NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, DC 20594

January 22, 1997

STRUCTURES GROUP - LANDING GEARS AND LANDING GEAR DOOR ASSEMBLIES FACTUAL SUMMARY

ACCIDENT	:	DCA96MA070
Location	:	East Moriches, New York
Date	:	July 17, 1996
Time	:	2031 Eastern Daylight Time
Airplane	:	Boeing 747-131, N93119 Operated as Trans World Airlines (TWA) Flight 800

GROUP

	Name/Organization
Chairman	**Deepak Joshi** **NTSB** **Washington, DC**
Member	**Dave Orth** 7/23/97 **Boeing Commercial Airplane Group** **Seattle, WA**
	Other Boeing Members **Barry Smith**
Member	**Steve Green** 01-22-97 **Air Line Pilots Association (ALPA)** **Herndon, VA**
Member	**Charlie Hale** 1-22-97 **International Association of Machinists (IAM)** **JFK Intl Airport, NY**
Member	**Dan Rephlo** 1-22-97 **Trans World Airlines (TWA)** **Kansas City, MO**
Member	**Steve Klapach** Stephen F. Klapach 01-22-97 **Federal Aviation Administration** **Garden City, NY**

1.0 LANDING GEAR AND LANDING GEAR DOOR ASSEMBLIES

1.1 General Description

The nose gear separated from the fuselage structure and was found in the Yellow debris area. Three out of four nose landing gear doors were found in the Red debris area and one was found in the Yellow debris area. All the main landing gear and main gear doors were found in the Green debris area. The nose gear suffered the least amount of impact damage as compared to the wing gears and body gears. All of the tires were recovered and documented in the System Group Notes. Refer to Fire and Explosion Group Notes for soot documentation.

2.0 LANDING GEAR ASSEMBLIES

2.1 Nose Gear Assembly

The nose gear assembly (LG1) separated from the fuselage and suffered impact damage. The outer cylinder, inner cylinder, axle, retract linkage, and trunnion fittings remained intact. The trunnion fittings separated from the fuselage structure and an eight foot section of bulkhead at STA 340 remains attached to the retract fitting. The right tire, wheel, and outer hub separated from the nose gear assembly. Some portions of hydraulic lines remained attached.

2.2 Left Wing Gear Assembly

The left wing gear assembly (LG2) separated from the rear spar and the STA 1350 landing gear beam. The outer cylinder, inner cylinder, and truck remained intact. The gear assembly had separated from the trunnion fittings. Some hydraulic lines and wiring remained attached. The downlock bungee was fractured and separated from the gear assembly. The inboard jury strut link fractured and separated from the side strut and the outboard jury strut. The outboard jury strut link remained attached to the outer cylinder. Three of the four brake rods were fractured. The aft outboard axle fractured 8.5 inches from the gear beam centerline. The retract stabilizing arms were bent and the aft stabilizing arm outboard section had separated from the gear assembly. The aft outboard tire, inner hub, outer hub, brake assembly, and outer portion of the axle had separated from the gear assembly. The forward outboard tire suffered impact damage and exhibited several cuts. The forward inboard tire, inner hub, outer hub, and outer two-thirds of brake pads and rotors had separated from the gear assembly. The inboard aft tire, inner hub, outer hub, and brake assembly had separated from the gear assembly.

2.3 Left Body Gear Assembly

Left body gear assembly (LG3), outer cylinder separated from the inner cylinder and the axle beam fractured into two segments. The outer cylinder remained attached to the trunnion fittings which separated from the STA 1480 bulkhead. The jury strut had

The inboard aft door broke into two segments. There is evidence of numerous punctures, cracks, and skin flapping on the door structure. A fuselage fitting remained attached at the aft hinge location. The second hinge forward of the trailing edge was fractured. The third hinge forward of the trailing edge remains attached to the outer skin. Approximately eleven inches by four inches of the leading edge suffered impact damage and had separated from the door assembly.

Outboard Aft Door

Not attached to door assembly. Door could not be identified.

3.6 Right Wing Gear Wheel Well Doors (LG10)

Inboard Door

There is evidence of cracks and punctures in the outer skin of the door. The rod was fractured at the threaded area adjacent to the door fitting. The aft rod arm had separated from the door assembly. The third and fourth hinges aft of the leading edge had separated from the door assembly.

Outboard Door

This door suffered impact damage at the leading edge and trailing edge. All hinges had fractured. The rod and fitting had separated from the door assembly. The aft inboard corner had separated from the door assembly. The inner skin is cracked running forward where the rod fitting was located. The forward inboard corner structure has separated from the door assembly.

3.7 Right Wing Gear Doors (LG10)

Outboard Door

The outboard door broke into three segments. The outboard corners separated from the door assembly. The forward edge was dented midway.

Inboard Door

The inner skin was cracked and dented.

separated from lower drag link. The outer cylinder gland nut had separated and the piston had separated from the outer cylinder. The axle beam and connecting rods were fractured and many hydraulic lines remained attached. The retract piston pulled the aircraft structure attach fitting out of the aircraft structure. Both inboard tires, inner hubs, outer hubs, and brake assembly had separated from the gear assembly. The forward outboard tire, inner hub, outer hub, and brake pads had separated from the gear assembly. The aft outboard outer hub fractured and the tire separated from the gear assembly.

2.4 Right Body Gear Assembly

Right body gear assembly (LG4), outer cylinder separated from the inner cylinder and the axle beam fractured into two segments. The outer cylinder remained attached to the trunnion fittings. The trunnion fittings tore from the STA 1480 bulkhead. The outer cylinder to lower drag strut was fractured. The upper drag strut, jury strut, and a portion of the lower drag strut remained attached to the fuselage fitting which had separated from the fuselage. The outer cylinder gland nut was not attached. The outer cylinder suffered impact damage and was cracked vertically in the thread area. The axle beam and connecting rods were fractured. The retract piston was not attached to the gear assembly. Both outboard tires and the aft inboard tire were not attached. The outer hubs were fractured allowing tires to depart the gear assembly.

2.5 Right Wing Gear Assembly

The right wing gear assembly (LG5) separated from the rear spar and the STA 1350 landing gear beam. The outer cylinder, inner cylinder, and truck remained intact. The gear assembly had separated from the trunnion fittings. Some hydraulic lines and wiring remained attached. The downlock bungee was fractured. The jury strut had separated from the outer cylinder, but remained attached to the downlock actuator. The jury strut fractured at the side strut joint. All brake rods fractured. The forward outboard axle fractured eighteen inches from gear beam centerline. The retract stabilizing arms were bent. The outboard tires, inner hubs, outer hubs, and brake pads had separated from the gear assembly. The forward inboard outer hub fractured and the tire separated from the gear assembly. The aft inboard tire exhibited cuts on the tread.

3.0 LANDING GEAR DOOR ASSEMBLIES

Except for the right body gear outboard aft door, all of the landing gear doors were accounted for. The documentation of the landing gear doors describes only the damage to the door structure.

