder pedals. Full movement of the steering quadrant commands 55 degrees of nose wheel steering and full deflection of the rudder pedals commands 7 degrees of nose wheel steering. The ECM adds the steering signals from the steering quadrant and the rudder pedals to produce the desired nose wheels rotation but will not command nose wheel steering angles greater than 55 degrees. Thus, if the steering controls are crossed, the ECM commands nose wheels rotation equal to the difference between the two steering signals. If the steering controls are coordinated, the nose wheels rotate to an angle equal to the sum of the steering commands until a nose wheels angle of 55 degrees is obtained. At this point, any further increase in the steering command has no effect on the position of the nose wheels. During operation of the system with the nose wheels near the maximum commanded steering angle, steering angles greater than 55 degrees can be obtained on rough terrain or when normal steering inputs are augmented by differential application of brakes or engine thrust. In this case, the ECM automatically places the system in the free castoring mode and steering can only be re-engaged by reducing the steering angle to below 55 degrees and cycling the N/W STEER switch between OFF and ARMED.

When the N/W STEER switch is off, if hydraulic power is removed from the system or if an automatic shutdown has been commanded by the ECM, the system reverts a free castoring mode. In this mode, the nose wheels are free to turn up to 99 degrees from the centered position. Free castoring is used during towing or when asymmetric thrust and braking must be used to obtain a low aircraft turning radius.

The ECM monitors the system and automatically places it in the free castoring mode if an electrical or mechanical fault is detected. After the fault is detected, the N/W STEER FAIL light comes on and the system remains in the free castoring mode, regardless of the position of the N/W STEER switch, until the fault is corrected and the system is reset.

On all aircraft, a centering cam in the nose wheel strut centers the nose wheel when the strut is extended during take-off.

7. BRAKES

Each main wheel is fitted with a hydraulic disc brake unit. The inboard brakes are powered by the No. 3 hydraulic system and the outboard brakes by the No. 2 hydraulic system. Each hydraulic system has a nitrogen-charged brake accumulator which provides sufficient hydraulic pressure for approximately eight brake applications following system failure or shutdown. A hydraulic fuse in each brake line prevents complete loss of fluid because of a leak in the brake area. Nitrogen pressure gauges, for both brake system accumulators, are located in the nose landing gear bay on the forward left-hand side.

8. ANTI-SKID SYSTEM (Figure 11)

The anti-skid system consists of a skid control unit, two dual anti-skid control valves and wheel speed sensors located in the axle of each main wheel. The system independently controls the braking of each main wheel by automatically varying the hydraulic pressure output of each dual brake control valve before these outputs reach the brakes.

An arming switch on the anti-skid panel controls power to the skid control unit from the 28-volt dc main bus via the anti-skid inboard and outboard relays and the parking brake microswitch. The system therefore cannot be armed when the parking brake is on (parking brake shutoff valve closed). When the parking brake is applied, the INBD FAIL anti-skid caution light comes on.

Inputs received by the control unit are weight-on-wheels and wheel velocity information. The control unit outputs consist of control signals to the anti-skid valves, warning signals to failure indication lights and a logic wheel spin-up signal to the ground spoiler control unit.

The anti-skid system has the following features:

- Modulated skid prevention of each wheel through the primary anti-skid circuits.

- Locked wheel prevention, which provides a pressure dump signal in the event of a deep skid or failure of a wheel to spin-up at touchdown, and which also provides a coarse backup circuit in the event of failure of the primary anti-skid circuit.

- Pre-landing protection which, via input from the weight-on-wheels circuitry, dumps all brake pressure at all wheels while the aircraft is still airborne, but is overridden to allow normal skid-controlled braking as soon as the wheels have spun up.

- Built-in test equipment to provide a check of virtually all the system circuits both on the ground (pre-take-off) and in the air (pre-landing).

9. PARKING BRAKE (Figure 12)

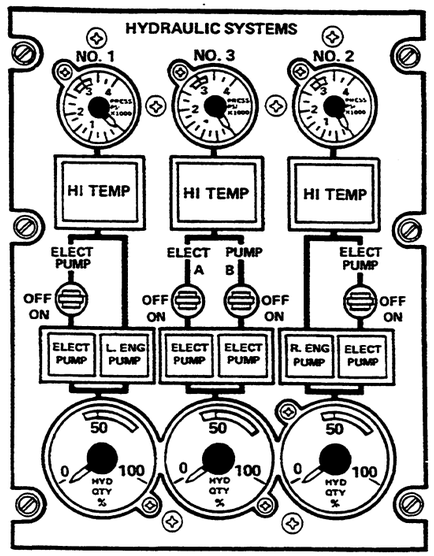
The parking brake system consists of a parking brake handle mounted at the lower right edge of the pilot's instrument panel connected via a push-pull cable assembly to the lever of the dual brake valve control mechanism.

The parking brake is applied by fully depressing both brake pedals on either the pilot's or copilot's rudder pedals and pulling the brake handle out to engage a pair of latches in the brake valve control mechanism, securing both dual brake valves in the on position. With the brake pedals depressed to contact stops, the handle is rotated 90 degrees in either direction to seat the handle in the locked position; pedal pressure may then be released, observing that the pressure remains trapped on the inboard brakes. The parking brake is released by applying brake pressure on the pedals until the parking brake is unloaded. The handle is then rotated 90 degrees to unlock the latches and release the handle to the stowed position when the pressure on the brake pedals may be released.

On applying the parking brake, the following occur:

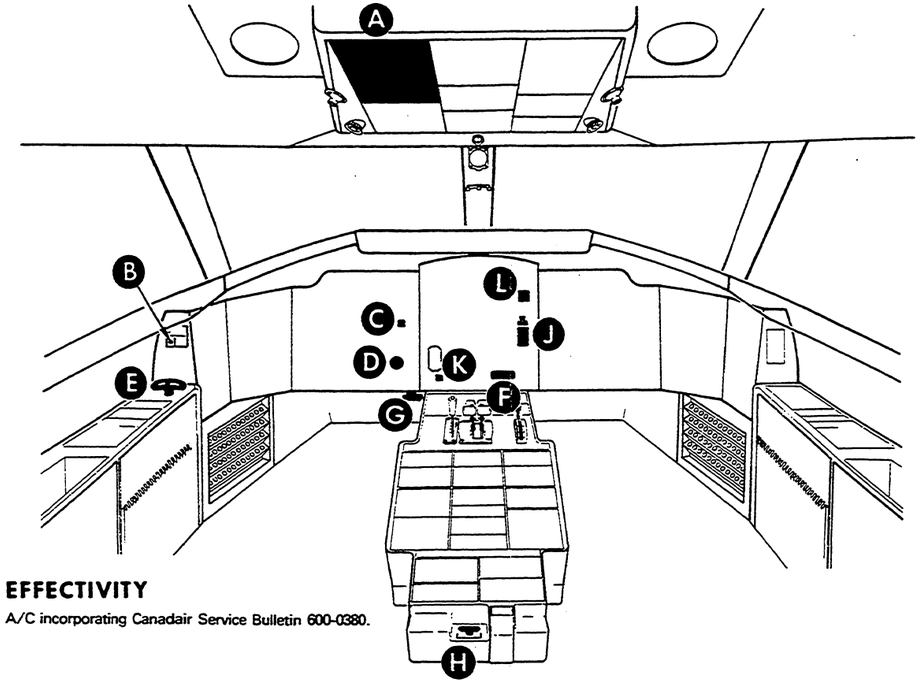
- PARKING BRAKE light comes on
- Parking brake shutoff valve closes
- Anti-skid system relays de-energize

