Qantas Boeing 707-138 Jet Stratoliner

Boeing Model 707-138 Jet Stratoliner

This document was produced for Qantas Empire Airways Ltd by the Boeing Airplane Company, Transport Division, Service Training And Publications Unit - May 1958.

I was given this document by a retired Qantas Radio Operator in 1965 and it has been in my possession ever since.

It is a very rare document and it clearly demonstrates that Boeing referred to this particular aircraft as a ‘Stratoliner’ - a term that has been hotly disputed by a number of so-called reputable aviation writers in recent years. Whilst the term ‘Stratoliner’ was subsequently dispensed with at a later date it was certainly used in official Boeing publications of the time.

FOREWORD

This preliminary training document on the Boeing 707-138 Jet Stratoliner was prepared specifically for Qantas Empire Airways. Its intended purpose is to provide introductory information covering the general features of the new jet transport for Qantas Personnel

It must be understood that this material is preliminary in nature and is not intended, in any way, to take the place of official engineering drawings, documents or handbooks for the Model 707 Airplane. At the present time there are no plans for future revision of this publication.

CONTENTS

GENERAL FEATURES

The Boeing Model 707-138 Stratoliner is a high speed jet transport utilizing the swept back wing, fin and horizontal stabilizer. The 35° swept back design is the hallmark of the jet age.

The structure design consists of a metal low wing monoplane with full cantilever wing and tail surfaces, and semimonocoque body. The principal dimensions are: wing span 130 feet 10 inches, total wing area of 2,433 square feet, vertical fin height 38 feet 7 inches, body length of 128 feet 10 inches.

The interior is completely free of permanent bulkheads or partitions making possible a wide variety of arrangements. Seat support tracks and 20-inch window spacing further increase this flexibility.

The Boeing 707 has been designed for minimum ground servicing time. Two passenger entrance doors are located on the left side of the airplane while the galley service and cargo doors are on the right side.

The landing gear consists of two four-wheel truck type gears and a steerable nose wheel. Main gear retraction is inboard into the wheel well area in the lower body. The nose gear is retracted forward into a wheel well. Both gears are hydraulically actuated.

Ailerons, elevators, and rudder are manually controlled. They are aerodynamically balanced and are actuated by means of cable controlled tabs.

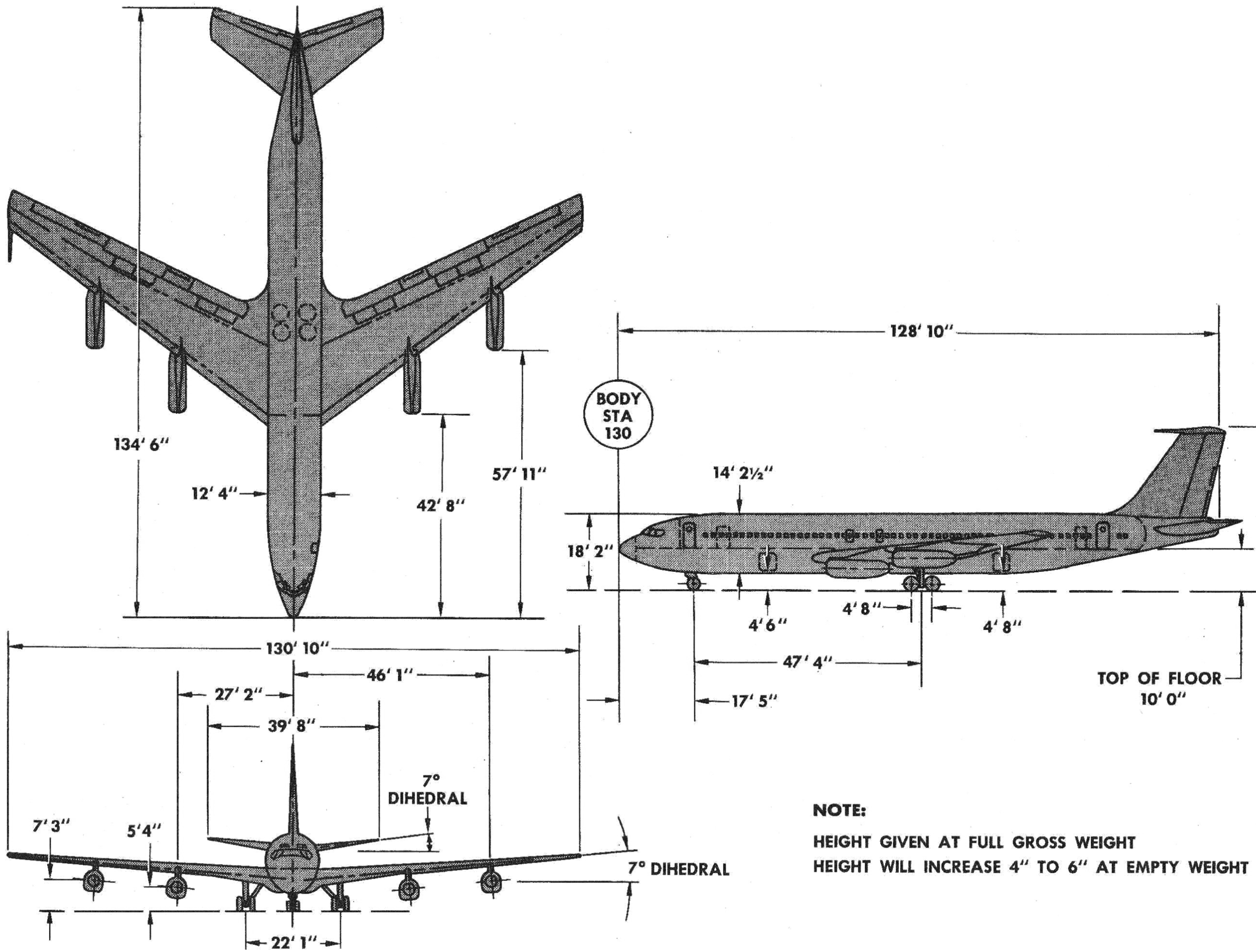
Outboard ailerons operate in conjunction with the inboard ailerons and wing spoilers to increase lateral control when flaps are lowered. Proper location and size of these control surfaces resulted from B-47, B-52 and prototype 707 experience.

Hydraulically actuated spoilers are used as aids to lateral control, as speed brakes for controlling rate of descent, and to reduce stopping distance.

Rudder and aileron trim are accomplished manually by a cable system. Stabilizer trim controls on the pilot's control wheels actuate an electrically driven jack screw to change the horizontal stabilizer angle of incidence. A cable system, with control wheels located on the control stand, may be used for manual operation of jack screw.

Pod-mounted engines and numerous access doors, make possible exceptional ease of systems maintenance. Underwing fueling connections with associated controls are provided.

A Boeing developed sound suppressor and thrust reverser is installed on each engine. The suppressor reduces noise levels and the reverser aids in braking the airplane on landing roll.



NOTE:

HEIGHT GIVEN AT FULL GROSS WEIGHT

HEIGHT WILL INCREASE 4" TO 6" AT EMPTY WEIGHT

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PRINCIPAL DIMENSIONS

The standard interior arrangement of the Qantas 707-138 airplane furnishes accommodation for 40 first-class and 50 tourist passengers with a 4 place forward lounge. Reclinable seats are arranged five abreast with triple seat units on the left, double seat units on the right and a 20 inch aisle. Spacing between seats is 40 inches. Seat attachment tracks in the floor permit conversion to alternate seating arrangements for all first class, tourist or mixed passenger service or additional lounges. A movable partition containing a closure may be installed at various locations in the passenger cabin. The lounge is easily replaceable with standard seats.

Foldable and reclinable double seats are installed at the entry areas for the cabin attendants. The aft seat is equipped with shoulder harnesses. Cabin attendants' panels are located over the service doors in the forward and aft galleys. An attendant call switch is installed in each lavatory, lounge, berth and on the passenger service units above the seats.

Coat closets and a stowage space with individual compartments for passenger effects are located in the area of the aft entry door. Overhead racks for stowage of blankets, pillows, hats, etc., furnish a steadying support for passengers walking in the aisle. A folding writing table is provided at the aft attendants' seat. Magazine racks are installed on forward and mid-cabin partitions.

A berth and rest area for the crew and four berths for passengers are located in the forward passenger cabin. Provisions are made for the installation of 10 additional berths in the aft portion of the passenger cabin.

Two Qantas furnished double unit galleys, one on either side of a service door, are provided with electrical power, lighting, ventilation, water supply and drain. All galley units are readily removable. Two of the units may be replaced with passenger seats.

Two separate 35.8 Imperial gallon water systems supply water for washing, galley and drinking purposes. Separate lavatory accommodations are furnished for men and women. Five lavatories, two forward and three aft, are equipped with a ground serviced flushing type toilet, wash basin with hot and cold water, mirror, electric razor outlets, dispensers and miscellaneous utility items.

Dual "dry shave" facilities, comprising two mirrors and electric razor power outlets, are installed against the bulkheads above the cabin attendant's seats in both the forward and aft passenger entrance areas.

Passenger cabin windows, spaced at 20 inches for maximum visibility, include anti-fogging and anti-glare provisions. Anti-fogging is accomplished by internal ventilation of the double pane structural windows and the protective inner window. The inner window is tinted to reduce glare. A track-mounted opaque shade may be pulled down over the inner window.