3.1 Nose Gear Doors (LG6)

Left Forward Door

The forward and aft hinges were pulled out of the door structure and the middle hinge remained attached. The outer skin has smooth denting between ribs structure.

Left Aft Door
This door was severely damaged and crushed.

Right Forward Door
The forward door broke into two segments. The inner skin, outer skin, and internal structure fractured at approximately sixty-two inches aft of leading edge. The forward hinge separated from the door structure. The center and aft hinge locations have fuselage hinge fittings attached. The rod fractured one inch from the door fitting.

Right Aft Door
The outboard edge bent upward .75 inch at leading edge running aft to center hinge location.

3.2 Left Wing Gear Doors (LG7)

Outboard Door
The door structure suffered severe impact damage. The outboard door inboard hinge beam fractured at the aft edge of the center hinge. Portions of the inner skin, outer skin, and the honeycomb core suffered impact damage and a portion was missing. The outer skin has some punctures.

Inboard Door
Portions of inner skin, outer skin, and honeycomb core suffered impact damaged or was missing. The outer skin suffered impact damage and exhibited some punctures at various locations. Inboard and outboard doors remained attached to each other at the hinge locations.

3.3 Left Wing Gear Wheel Well Doors (LG7)

Inboard Door
The inboard door broke into two segments. The outer skin separated from the door structure. The aft three hinge locations have fuselage hinge fittings attached. The forward hinge location door hinge was fractured. At the second hinge location aft, the fuselage hinge was fractured. The aft inboard corner structure was crushed. The trailing edge has a dent and puncture. The rod fractured one inch from the door fitting.

Inboard Forward Door
The inner skin was cracked and suffered a dent. The outboard hinges were fractured. The inboard and outboard sections of the leading edge door seals had separated from the door and the rod had separated from the door.

Outboard Door
All hinges had fractured. The outboard outer skin segment had separated from the door. The rod fractured three inches from the door attach fitting. The aft inboard corner

was crushed and the trailing edge midway outboard transition corner was crushed. The forward outboard corner was crushed and a portion had separated from the door. The inner skin surface suffered impact damage and had two holes. A section of seal assembly was found embedded in one hole, and a second hole was near the loose end of the seal assembly.

3.4 Left Body Gear Doors (LG8)

Outboard Forward Door

The outboard hinges had fractured and separated from the door. The inner skin suffered punctures, cracks, and flapping at various locations. The rod fractured at the door fitting.

Inboard Forward Door

The inboard frame had fractured at the hinge locations and the hinges had separated from the door assembly. The outboard hinges were fractured. The leading edge door seal had separated from the door assembly. The rod had separated from the door assembly. The forward transverse inner skin stiffener outboard twenty-four inches of vertical flange had separated from the door assembly.

Inboard Aft Door

The inboard aft door broke into two segments. Only the forward segment of the door could be identified and the aft segment of the door could not be identified. The forward segment separated approximately forty-one inches aft of leading the edge. The fuselage hinge was fractured at the forward hinge location. The second door hinge aft of the leading edge was fractured.

Outboard Aft Door

The outer skin was torn downward from the top approximately twelve inches and suffered various dents. The hinges were fractured. Approximately three inches of rod remained attached. The seal retainer was cracked and deflected.

3.5 Right Body Gear Doors (LG9)

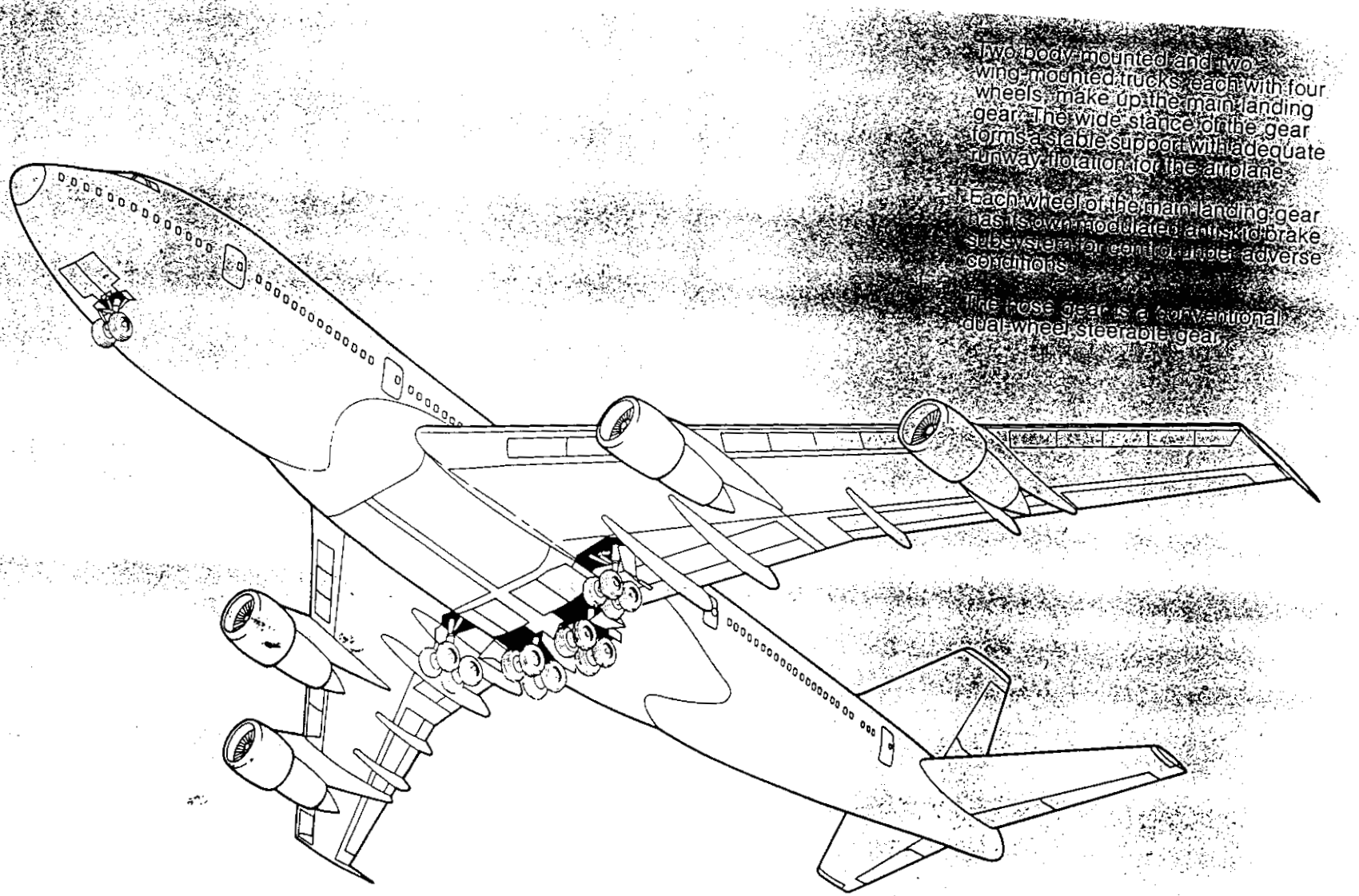
Outboard Forward Door

The outboard hinges remained attached to the fuselage structure which is approximately 17 inches circumferentially x 130 inches fore-aft. The outer skin suffered dents and cracks. The rod was fractured 1.5 inches from the door fitting.

