Chapter Two —NOSE LANDING GEAR AND DOORS

GENERAL

The nose landing gear (NLG) and doors is a four-wheel, steerable, double-acting shock strut assembly that retracts rearward and upward into the fuselage during flight. It is completely enclosed by its door system when retracted. The strut trunnion beam is an integral part of the strut forging. The strut is supported by a drag brace assembly which is connected to the top of the strut and a drag brace trunnion. The wheels are mounted on the axle which is located at the lower end of the strut piston. The axle is a part of the piston. The drag brace assembly incorporates an overcenter linkage which locks the gear in the down or up position. The nose gear trunnion includes four integral, rearward-extending retract arms. Two each are located on either side of the strut. These provide the interface for the gear retraction and extension system.

The NLG steering cylinders are mounted to the bottom side of the trunnion and their piston rods are attached to a steering collar. The steering collar attaches to the piston and axle by the torque arm assembly. (See figure 2-2)

NLG DOOR ACTUATION SYSTEM—The nose landing gear doors consist of two inboard doors and two outboard doors and are actuated separately from the gear. (See figure 2-6 and 2-7)

- CENTER GEARBOX—The center gearbox is the initial torque amplifying drive unit for the door actuation system. The gearbox transmits rotational force from a single input of either hydraulic or an electrical power source to an output of two opposite directions. The gearbox provides mount pads for the primary drive hydraulic motor and brake assembly and emergency drive electric motor. The primary drive ratio is 5:1 resulting in a normal door actuation time of 6 seconds. The emergency drive ratio is 156:1.
- TEE GEARBOX—The tee gearbox transmits rotational force from a single input to an output of two opposite directions. The gearbox contains two torque brakes which limit output torque to the output section of the nose landing gear door actuation mechanism.
- OPERATION—Power from the center gearbox is transmitted by torque tubes to the 48° gearboxes and to the tee gearbox assemblies. The forward door actuators are driven by torque tubes from the 90° torque limiter gearbox assemblies attached to the tee gearboxes. The aft door actuators are driven by torque tubes from the 90° gearbox assemblies. They are driven by torque tubes from the torque limiter connector assemblies attached to the tee gearbox assemblies.

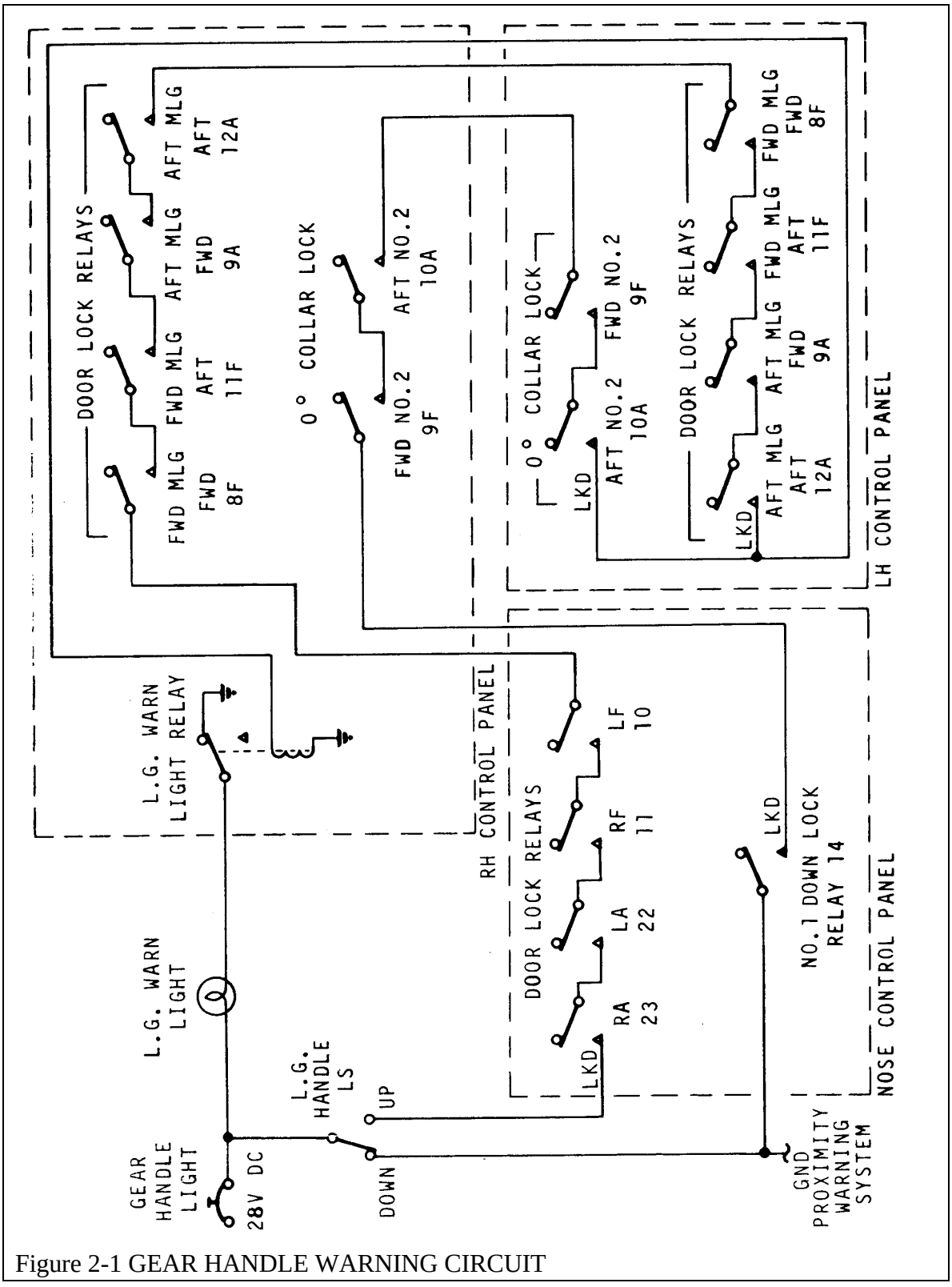


Figure 2-1 GEAR HANDLE WARNING CIRCUIT

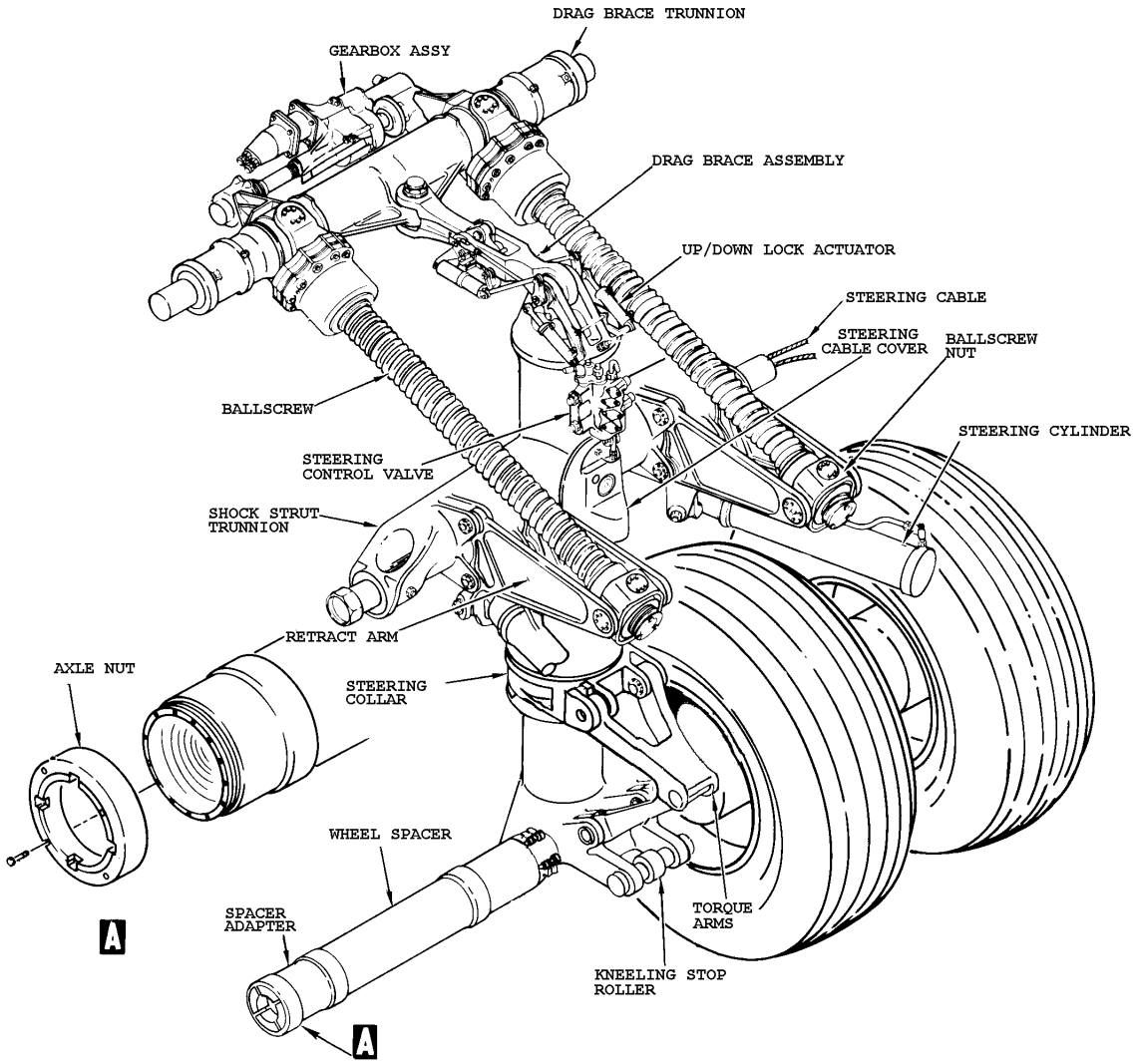
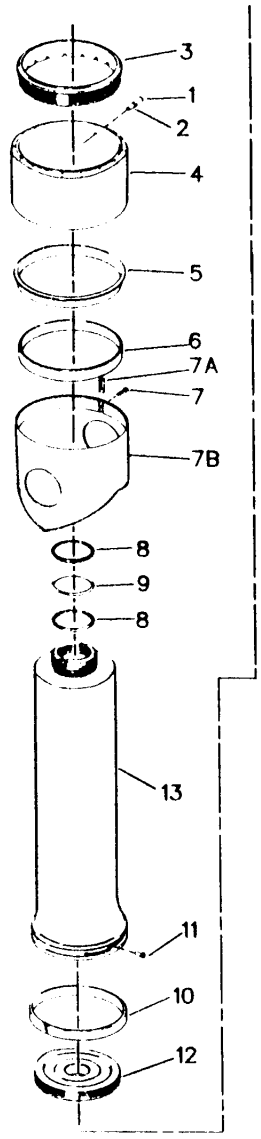
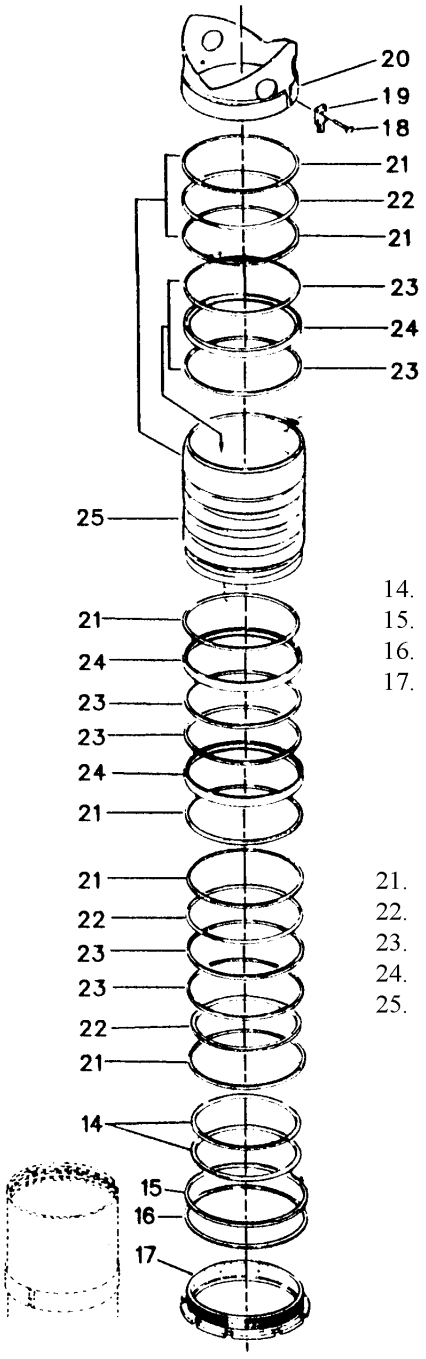


Figure 2-2 NOSE LANDING GEAR ASSEMBLY





1. PLUG, Nylon
2. PIN, Lock
3. NUT, Special
4. BEARING, Upper
5. RING, Snubber
6. SPACER
7B. CAM
13. TUBE, Orifice support
19. KEY
20. CAM