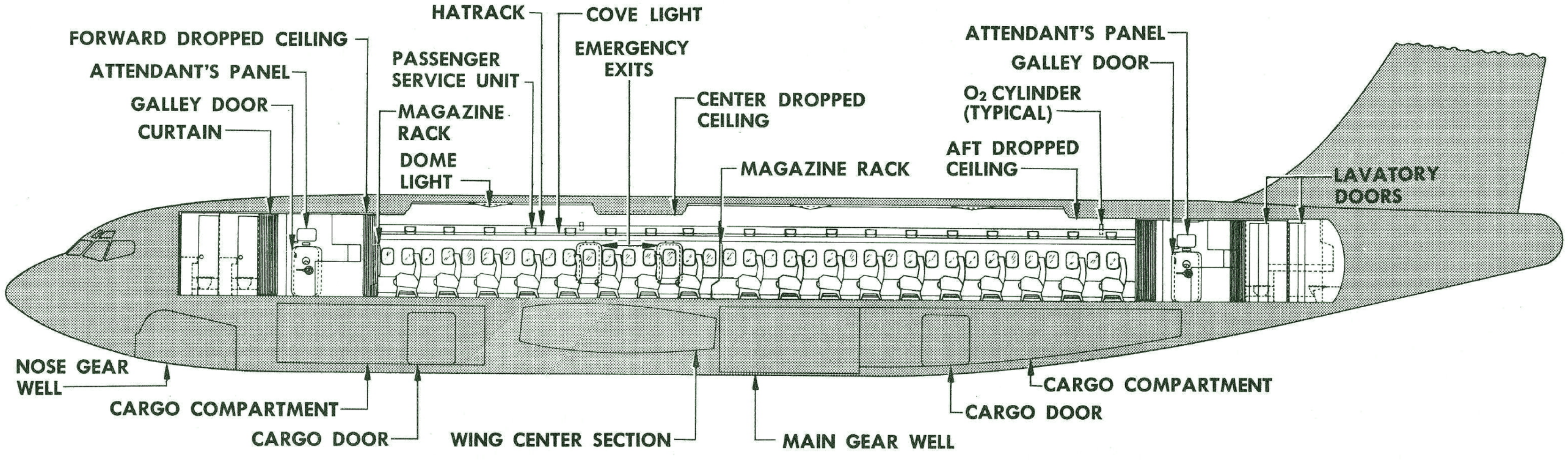
Main cabin illumination is furnished by fluorescent cove lighting under the overhead hat racks, large variable effect dome lights and lights in the dropped ceilings. All passenger cabin lighting is controlled from the cabin attendants' panels.

Passenger service units are track mounted to the under side of the hat racks. Each contain four oxygen mask connections, an oxygen mask for each seat, three fresh air outlets, three individually controlled reading lights, an attendant call button and a back lighted seat row number sign. On the aft side of each unit are back lighted seat letter signs, no smoking and fasten seat belt signs. Alternate passenger service units contain a public address system speaker. Oxygen masks, speakers, passenger signs and attendant call buttons are also located in each lavatory, lounge and berth area. An oxygen outlet and mask are furnished over each attendant's seat.

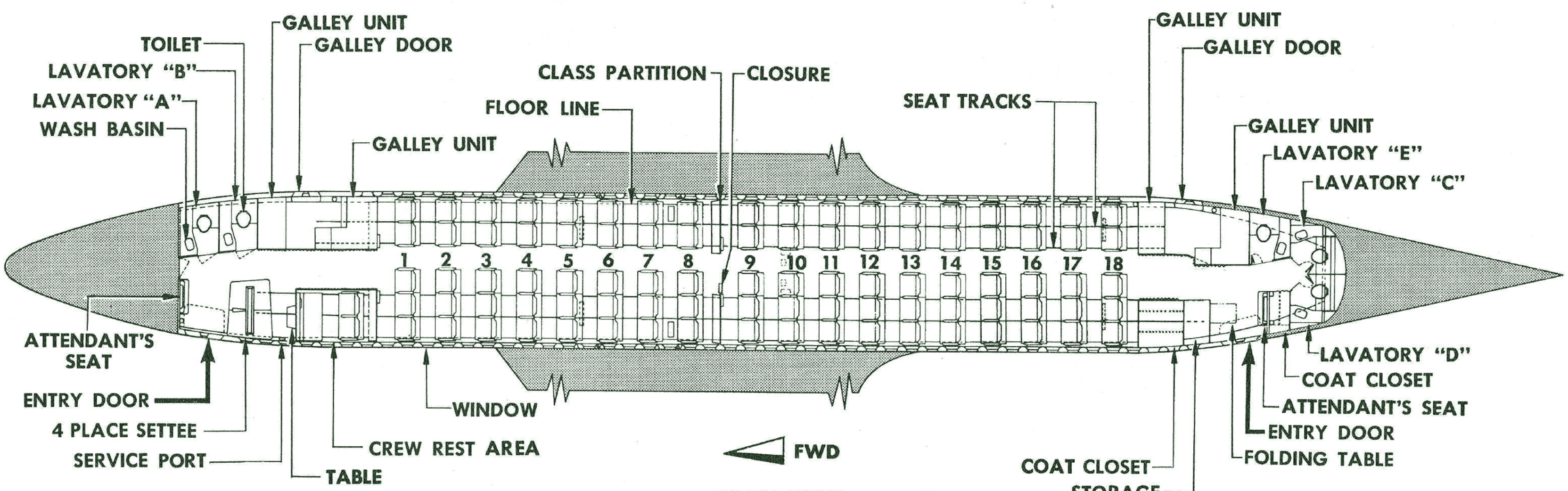
A pressure sensitive valve installed in the passenger oxygen system will turn on the oxygen automatically at approximately 15,000 feet cabin altitude and cause oxygen masks to be dropped for immediate passenger use. Four portable oxygen cylinders are made available for individual supplemental or therapeutic oxygen requirements.

Emergency equipment and life raft stowage is provided in the dropped ceilings. Escape ropes are stowed at the overwing emergency exits, and escape slides are located over each entry and galley door. Portable CO_2 and H_2O fire extinguishers and first aid kits are located as follows:

CO_2	H_2O	KITS	
1		1	Fwd. RH side of bulkhead 302 (in control cabin)
	1	1	Aft LH side of bulkhead 302 near attendants' seat
1	1		Fwd. galley wall aft of service door
1			Aft galley wall aft of service door
1		1	Hatrack RH by emergency exit
		1	Hatrack LH by emergency exit
1			Hatrack RH at aft end of cabin
	1	1	Aft cloak locker
		1	Crew rest compartment



SIDE VIEW OF RIGHT SIDE



PLAN VIEW

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PASSENGER CABIN ARRANGEMENT

CARGO COMPARMENTS

The airplane has two cargo compartments which provide a total volume of 1325 cubic feet and a capacity of 15,900 pounds. Loading is from the right side. Cargo compartment doors are of the sliding plug type which may be opened from the inside or outside. The doors are sealed tightly under cabin pressurization.

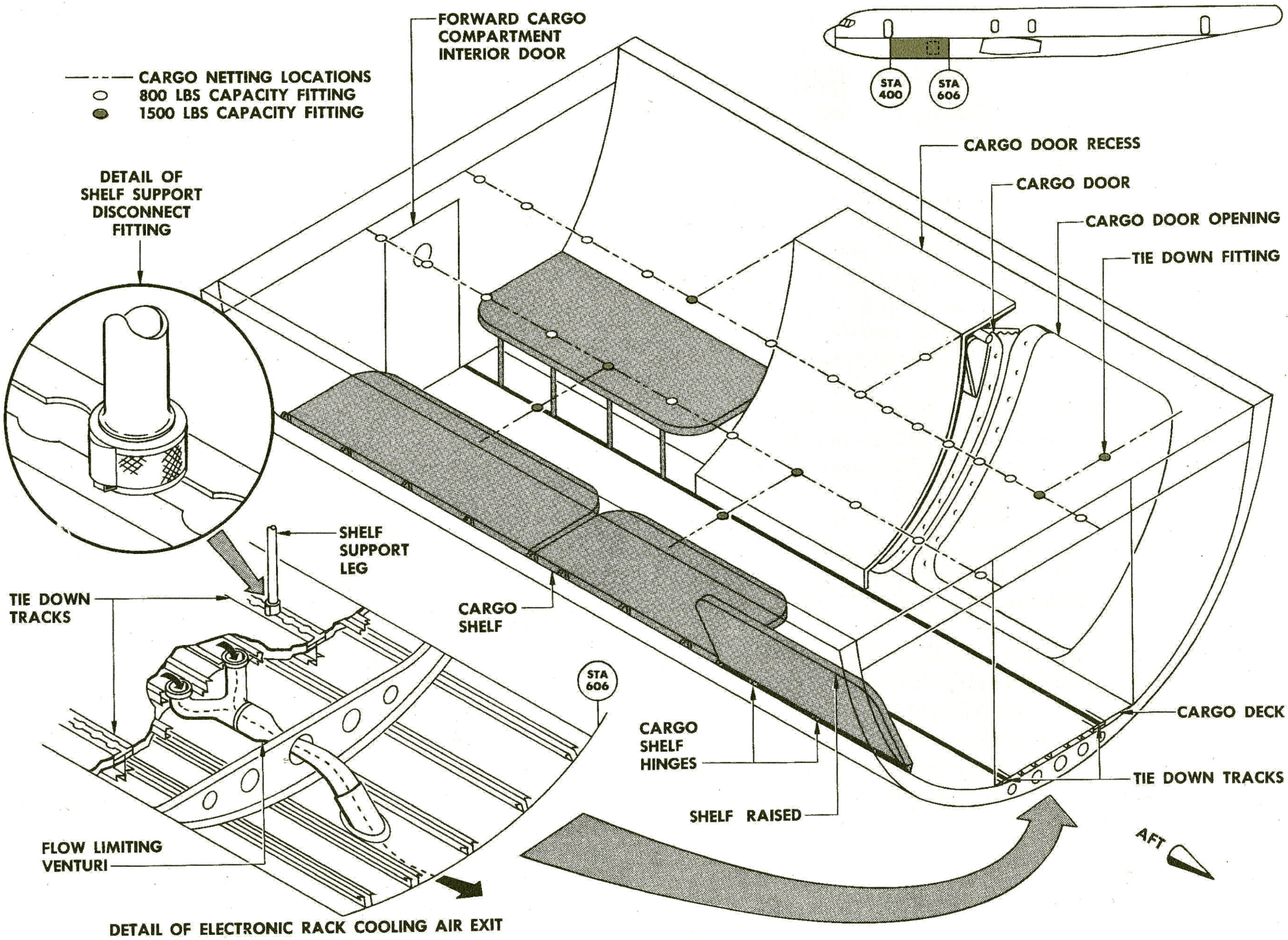
Standard stowage provisions include hinged folding cargo shelves, removable partition nets with quick latching fasteners and flush type tie-down rings. The shelves may be folded against the wall to facilitate loading or they may be removed. Cargo compartment floors are of metal construction and provide two tie-down tracks located 32 inches apart. These tracks also serve as an attachment for cargo shelf supports.

The forward compartment has a volume of 575 cubic feet and a maximum capacity of 6900 pounds. It is designed for uniformly distributed floor loading of 150 pounds per square foot but not to exceed 47 pounds per linear inch. This area is heated to a minimum of 40° F. The cargo door is 48 inches wide by 50.5 inches high.