The INBD FAIL anti-skid light comes on if the parking brake shutoff valve fails to open when the parking brake is released and the anti-skid system is armed.



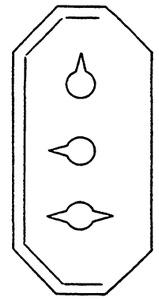
HYDRAULIC SYSTEM PANEL

A



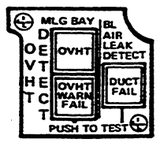
EFFECTIVITY

① A/C incorporating Canadair Service Bulletin 600-0380.



PARKING BRAKE LIGHT

K

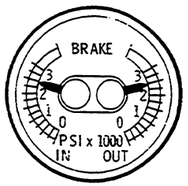


MAIN LANDING GEAR BAY
OVERHEAT WARNING LIGHTS

L

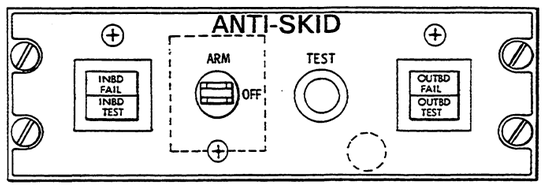
LANDING GEAR CONTROL PANEL
WEIGHT ON WHEELS FAIL LIGHTS
NOSE LANDING GEAR DOOR UNLOCKED LIGHT