14. WIPER, Felt
15. RING, Scraper
16. SHIM
17. NUT, Packing

21. RING
22. PACKING
23. RING, Teflon
24. PACKING
25. BEARING

Figure 2-3 SHOCK STRUT ASSEMBLY

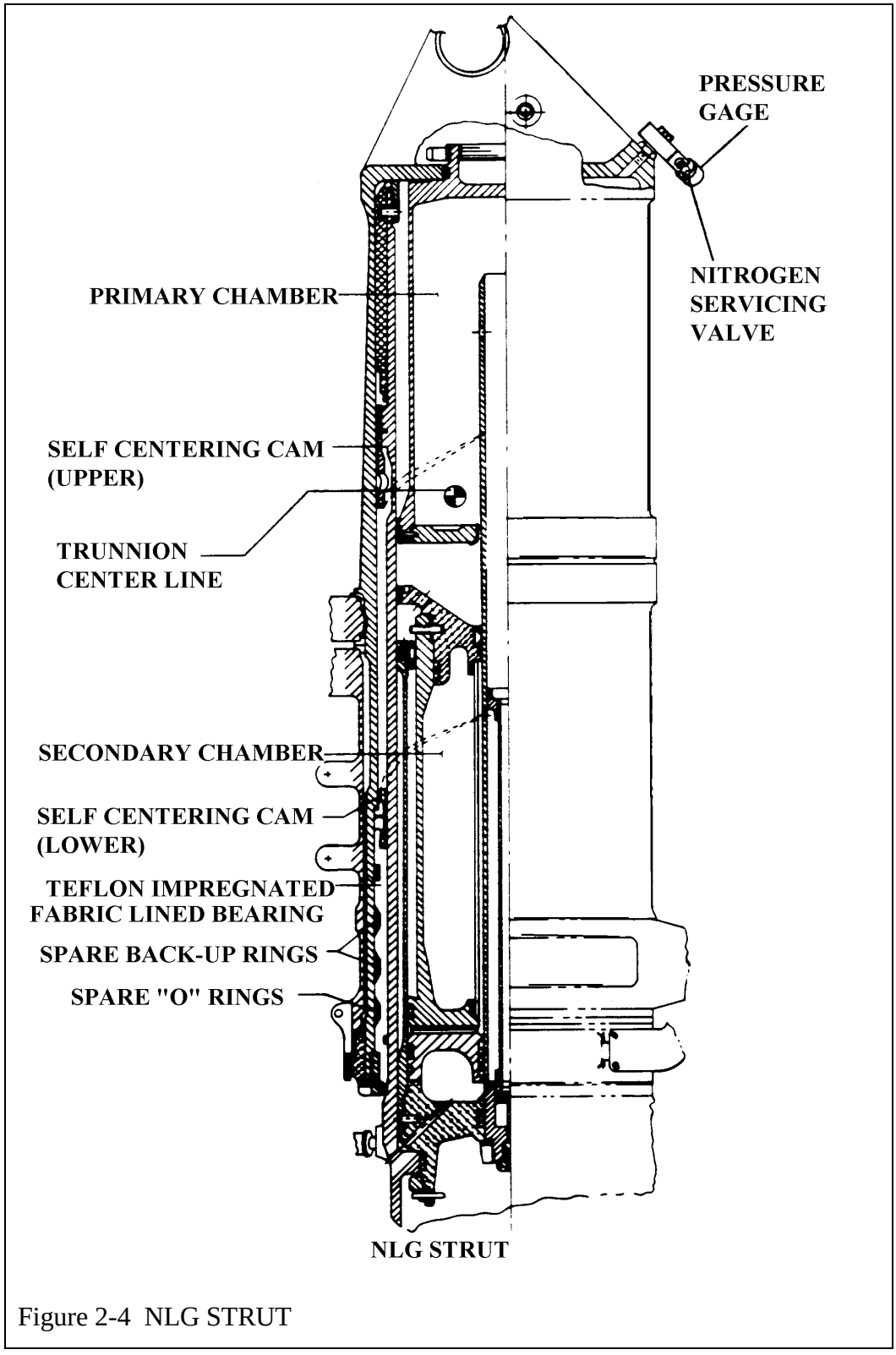


Figure 2-4 NLG STRUT

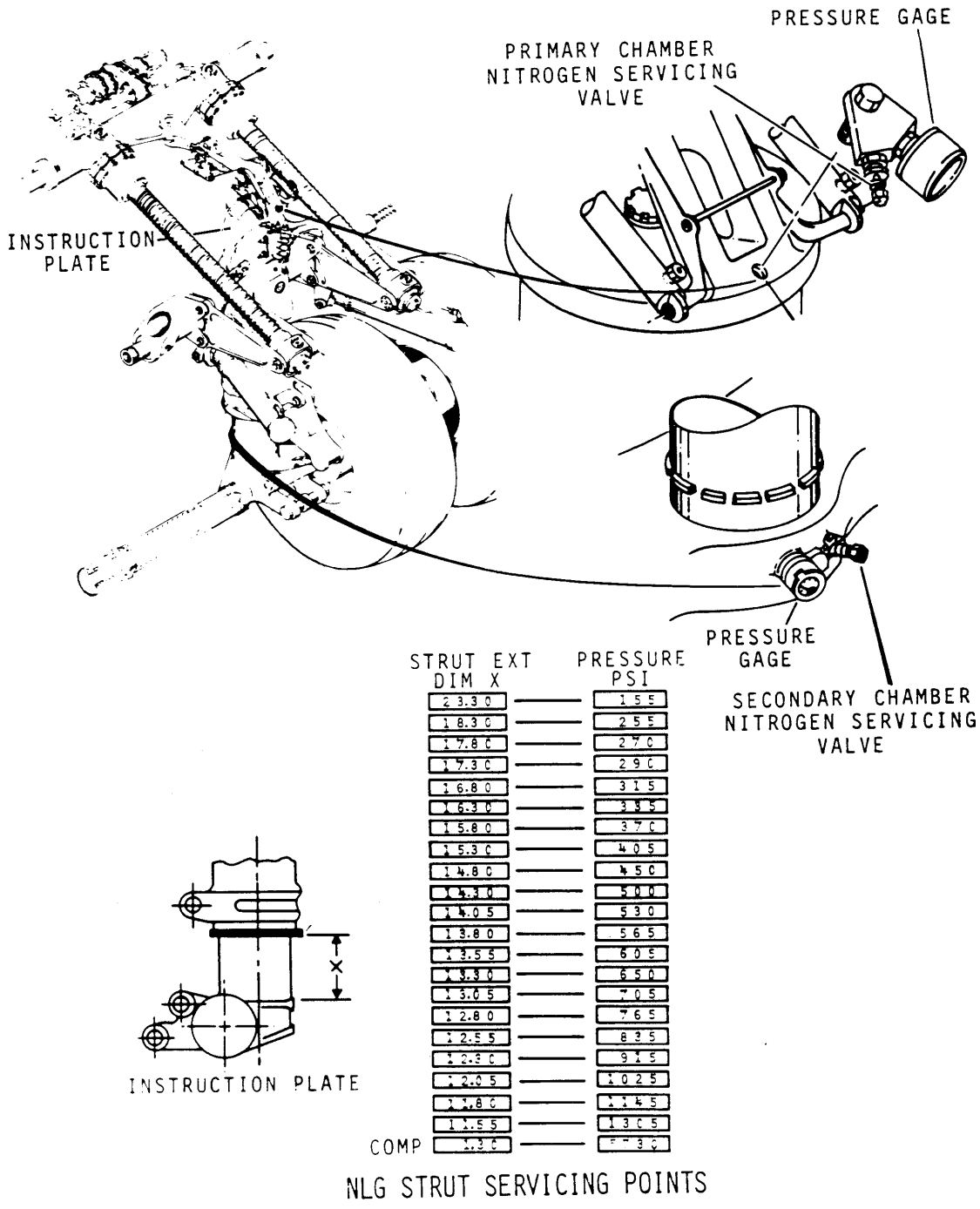


Figure 2-5 NLG STRUT SERVICING POINTS

Should an overtorque condition develop within the door actuators or 90° gearboxes, the affected torque limiter will lockup, stall the system, and remain locked until the problem is identified and corrected. The torque limiters automatically release with the elimination of the overtorque condition.

NOSE GEAR DOORS—Enclose the nose wheel well after gear retraction and consist of four individual doors - two inboard doors and two outboard doors. (See figure 2-8)

NLG DOOR LOCKS—The NLG doors are held in the closed position by eight lock assemblies, four of which are mounted to each inboard door. Four hydraulic lock actuators are used for normal operation with one actuator operating two lock assemblies. Emergency provisions for unlocking the door locks are provided by emergency hydraulic lock actuators with one actuator mounted to each lock assembly. The individual door lock assemblies are identical in operation and construction to that of the MLG door locks. (See (See figure 2-9 and 2-10)

NLG KNEELING DOOR—The kneeling door is located immediately aft of the NLG inboard doors and provides the necessary aircraft-to-ground clearance during kneeling operations. It is attached to the folding bulkhead of the NLG wheel well and hinged at its aft edge to the fuselage structure. The folding bulkhead is positioned by the NLG kneeling stop actuator.

NLG MECHANICAL ACTUATION

The NLG actuation mechanism provides retraction, extension, and kneeling operations. The gear retracts aft into the wheel well, rotating about its trunnion pins. A dual power source for the actuation mechanism is provided, two right-angle gearbox assemblies, two ballscrews drive assemblies, and two ballscrew and ball nut assemblies. The entire actuator mechanism is supported in the nose wheel well by the drag brace trunnion.

DRAG BRACE ASSEMBLY—The drag brace assembly is mounted to the top of the shock strut and extends forward to attach to aircraft structure by means of a drag brace mechanism, a knee joint, and an aft drag link. The drag brace assembly overcenter linkage serves as a NLG uplock and downlock. Once the NLG assumes its down and locked position, the drag brace transmits forces encountered during landing, taxiing, and braking from the shock strut to the structure. The aft drag link includes drilled passages for the insertion of a ground lock pin which provides a positive lock of the overcenter linkage.

Two hydraulic actuators are used to provide the necessary actuation of the overcenter linkage into a locked or unlocked condition. The two actuators, one used during normal operations and the other used during emergency operations, are located on the top side of the strut and connect to the overcenter linkage by push-pull rods. Two spring capsules located on either side of the knee joint assist the overcenter linkage into a locked condition in both gear uplock and downlock positions.

STEERING COLLAR—The steering collar is located about the lower portion of the NLG cylinder. The collar transmits linear action of the two steering cylinders into a rotational motion which, in turn, positions the nose wheels to a desired steering angle.