The aft compartment has a volume of 750 cubic feet and a maximum capacity of 9,000 pounds. It is designed for uniformly distributed floor loading of 150 pounds per square foot but not to exceed 50 pounds per linear inch in the constant section. Loading is reduced in the taper section. The cargo door is 48 inches wide by 49 inches high.

High density seating arrangements affect the cargo loading procedures. A placard with appropriate instructions is attached inside and adjacent to each cargo compartment door.

Both the forward and aft cargo areas are CAA defined Class D "smother" compartments. This means that restriction of leakage results in insufficient oxygen to support fire. Fire resistant Fiberglas is used for compartment lining. In-flight inspection of the forward cargo compartment can be made from the lower nose section. An access door with window is installed in the bulkhead which separates the two compartments. Increased temperatures in the aft cargo compartment are sensed by heat detectors which illuminate a warning light on the pilot's light shield. There is no in-flight access to the aft cargo compartment; however, its interior may be inspected through a wide angle viewing lens located in the passenger cabin floor.



FORWARD CARGO COMPARTMENT

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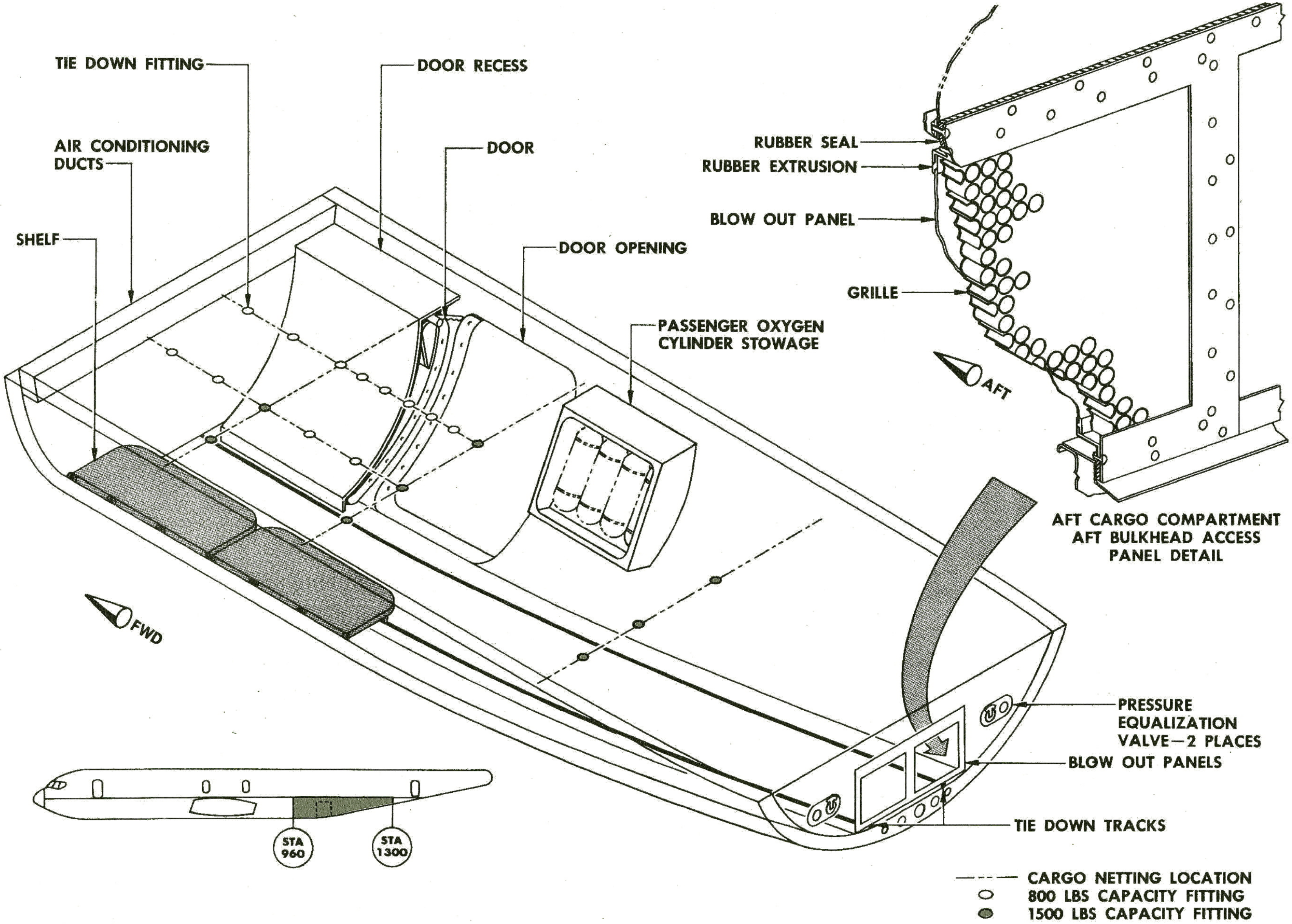

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AFT CARGO COMPARTMENT

The 707-138 control cabin contains crew stations for the pilot, copilot, flight engineer and navigator. An observer or check pilot is accommodated behind the pilot.

The pilot's and copilot's seats are adjustable vertically, fore and aft. Seat arms fold up to facilitate entry. Seats for the flight engineer and navigation station swivel, adjust vertically and athwartships. The nonadjustable observer's seat is removable.

The control stand is located in the aisle between the two pilots. It contains controls for the throttles, engine start levers, throttle brake, wing flaps, speed brake, autopilot, radio and control surface trim wheels.

The main instrument panel contains dual flight instruments for the pilot and copilot. Hydraulic pressure and water injection controls, flap position and door warning indicators are on the copilot's side of the panel. The center section of the panel carries engine instruments and landing gear controls. A light shield over the main instrument panel accommodates fire warning indicators and controls, and engine shutoff switches. A radio and radar panel is inclined from the control stand to the main instrument panel.

The pilot's and copilot's overhead panel arrangement includes controls for engine starting, emergency flaps, anti-icing, lights, passenger oxygen, passenger signs and crew calls.

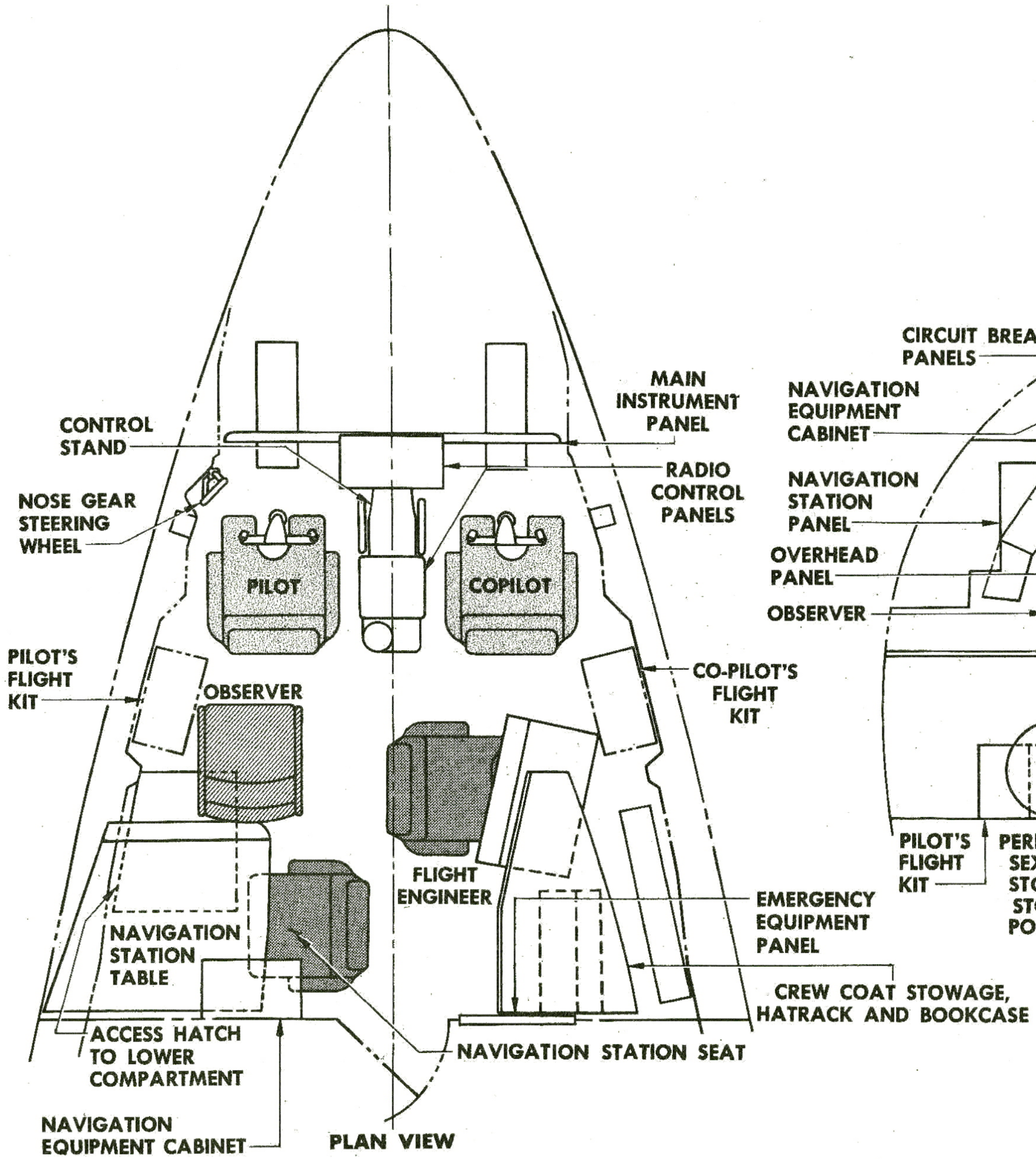
The flight engineer's panels are arranged as upper, lower and auxiliary panels. The upper portion of the panel is tilted approximately 35 degrees from vertical and contains the AC power, DC power, air conditioning and pressurization controls. The lower panel carries the fuel management controls, engine start air pressure, oil pressure and temperature indicators, and quantity indicators for fuel, oil, water and hydraulic oil. The auxiliary panel contains fuel dump controls, panel and table light controls. The copilot, by moving his seat to the full aft position, can operate the controls on the flight engineer's panel.