J



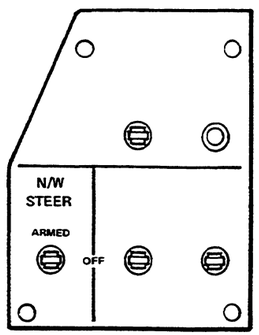
BRAKE PRESSURE INDICATOR

D



ANTI-SKID PANEL

F

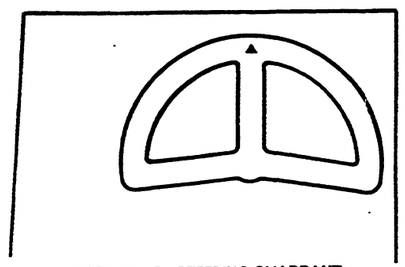


NOSE WHEEL STEERING ARMING SWITCH

B

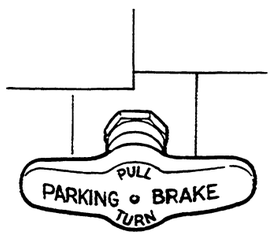
NOSE WHEEL STEERING FAIL LIGHT

C ①



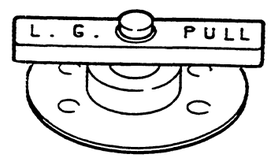
NOSE WHEEL STEERING QUADRANT

E



PARKING BRAKE HANDLE

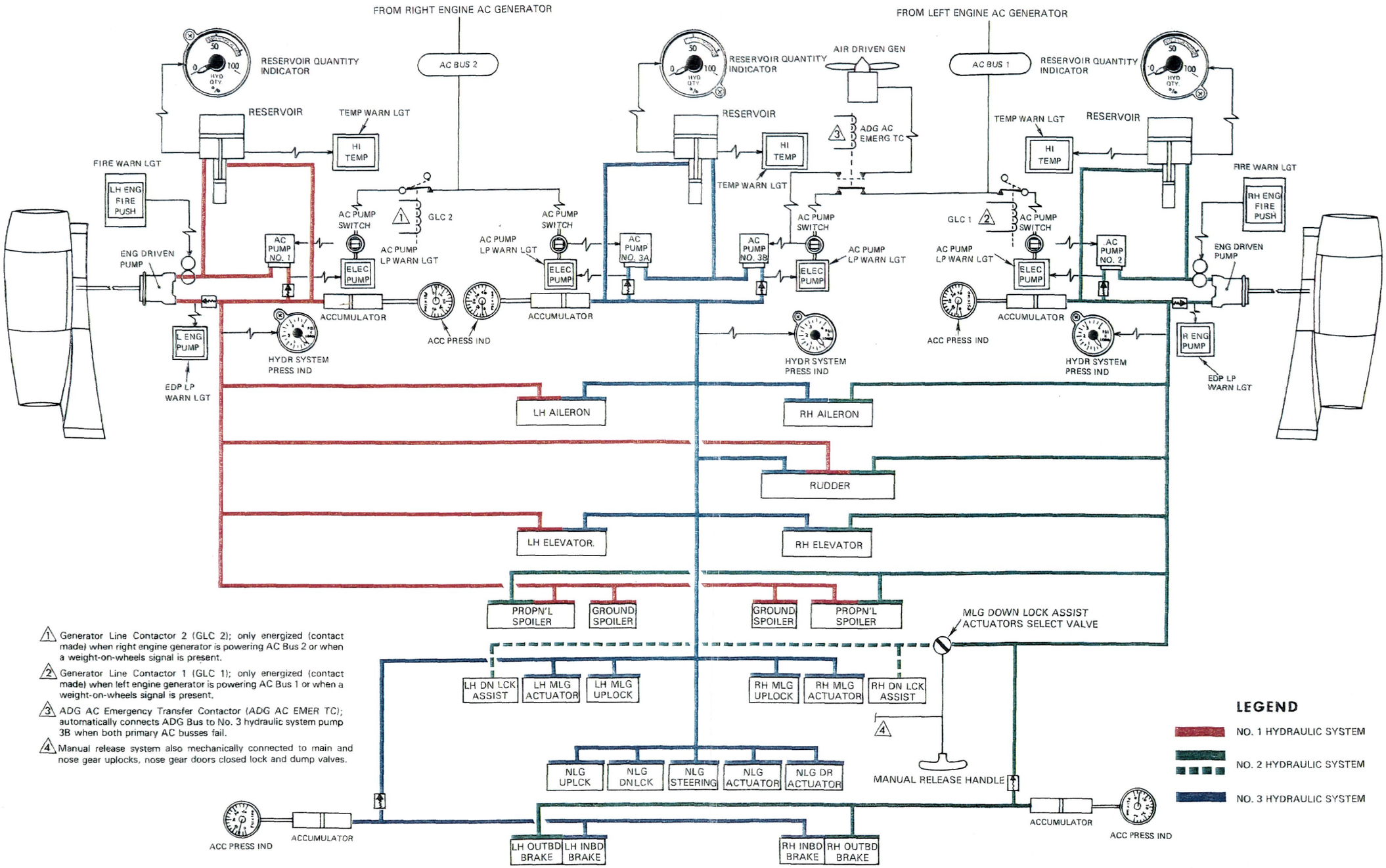
G



LANDING GEAR MANUAL RELEASE HANDLE

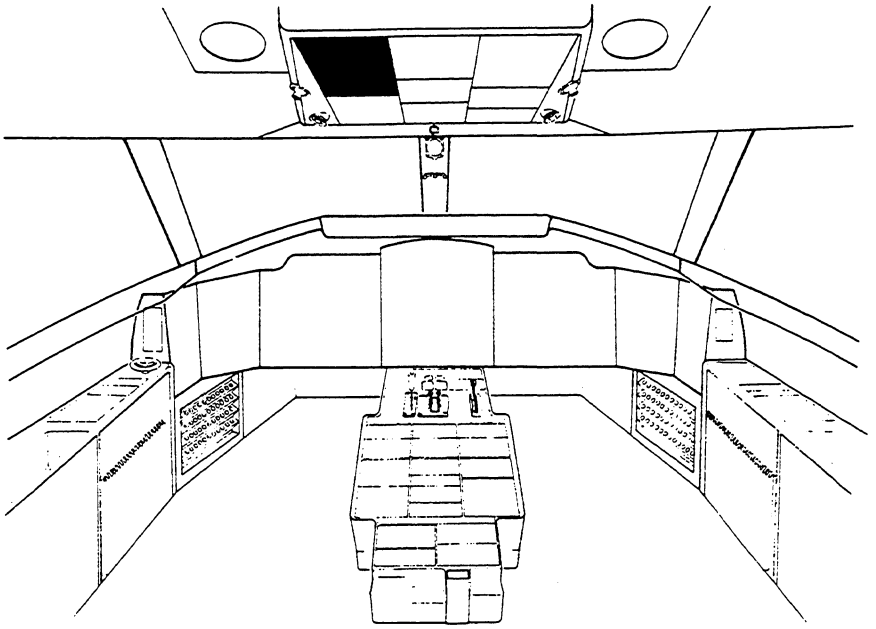
H

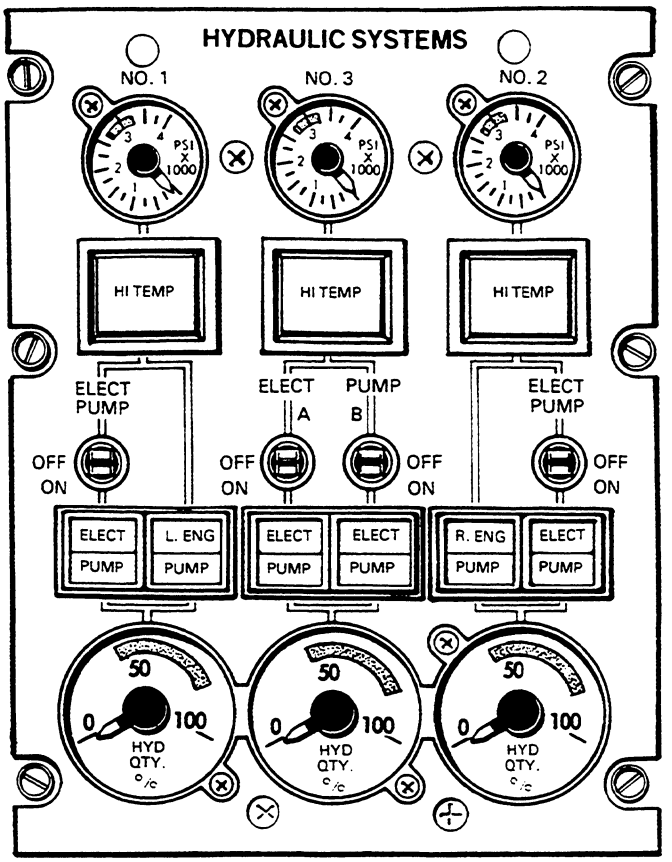
Hydraulic System Controls and Indicators
Figure 1



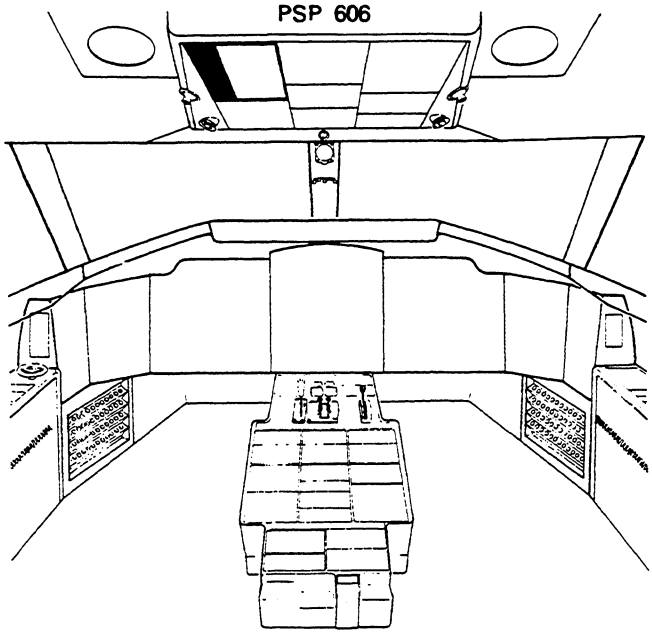
1. Generator Line Contactor 2 (GLC 2); only energized (contact made) when right engine generator is powering AC Bus 2 or when a weight-on-wheels signal is present.
2. Generator Line Contactor 1 (GLC 1); only energized (contact made) when left engine generator is powering AC Bus 1 or when a weight-on-wheels signal is present.
3. ADG AC Emergency Transfer Contactor (ADG AC EMER TC); automatically connects ADG Bus to No. 3 hydraulic system pump 3B when both primary AC busses fail.
4. Manual release system also mechanically connected to main and nose gear uplocks, nose gear doors closed lock and dump valves.