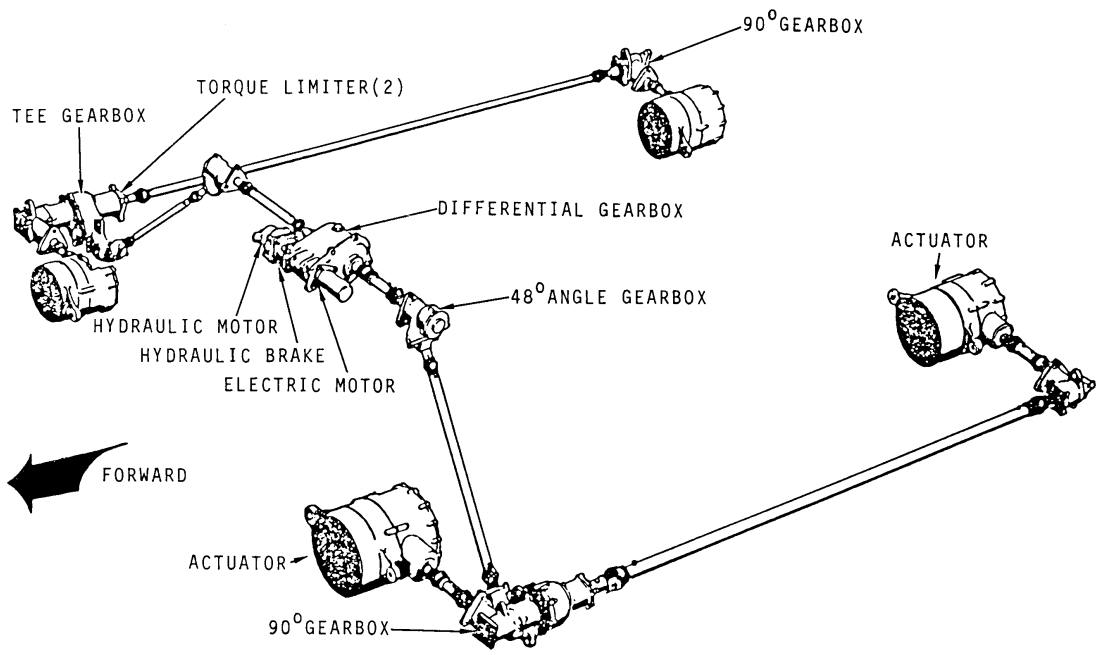


Figure 2-6 NLG DOOR DRIVE MECHANISM

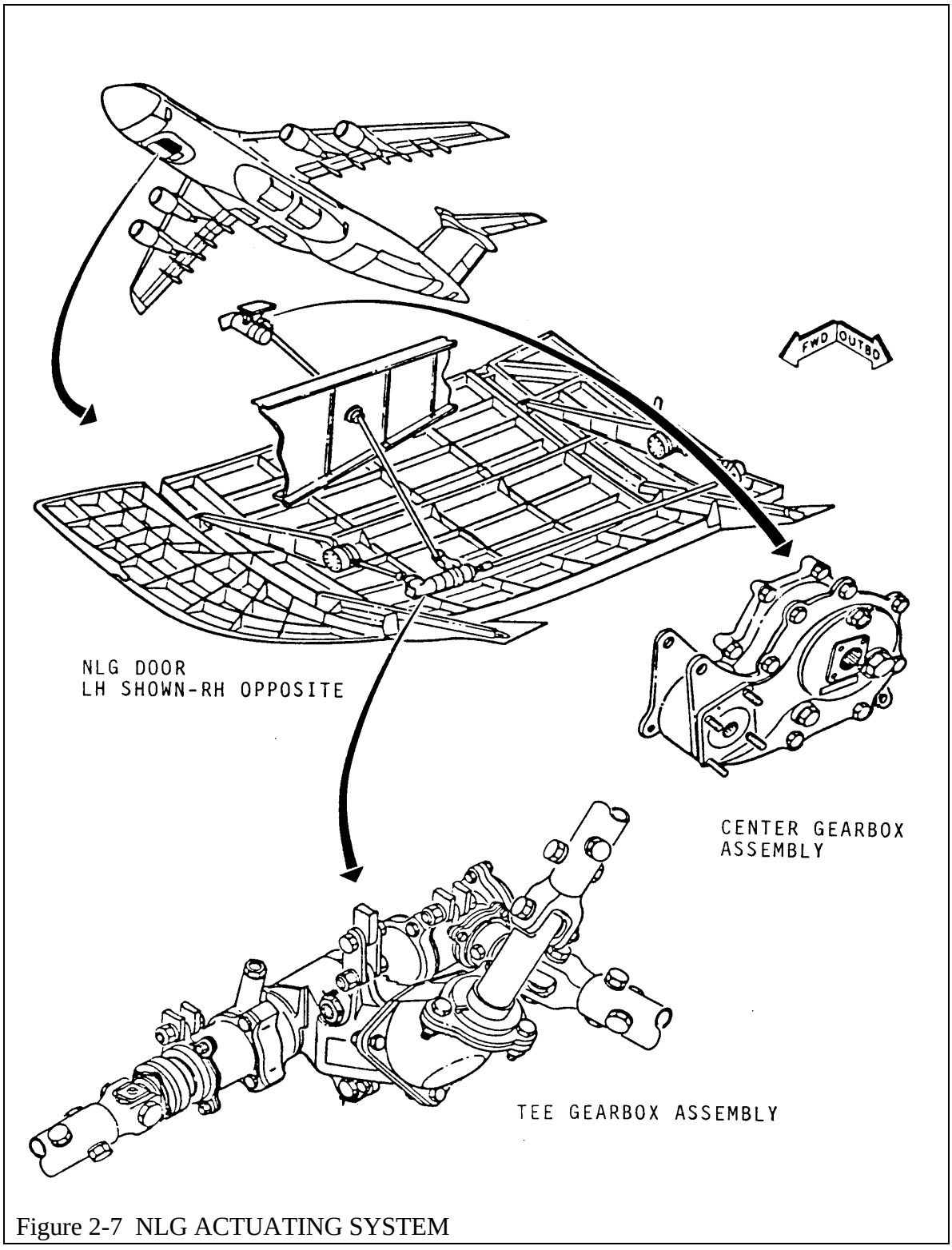


Figure 2-7 NLG ACTUATING SYSTEM

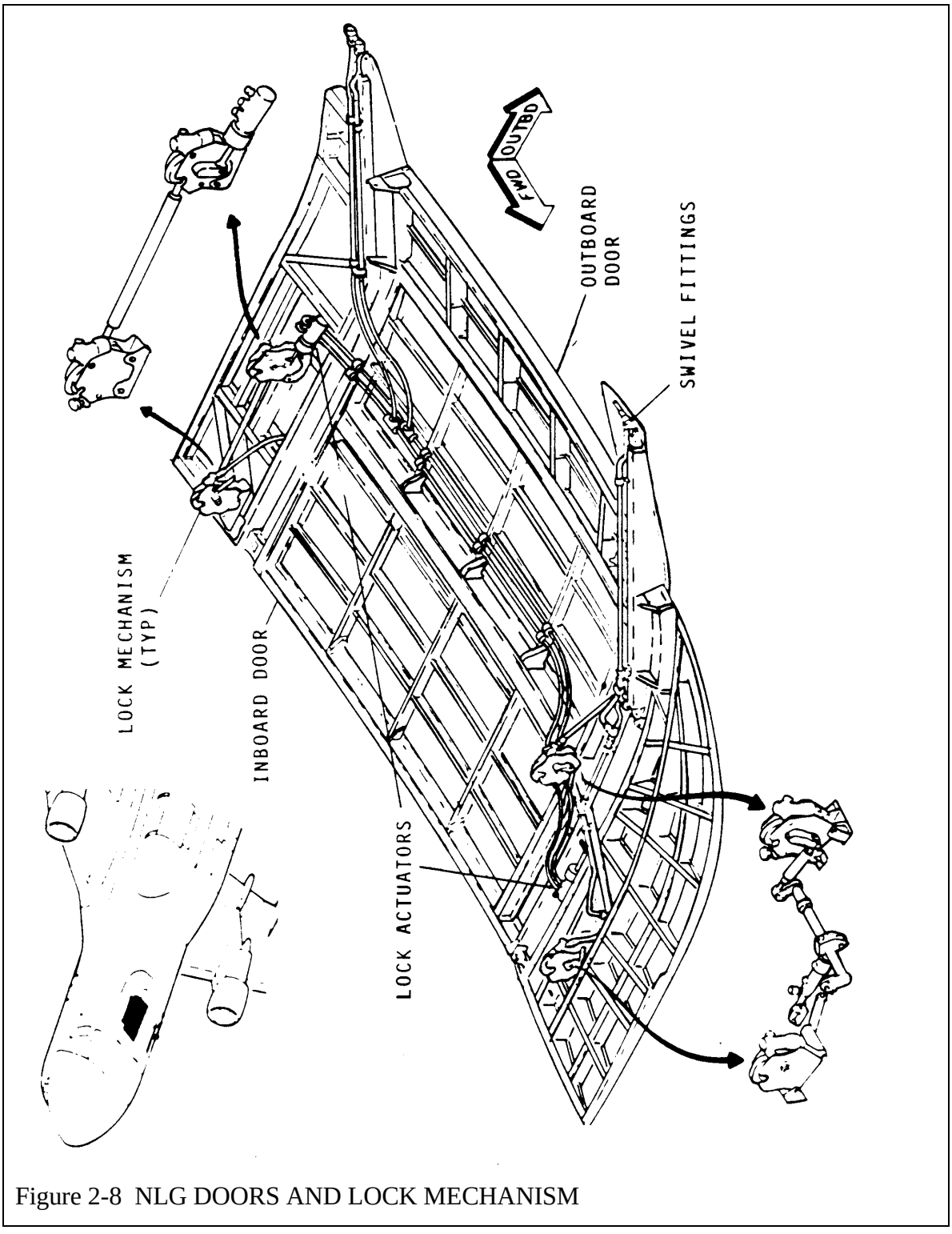


Figure 2-8 NLG DOORS AND LOCK MECHANISM

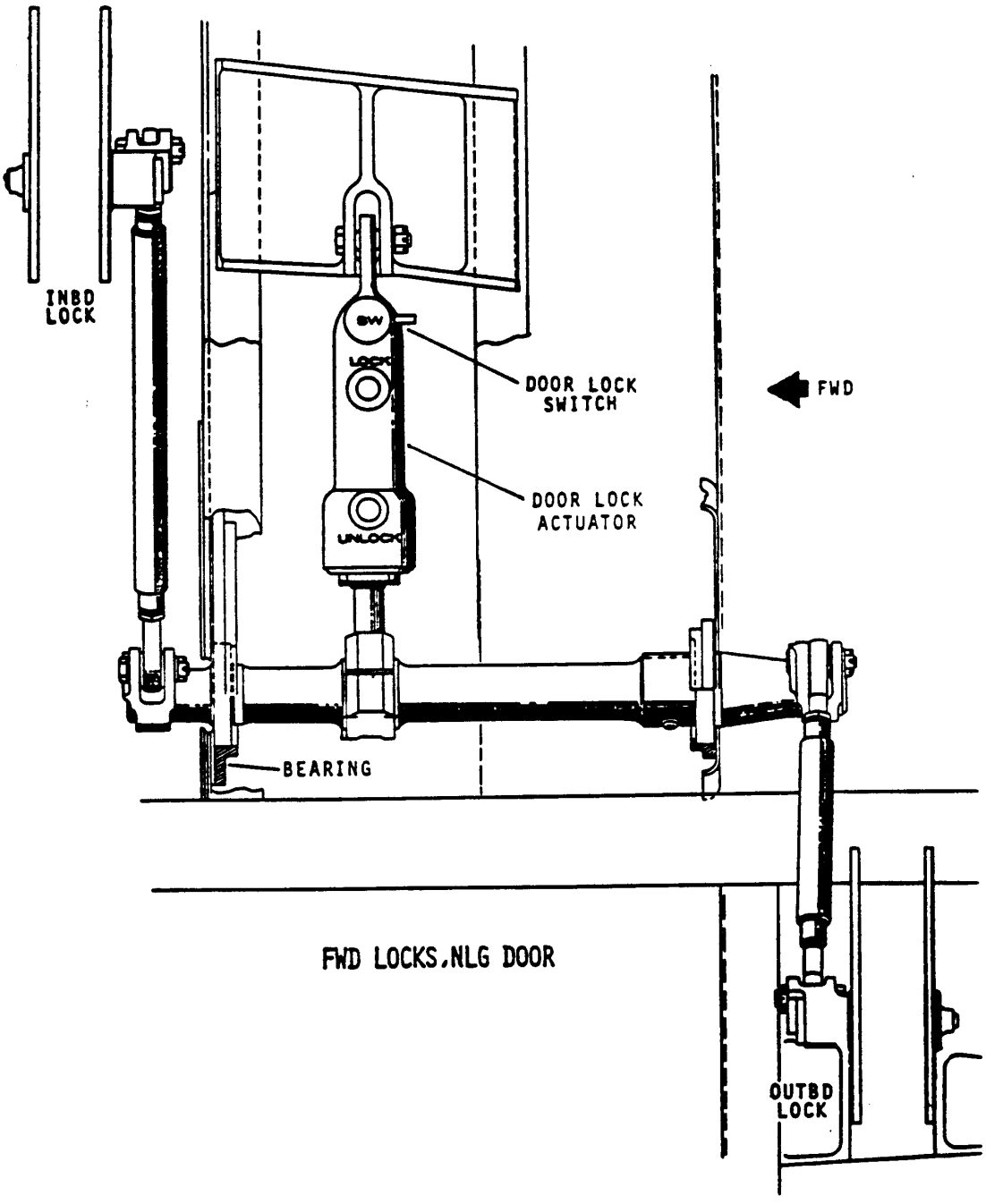


Figure 2-9 NLG DOOR LOCKS, FWD MLG44

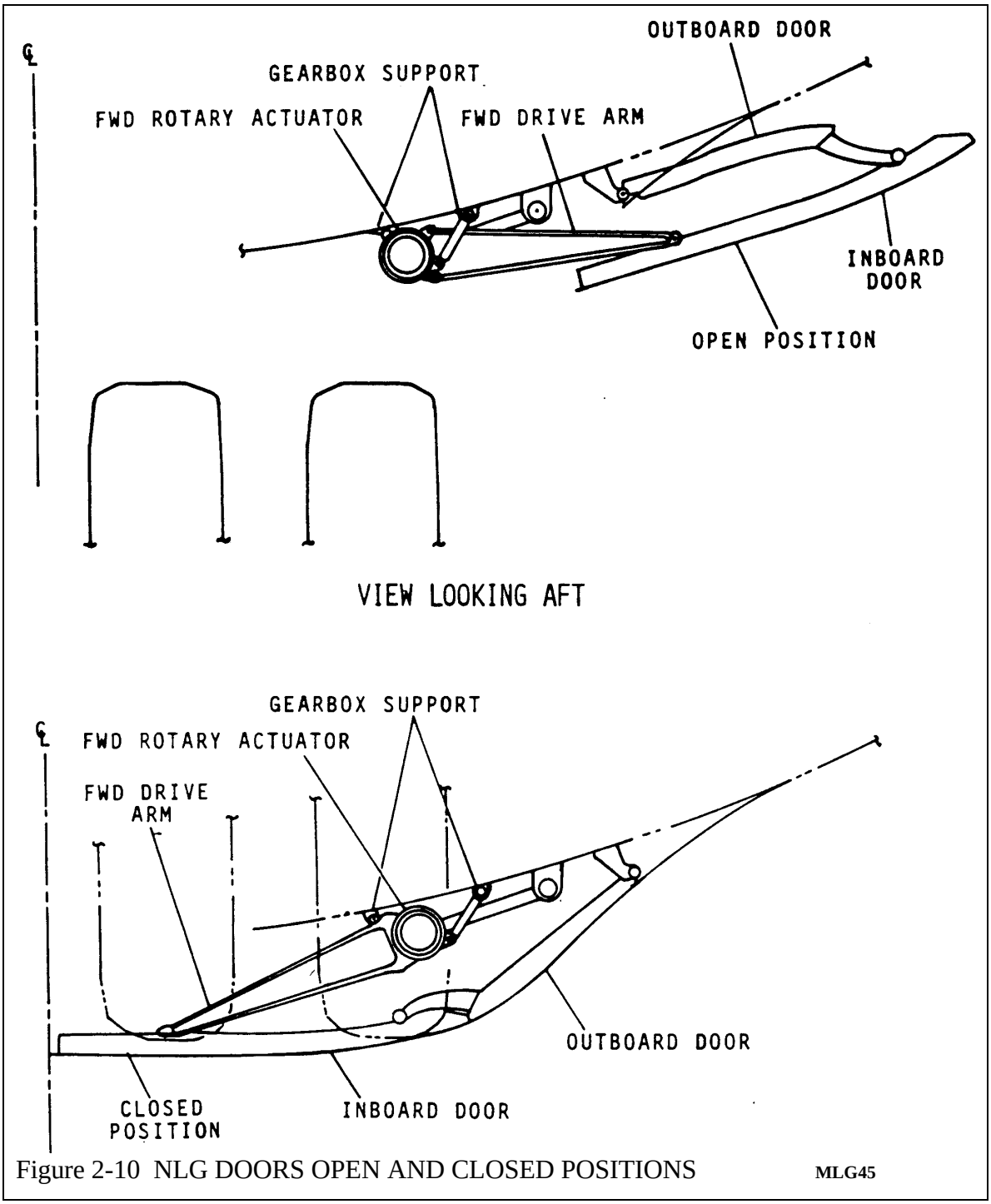


Figure 2-10 NLG DOORS OPEN AND CLOSED POSITIONS MLG45

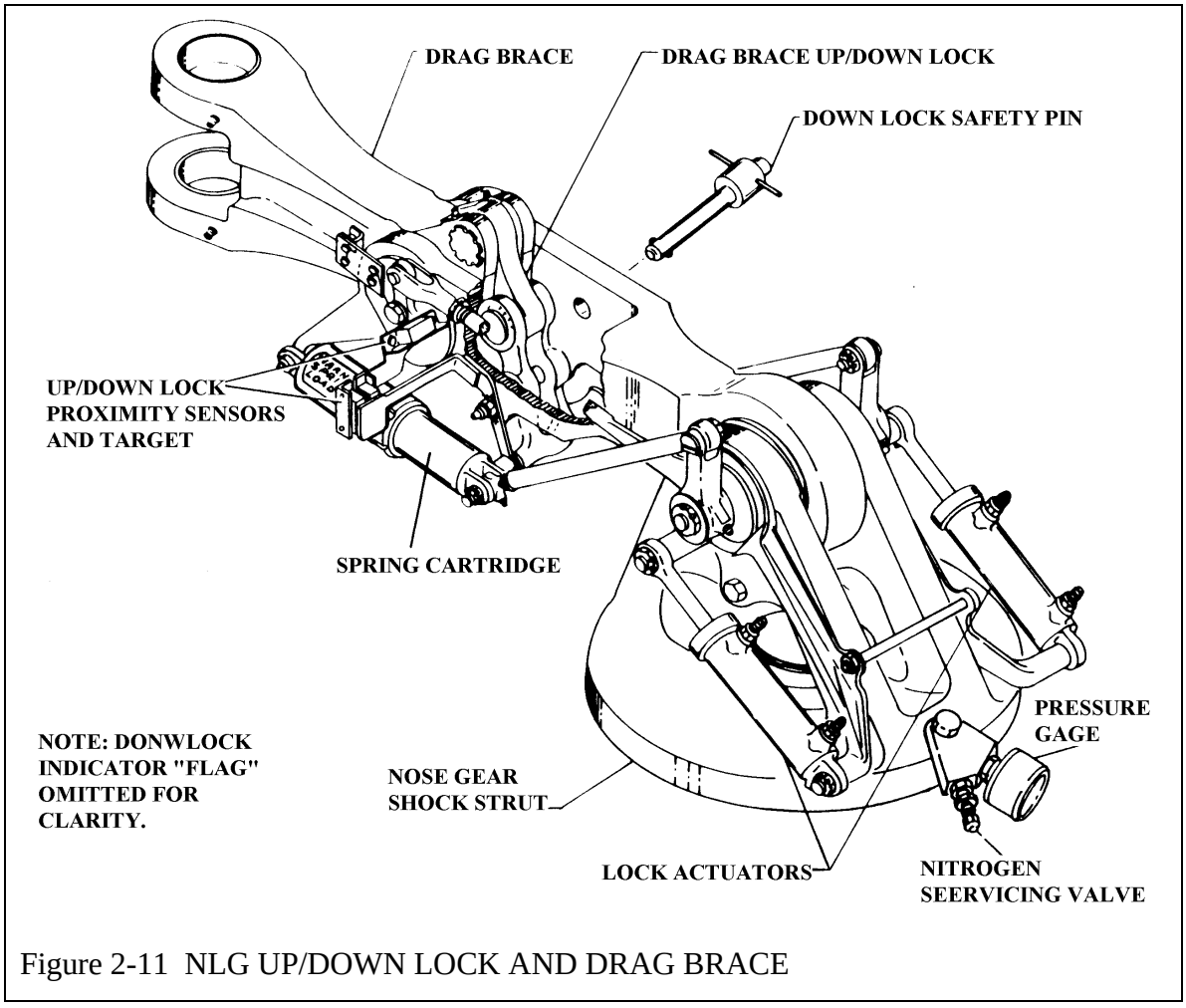


Figure 2-11 NLG UP/DOWN LOCK AND DRAG BRACE

The collar is connected to the strut piston by a torque arm assembly which transmits the rotational movement of the steering collar to the piston.

The torque arm assembly consists of an upper and lower arm jointed to form a center hinge point. The upper torque arm is attached to the rear side of the steering collar and the lower torque arm is attached to the rear side of the piston. The center hinge point permits piston extension or compression.

NLG GEARBOX ASSEMBLY

The gearbox is the primary drive mechanism and consists of a network of planet gears, sun gears, and shafts. It is used to transfer the drive power from either the hydraulic motor or the emergency electric motor to the right-angle drive assemblies. The gearbox includes a mechanically controlled and hydraulically operated shift mechanism which incorporates two positions: high speed (low torque) and low speed (high torque). (See figure 2-12)

The gearbox incorporates a mounting pad for the emergency electric motor and brake assembly. This motor extends the gear when the normal method is inoperative. The motor is driven by 115/200-Volt AC, three-phase, 400-Hz power and operates at 11,500 RPM. The motor incorporates an electrically disengaged brake. During emergency operations the gear and doors are unlocked by hydraulic pressure.

Gear and door cycles are initiated electrically from the flight station, by the gear control handle, and through the use of the NLG electrical sequence control panel. The sequence control panel is located on the right cargo compartment sidewall in line with the wheel well. (See figure 2-13)

The electrical control system incorporates mechanical switches and proximity switch sensors located at various points on the gear to provide the sequence operations.

CONTROL MANIFOLD—The NLG control manifold is a seven-port module located on the left cargo compartment sidewall in line with the nose wheel and controls all normal NLG extension and kneeling operations. The manifold contains four manually/electrically actuated pilot valves; a three-position, pilot-actuated door control valve; a three-position, pilot-actuated gear control valve; a kneel pressure reducer, and a check valve. Hydraulic system No.1 furnishes pressure for normal operation and system No.4 furnishes pressure for emergency operation.

RETRACT MANIFOLD (GEAR-UP CONTROL)—The gear-up control manifold is located on the left forward side of the cargo compartment. It contains a manually/electrically operated pilot valve and a two-way control valve. The manifold controls normal gear-up operations.

KNEEL PRESSURE REDUCER—The kneel pressure reducer is located in the NLG control manifold. The reducer limits gear-down operating pressure to approximately 2200 PSI to prevent structural damage to the shock strut during kneeling operations.

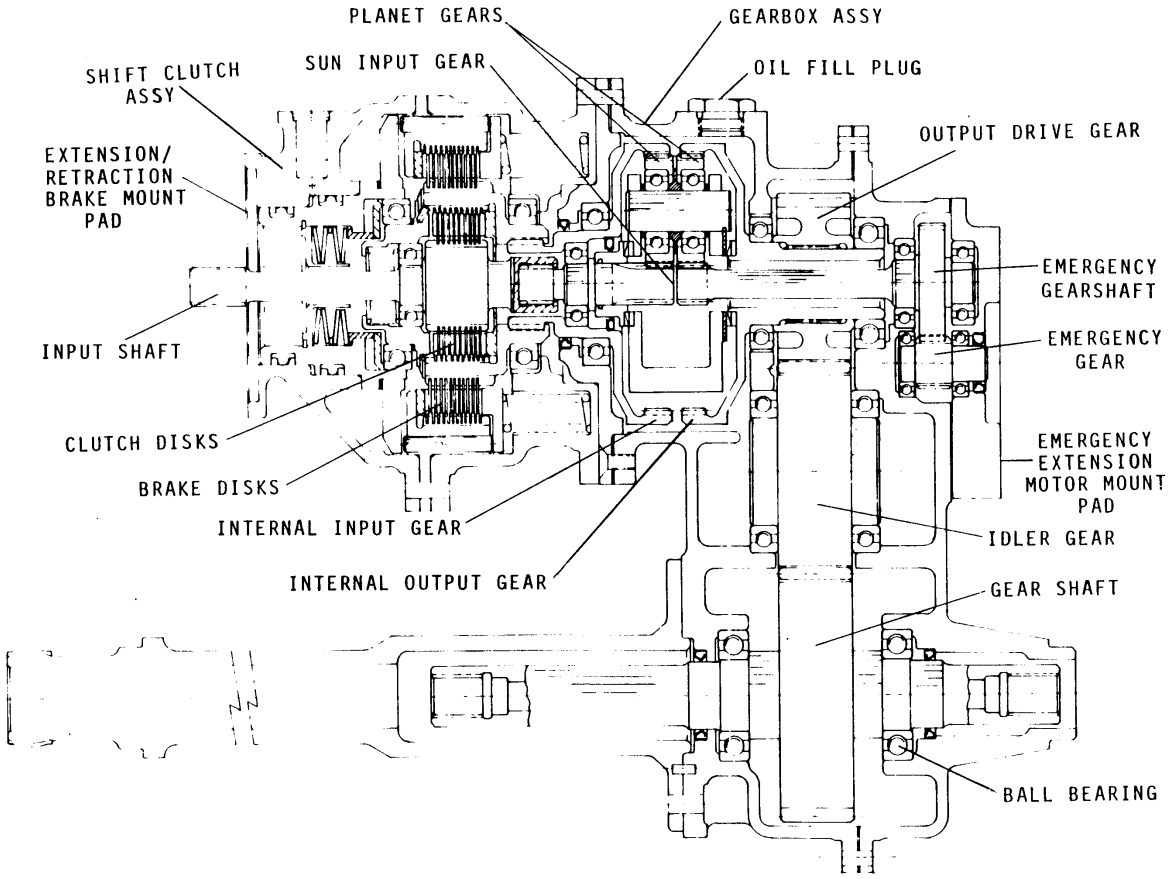


Figure 2-12 NLG MAIN GEARBOX ASSEMBLY

HYDRAULIC MOTORS—Two hydraulic motors are used in the NLG and door actuation systems. One motor provides power for the NLG actuation mechanism and is mounted to the actuation system gearbox[1]. The other motor is used for NLG door actuation and mounted to the NLG door center gear box assembly[2].