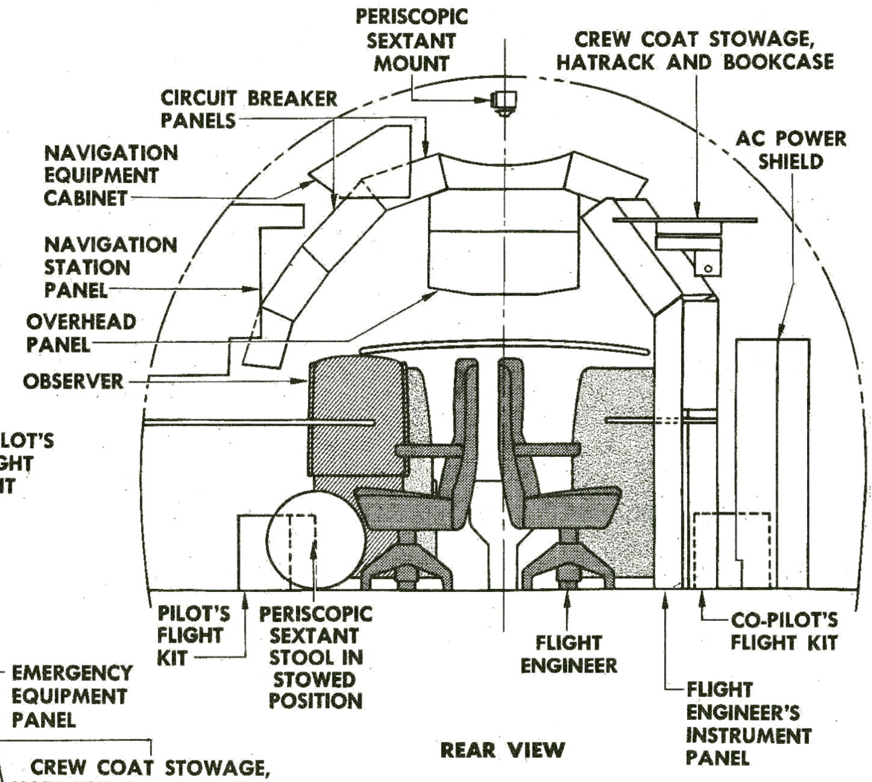
The navigation station is equipped with a work table, Loran, a panel with light controls, an equipment cabinet, and a periscopic sextant. A blackout curtain is installed to shield the lights at the navigation station from the other crew members.

The compartment for crew coat stowage, hat rack and bookcase is located adjacent to the flight engineer's station. The main AC power shield is on the right side of the control cabin behind the flight engineer's station and coat rack. The main circuit breaker panels are aft of the overhead panel.

Access to the lower compartment, containing electrical and radio equipment, is through a hatch in the floor between the observer and navigation station.

The control cabin has two windshields, four side windows and four overhead (eyebrow) windows. Two of the side windows open inward and aft to provide for oral ground communication. Two electrically operated windshield wipers are provided at the windshields.





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CONTROL CABIN ARRANGEMENT

The body is composed of three primary sections; the control cabin, main cabin, and a tail cone which supports the empennage. The main body section encloses a permanently attached wing center section. The body is of semimonocoque construction consisting mainly of skin stiffened hat section stringers supported by zee section frames.

The wing is composed of five sections; one main section (inner wings and center section), two outer wing sections and two wing tips. The primary wing structure consists of two spars and upper and lower skins stiffened by extruded zee section stringers. The spars serve primarily as shear load carrying members. The skin and stringers carry the major portion of the bending loads.

The leading edges are fixed to the front spar except for spanwise removable access panels which are attached by means of screws and gang nut channels.

The trailing edge is fixed to the rear spar. Bonded honeycomb panels are used for light weight and structural strength.

The wing surfaces include four trailing edge double slotted type wing flaps and two fillet flaps, two leading edge hinged flaps, two inboard ailerons, two outboard ailerons and eight spoilers. The spoilers are semi-monocoque structures hinged from the wing rear spar. The ailerons are torsionally rigid structures consisting of a spar, ribs and skin.

The tail surfaces include a dorsal and vertical fin, an adjustable stabilizer, rudder, elevators and tabs.

The left and right stabilizers are fastened to the movable center section torque box at the sides of the body. Each stabilizer consists of two spars, ribs and metal covering. The leading edge, except for a short length near the body, is removable.

The elevators are metal covered monospar surfaces each having a trim tab and control tab.

The fin consists of two spars, ribs and metal covering. The leading edge is removable except for a short length above the dorsal fin. The fin is removable from the body by shear bolt attachments at the front and rear spars. The fin may be folded by use of ground hoisting equipment.

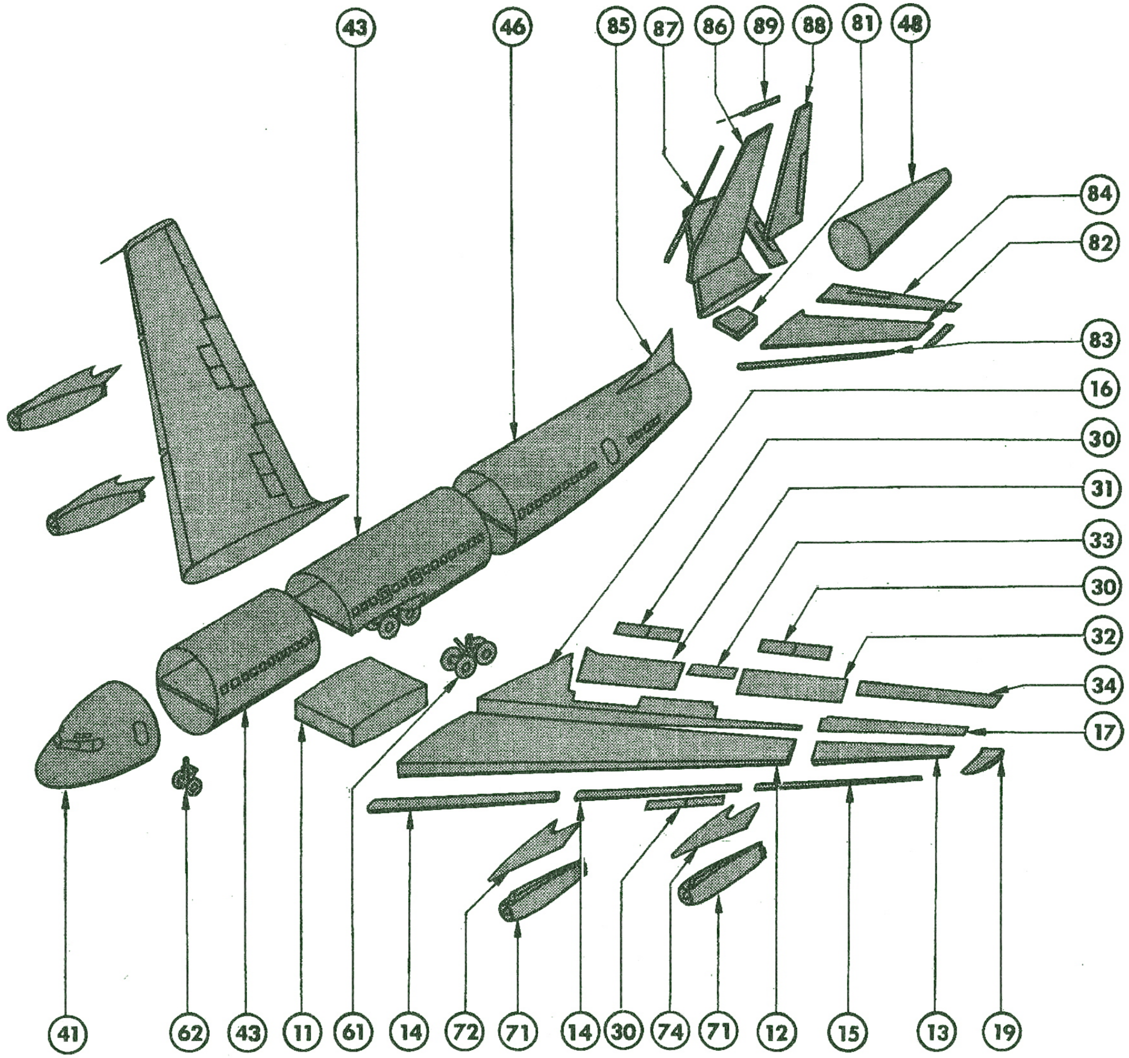
The rudder is a metal covered monospar surface with control and trim tabs.

Each engine nacelle and strut assembly is attached to the wing by four bolts. Two hinged, yet quickly removable, cowl side panels offer the accessibility to major engine components.

The airplane structure in general is fabricated of high strength aluminum alloys, including 2024, 7075 and 7178. Steel, stainless steel, titanium and magnesium alloys are used where appropriately advantageous to strength, endurance, weight or heat protection. Protection against structural fatigue is a foremost consideration throughout the design to provide structure with long service life.

STRUCTURE ASSEMBLY
SECTION

11—CENTER WING
12—INBOARD WING
13—OUTBOARD WING
14—INBOARD WING—LEADING EDGE
15—OUTBOARD WING—LEADING EDGE
16—INBOARD WING—TRAILING EDGE
17—OUTBOARD WING—TRAILING EDGE
19—WING TIP
30—SPOILERS & LEADING EDGE FLAPS
31—INBOARD FLAPS
32—OUTBOARD FLAPS
33—INBOARD AILERON
34—OUTBOARD AILERON
41—FIRST BODY SECTION
43—FWD—SECOND BODY SECTION
43—AFT—THIRD BODY SECTION
46—FOURTH BODY SECTION
48—FIFTH BODY SECTION
61—MAIN LANDING GEAR
62—NOSE LANDING GEAR
71—POWER PACKS
72—INBOARD STRUT
74—OUTBOARD STRUT
81—TORQUE BOX
82—HORIZONTAL STABILIZER
83—HORIZONTAL STABILIZER—LEADING EDGE
84—ELEVATORS
85—DORSAL FIN
86—VERTICAL FIN
87—VERTICAL FIN—LEADING EDGE
88—RUDDER
89—VERTICAL FIN—TIP



SECTIONAL BREAKDOWN

The Model 707-138 airplane is powered by four Pratt and Whitney JT3C-6 Series turbojet engines. The engines are installed in strut-mounted pods beneath the wing. This location increases flight safety and allows future installation of advance engine types with minimum structural change. The engines are attached to the strut by bolts at three pilot fittings. The support fittings are designed to allow for thermal expansion of the engine. Ease of maintenance is obtained by use of hinged cowl sections. The power plant assemblies are interchangeable in any of the four airplane positions, except as they may be affected by accessories peculiar to specific engine positions.