Hydraulic System - Schematic
Figure 2





Hydraulic System Control Panel
Figure 3



HIGH TEMPERATURE WARNING LIGHT

Light comes on to indicate that hydraulic fluid temperature has exceeded upper limit.

AC ELECTRIC PUMP LOW PRESSURE WARNING LIGHT

Warning light comes on at 1800 psi decreasing pump discharge pressure and goes out at 2300 psi increasing pump discharge pressure. Warning light is armed when AC electric pump control switch is set to ON and/or wing flaps are extended.

RESERVOIR QUANTITY INDICATOR

Gauge indicates the hydraulic fluid quantity in the system reservoir. Normal quantity, with the system operating, is 40% to 80% full (green band). Gauge indicates 0% when electrical power is removed.

HYDRAULIC SYSTEM PRESSURE INDICATOR

Gauge indicates hydraulic pressure in the system. Normal operating pressure is 3000 psi ± 150 psi. Gauge indicates 0 psi when electrical power is removed.

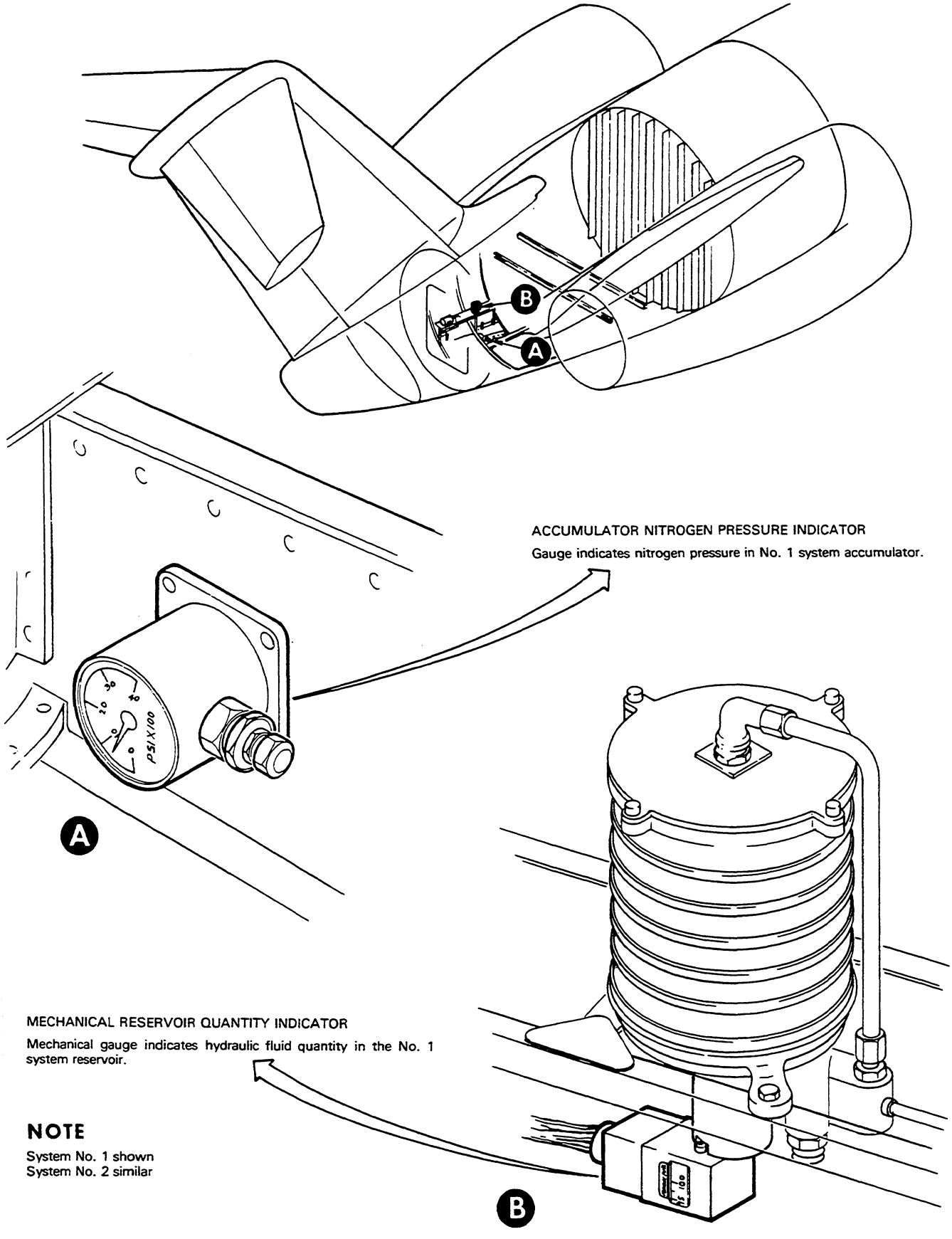
AC ELECTRIC PUMP ON-OFF SWITCH

Switch provides control of AC pump.

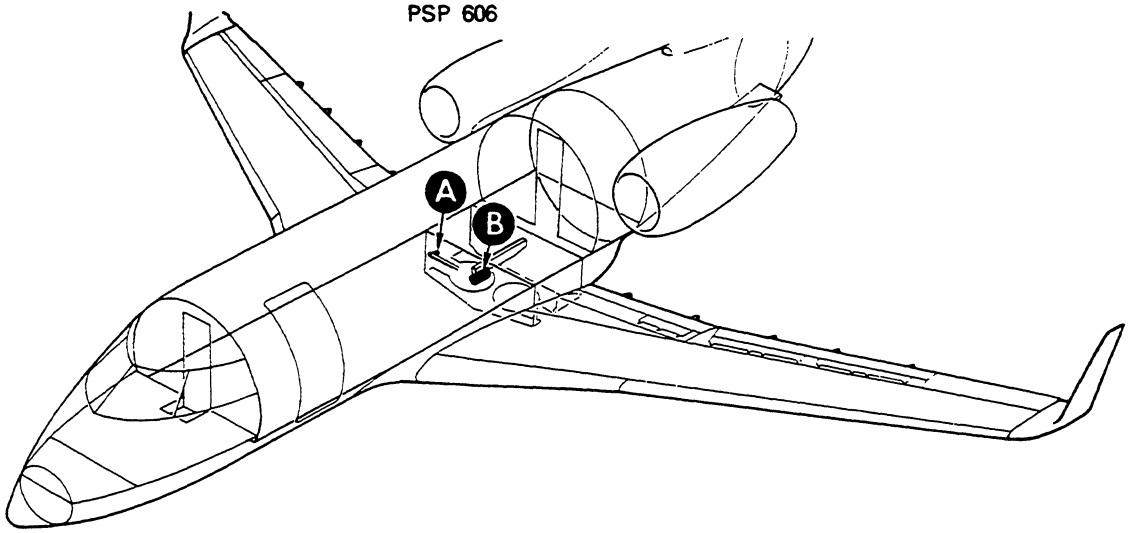
ENGINE DRIVEN PUMP LOW PRESURE WARNING LIGHT