LOCK CYLINDER—A hydraulically powered NLG lock cylinder located on the top of the NLG strut locks the gear in the retracted and extend positions. (See figure 2-11)

DOOR LOCK CONTROL MANIFOLD—The door lock control manifold is located on the left forward side of the cargo compartment and sequences door locking and unlocking operations. The manifold contains two manually/electrically actuated pilot valves and three-position, pilot-actuated control valve.

[1]P/N 4G94032-101B Motor is used in several locations on the C-5 aircraft, it may also be found in the MLG Drive System, hydraulic winch, and in the MLG Kneel System.
[2]P/N 9H90103-101B Motor is also used in the Visor and AFT Center Door System.

DOOR LOCK/UNLOCK CYLINDERS—Two door lock cylinders are mounted to each inboard door and lock or unlock the door lock mechanism. The door lock cylinders are identical and interchangeable with the MLG door lock cylinders. Each lock cylinder has an internal lock which hold the lock in the locked position. Fifty PSI of hydraulic pressure is required to lock the lock and 900 PSI is required to unlock the lock. (See figure 2-8 and 2-9)

EMERGENCY ISOLATION MANIFOLD—The three port emergency isolation manifold is located on the left side of the cargo compartment forward sidewall in line with the nose gear wheel well. The manifold isolates the normal NLG hydraulic system so that emergency operations are not hindered by normal system pressure. The manifold consists of a manually/electrically actuated pilot valve and a two-position, pilot-actuated emergency isolation control valve.

NLG AND DOOR EMERGENCY UNLOCK MANIFOLD—The gear and door emergency unlock manifold is a five-port module located on the left cargo compartment sidewall in line with the nose wheel well.

The manifold controls emergency unlocking operation of the NLG only. The emergency door unlock solenoid valve is deactivated and the emergency door unlock port is capped. The manifold contains two manually/electrically operated control valves and two check valves.

DOOR EMERGENCY UNLOCK VALVE—The door emergency unlock valve controls the unlocking of the door locks during emergency NLG extension. It is operated electrically or manually.

NLG EMERGENCY UNLOCK CYLINDER—The NLG emergency unlock cylinder is interchangeable with the NLG lock cylinder and is mounted to the strut in the same manner as the NLG lock cylinder. The emergency cylinder unlocks the gear from its retracted position and locks it in its extended position during emergency operations. (See figure 2-11)

EMERGENCY DOOR UNLOCK CYLINDERS—Eight emergency door unlock cylinders, one located on each NLG door lock mechanism, unlock the doors during emergency gear extension.

NLG SEQUENCE CONTROL PANEL

The NLG sequence control panel, located on the RH side of the forward cargo compartment, controls the NLG hydraulic and electrical functions during retraction and extension. The NLG sequence control panel has the same components as the MLG sequence control panels. In addition, the NLG sequence control panel has two emergency electrical override switches. (See figure 2-13)

EMERGENCY ELECTRICAL OVERRIDE SWITCHES—Two red guarded emergency electrical override switches are located on the NLG sequence control panel, one for doors operation and one for gear operation. The switches are used to open the doors or extend the gear if a door open relay(s) circuit fails.

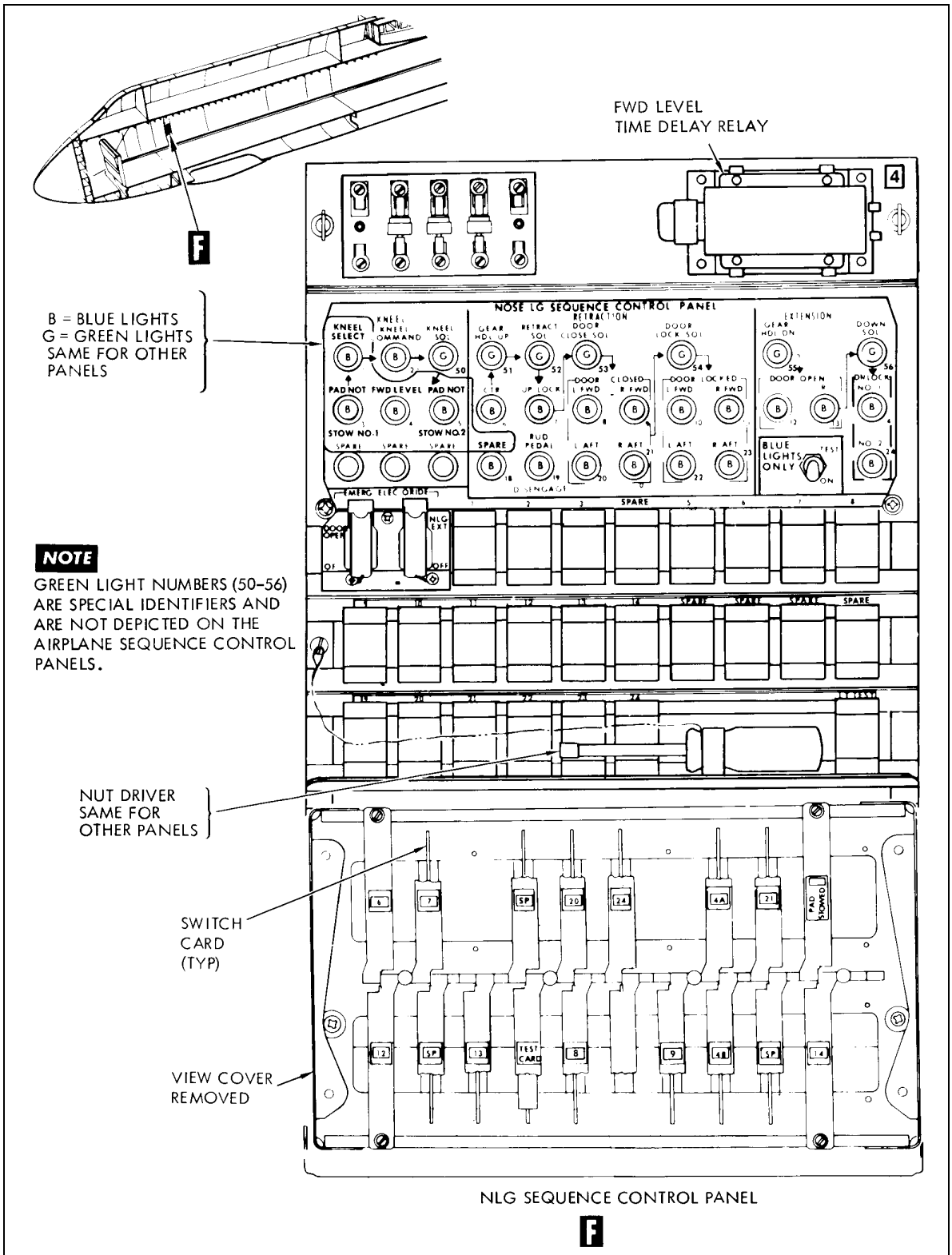


Figure 2-13 NLG SEQUENCE CONTROL PANEL

NLG RETRACTION AND EXTENSION

GENERAL—Hydraulic system No.1 furnishes pressure for normal operation with No.4 system serving as an alternate system for emergency operation. In the event of a normal hydraulic system power loss, the NLG normal system may be pressurized by PTU. A loss of normal system pressure is backed up by electric motors for emergency power.

During emergency operation, emergency door lock actuators and the emergency down lock cylinder receive pressure from hydraulic system No.4. A total hydraulic power loss is backed up by the electric motors and hydraulic pressure which is furnished by the crew entry door accumulator.

Normal gear and door cycles are initiated electrically from the flight station by the gear control handle and through the use of the NLG sequence control panel. The sequence control panel receives desired gear position command signals from the landing gear control handle or from the emergency extend switch located in the flight station. The signals command the sequence control panel to energize or de-energized solenoids and relays which control the hydraulic system.

The following list identifies the solenoid valves and relays that are external to the sequence control panel and are used during normal and emergency NLG operation:

- Gear-down Solenoid—Located on the NLG Control Manifold.
- Gear-up Manifold—Located on LH forward side of cargo compartment.
- Door Open Solenoid—Located on NLG Control Manifold.
- Door Closed Solenoid—Located on NLG Control Manifold.
- Normal Door Lock Control Manifold—Contains door lock and door unlock solenoid valves—Located in cargo compartment.
- NLG Down Lock Valve—Located in cargo compartment.
- Emergency Gear Unlock Solenoid—Located in cargo compartment on emergency unlock manifold.
- Emergency Door Unlock Solenoid—Located in cargo compartment, LG forward side.
- Emergency Isolation Solenoid—Located in emergency isolation manifold, LH forward side of cargo compartment.
- No.1 Down Lock Relay.
- No.2 Down Lock Relay.
- Emergency NLG Motor Control Relay.
- Emergency NLG Door Motor Control Relays.
- NLG Down Lock Latching Relay.

Microswitches and proximity switches are used to provide the sequence control panel with the necessary input signals by indicating the prerequisite requirements of gear and door positions.

The following is a list of the microswitches, and proximity switches, along with their locations and functions:

- Door Closed Proximity Sensors—Located on forward outboard and aft inboard stirrups, both doors.

- NLG-Centered Proximity Switch—Verifies centered conditions of the NLG. The sensor is located on the lower aft side of the steering collars. Its target is located on the strut cylinder.
- Four NLG Door Lock Microswitches—Located on the forward and aft door lock cylinders on each NLG inboard door. The door microswitches verify locked or unlocked conditions of the NLG door.
- NLG Downlock and Uplock Proximity Switches—Verify downlock and Uplock conditions of the NLG. Three sensors are located on the left side, forward end of the aft drag brace link. The sensors use a common target located on the left side of the aft drag brace link.
- Right-hand and Left-hand NLG Door-Open Proximity Switches—Verify an open condition of the NLG doors. A target is located on each aft door actuator rotating arm. The sensors are located on the structure.
- NLG Kneel Pad Proximity Switch—Verifies stowed or unstowed positions of the kneeling pad. (NLG kneel pad and switch are discussed in the kneeling section of this manual.)

OPERATIONAL DESCRIPTION OF NLG EXTENSION AND RETRACTION

Normal operation

See figures 2-14, 2-15, 2-16, 2-17, 2-18 and 2-19 for both hydraulic and electrical circuit schematics. Prior to gear-up, all gear hydraulic solenoid valves are de-energized, with the exception of the NLG down lock solenoid, NLG door open solenoid, and the door unlock solenoid. Total time for either retraction or extension is 18 seconds maximum.

GEAR-UP OPERATION—Selection of gear-up at the gear control panel initiates the following automatic sequence of operation:

- NLG door open solenoid de-energized.
- NLG door unlock solenoid de-energized.
- NLG down lock solenoid de-energized, downlock latch relay de-energized.
- UP solenoid energized—Circuit is completed through the energized contacts of the centered relay, de-energized contacts of the uplock relay, and de-energized contacts of the No.2 pad not stowed relay.

Energizing the gear-up solenoid allows pressure to be applied to the following units:

- Gear downlock/uplock cylinder—Unlocks the drag brace overcenter linkage from its down and locked position. Pressure is maintained on the cylinder to lock the overcenter linkage once the gear is fully retracted.
- Gear hydraulic brake and motor—Releases the brake and allows the motor to retract the gear.

When the gear is completely up and locked, the uplock proximity switch is actuated to energize the uplock relay. This causes the door-close solenoid to energize.

Energizing the door-close solenoid allows pressure to be applied to the following units.

- Door hydraulic motor—Allows the motor to drive the doors closed.
- Door lock/unlock valve—Valve is detented to unlock position. Hydraulic pressure directed to the rod end of the door lock actuators maintains the locks in an unlocked condition during door closing operations. A 1000 PSI relief valve, located on each inboard door, opens to furnish pressure to the forward cylinder during door unlock operation.

When the doors are closed, the door-closed proximity switches on the forward and aft door lock assemblies are actuated to energize the door-closed relays. The door lock solenoid is then energized and ports hydraulic pressure to lock the doors. The door-lock solenoid remains energized with the gear-up and locked, and with the doors closed and locked. The door-close solenoid is de-energized when the door-lock relays are energized to the locked condition.

GEAR-DOWN OPERATION—Positioning the gear handle to DN initiates the following automatic sequence of operation:

- Door-lock solenoid: de-energized.
- Door-unlock solenoid: energized.
- Door open solenoid: energized. Pressure is applied to the door unlock cylinders and the door motors open the doors. Forward door locks unlock after pressure relief valves open (approx. 1000-PSI buildup).

When both doors are open, the LH and RH door open proximity switches close to energize the RH and LH door open relays. The NLG down lock latch relay and the gear-down solenoid are then energized. The following sequence is initiated:

- NLG down lock solenoid-energized through contacts of the latch relay. Pressure is directed to the gear down/uplock cylinder which unlocks the drag brace overcenter linkage. Pressure is maintained to lock the overcenter linkage once the gear is down.
- Gear-down solenoid—applies pressure to release the hydraulic brake. The hydraulic motor then operates to extend the gear.

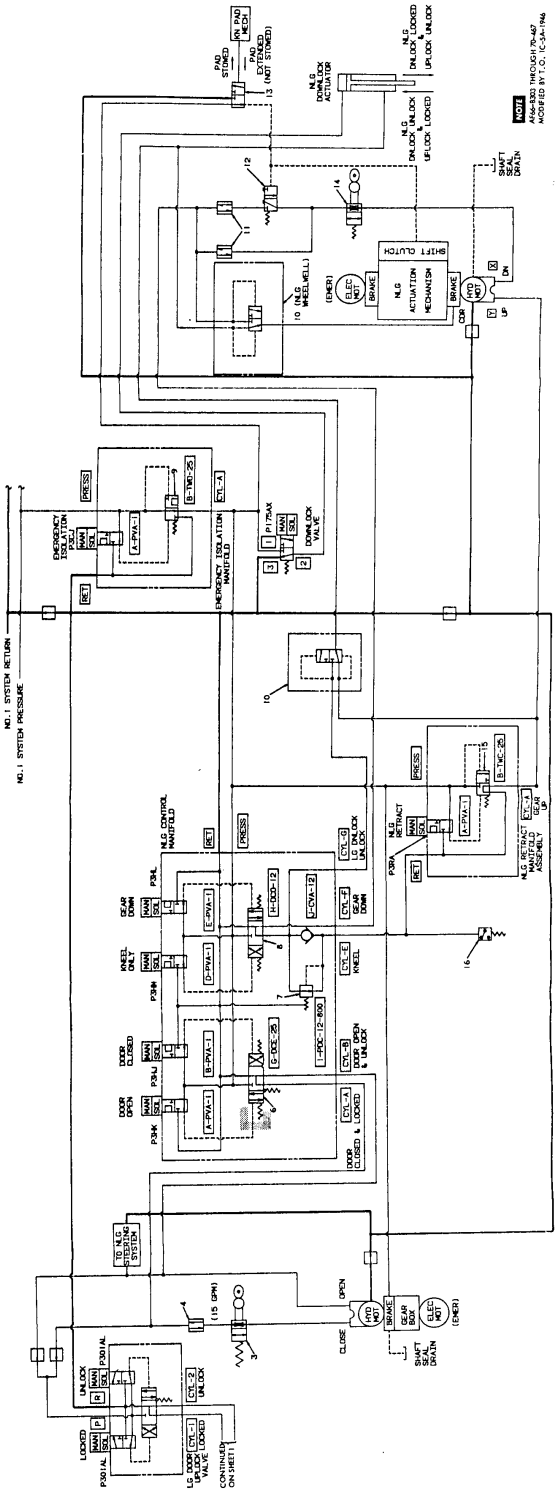


Figure 2-14 NLG HYDRAULIC SCHEMATIC - NORMAL (1 OF 2)