Inboard Forward Door

The outboard hinges were fractured. The inboard and outboard sections of the leading edge door seals and the support rod had separated from the door assembly.

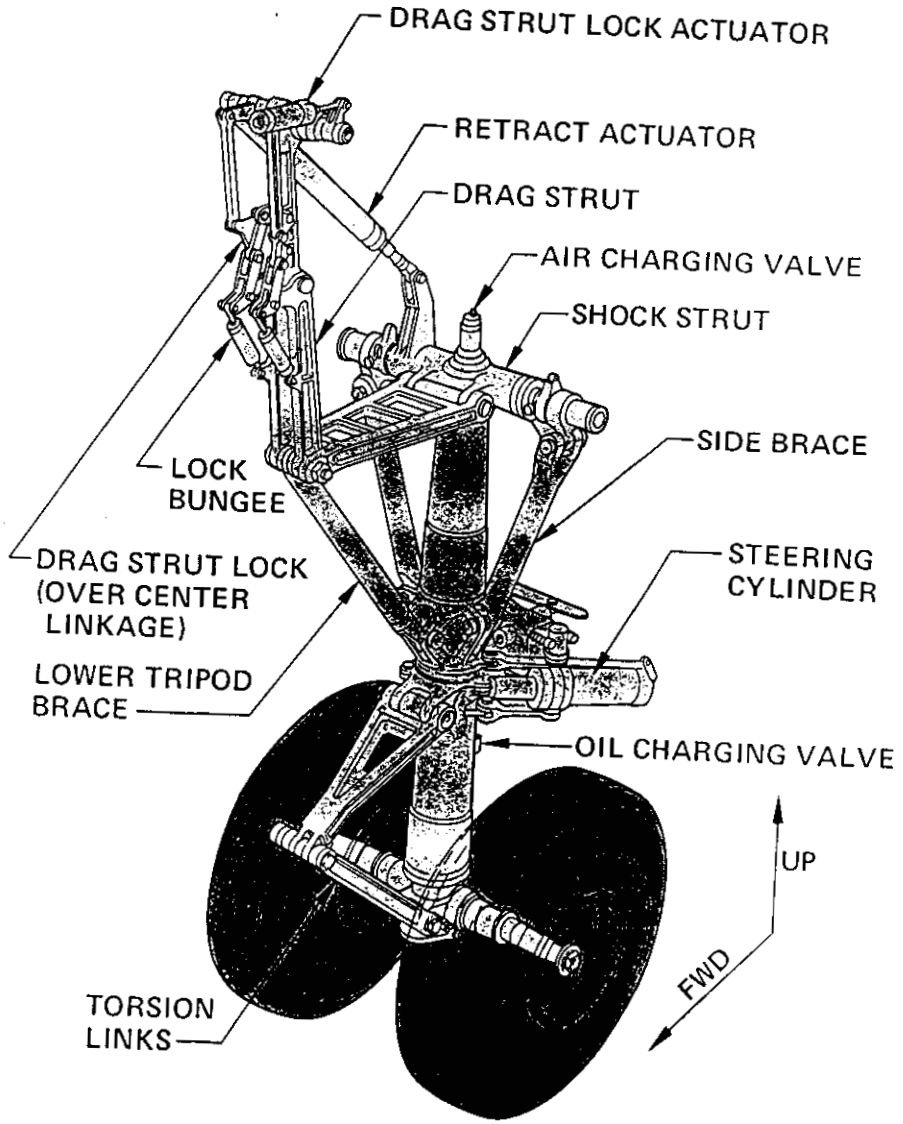
Inboard Aft Door

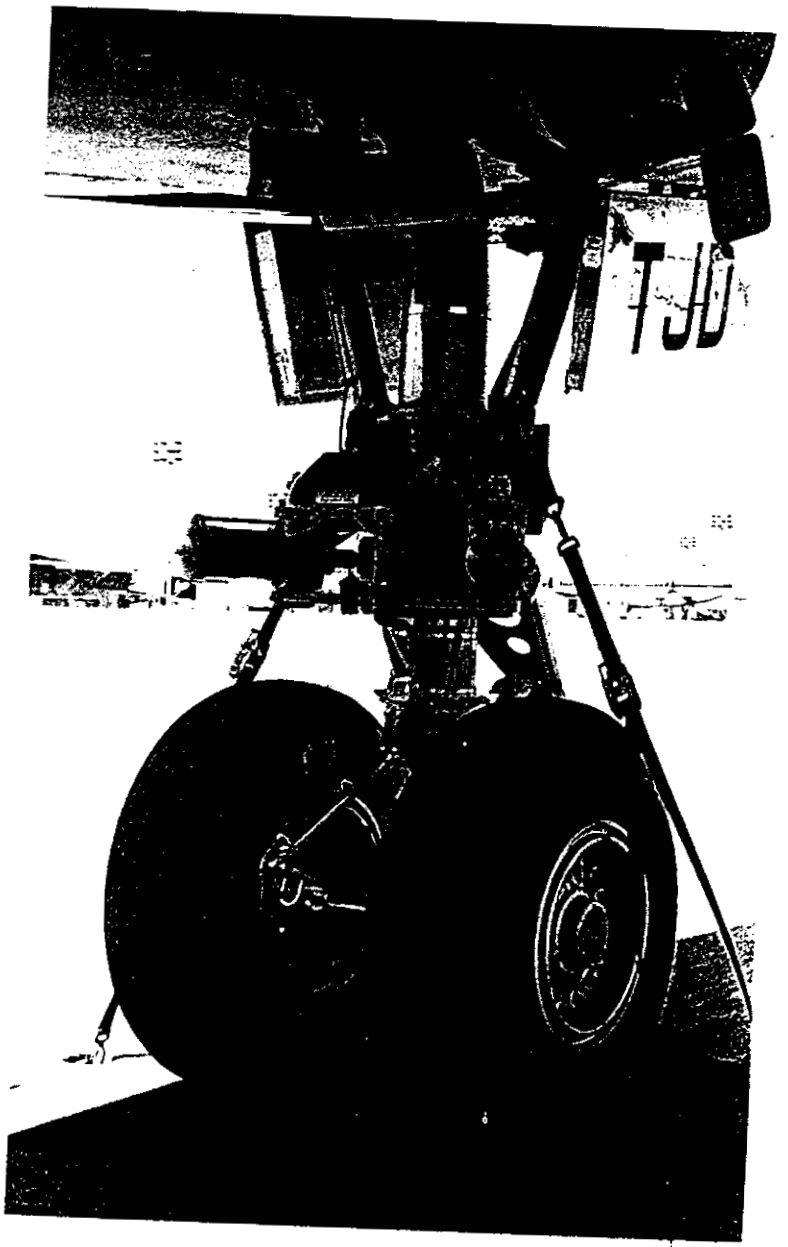


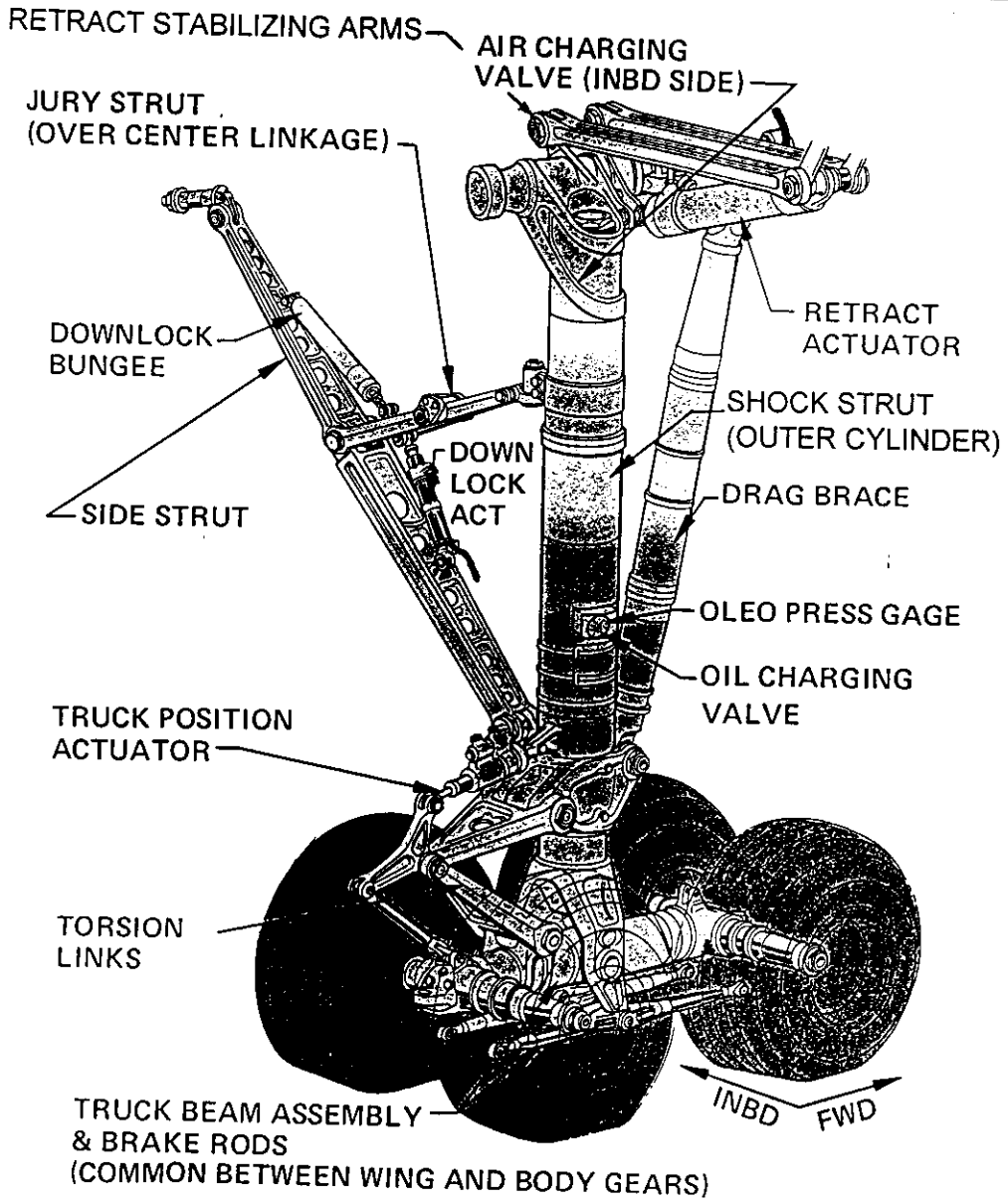