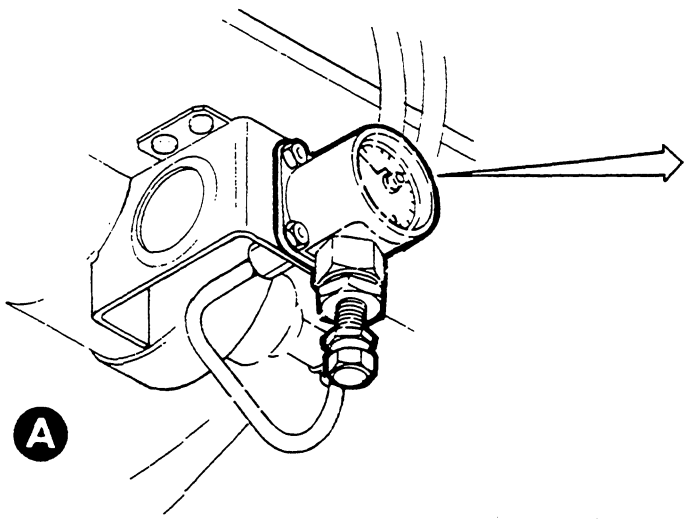
Warning light comes on at 1800 psi decreasing pump discharge pressure and goes out at 2300 psi increasing pump discharge pressure. Warning light is armed when master caution and warning system is activated

Hydraulic Control Panel
Figure 4



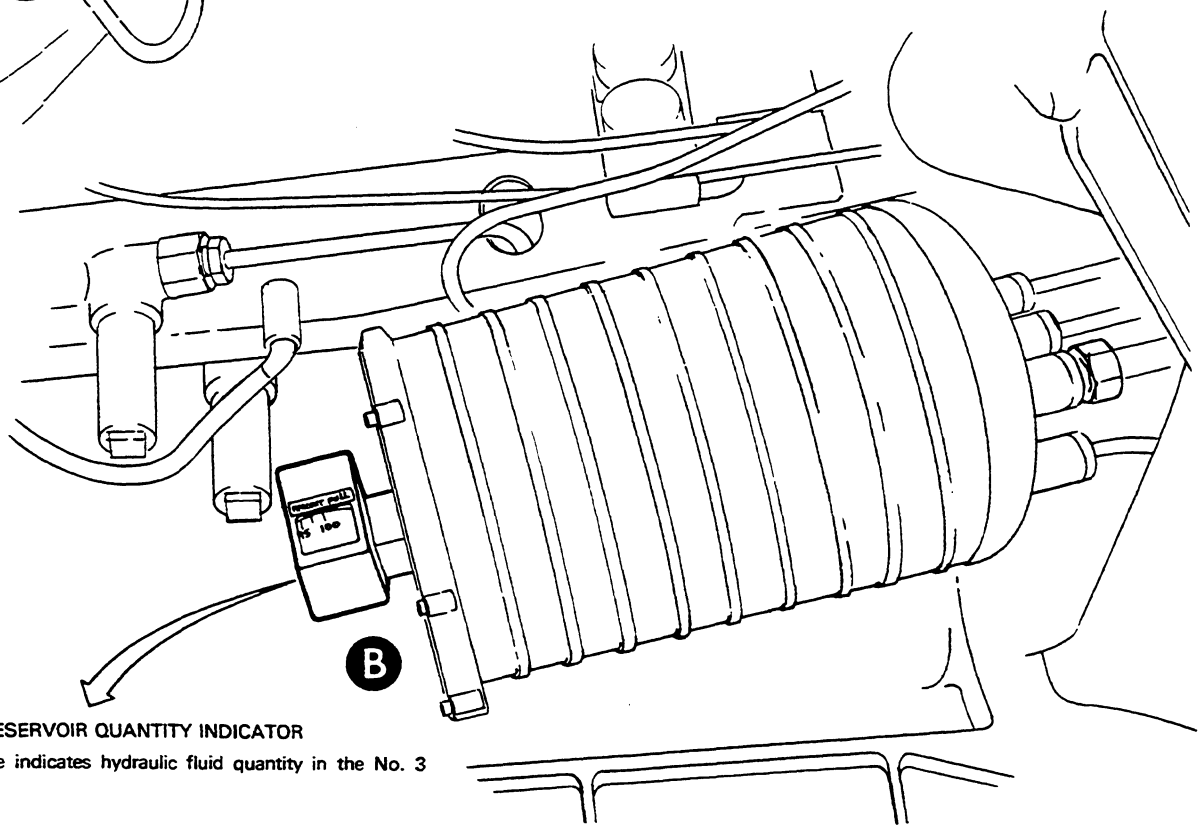
Components - No. 1 and No. 2
Hydraulic Systems
Figure 5





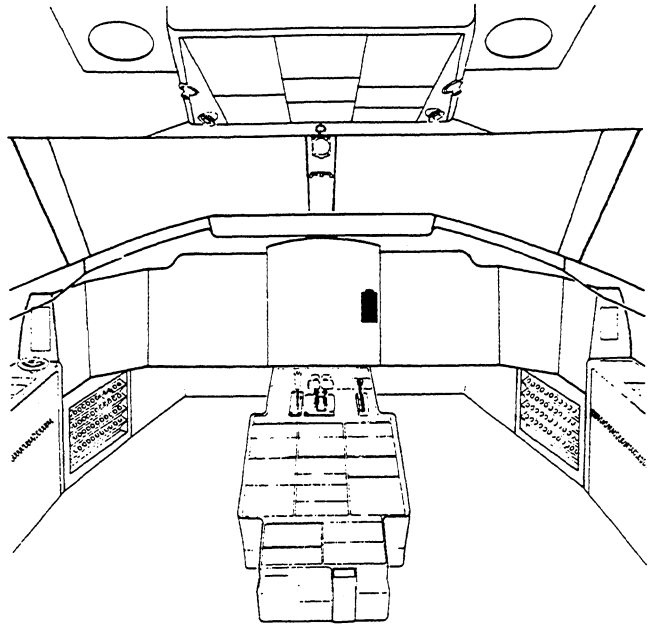
ACCUMULATOR NITROGEN PRESSURE INDICATOR

Gauge indicates nitrogen pressure in No. 3 system accumulator.