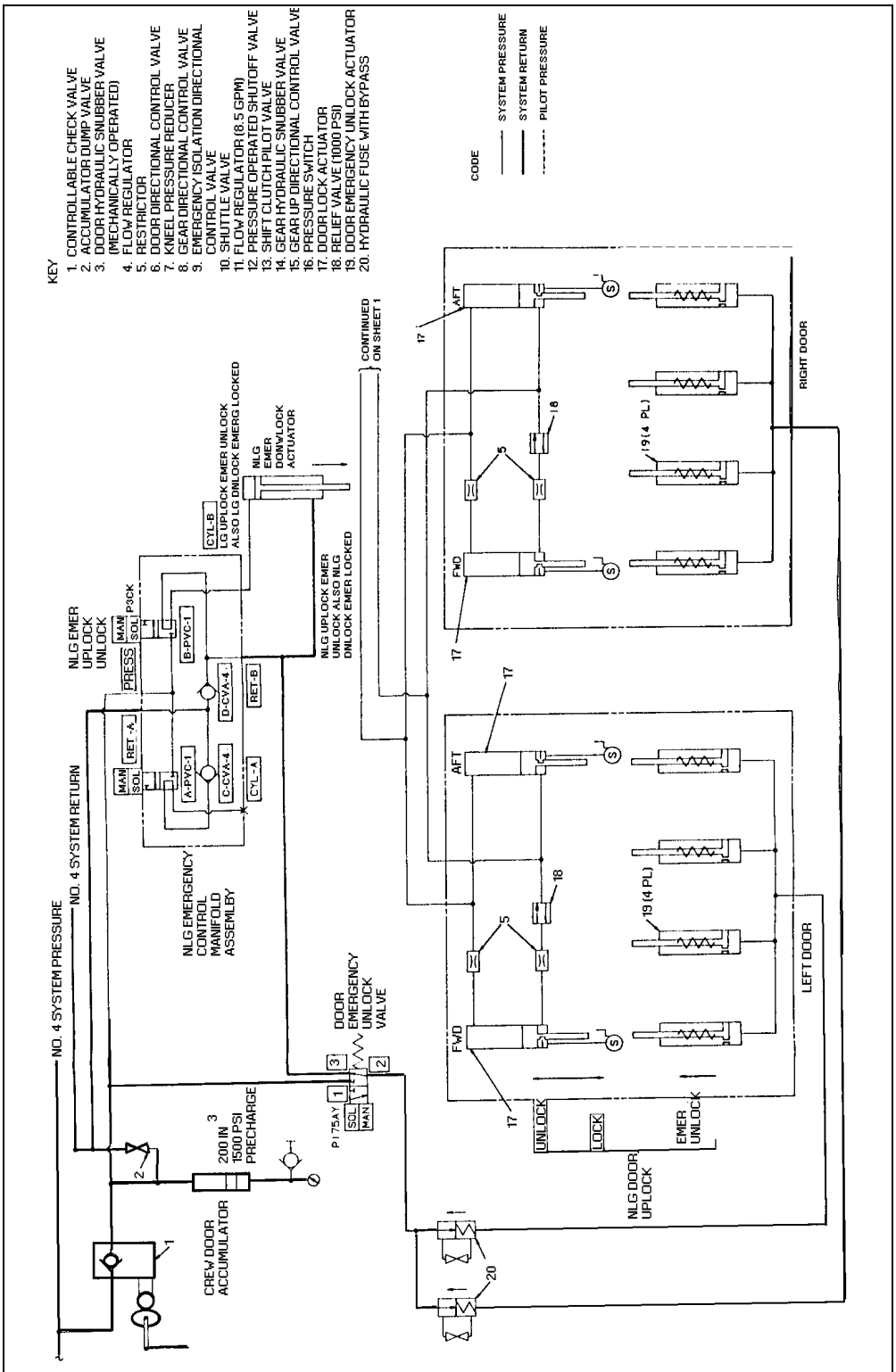


Figure 2-15 NLG SYSTEM HYDRAULIC SCHEMATIC (2 OF 2)

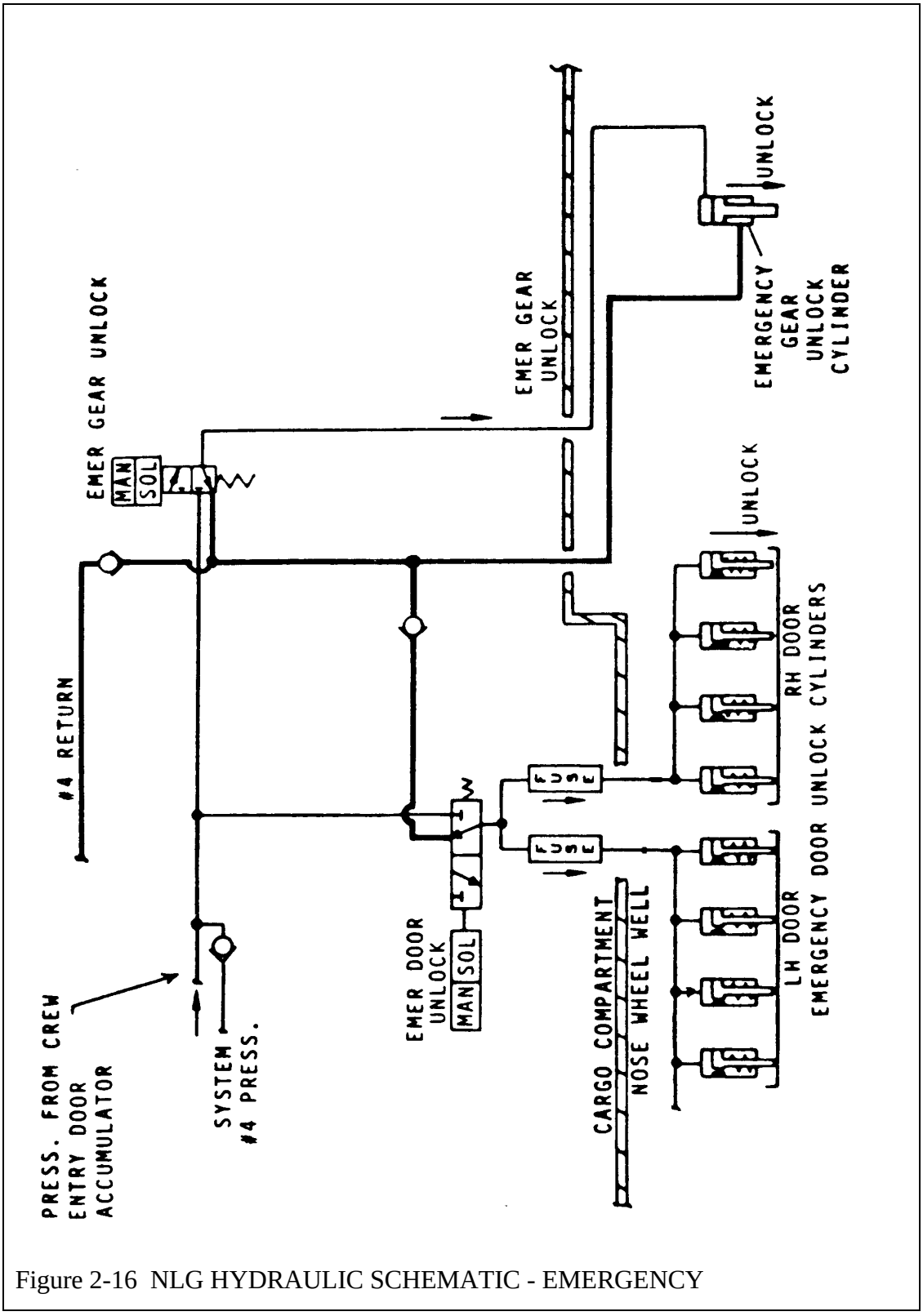


Figure 2-16 NLG HYDRAULIC SCHEMATIC - EMERGENCY

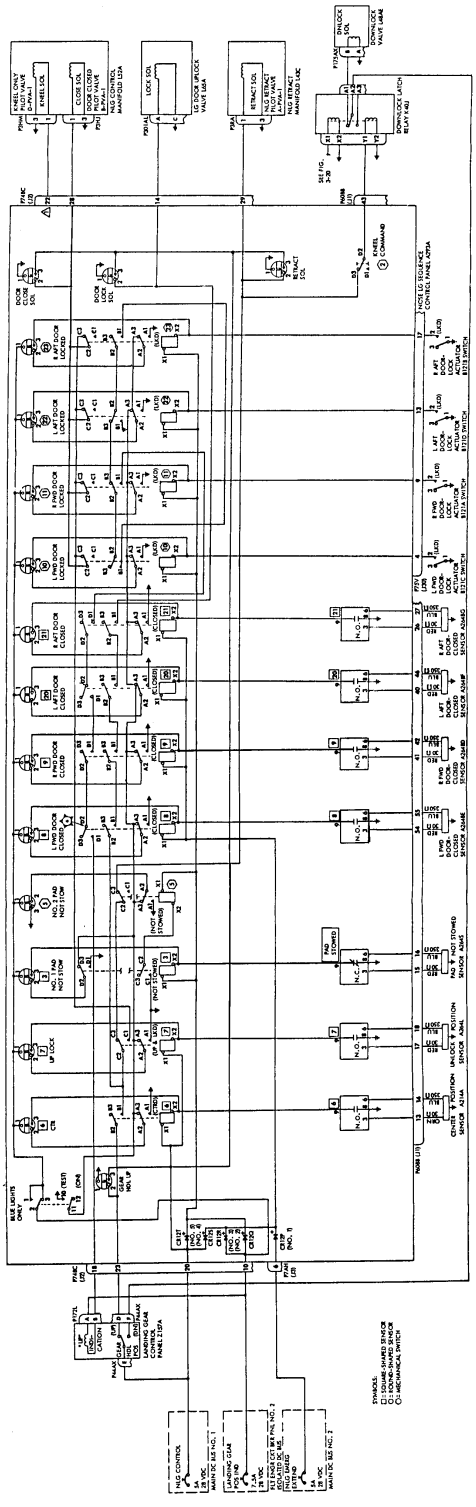


Figure 2-17 NLG ELECTRICAL CONTROL - RETRACTION

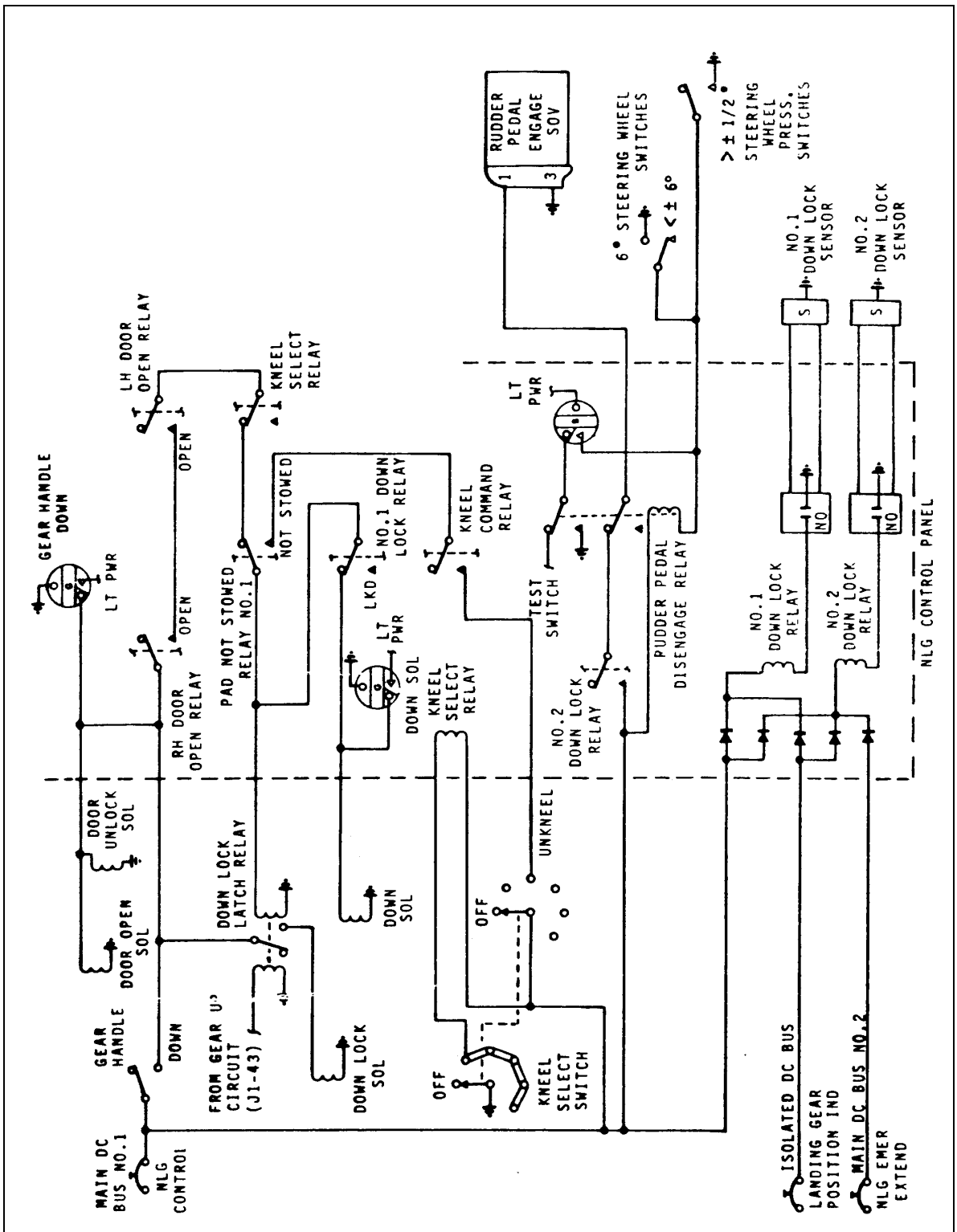


Figure 2-18 NLG ELECTRICAL CONTROL - EXTENSION

NOTE: When the gear is down and locked, the No.1 and No.2 down-lock proximity switch energizes the No.1 and No.2 down-lock relays.

The following sequence is then initiated:

- Gear-down solenoid de-energized—Gear hydraulic motor is vented to return.
- NLG down-lock solenoid remains energized—Pressure remains on the down-lock cylinder.
- NLG door-unlock solenoid valve remains energized—Pressure holds door locks unlocked.
- NLG door-open solenoid remains energized—Pressure remains on the door motor.

The door control valve is detented to the door open position thus assuring pressure availability to the NLG steering control manifold in the event electrical power is lost. The door lock control valve is detented to the unlock position. With gear handle moved to the UP position, the detented door lock control valve will allow pressure to maintain locks unlocked during closing.

EMERGENCY EXTENSION—An emergency hydraulic system and electric motors in the EXTEND position provide the following fully automatic sequence of operation:

- Energizes the NLG hydraulic system emergency isolation solenoid, which blocks pressure from the normal system and ports the system to return.
- Energizes the NLG emergency door-unlock solenoid, through the energized contacts of the emergency door motor control relays, and unlocks the NLG door locks.
- Energizes the emergency door motor control relay which releases the NLG door motor brake allowing the NLG emergency door motor to drive the doors open.
- When both doors assume an open position, the door-open proximity switches energize the door-open relays, de-energizing the emergency door-unlock solenoid and the emergency NLG door motor control relays. The emergency NLG unlock solenoid and the emergency NLG motor control relay will be energized when the doors are open.

NOTE: When either the right or left door opens, the EMERG SW ON light will illuminate.

- Energizing the emergency NLG unlock solenoid directs emergency system pressure or crew entry door accumulator pressure to unlock the NLG uplock mechanism.
- Energizing the emergency NLG motor control relay allows the electric motor brake to be released and drives the electric drive motor extending the gear.
- Once the gear reaches full down position, the overcenter linkage is locked by the emergency NLG lock cylinder.
- When the NLG downlock proximity sensor verifies a locked condition, the No.2 downlock relay energizes, the emergency NLG unlock solenoid and the emergency NLG motor control relay are de-energized.
- The emergency hydraulic isolation solenoid remains energized until the emergency extend switch is returned to normal.
- The EMER SW ON light will remain illuminated when the emergency EXTEND switch is positioned to EXTEND and the No.1 downlock relay is energized.

NOTE: The EMERGENCY EXTEND switch must be returned to normal after completion of the emergency gear extension cycle to allow the isolation valve to supply normal system hydraulic pressure (if available) for NLG steering.

EMERGENCY ELECTRICAL OVERRIDE SWITCHES

Two emergency electrical override switches are located on the NLG sequence control panel. The switches are used in conjunction with the Emergency EXTEND switch to backup the emergency system in the event of a door open relay circuit failure. Both RH and LH door open relays are used in the normal and emergency systems.

If during an emergency operation the NLG doors fail to open because the door open relay has already energized, the emergency electrical override switch for doors operation can be positioned to DOOR OPEN. This completes the circuit for the emergency door control relay which control the inoperative doors. After the doors are open, the NLG emergency extend relay will energize. The NLG emergency unlock solenoid will then energize through a contact of the emergency extend relay. The NLG should now extend by the emergency system.

As another example, suppose that the NLG doors open during an emergency extension operation, but the NLG does not extend. A door open relay may not have energized. Placing the emergency electrical override switch to NLG EXT completes the circuit to the NLG emergency extend relay. The uplock is unlocked and the gear is then driven down electrically.

The EMERG SW ON light, located at the center console, will be illuminated as long as the EMERGENCY EXTEND switch for the NLG is positioned to EXTEND and the NLG No.1 downlock relay is energized.

Positioning the EMERGENCY EXTEND switch to NORMAL will extinguish the light. The EMERG SW ON light will also illuminate to warn the flight crew that a door open relay circuit at the NLG sequence control panel has failed. The light circuit is completed if the No.1 downlock relay is de-energized (gear not down and locked), RH forward door lock switch is positioned to the lock condition (indicating door closed and locked), and either the RH or LH door open relay is indicating door open (relay energized or contacts stuck).

NOTE: If the *EMERGENCY SW ON* light on the center console *is illuminated* with the EMERGENCY EXTEND switches in their normal position and the nose gear is in its UP and LOCKED position, *do not* emergency extend the gear. Refer to the applicable T.O. to troubleshoot before extending the gear.