Two body-mounted and two wing-mounted trucks, each with four wheels, make up the main landing gear. The wide stance of the gear forms a stable support with adequate runway flotation for the airplane.

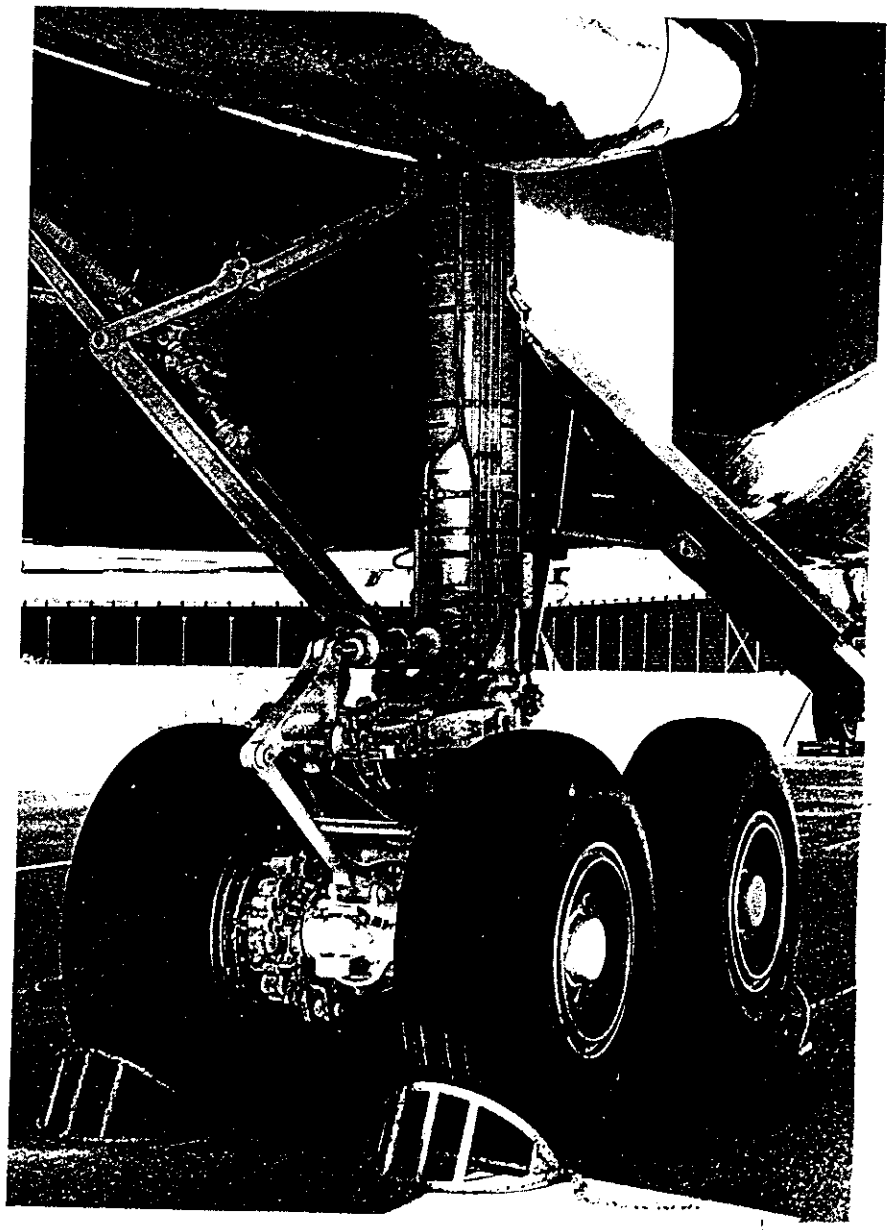
Each wheel of the main landing gear has its own modulated anti-skid brake subsystem for control under adverse conditions.