MECHANICAL RESERVOIR QUANTITY INDICATOR

Mechanical gauge indicates hydraulic fluid quantity in the No. 3 system reservoir.



LANDING GEAR SAFE LIGHTS

NOSE, LEFT AND RIGHT lights come on when respective landing gear legs are down and locked.

LANDING GEAR UNSAFE LIGHTS

Two flashing lights in landing gear handle come on when landing gear leg position does not agree with landing gear handle position and while gear is in transit.

GEAR WARNING MUTE HORN SWITCH

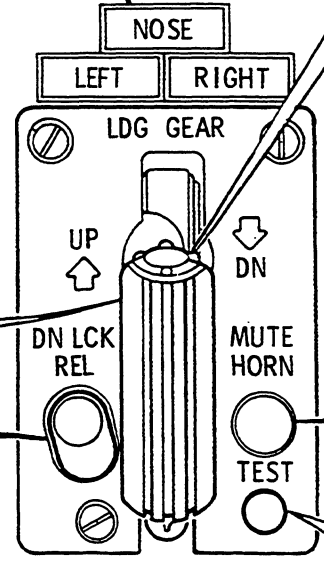
Landing gear warning horn sounds when either throttle is retarded to HIGH IDLE and down and locked signals are not received from all three landing gear downlocks.

Pressing push-button switch mutes landing gear warning horn. Push-button amber light comes on to indicate mute condition and will remain so until one or both throttles are advanced beyond HIGH IDLE.

Aural warning also sounds when 30 degree flap position is selected in absence of down and locked signals from all three downlocks. Under these conditions, warning cannot be muted by pressing MUTE HORN button.

LANDING GEAR HANDLE

Two-position handle. Controls landing gear hydraulic operation.
UP - Pulling handle out then up retracs landing gear, applies main wheel brakes and closes nose wheel doors.
DN - Pulling handle out then down opens nose wheel doors and extends and locks nose and main landing gear legs.



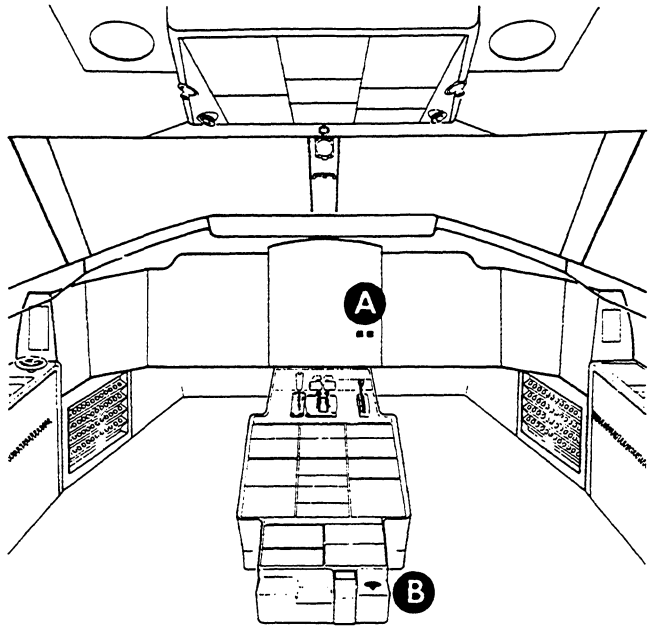
DOWN LOCK RELEASE BUTTON

For manual override of landing gear handle solenoid lock.
Pushing and holding DN LCK REL button down allows normal landing gear retraction with landing gear handle.

LANDING GEAR TEST SWITCH

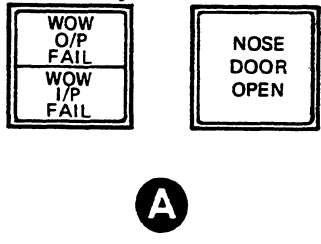
When TEST push-button is pressed, LEFT, NOSE and RIGHT green lights, landing gear selector handle red lights, MUTE HORN amber light and NO SMOKING and FASTEN SEAT BELT lights come on.

Landing Gear Control Panel
Figure 7



WEIGHT-ON-WHEELS (WOW) FAIL LIGHTS

The appropriate caption comes on to indicate a failure in either the WOW input or WOW output system. The WOW input system receives a WOW signal from independent sensors, two on each landing gear shock strut.

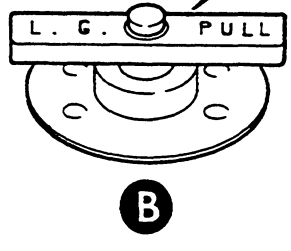


NOSE LANDING GEAR DOORS OPEN LIGHT

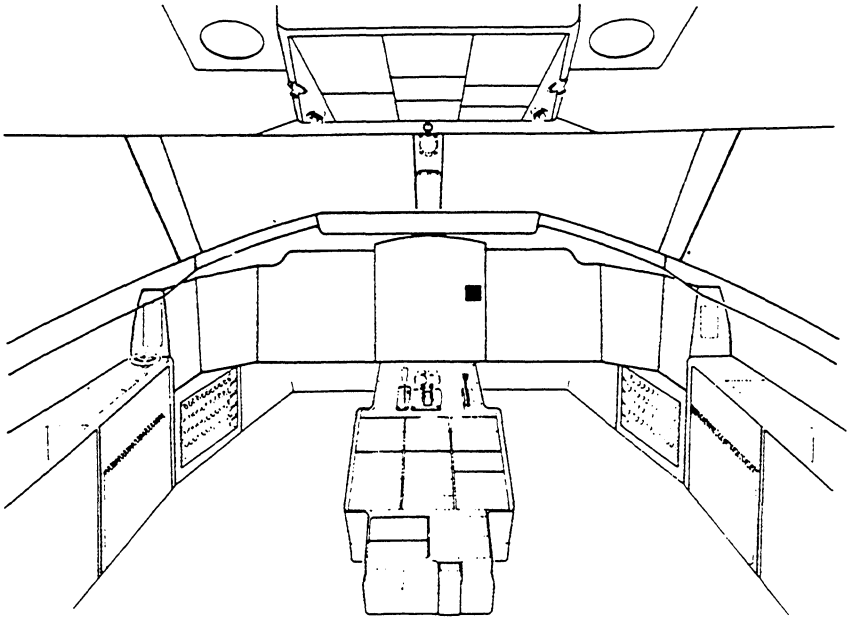
Light comes on when hydraulically operated nose landing gear doors are unlocked.