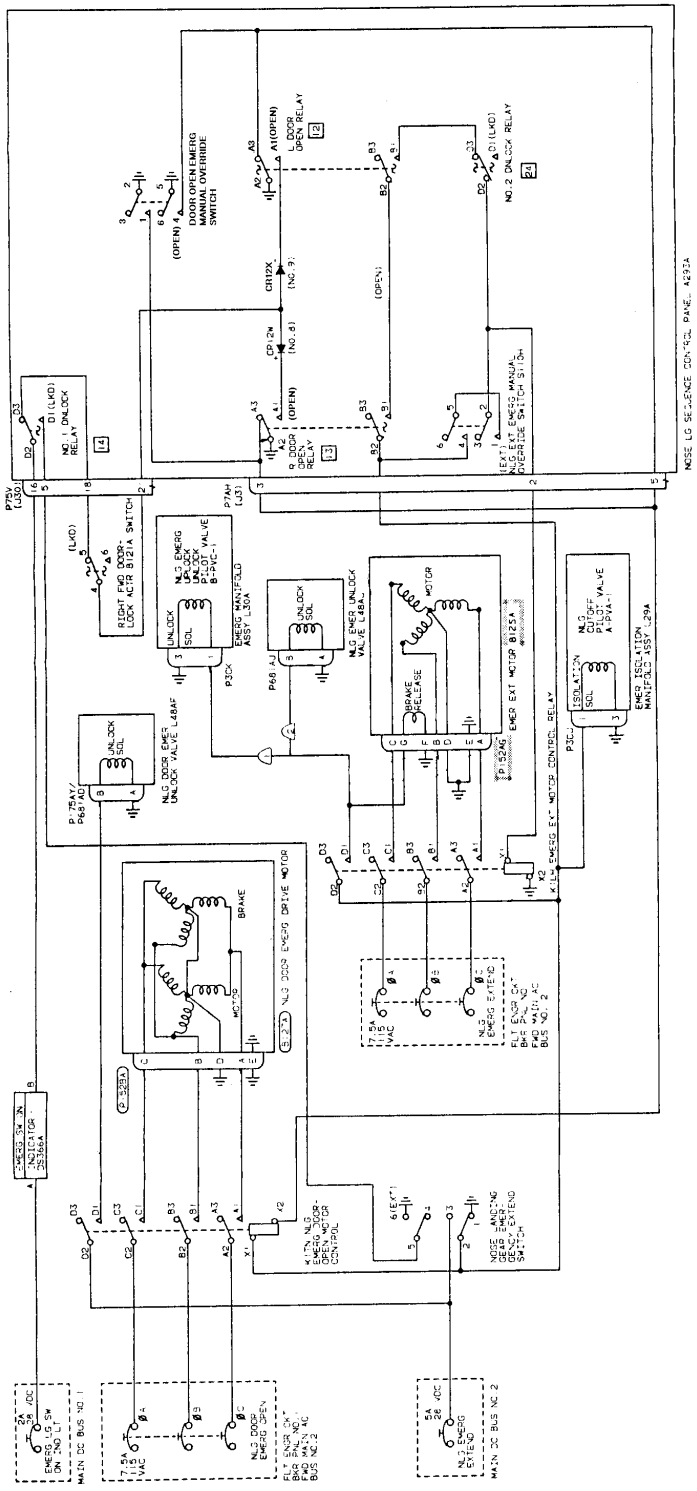


Figure 2-19 NLG ELECTRICAL CONTROL - EMERGENCY

POSITION AND WARNING INDICATION

GENERAL—The landing gear position and warning system provide an audible and visual indication of gear positions. Five pictorial display gear-position indicators are located on the landing gear control panel above the gear control lever. A red warning light located in the landing gear control lever indicates an undesirable gear condition. A landing gear warning horn, located on the flight station overhead area, sounds to indicate an unsafe condition for landing.

Each MLG position indicator is controlled by the 0° collar-lock relay, the downlock relay, the door closed relay, the 90° rotation relay, and the door lock microswitches.

The NLG position indicator is controlled by the No.2 NLG downlock relay, the NLG door close relays, the NLG door lock relays, and the door open relays.

The position indicators are labeled NOSE, L FWD, L AFT, R FWD, R AFT. The NLG indicator has four pictorial positions: UP, Red Wheels, Green Wheels, and In Transit. Each MLG indicator has four positions: UP, Red Wheels, Green Wheels, and in Transit.

The red warning light located in the landing gear control handle comes on under any of the following conditions:

- The landing gear handle is down and the nose gear is not in the down-and-locked position, or any of the MLG positioning collars are not locked.
- The landing gear handle is up and any of the nose or main gear door lock actuators are not in the locked position.

The landing gear warning horn sounds to indicate an unsafe gear condition as follows:

- When the flaps are below the approach setting and the nose gear is not down and locked or any of the main gear positioning collars are not locked.
- When the airspeed is less than 200 KCAS and all the following conditions exist:
    - The ADS switch is in the SAFE position and any throttle is below a minimum cruise power setting.
    - The nose gear is not down and locked or any main gear positioning collar is not locked.

A test button marked WARN LIGHT & HORN TEST is located beneath the landing gear control handle and tests the red warning light in the control handle and energizes the warning horn. A HORN SILENCE button located beneath the control lever may be used to silence the warning only if the horn sounded as a result of throttle position.

Four bogie pitch warning lights located on the annunciator panel, indicate that an unsafe bogie pitch condition exists when any one of the landing gears are down and locked and the bogie pitch down is greater than 15°.

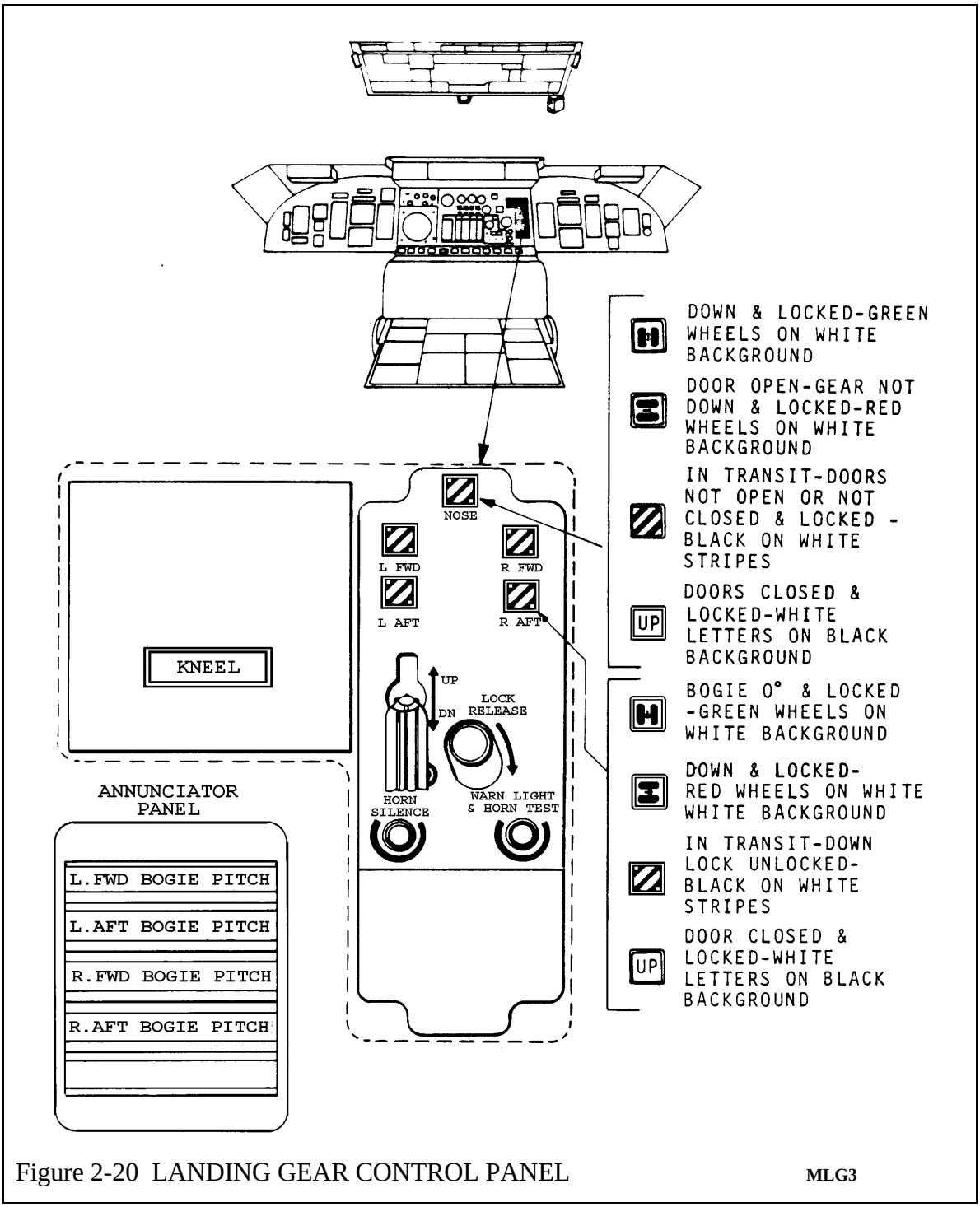


Figure 2-20 LANDING GEAR CONTROL PANEL **MLG3**

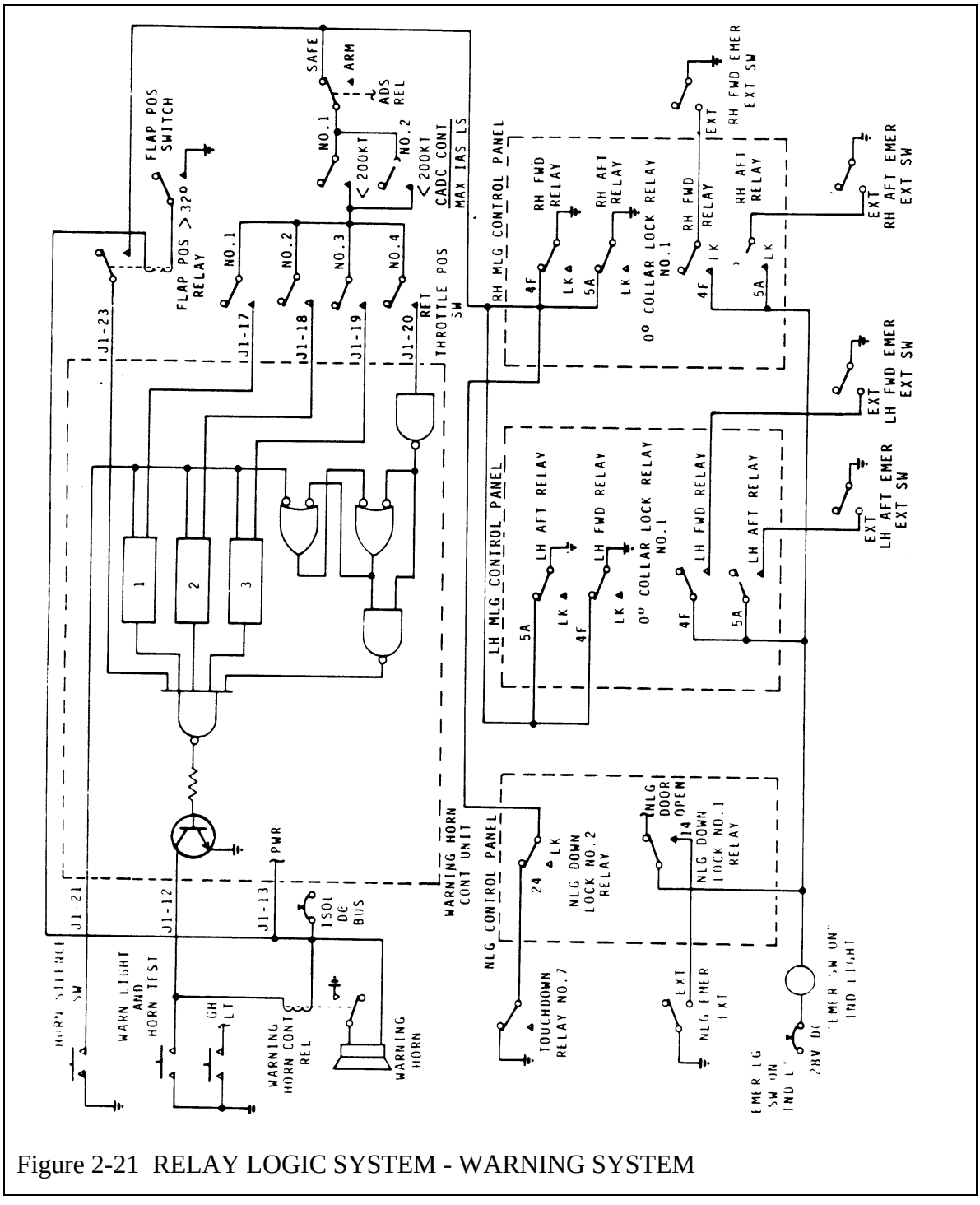


Figure 2-21 RELAY LOGIC SYSTEM - WARNING SYSTEM

GEAR INDICATION WITH SYSTEM NORMAL OPERATION—With the landing gear position indicators showing Green Wheels on a white background and all landing gear warning lights extinguished, positioning the landing gear handle to the UP position will initiate the following conditions:

- The red light in the landing gear handle will illuminate.
- The landing gear position indicators will show the following positions as each gear moves out of the 0° or straight ahead position:
    - The nose gear position indicator will show Red Wheels on white background as the gear moves out of the down and locked position.
    - After the nose gear reaches the uplock position and the nose gear doors start closing, the nose gear position indicator will show an In-Transit condition (black crosshatched bars on a white background).
    - The main gear position indicators will show Red Wheels on white background when the inter-collar lock unlocks.

CAUTION: Before the main gears start their retraction cycle, their position indicators must show Green Wheels on white background at 0° position.

- After the gear is fully rotated 90° and moves out of the down and locked position, each main gear position indicator will show an In-Transit condition (black crosshatched bars on a white background).
- When the MLG doors are locked, the NLG is up and locked and the NLG doors are locked, the red light in the landing gear control handle will extinguish and the landing gear position indicators will display the word UP in white letters on a black background. At the same time all landing gear retraction systems will be depressurized, except for the nose gear door actuation gear box brake and shifter.

Time required for MLG retraction should not exceed 17 seconds from the time the landing gear control lever is placed in the UP position until the red light in the landing gear control handle extinguishes.

The time required for the nose landing gear should be 12 seconds maximum. The nose gear doors should close in 6 seconds maximum.

Time required for the main gears to rotate 90° should be 6 seconds maximum and retracting the gears to their UP position should take 11 seconds maximum.

When the landing gear control handle is placed to the DN position, the red light in the landing gear control will illuminate.

Each MLG position indicator will show the In-Transit position as the door locks come unlocked and the gears start out of the up-and-locked position.

After main gears extend to the down-locked position (90° position), the main gear position indicators will show Red Wheels on white background.

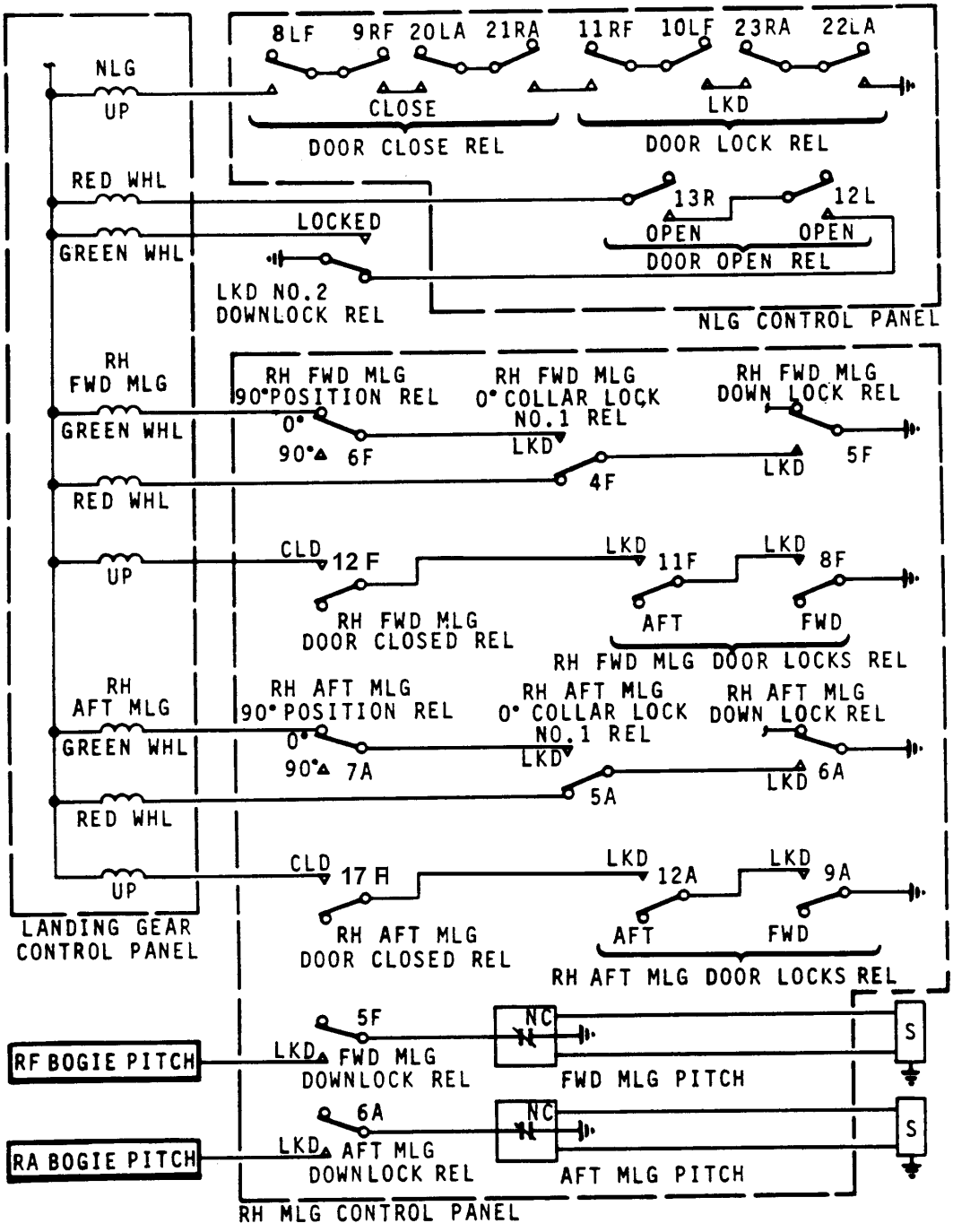


Figure 2-22 LANDING GEAR POSITION INDICATION ELECTRICAL **MLG60**

After the main gears rotate from the 90° position to the 0° position and the inter-collars lock locks, the main gear position indicators will show Green Wheels on white background. When the nose gear doors unlock, the nose gear position indicator will indicate the black-on-white stripes In-Transit condition.
After the nose gear doors open the nose gear position indicator will show Red Wheels on white background. The nose gear then extends.