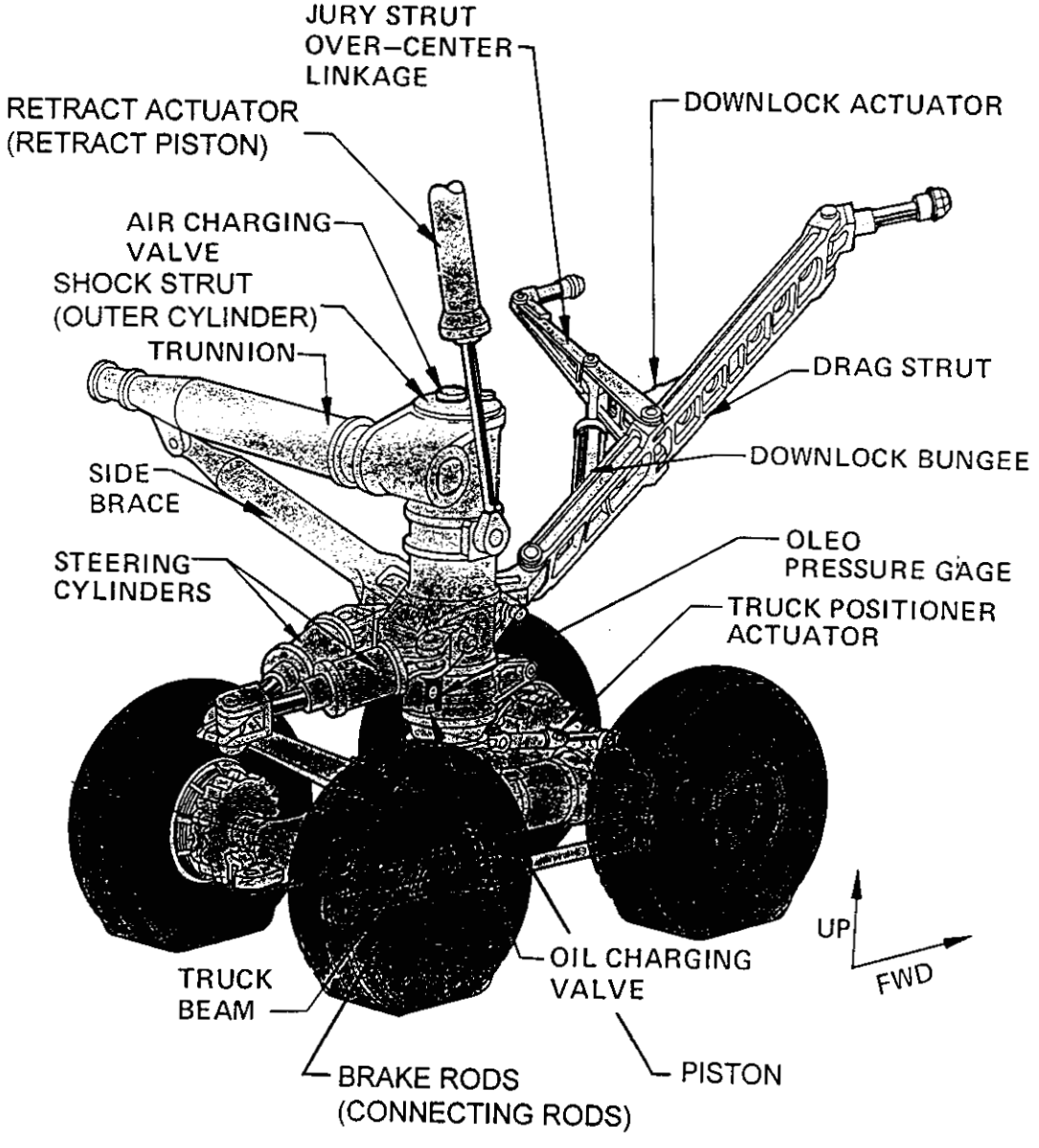
The nose gear is a conventional dual-wheel steerable gear.