A thrust reverser providing approximately 50% thrust in the reverse direction is installed on the tail pipe of each engine. A noise suppressor is incorporated with the thrust reverser.

Each engine incorporates an independent oil system. The engine mounted tank has a capacity of approximately 5.4 Imperial gallons. An oil tank level indicator is visible from the ground without opening the engine cowl. Oil quantity, pressure and temperature are sensed by transmitters for remote indication in the control cabin.

Each engine installation is equipped with an air-oil heat exchanger type cooler with separate passages to prevent intermixing of the engine turbocompressor and generator drive oil. Control valves automatically maintain oil temperatures within the required limits.

Airplane electrical power is generated by four 30 KVA generators driven by the engines through constant speed drives.

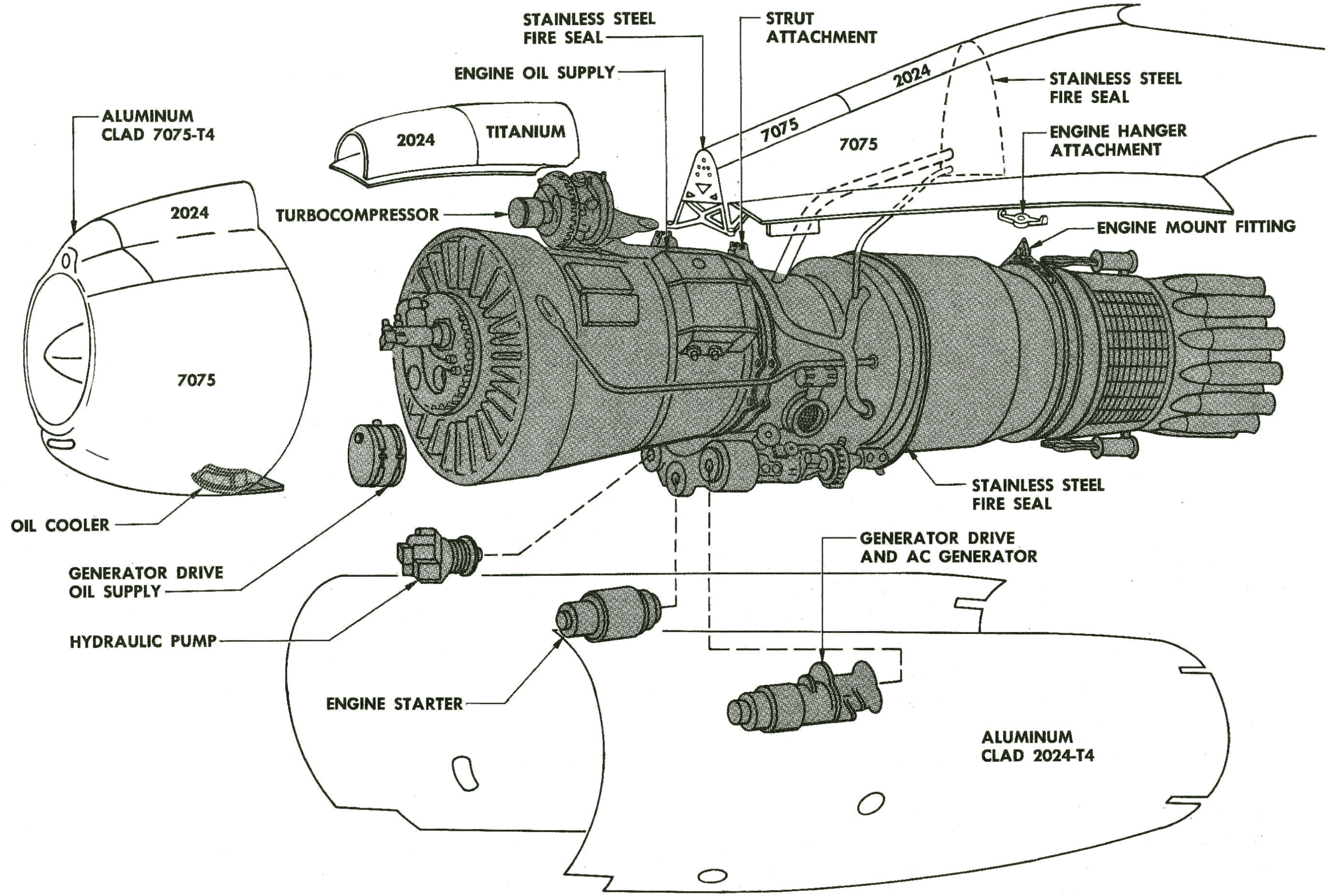
A 1.25 Imperial gallon tank supplies oil for operation, lubrication, and cooling of the generator constant speed drive. Oil temperature and pressure warning transmitters provide control cabin indications for the constant speed drive system. The generator is air-cooled through ducts connected with the engine nose cowl.

Pneumatic starters on all engines operate from the air conditioning manifold. Engines 2 and 3 have combustor attachments which permit starting without pneumatic ground support equipment. An air bottle for combustor starter operation is installed in the right trailing edge wing-body fairing. The bottle is automatically recharged by a hydraulically operated air compressor. It may also be charged through a ground service air connection. The service connection also permits combustor operation direct from the ground source.

A pump is installed on each inboard engine to supply fluid pressure to the hydraulic system.

A turbocompressor is installed on three engines with air inlet through a passage in the nose cowl upper leading edge. Air from the turbocompressors is ducted into a common manifold for engine starting, air conditioning and pressurization systems.

The engine incorporates provisions for water injection which is used for increasing thrust during takeoff. An integral water tank of 375 Imperial gallons capacity is provided in the keel beam between the two wheel wells. Additional 117 Imperial gallon tanks in the aft of each wheel well are interconnected to the main tank. Two submerged AC electrically driven water boost pumps mounted in the main tank deliver water under pres-



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POWER PLANT INSTALLATION

sure to gear driven water pumps on the lower right side of each engine. Arming switches for water injection are located on the main instrument panel. Engine water injection is controlled by thrust lever action through a microswitch in the fuel control unit.

The Pratt and Whitney JT3C-6 Series engine is a continuous flow gas turbine engine consisting of an axial flow compressor, an eight unit semi-annular combustion chamber and a split 3 stage reaction turbine. The multistage axial compressor consists of a 9 stage low pressure rotor assembly (1st spool) and a 7 stage high pressure rotor assembly (2nd spool). Stator assemblies made up of inner shroud, outer shroud and a series of airfoil shaped vanes, are installed in two halves between each row of rotating blades. The low pressure compressor is connected by a through shaft to the 2nd and 3rd stage (low speed) turbine assembly. The high pressure compressor is connected independently by a hollow shaft to the 1st stage (high speed) turbine assembly. Turbine nozzle assemblies, supported by the combustion chamber rear case, direct exhaust gases at each of the turbines.

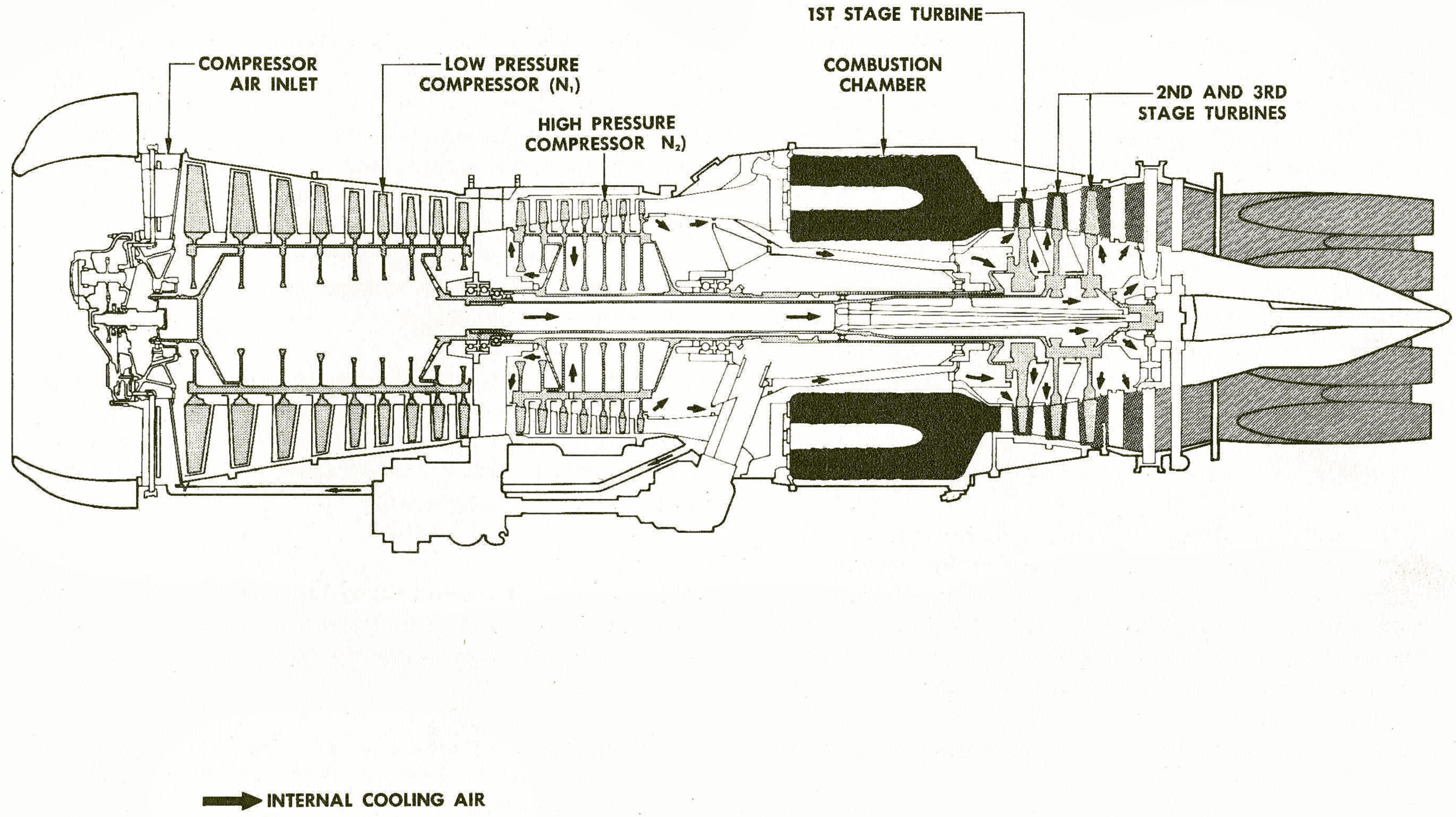
The compressors deliver air under a minimum pressure ratio of approximately 10:1 at sea level static conditions to the combustion chamber. The combustion chamber contains eight burner cans. Fuel under pressure is sprayed into the burner section through dual orifice nozzles mounted in clusters of six at the inlet of each burner can. After being initially ignited by two spark igniters in burner cans No. 4 and No. 5, continuous combustion supplies heat for expanding the air which increases the velocity of the gas flow through the turbine.