After the nose gear reaches the down-and-locked position the nose gear position indicator will show Green Wheels on white background.

When the NLG is in the down-and-locked position, the MLGs are down-and-locked-and-rotated to the 0° position, and the 0° collar locks are locked, the red light in the landing gear control handle will extinguish.

All gears should extend in a maximum of 18 seconds. The approximate time for the MLG will be 11 seconds for extension and 4 seconds for rotation. The time for the NLG will be 6 seconds maximum for door opening and 12 seconds maximum for gear extension. The time for gear extension is measured from the time the landing gear control lever is placed in the DN position until the red lights in the landing gear control handle extinguish.

Hydraulic pressure will be available for normal steering/alternate brakes with the landing gear in the extended position and with the landing gear hydraulic systems pressurized.

GEAR INDICATION WITH SYSTEM EMERGENCY OPERATION—To describe the indication noted during nose landing gear emergency extension, it is assumed that after positioning the gear control handle to DN, the nose landing gear normal extension system did not work.

NOTE: If the red light on the LANDING GEAR EMERGENCY EXTEND switch panel is illuminated with all EMERGENCY EXTEND switches in their normal position and nose gear in its up-and-locked position, do not EMERGENCY EXTEND the nose gear. Refer to the applicable T.O. to troubleshoot/extend the gear.

Raise the red switch guards and place the NLG EMERGENCY EXTEND switch, located on the center console to the EMERGENCY EXTEND position. The red lights in the landing gear control handle will illuminate. The NLG position indicator will show the In-Transit position as the doors unlock and open.

After the nose gear doors are open, the nose gear position indicator will show Red Wheels on white background, and the EMERG SW light will illuminate.

NOTE: The nose gear doors will not fully open. They will only open to approximately 162° due to the electrical drive mechanism during NLG emergency extension.

When the nose gear extends to its down-and-locked position, the nose gear position indicator will show Green Wheels with white background and the EMERG SW ON light will remain illuminated.

When the LANDING GEAR EMERGENCY EXTEND switch is returned to the normal position by closing the switch guards, the red light on the emergency extension panel extinguishes.

NOTE: The nose gear doors will open to their fully open position (165°), when normal system pressure is available.

If it is now assumed that a main landing gear did not extend during normal operation, placing the related EMERGENCY EXTEND switch to EXTEND will initiate the following conditions:

- The red light in the landing gear control handle will illuminate.
- The landing gear position indicator will show the In-Transit position as the door locks unlock and the gear extends.

After the main gears extend to their down-and-locked position (90°), the main gear position indicators will show Red Wheels on white background.

After the main gear rotates from the 90° position to the 0° position and the inter-collar lock locks, the main gear position indicator will show Green Wheels on white background, and the EMERG SW ON light will illuminate.

The MLG shall extend and lock in 180 seconds maximum and the NLG shall extend and lock in 195 seconds maximum. The nose gear and main gear extension is measured from the time the landing gear emergency extend switches are positioned to the EXTEND position, until the Green Wheels show in their indicators.

LANDING GEAR SEQUENCE CONTROL PANEL LIGHTS

With the landing gear control handle in the DN position and the nose gear indicating Green Wheels, hold the test switch on the nose landing gear sequence control panel in the TEST position. Observe that all numbered lights (blue lenses) on the control panel illuminate. Release the test switch.

Press-to-test all green lights for lamp test.

The following lights shall be illuminated:

RET	EXT
CTR (6)	GEAR HDL DN DOOR OPEN (12 &13 DN LOCK (14 &24)

All lights on the control panel except CTR(6), GEAR HDL DN, DOOR OPEN (12 & 13), AND DN LOCK (14 & 24) shall be extinguished.

Place the landing gear control handle in the UP position.

NOTE: During the retraction cycle the lights on the control panel can be monitored. All lights shall be extinguished except as noted.

During the nose gear retraction, the following lights should be illuminated:

RET	EXT
CTR (6) GEAR HDL UP RET SOL	DOOR OPEN (12 & 13)

With the nose gear-up and locked and the doors closing, the following lights should be illuminated:

RET	EXT
CTR (6) GEAR HDL UP UPLOCK (7) DOOR CLOSE SOL	

With the nose gear-up and locked and the both doors locked, the following lights should be illuminated:

RET	EXT
CTR (6) GEAR HDL UP UPLOCK (7) DOOR CLOSED (8,9,20,21) DR LK SOL DOOR LOCKED (10,11,22,23)	

Place the landing gear control handle in the DN position.

NOTE: All lights should be extinguished except as noted.

During the nose door opening, the following lights should be illuminated:

RET	EXT
CTR (6) UPLOCK (7)	GEAR HDL DN

After the doors open and the nose gear starts to extend, the following lights should be illuminated:

RET	EXT
CTR (6)	GEAR HDL DN DOOR OPEN (12 & 13) DOWN SOL

After the nose gear indicates "Green Wheel", the following lights should be illuminated:

RET	EXT
CTR (6)	GEAR HDL DN DOOR OPEN (12 & 13) DN LOCK (14 & 24)

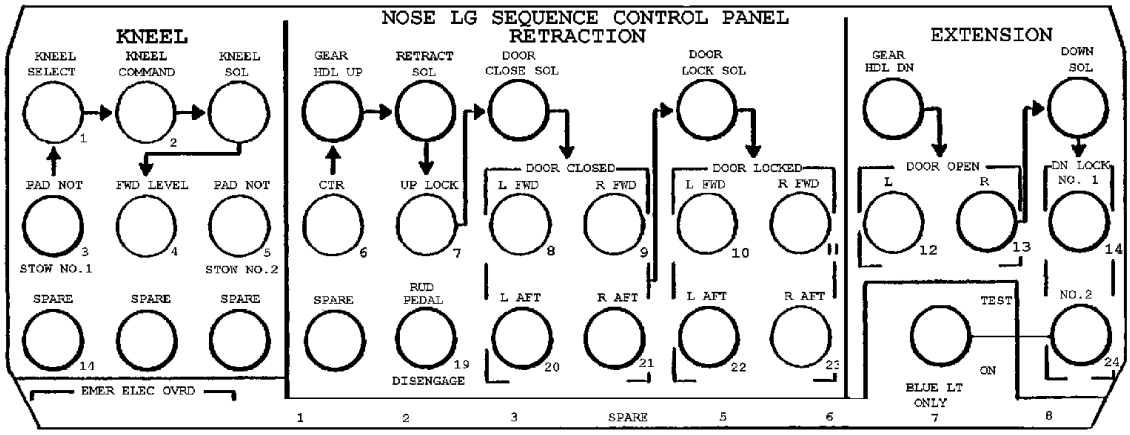


Figure 2-23 NLG SEQUENCE CONTROL PANEL

LH MLG Sequence Control Panel Lights—With the landing gear control handle in the DN position and the LH fwd, and LH aft MLG indicating "Green Wheels", hold the test switch on the LH MLG sequence control panel in the TEST position. Observe that all numbered lights (blue lenses) on the control panel illuminate. Release the test switch.

Press-to-test the green lights for lamp test.

The following lights shall be illuminated:

AFT		FWD	
UP	DOWN	UP	DOWN
CTR (2A)	GEAR HDL DN (13A,18A)		GEAR HDL DN (13F,18F)
	DR UNLK SOL		DR UNLK SOL
	GEAR DN TD (4A)		GEAR DN TD (3F)
	DOWN SOL		DOWN SOL
	DN LOCK 6A		DN LOCK (5F)
	DN ROTATE SOL		DN ROTATE SOL
	COLLAR LOCK (5A&10A)		COLLAR LOCK (4F&9F)

All other lights will be off except for CASTER CRT TD (1A) and the 4 TOUCH-DOWN REL LTS which may be either on or off.

With the LH AFT MLG control circuit breaker engaged and all other MLG control circuit breakers disengaged, place the landing gear control handle in the UP position.

NOTE: All lights for that gear will be off except as noted. For the aft gear the CASTER CTR TD (1A) may be either on or off.

Lights AFT Gear—Immediately after the gear handle is raised, the following lights shall be illuminated:

AFT	
UP	DOWN
CTR (2A) GEAR HDL UP GEAR HDL UP UNLK (3A) (After 1-2 Seconds the following lights shall also be illuminated) UP ROTATE SOL	DN LOCK (6A)

After the gear rotates to 90° and begins to retract, the following lights shall be illuminated:

AFT	
UP	DOWN
CTR (2A) GEAR HDL UP GEAR HDL UP UNLK (3A) UP ROTATE SOL 90° POS (7A) UP SOL	

After the gear is UP and locked the following lights will be illuminated:

AFT	
UP	DOWN
CTR (2A) GEAR HDL UP 90° POS (7A) DR CL (8A,11A. & 17A) DR LK SOL DR LOCK (9A & 12A)	

NOTE: For the aft gear the CASTER CTR TD (1A) may be either on or off.

Immediately after the gear handle is raised, the following lights shall be illuminated. All other lights shall be off except as noted.

FWD	
UP	DOWN
GEAR HDL UP UNLOCK (2F) UP GEAR HDL UP UNLOCK (2F) UP ROTATE SOL	DN LOCK (5F)

After the gear rotates to 90° and begins to retract, the following lights shall be illuminated:

FWD	
UP	DOWN
GEAR HDL UP GEAR HDL UP UNLK (2F) UP ROTATE SOL 90° POS (6F) UP SOL	

After the gear is up and locked, the following lights shall be illuminated:

FWD	
UP	DOWN
GEAR HDL UP 90° POS (6F) DR CL (7F, 10F, & 12F) DOOR LOCK (8F & 11F)	

AFT	
UP	DOWN
CTR (2A) GEAR HDL UP 90° POS (7A) DR CL (8A, 11A&17A DOOR LOCK SOL DR LOCK (9A &12 A)	

Place the landing gear control handle in the DN position.

While the gear is extending, the following lights shall be illuminated:

AFT	
UP	DOWN
CTR (2A) UP ROTATE SOL 90° POS (7A) UP SOL FWD DR CL NO.1 (17A) FWD DR CLO NO.2 (8A) AFT DR CL (1A) After 1 to 2 seconds, the following lights shall go off: FWD DR CL NO.1 (17A) FWD DR CL NO.2 (8A) AFT DR CL (11A)	GEAR HDL DN (13A, 18A) DR UNLOCK SOL After 1 to 2 seconds, the following lights shall go off: GEAR DN TD (4A) DOWN SOL

After the gear extends and is rotating toward 0°, the following lights shall be illuminated:

AFT	
UP	DOWN
CTR (2A)	GEAR HDL DN (13A, 18A) DN UNLOCK SOL GEAR DN TD (4A) DOWN SOL (6A) DN ROTATE SOL

After the gear is at 0° with the indicator showing "Green Wheels" the lights for the aft gear will be illuminated as follows:

AFT	
UP	DOWN
CTR (2A)	GEAR HDL DN (13A, 18A) DN UNLOCK SOL GEAR DN TD (4A) DOWN SOL DN LOCK (6A) DN ROTATE SOL COLLAR LOCK (5A & 10A)

Lights FWD Gear—Immediately after the handle is raised, the following lights shall be illuminated:

FWD	
UP	DOWN
GEAR HDL UP GEAR HDL UP UNLK (2F) (After 1-2 seconds the following lights shall also be illuminated) UP ROTATE SOL	DN LOCK (5F)

After the gear rotates to 90° and begins to retract, the following lights shall be illuminated:

FWD	
UP	DOWN
GEAR HDL UP GEAR HDL UP UNLK (2F) UP ROTATE SOL 90° POS (6F) UP SOL	

After the gear is up and locked, the following lights shall be illuminated:

FWD	
UP	DOWN
GEAR HDL UP 90° POS (6F) DR CL (7F, 10F & 12F) DR LK SOL DOOR LOCK (8F & 11F)	

Place the landing gear control handle in the DN position.

While the gear is extending, the following lights shall be illuminated:

FWD	
UP	DOWN
UP ROTATE SOL 90° POS (6F) UP SOL FWD DR CL NO.1 (12F) FWD DR CL NO.2 (10F) After 1 to 2 seconds the following lights shall go off: UP SOL FWD DR CL NO.1 (12F) AFT DR CL NO.2 (10F)	GEAR HDL DN (13F, 18F) DR UNLOK SOL After 1 to 2 seconds the following lights shall come on: GEAR DN TD (3F) DOWN SOL

After the gear extends and is rotating toward 0°, the following lights shall be illuminated:

FWD	
UP	DOWN
	GEAR HDL DN (13F, 18F) DR UNLK SOL GEAR DN TD (3F) DN LOCK (5F) DN ROTATE SOL DOWN SOL

After the gear is at 0° with the indicator showing "Green Wheels" the lights for the Forward gear shall be illuminated as following:

FWD	
UP	DOWN
	GEAR HDL DN (13F, 18F) DN UNLK SOL GEAR DN TD (3F) DOWN SOL DN LOCK (5F) DN ROTATE SOL COLLAR LOCK (4F & 9F)

DOWNLOCK VISUAL INDICATION— A fiber scope is located on the left cargo compartment sidewall in line with nose gear wheel well. The scope provides an inflight means of visually sighting the NLG red and black marker and flag indicator to accretion whether or not the NLG is down and locked.

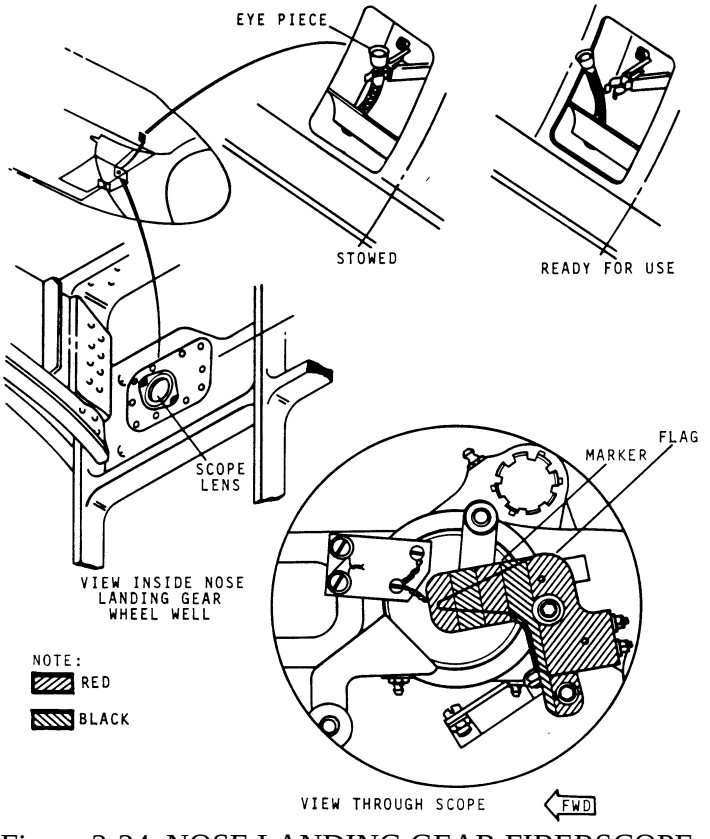


Figure 2-24 NOSE LANDING GEAR FIBERSCOPE INSTALLATION **MLG62**

Chapter Three —NLG STEERING

The NLG steering system is a hydraulically actuated system that is mechanically controlled from either a hand wheel or the rudder pedals. The hand wheel located on the pilot's side console controls 60° of turning angle either side of center while the rudder pedals control 5° of turning angle either side of center.