LANDING GEAR MANUAL RELEASE HANDLE

Pulling handle releases landing gear legs and nose wheel door up-locks, to allow landing gear to free-fall and also supplies No. 2 hydraulic system pressure to the main landing gear free-fall down lock assist actuators. Landing gear position indicators and warnings operate normally and gear cannot be retracted.

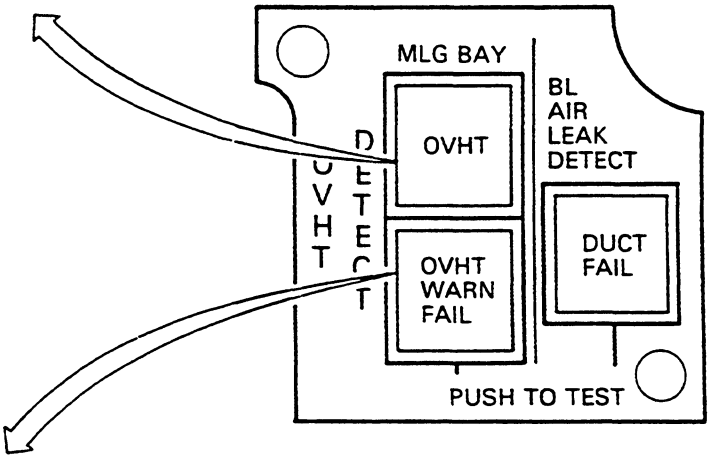


Landing Gear Manual Release Handle, WOW Fail Lights and Nose Gear Door Unlocked Light
Figure 8



OVERHEAT (OVHT) LIGHT

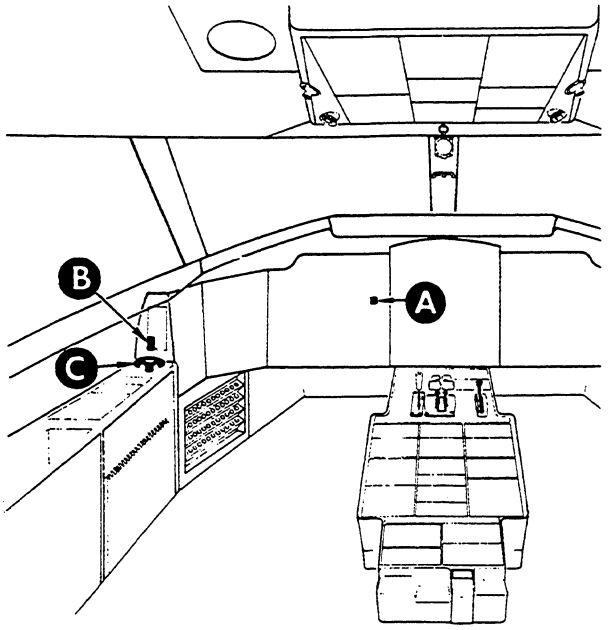
Red light comes on when overheat condition is detected by fire sensing cables in main landing gear bay.



OVERHEAT WARNING FAILED (OVHT WARN FAIL) LIGHT

Amber light comes on when a short in the system is detected by the detection control unit.

Main Landing Gear Bay Overheat Warning Lights
Figure 9



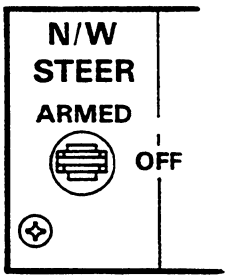
EFFECTIVITY

[1] Aircraft incorporating Canadair Service Bulletin 600-0380.

A [1]

NW STEER FAIL LIGHT

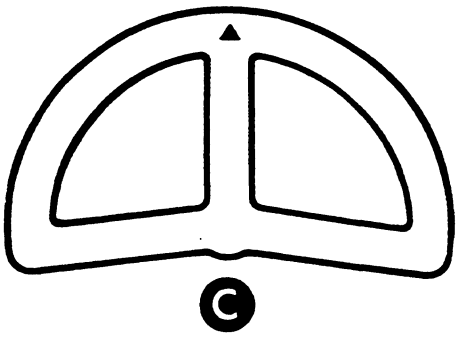
Amber light comes on when electronic control module of steer-by-wire system detects electronic or mechanical fault in steering system. Light stays on and system remains in free castoring mode until fault is corrected and system reset.



B

NOSE WHEEL STEERING ARM SWITCH

Switch provides ARMED-OFF control of the hydraulic nose wheel steering.
ARMED - Nose wheel steering will operate when the landing gear is down and locked and weight-on-wheels signals are present from one or both WOW systems.
OFF - Nose wheel hydraulic steering off. Nose wheel will castor for towing or for steering by differential braking.