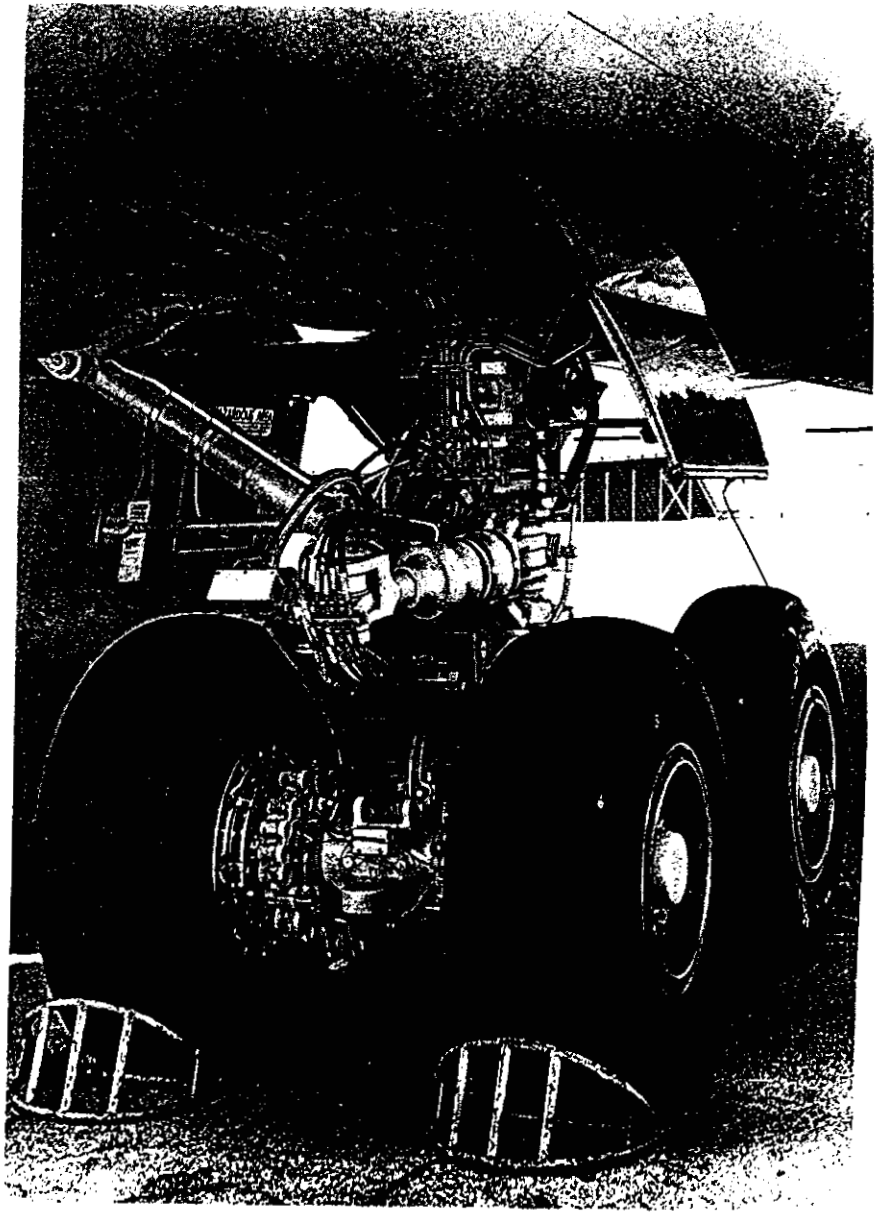

DRAG STRUT LOCK ACTUATOR
RETRACT ACTUATOR
DRAG STRUT
AIR CHARGING VALVE
SHOCK STRUT
SIDE BRACE
LOCK BUNGEE
DRAG STRUT LOCK (OVER CENTER LINKAGE)
STEERING CYLINDER
LOWER TRIPOD BRACE
OIL CHARGING VALVE
UP
FWD
TORSION LINKS


TJD

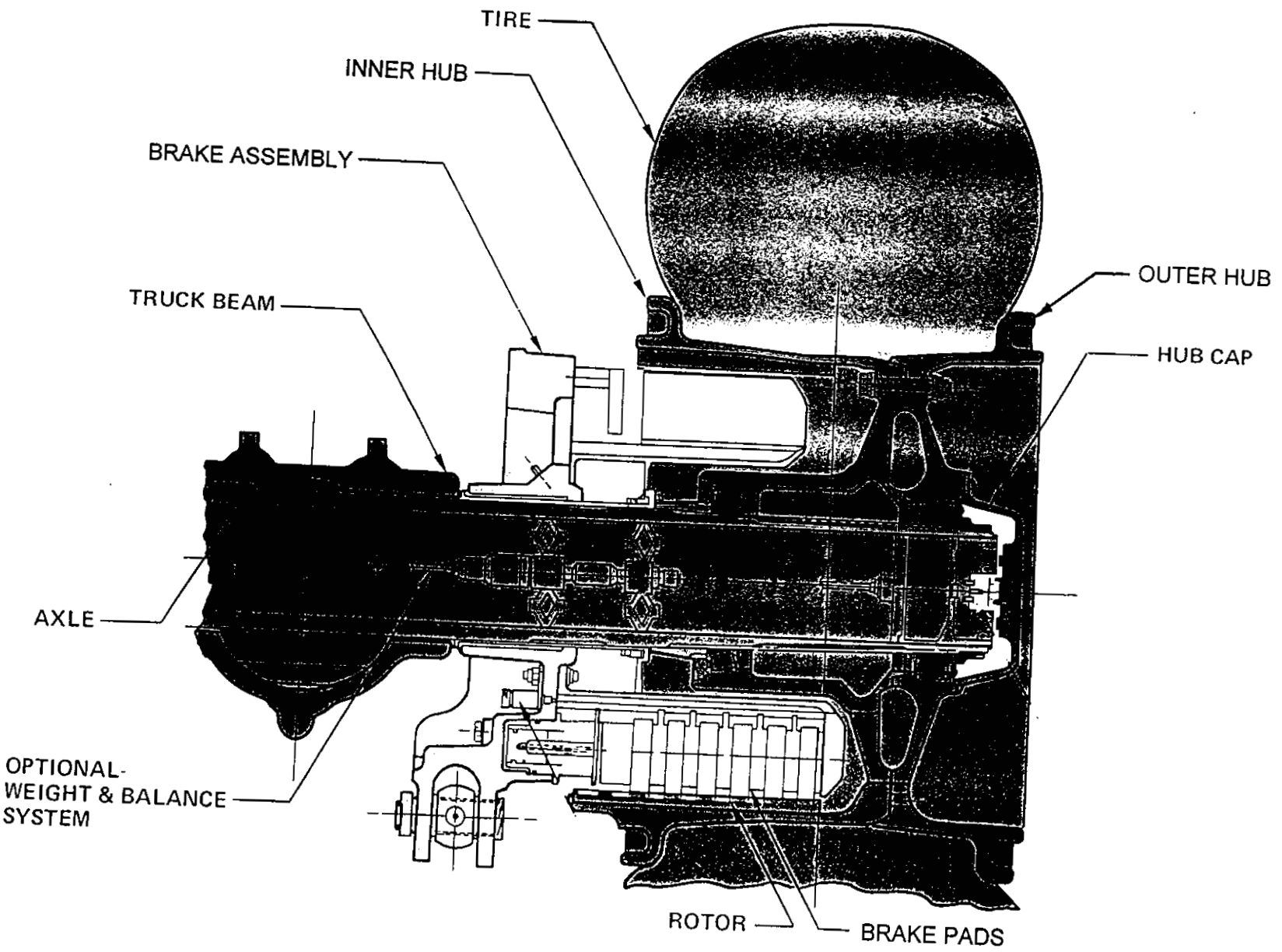

RETRACT STABILIZING ARMS
AIR CHARGING VALVE (INBD SIDE)
JURY STRUT (OVER CENTER LINKAGE)
DOWNLOCK BUNGEE
SIDE STRUT
DOWN LOCK ACT
RETRACT ACTUATOR
SHOCK STRUT (OUTER CYLINDER)
DRAG BRACE
OLEO PRESS GAGE
OIL CHARGING VALVE
TRUCK POSITION ACTUATOR
TORSION LINKS
TRUCK BEAM ASSEMBLY & BRAKE RODS (COMMON BETWEEN WING AND BODY GEARS)
INBD
FWD