After passing through the three turbine stages, the gases discharge through the tail pipe nozzles as a high velocity jet.

Cooling of many internal parts of the engine is achieved by use of discharge air from the compressors. Engine low pressure compressor air is used for thermal anti-icing of the wing leading edges. Air bleed from the high pressure compressor is utilized for anti-icing the engine air inlet section and for driving the cabin air turbocompressor. High pressure engine air is also used for nose cowl anti-icing, and for air supply to the oil cooler ground air ejector. An air pressure bleed is also provided to pressurize the hydraulic reservoir.

Engine accessories are driven by the high pressure rotor assembly through a gear train to the oil pump and accessory drive housing. The fuel pump and fuel control units are contained on the basic engine assembly.

Engine forward mounting provisions are incorporated on the compressor intermediate case which contains air guide vanes for the 10th stage compressor and structural support for the No. 2 and No. 3 main shaft bearings. The engine aft mounting provisions are incorporated on the turbine exhaust front case which contains structural support for the No. 6 main shaft bearing.



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TYPICAL ENGINE INTERNAL ARRANGEMENT

ELECTRICAL POWER—AC SYSTEM

Primary electrical energy for the 707-138 airplane is 3 phase, 400 cycle alternating current at a regulated potential of 200 volts phase-to-phase and 115 volts phase-to-structural ground. Power is supplied by four 30 KVA generators driven by the engines through Sundstrand constant speed drives. Driven by power from the engine, the constant speed drive transmission assembly is basically a variable displacement hydraulic pump powering a constant displacement hydraulic motor. Governing and control mechanisms adjust output from pump to motor so that motor furnishes a constant output speed, compensating for variations in input speed from the engine and variations in load on the generator. This action provides frequency regulation for paralleling the generators and dividing the real load.

Drive protection includes an output over-running clutch, input shaft shear section, and over-under speed control system. A manual speed trimming control for each generator drive is located on the Flight Engineer's panel. Also located on this panel is a generator drive disconnect switch. Actuation of this switch operates a clutch to disconnect the drive from the engine. Re-engagement of the clutch is accomplished manually as a ground operation.

The generators are normally operated in parallel, but nonparallel operation is possible. Load busses are provided for each generator, and the generators are paralleled through a synchronizing bus.

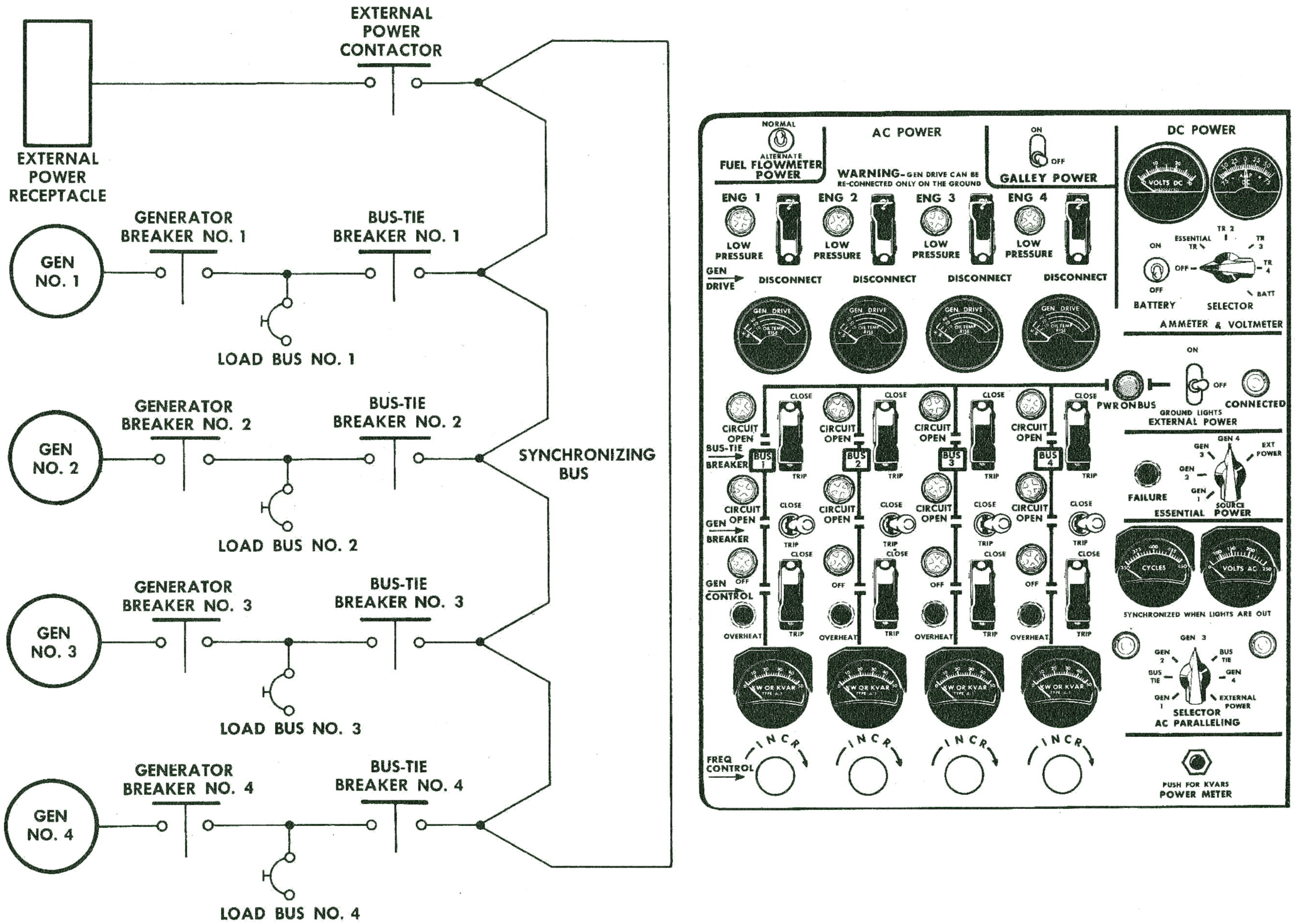
The electrical system and generator drive controls are installed on the Flight Engineer's panel. Lights indicate the position of main power circuit breakers. A watt-varmeter is supplied for each generator with a selector switch to select function. A frequency meter and an AC voltmeter are connected through a selector switch to select the generator being monitored. Magnetic amplifier regulators are used in regulating primary electrical system voltage. A reactive load equalizer loop is incorporated.

An external AC power receptacle, located forward of the nose wheel well, is connected to the generator synchronizing bus through external power circuit breakers. Lights on the AC power control panel will indicate whenever external power is on.

AC power can be supplied to the essential bus, fuel quantity system and most lights without energizing the airplane power distribution system.

An electrical equipment cabinet, which is accessible in flight, is installed in the lower deck to the right of the nose wheel well.

The main AC power shield is located in the control cabin and contains all main power distribution circuit breakers.



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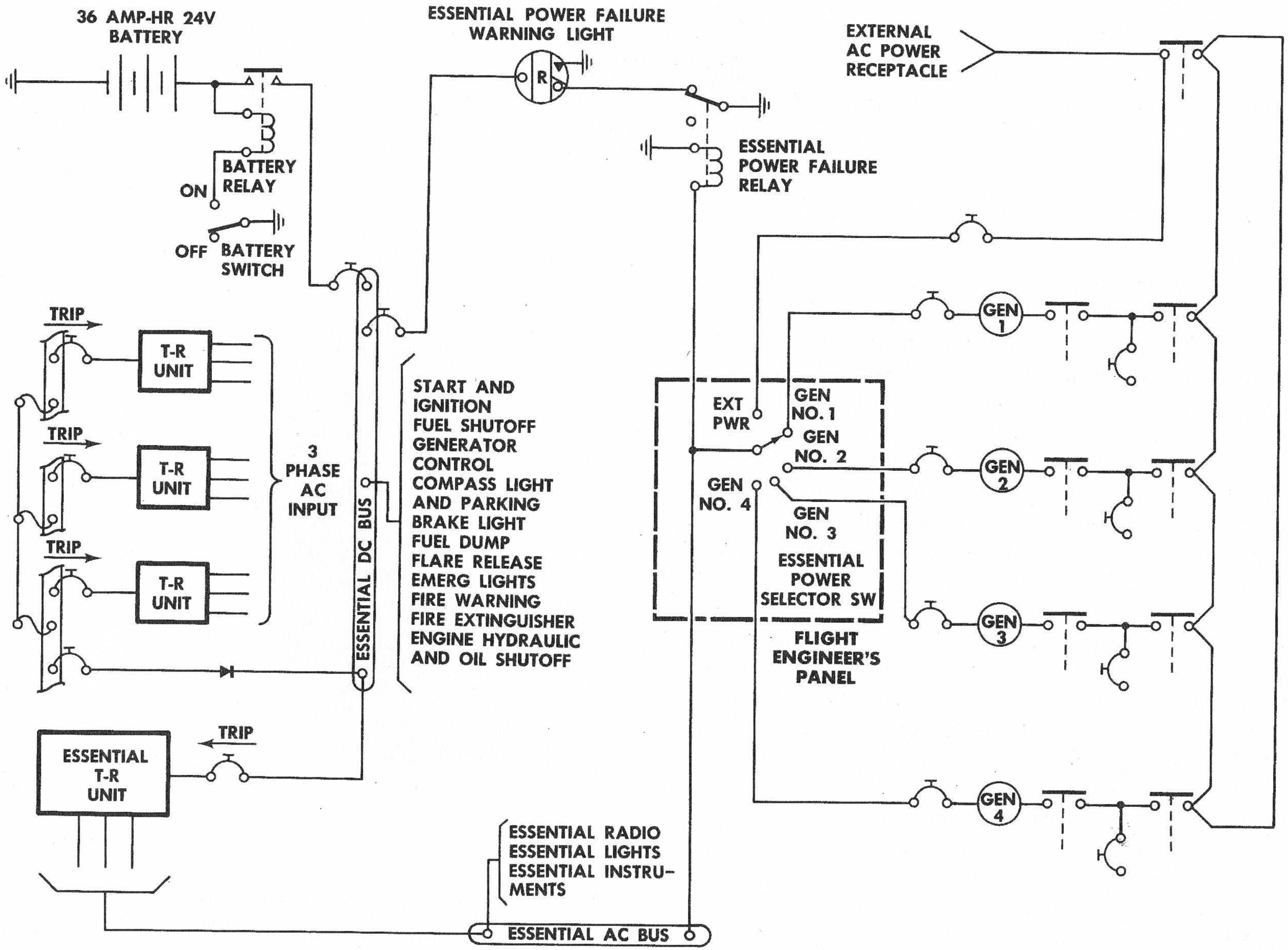
AC POWER SYSTEM