NLG STEERING MECHANICAL CONTROL—The NLG steering mechanical control system controls the NLG hydraulic actuation system during steering operations. The mechanical control system consists of a quadrant assembly, a single, two-way closed circuit cable run, a self-nulling pivot beam, a hand wheel and chain drive, and the rudder pedals and associated linkage.

QUADRANT ASSEMBLY—The quadrant assembly is located under the flight deck floor, aft and left of the pilot's rudder pedal. The quadrant assembly serves as a common input point for the hand wheel and rudder pedal positioning commands. A hydraulically actuated, electrically controlled, rudder pedal disconnect assembly is located forward of the quadrant and provides for hand wheel inputs to override other inputs to the quadrant. The disconnect assembly must be connected in order for rudder pedal positioning inputs to have effect on the quadrant. It must be disconnected in order for hand wheel operation to have effect. The disconnect assembly is connected whenever the NLG is down and locked and hand wheel steering is not in use.

CABLE RUN AND SELF-NULLING BEAM—The two-way closed circuit cable run connects the steering quadrant to the NLG steering collar, and controls the NLG hydraulic steering actuation system by traveling through a group of pulleys connected to a self-nulling beam on the NLG Steering Manifold.

As cable tension is increased on either side of the pivot beam, due to a left or right steering command from the quadrant, the pivot beam positions a steering control valve to meet the command inputs. As the steering collar reaches the desired command position, the cable tension is relaxed, thus allowing the pivot beam to reposition the steering control valve to its previous position.

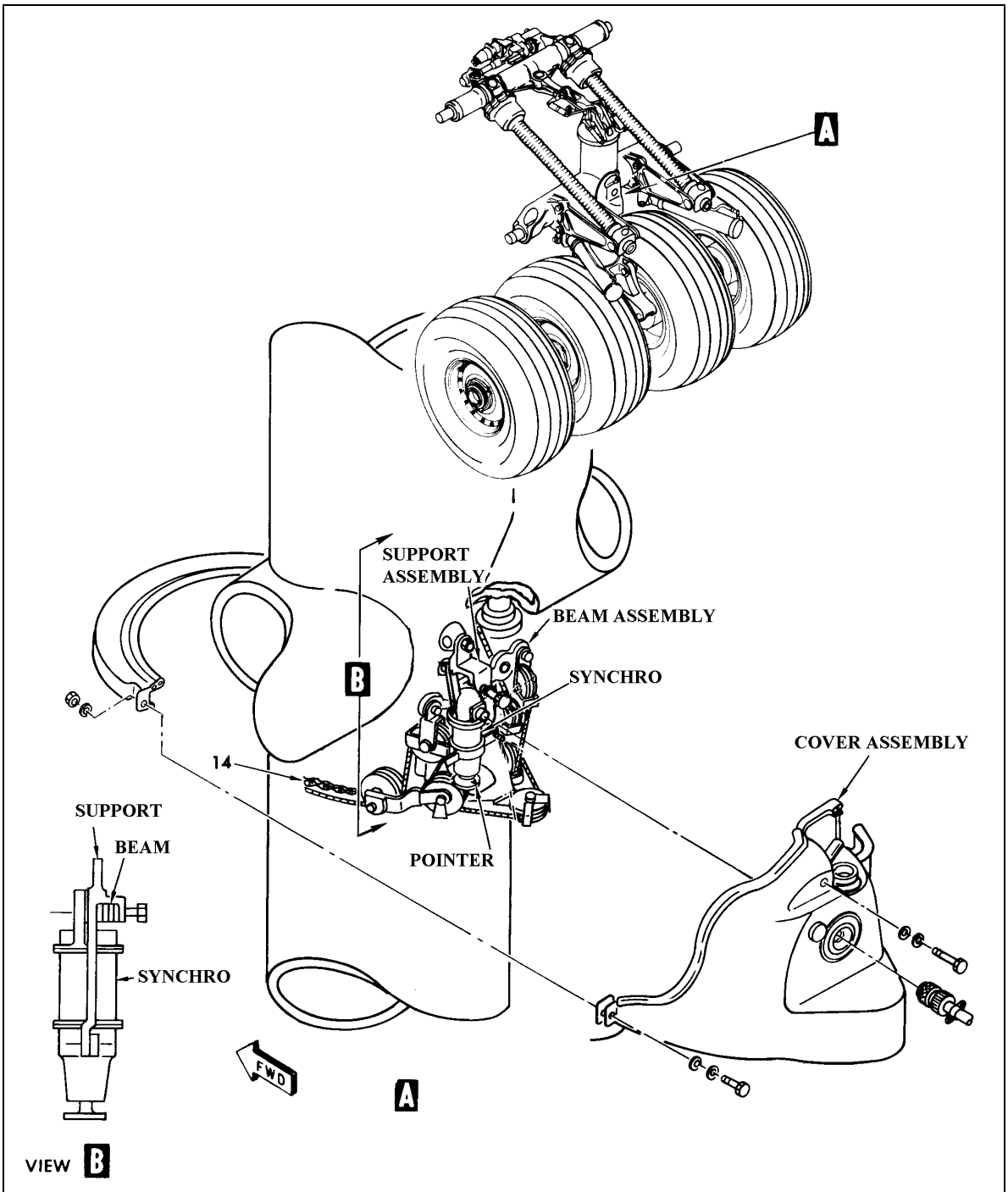


Figure 3-1 NLG SELF NULLING BEAM MLG63.TIF

HAND WHEEL AND CHAIN DRIVE—The hand wheel located on the forward end of the pilot's side console is the primary control for steering the aircraft during ground operations. Rotation of the hand wheel 570° from its centered position in a left or right direction provides for 60° nose gear steering left or right of center at a rate of 10° to 12° per second. Located at the base of the hand wheel shaft is a torque-sensitive microswitch used to electrically control the rudder pedal disconnect assembly by deenergizing or energizing a rudder pedal engage solenoid. Energizing the solenoid connects the disconnect assembly. Approximately 1/2° turn of the hand wheel in either direction causes sufficient torque to open the microswitches and disconnect rudder pedal steering, thus allowing hand wheel operation. Releasing the hand wheel in any position allows the 1/2° microswitch to close. Wired in parallel with the 1/2° microswitch is a 6° switch mounted to the steering quadrant. The 6° switch opens when nose gear steering inputs from the hand wheel exceed 6°, allowing the pilot to release pressure on the hand wheel. Releasing the hand wheel prior to a 6° steering angle re-energizes the disconnect assembly causing the nose gear to return to center.

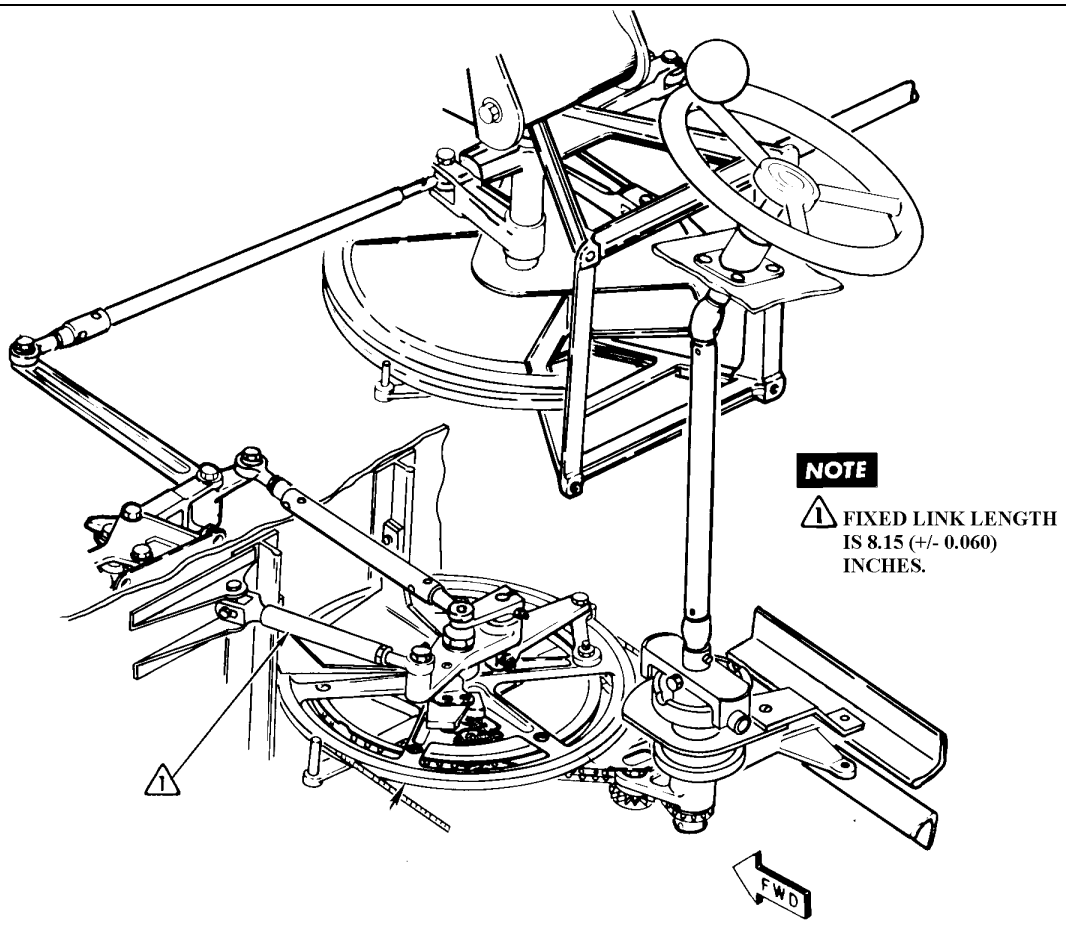


Figure 3-2 NLG STEERING QUADRANT ASSEMBLY

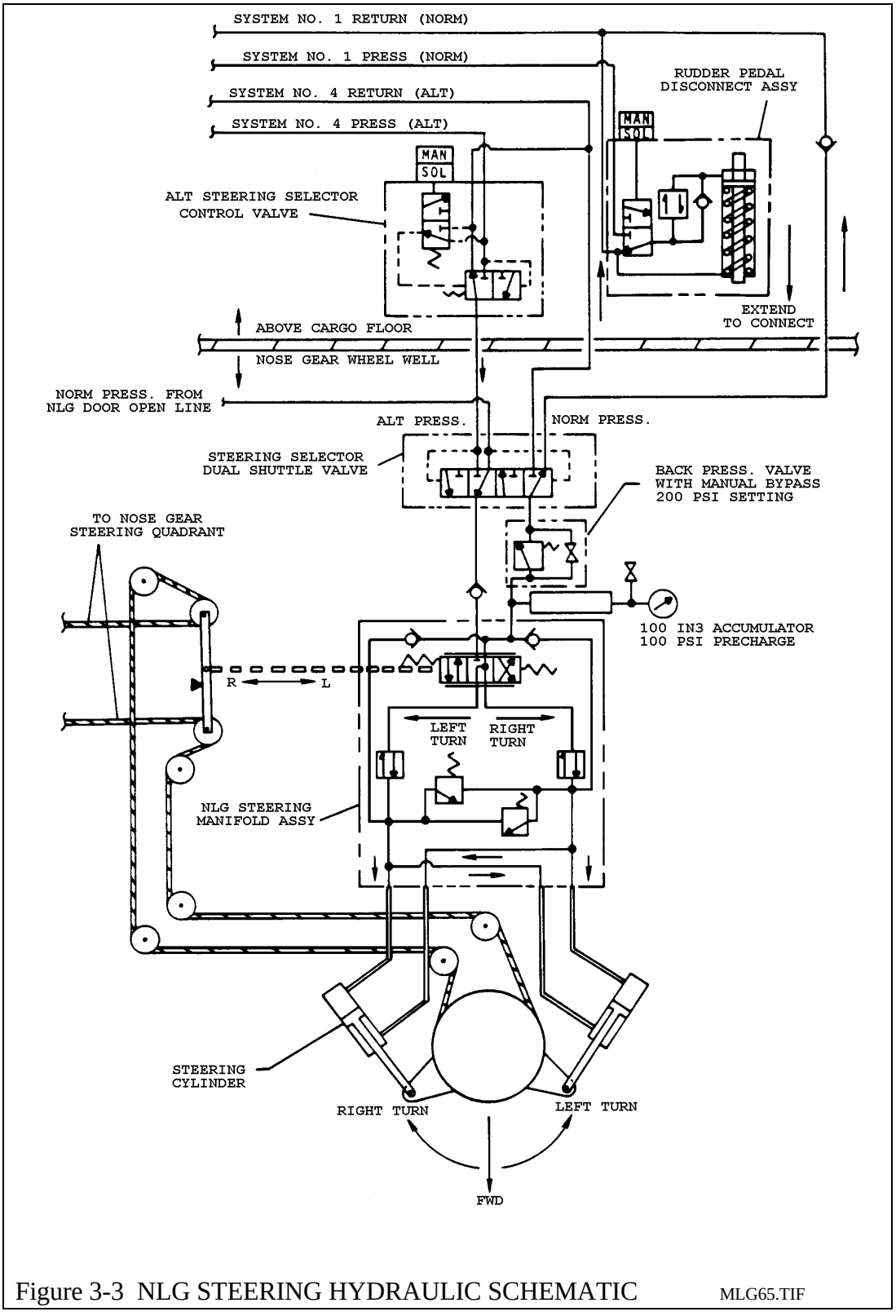


Figure 3-3 NLG STEERING HYDRAULIC SCHEMATIC MLG65.TIF

RUDDER PEDAL AND LINKAGE—The rudder pedals are connected to the quadrant assembly by a series of pushrods and lever arms. Rudder pedal steering is limited to 5° of travel left or right of neutral by rudder pedal travel itself.

NLG STEERING HYDRAULIC ACTUATION SYSTEM—The NLG steering hydraulic actuation system consists of a NLG steering control manifold, two steering cylinders, an accumulator and back pressure valve, an alternate steering selector valve and a steering pressure shuttle valve. Pressure for normal operation is provided by the No.1 hydraulic system from the NLG door open pressure line. Alternate steering system pressure is provided by the No.4 hydraulic system.

STEERING CONTROL MANIFOLD—The steering control manifold located on the aft side of the NLG shock strut contains a steering control valve, two restrictors, two relief valves, and two check valves.

The spool-type control valve is mechanically positioned by the NLG mechanical control system to direct hydraulic pressure from the normal or alternate hydraulic system to the two steering cylinders.

NOSE GEAR STEERING CYLINDERS—The nose gear steering cylinders are two-way operating cylinder-and-piston assemblies used to position the nose gear during ground maneuvering.

ALTERNATE (ALT) STEERING SYSTEM—An alternate steering pressure selector control valve and a steering pressure shuttle valve are used to direct alternate steering pressure to the system in the event of normal system pressure loss.

When alternate steering operations are in effect, rudder pedal steering of the nose gear is not available. This condition exist due to the unpressurized condition of the rudder pedal disconnect assembly. In the event of total steering system pressure loss the nose gear has the ability to freecaster, using engine thrust and wheel brake action for control.

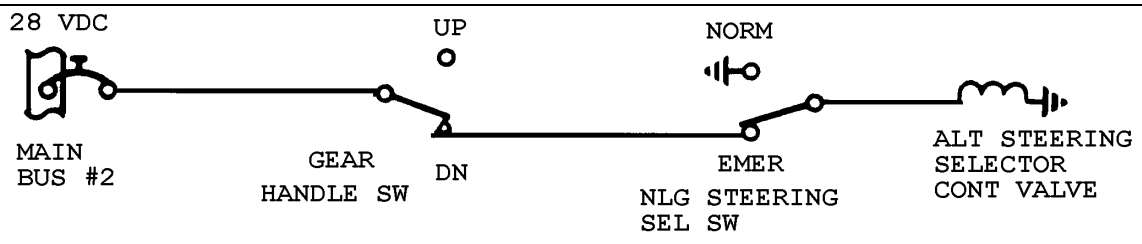


Figure 3-4 NLG Emergency Steering Electrical Schematic

ALTERNATE STEERING SELECTOR CONTROL VALVE—The alternate steering control valve is an electrically controlled, normally closed three-port valve which directs hydraulic pressure to the steering pressure shuttle valve. The selector valve is located in the cargo compartment, mounted on the right cargo compartment sidewall in line with the nose wheel well area.

Placing the NLG STEERING selector switch located on the landing gear control panel to EMER energizes a solenoid located within the selector valve. This action ports

pressure from the inlet port to the steering pressure shuttle valve. Deenergizing the solenoid connects the outlet pressure port to the return port of the valve.

STEERING PRESSURE SHUTTLE VALVE—The hydraulically operated, six-port, steering-pressure shuttle valve is located in the nose wheel well and serves to direct either normal steering system pressure or alternate steering system pressure to the control manifold. The shuttle valve also provides necessary return line ports for system operation.