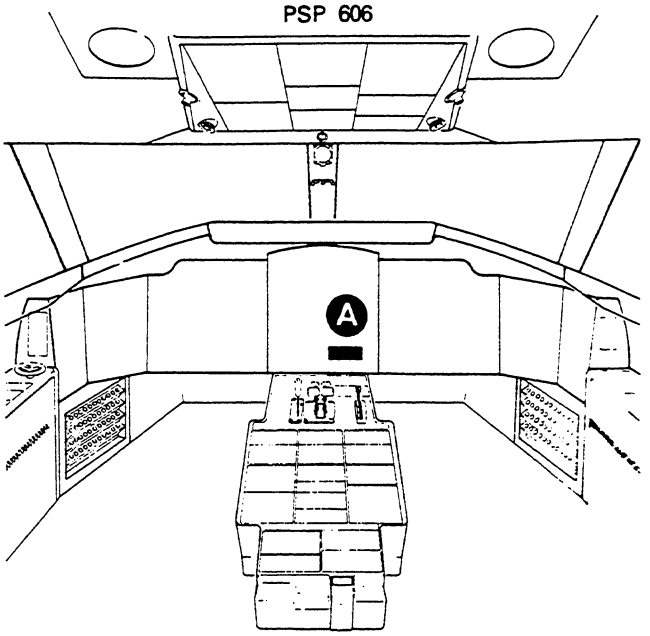


C

NOSE WHEEL STEERING QUADRANT

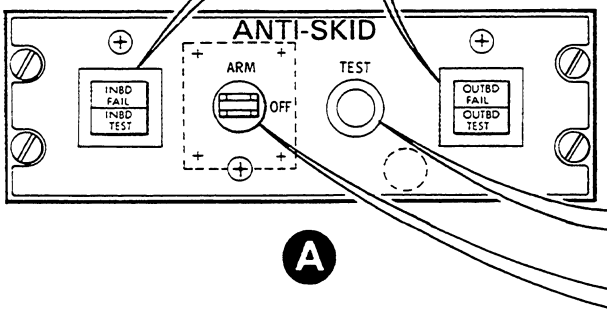
Steering quadrant rotates the nose wheel when landing gear is down and locked, weight-on-wheels signals are present from one or both WOW systems and the N/W STEER switch is in the ARMED position. The nose wheel is automatically centered when the nose landing gear strut is extended on take-off.

Nose Wheel Steering Controls
Figure 10



ANTI-SKID SYSTEM FAIL LIGHTS

Caution lights indicate the failure of the inboard and/or the outboard brake anti-skid systems.

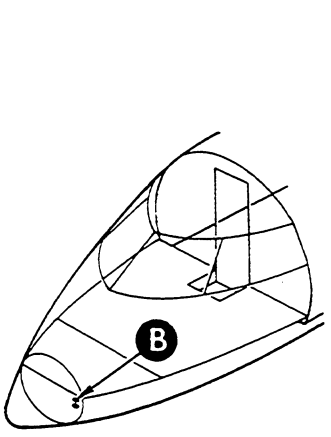


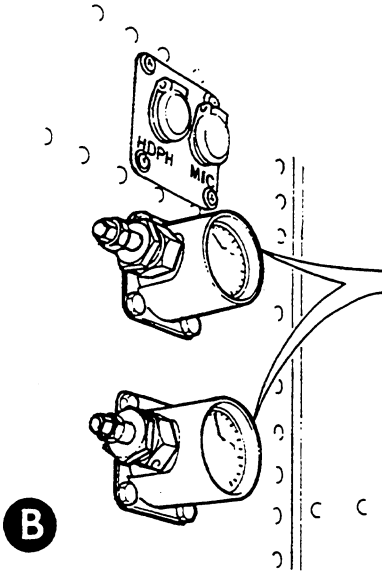
ANTI-SKID TEST BUTTON

Pressing momentary push button switch tests the anti-skid circuitry and INBD FAIL, OUTBD FAIL, INBD TEST and OUTBD TEST lights. On releasing push button all four lights go out.

ANTI-SKID ARM SWITCH

Switch provides ARM OFF control of anti-skid system.
ARM - Anti-skid system armed. Parking brake must be off for anti-skid protection. Anti-skid will cycle as required.
OFF - Anti-skid system off. Anti-skid must be selected OFF if both WOW systems fail or brakes will become inactive below 30 kts.

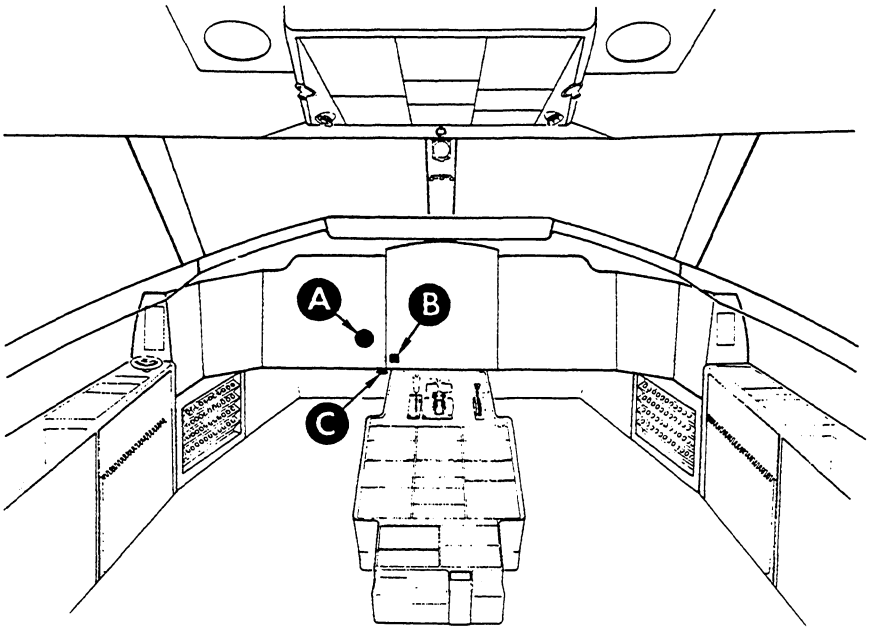


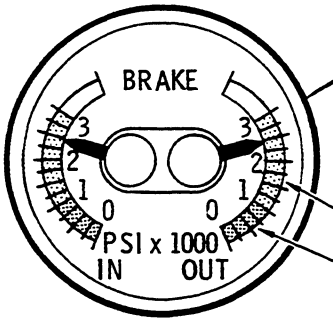


BRAKE ACCUMULATOR NITROGEN PRESSURE GAUGES

Upper and lower gauges indicate nitrogen pressure in inboard and outboard main wheel brake accumulators respectively.

Anti-Skid Panel and Brake Accumulator Pressure Gauges
Figure 11





A

BRAKE PRESSURE INDICATOR

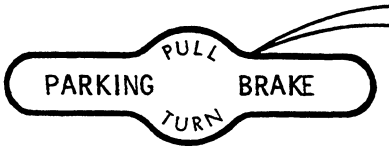
Indicates hydraulic pressure in the inner and outer main wheel independent brake systems. Normal brake pressure is 3000 psi. Indicates 0 psi when electrical power is removed.

GREEN

RED

PARKING BRAKE LIGHT

Light comes on when parking brake is applied.



C

PARKING BRAKE HANDLE

PARKING BRAKE ON — Apply and maintain full brake pedal travel. Pulling parking brake handle then causes a pair of latches in the brake valve control mechanism to engage, securing both dual brake valves in the brake applied condition. Rotating the handle locks the latches at which point pedal pressure may be relaxed.

PARKING BRAKE OFF — Parking brake is released by applying pressure to brake pedals until parking brake unloads. Handle is then rotated 90 degrees to release it to stowed position. Pressure on brake pedals is then released.

Brake Controls and Indicators
Figure 12