Airplane 28 volt DC power is derived from the AC system through three transformer-rectifier (T-R) units located in the electrical equipment cabinet. A fourth T-R unit, energized at all times from the essential AC bus and isolated by a rectifier from the main DC bus, supplements DC power to essential loads during normal operation so as to be immediately available when main bus power is interrupted.

A 36 ampere-hour, 24 volt battery is located in a compartment in the nose gear wheel well area. This battery is charged from the essential DC bus through a battery relay controlled by a battery switch on the Flight Engineer's panel. The battery may also supply power to all essential DC loads if power is not available from any of the T-R units.

One DC voltmeter and one DC ammeter are used to monitor power sources by means of a selector switch. These indicators, selector switch, and a battery control switch are mounted on the Flight Engineer's panel.

Exit identification lights are operated from self-contained non-acid batteries. Lights are illuminated when a cockpit switch is actuated or upon interruption of the essential DC power.



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DC AND ESSENTIAL POWER SYSTEMS

FUEL TANKS

All fuel is carried in the interspar area of the wing structure. Two outboard reserve tanks and four main tanks are integral with the wing structure. The center wing tank is composed of two integral sections at the wing roots plus six nylon and rubber bladder cells enclosed by wing structure. Each bladder cell is contained in a fuel and vapor tight cavity with appropriate drainage and venting. The six bladder cells have a capacity of approximately 3,264 Imperial gallons, providing a total capacity of approximately 6,088 Imperial gallons for the center wing tank.

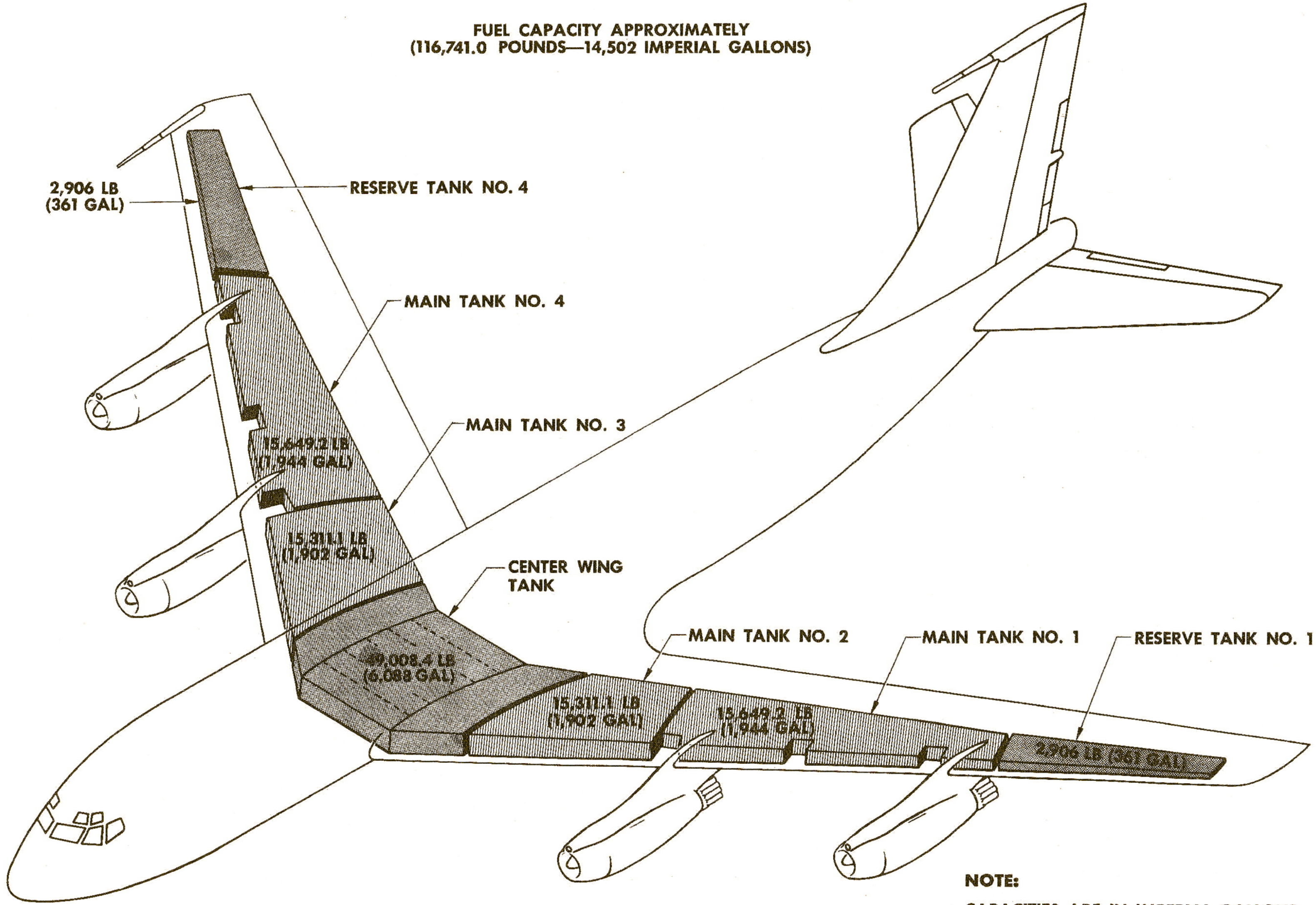
Boost pumps are strategically located in each tank, except the reserve tanks, to reduce the unavailable fuel to an absolute minimum. They can be removed individually from their respective tanks without draining the fuel from the tank.

The fuel tanks are vented through tubes and hat type stringers to a single outlet at each wing tip lower surface. The outlet is provided with a ram, non-icing, flush scoop. Its arrangement insures positive ram air pressure within the tanks and avoids negative pressure in the tanks during rapid descent.

TANK	CAPACITY (IMPERIAL GALLONS)	CAPACITY (POUNDS*)
L.H. Outboard Reserve	361	2,906
No. 1 Main	1,944	15,649.2
No. 2 Main	1,902	15,311.1
Wing Center Section	6,088	49,008.4
No. 3 Main	1,902	15,311.1
No. 4 Main	1,944	15,649.2
R.H. Outboard Reserve	361	2,906
	14,502	116,741.0

*Weights given are based on aviation kerosene at a mean specific gravity of 0.805 (or 8.05 lbs. per Imperial gallon).

FUEL CAPACITY APPROXIMATELY
(116,741.0 POUNDS—14,502 IMPERIAL GALLONS)



NOTE:

CAPACITIES ARE IN IMPERIAL GALLONS.
WEIGHT BASED ON A FUEL DENSITY OF
8.05 POUNDS PER IMPERIAL GALLON

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FUEL TANK ARRANGEMENT

Independent main tank-to-engine fuel feed systems are used which can be interconnected through a manifold such that fuel can be delivered from any tank to any or all engines. Use of fuel in the outboard reserve fuel tanks is by gravity flow into main tanks No. 1 and No. 4.

Each fuel tank, except the outboard reserves, is equipped with two AC powered fuel boost pumps which are normally operated in parallel. They are controlled by separate switches and independent circuits so that the engine operation will not be affected by the failure of a single power source. The individual main tank boost pumps will deliver 6,000 pounds of fuel per hour at approximately 12 psi into the fuel feed line. Operations of a single valve in each fuel line controls the flow of fuel to the engine.