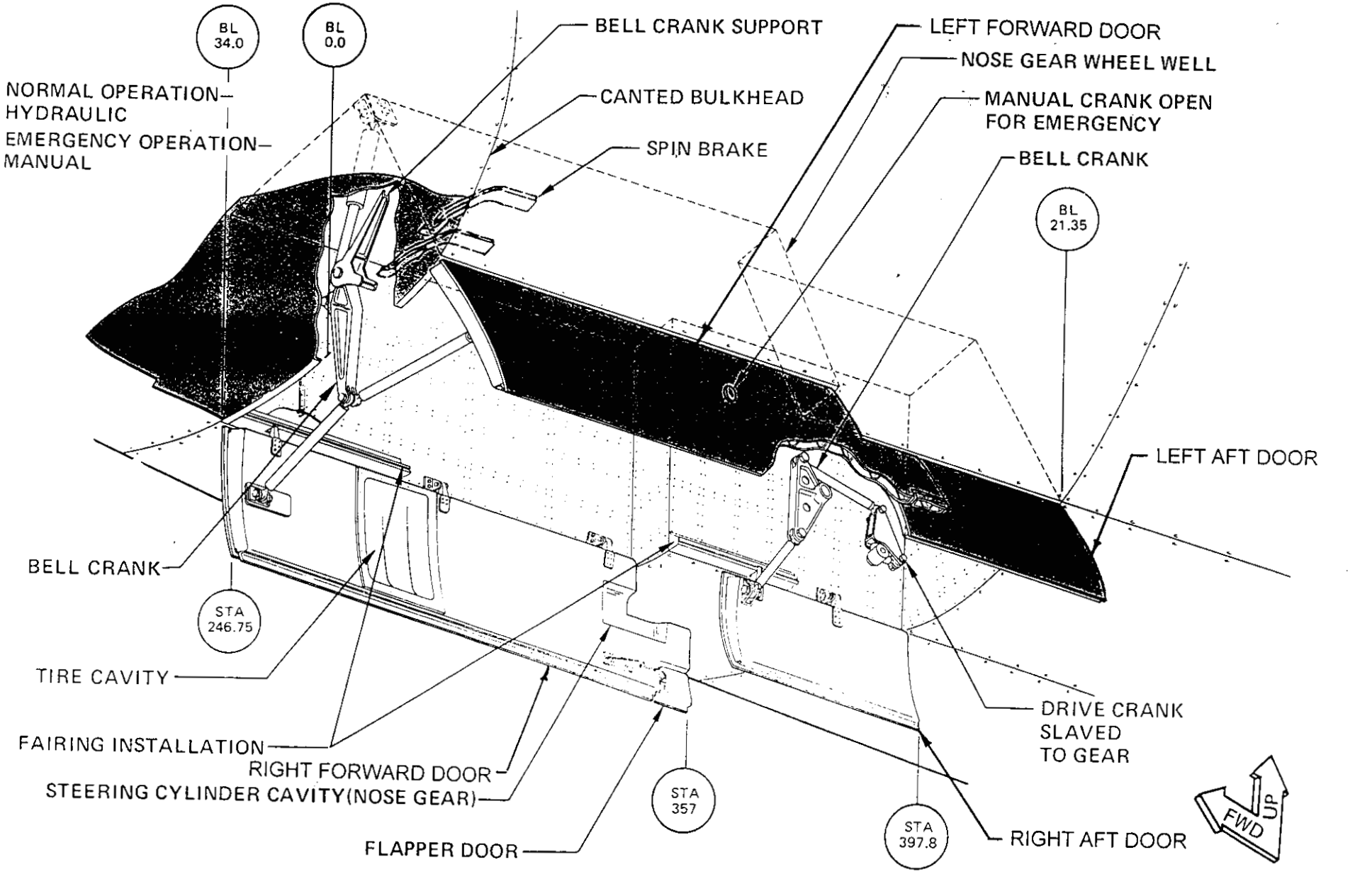

JURY STRUT
OVER–CENTER
LINKAGE
RETRACT ACTUATOR
(RETRACT PISTON)
DOWNLOCK ACTUATOR
AIR CHARGING
VALVE
SHOCK STRUT
(OUTER CYLINDER)
TRUNNION
DRAG STRUT
DOWNLOCK BUNGEE
SIDE
BRACE
OLEO
PRESSURE GAGE
STEERING
CYLINDERS
TRUCK POSITIONER
ACTUATOR
UP
FWD
OIL CHARGING
VALVE
TRUCK
BEAM
PISTON
BRAKE RODS
(CONNECTING RODS)



Typical Main Gear Tire/Wheel Brake Installation

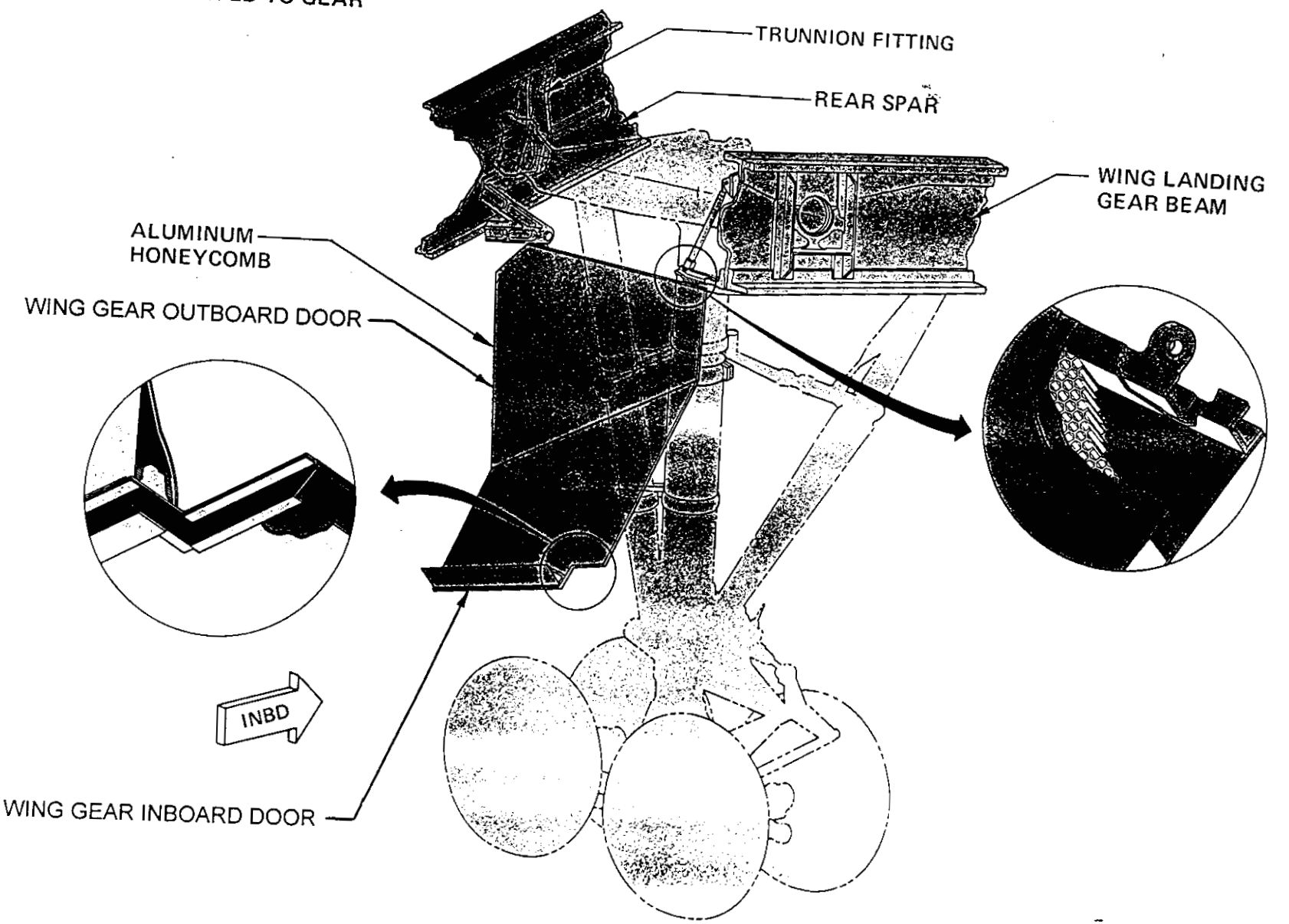


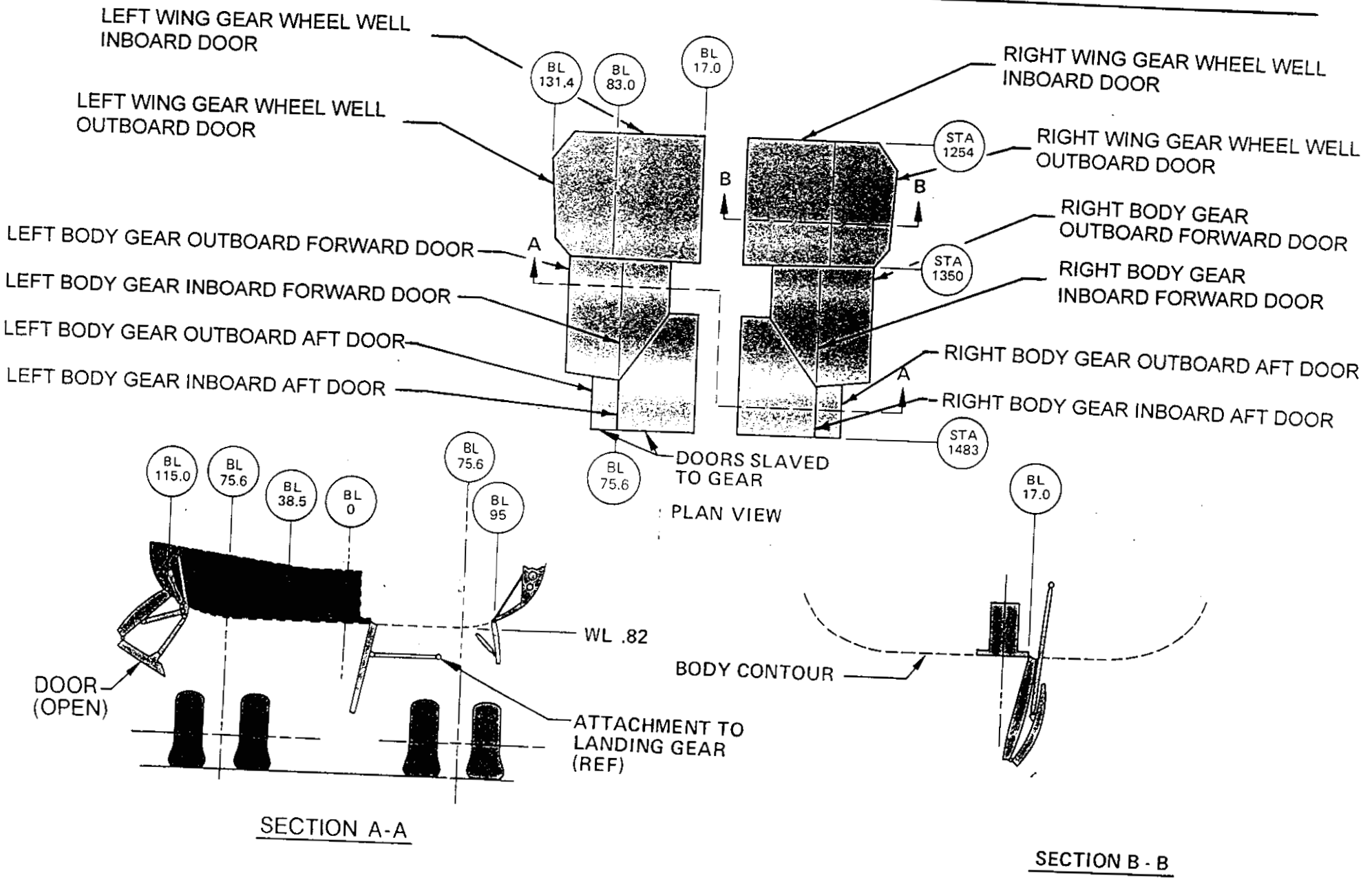
Nose Gear Doors



Wing Main Landing Gear Door Detail

NOTE: DOOR SLAVED TO GEAR




LEFT WING GEAR WHEEL WELL INBOARD DOOR
LEFT WING GEAR WHEEL WELL OUTBOARD DOOR
LEFT BODY GEAR OUTBOARD FORWARD DOOR
LEFT BODY GEAR INBOARD FORWARD DOOR
LEFT BODY GEAR OUTBOARD AFT DOOR
LEFT BODY GEAR INBOARD AFT DOOR
BL 131.4
BL 83.0
BL 17.0
BL 75.6
A
B
RIGHT WING GEAR WHEEL WELL INBOARD DOOR
RIGHT WING GEAR WHEEL WELL OUTBOARD DOOR
RIGHT BODY GEAR OUTBOARD FORWARD DOOR
RIGHT BODY GEAR INBOARD FORWARD DOOR
RIGHT BODY GEAR OUTBOARD AFT DOOR
RIGHT BODY GEAR INBOARD AFT DOOR
STA 1254
STA 1350
STA 1483
DOORS SLAVED TO GEAR
PLAN VIEW
BL 115.0
BL 75.6
BL 38.5
BL 0
BL 75.6
BL 95
WL .82
DOOR (OPEN)
ATTACHMENT TO LANDING GEAR (REF)
SECTION A-A
BL 17.0
BODY CONTOUR
SECTION B - B