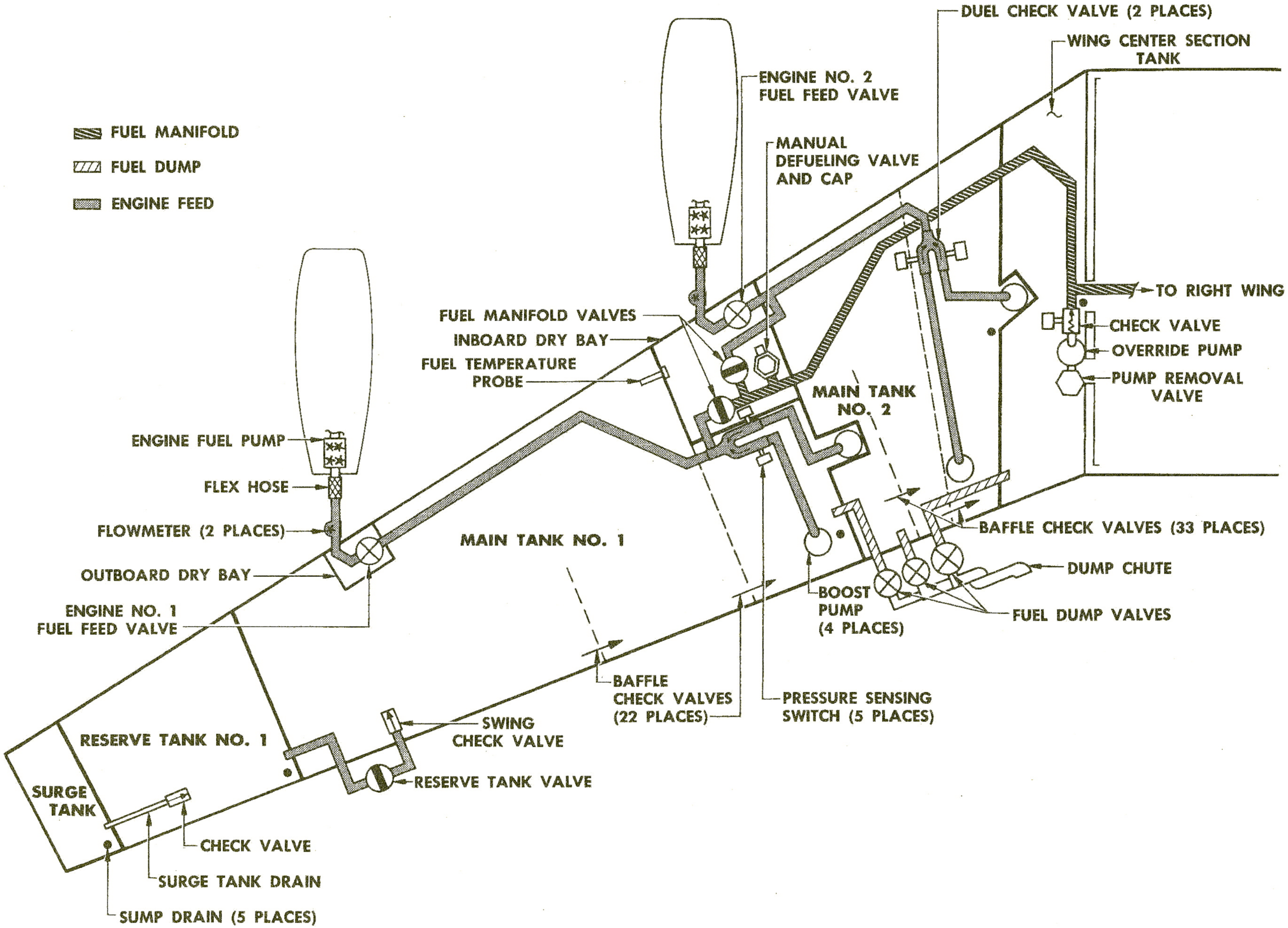
Fuel from the center wing tank is directed into the manifold to feed any combination of engines as selected by opening manifold valves. The center wing tank boost pumps will deliver 12,000 pounds per hour at approximately 30 psi and, while supplying fuel, will override the main tank boost pumps. Check valves prevent reverse flow into any of the tanks and main tank feed is reinstated automatically before the center wing tank empties.

Control for the fuel feed and fuel dump systems is provided at the flight engineer's station. The fuel system is laid out schematically on the lower panel. The panel includes individual tank quantity gages, boost pump switches, low pressure warning light, valve switches and valve position indicator lights.

A defueling connection is located in an inboard wing dry bay. Defueling rate, when using boost pumps, is approximately 41.6 Imperial gpm from each tank.

A fuel dump system with a dump chute in the trailing edge of each wing will, by gravity flow, jettison fuel directly from the main and center wing tanks at a minimum rate of approximately 2,480 pounds per minute. The outboard reserve tanks are dumped by gravity flow into adjacent main tanks. Separate dump valves permit individual on-off control of flow from each tank except the reserves, which are controlled by the adjacent main tank switch. The dump lines are installed in the tanks in such a manner as to retain approximately 15,000 pounds of fuel aboard the airplane.

The fuel dump switches are in a covered panel box on the flight engineer's auxiliary panel. Actuation of the fuel dump switch extends both dump chutes. Six switches control individual tank dump valves, one for each main tank and two for the center wing tank.



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FUEL FEED AND FUEL DUMP SYSTEMS

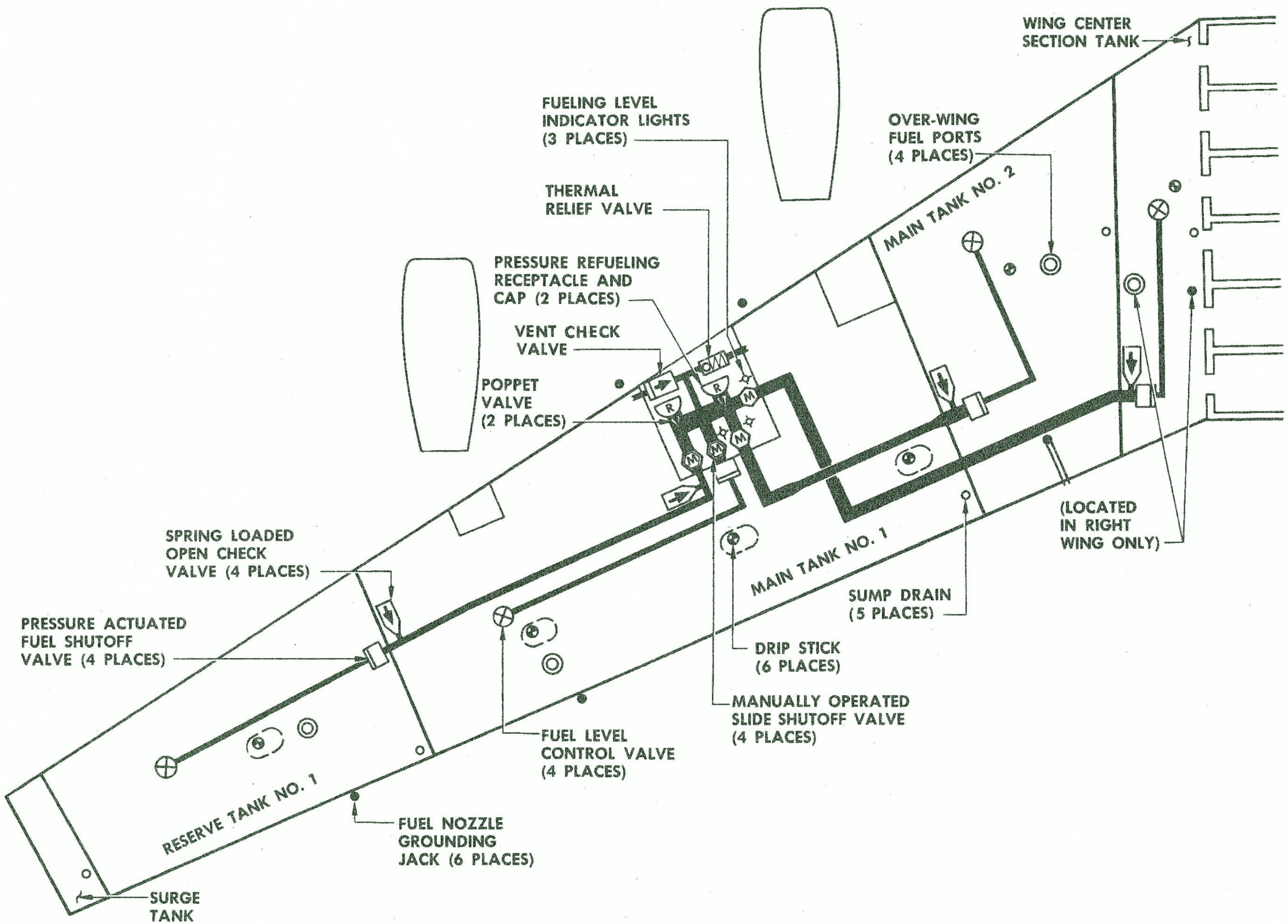
A four point underwing pressure fueling system is used on the 707-138 airplane. Fueling is accomplished at two stations, each located in a dry bay between two inboard and outboard nacelles. Each station has two fuel adapters for supply hose connections, four manual shutoff valves, and two static ground connectors.

A fuel operated level control valve is installed in each tank to automatically shut off the fuel flow at maximum tank capacity. The center wing tank employs two level control valves with flow rates of 208 Imperial gallons per minute and can be fueled from either side of the airplane. Main tanks 1 and 4 each have a flow rate of 195 Imperial gallons per minute, main tanks 2 and 3 each have a flow rate of 189 Imperial gallons per minute, and the outboard reserve tanks have a flow rate of 54 Imperial gallons per minute. All of these flow rates are based on a delivery pressure not to exceed 50 psi.

Signal lights are placed adjacent to the manual control valves at the fueling stations to indicate when a predetermined quantity of fuel has been loaded into the wing center section and main tanks. Switches and preset controls are installed on the flight engineer's lower panel to permit setting the signal system for ground fueling. Overwing fueling ports, 3 inches in diameter, are also provided for each tank.

All fuel tanks incorporate internally mounted electronic capacitance type probes for fuel gaging. The system compensates for fuel dielectric variation and the instruments read in pounds of fuel remaining.

In addition to the airplane capacitance type fuel gaging system, provisions are made to determine the quantity of fuel in each tank in the normal taxi attitude with a calibrated drip stick. The locking-sealing base and hollow tube of the drip stick assembly is lowered through the wing lower surface until the open top of the stick is at the fuel surface height and fuel can be observed dripping from a small hole near the base.



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FUELING SYSTEM

CABIN AIR CONDITIONING

The air conditioning system receives fresh ambient air from three turbocompressors located in the nacelles of engines 2, 3, and 4. The turbines and compressors are single stage centrifugal units. Each turbine is driven by bleed air from the engine high pressure compressor. Fresh ambient air, from an inlet on the top of the engine nose cowl, enters the turbine driven compressor and is discharged into a common pneumatic crossfeed manifold in the wing leading edge. Normal temperature in the manifold during cruise power at 35,000 feet is approximately 280°F; maximum temperature is approximately 500°F.

Two air conditioning system units, located in the body below the wing center section, and on either side of the keel beam, operate in parallel from the pneumatic supply manifold. Air supplied to each pack is controlled by separate control valves.

During normal cruise operation, cooling is accomplished by passing the air from the turbocompressors through the primary heat exchanger where heat is extracted by ram air. The air then flows directly out of the unit into a modulated temperature control valve, where it is mixed with warm air to an automatically controlled temperature, and then into the main cabin and control cabin distribution system.

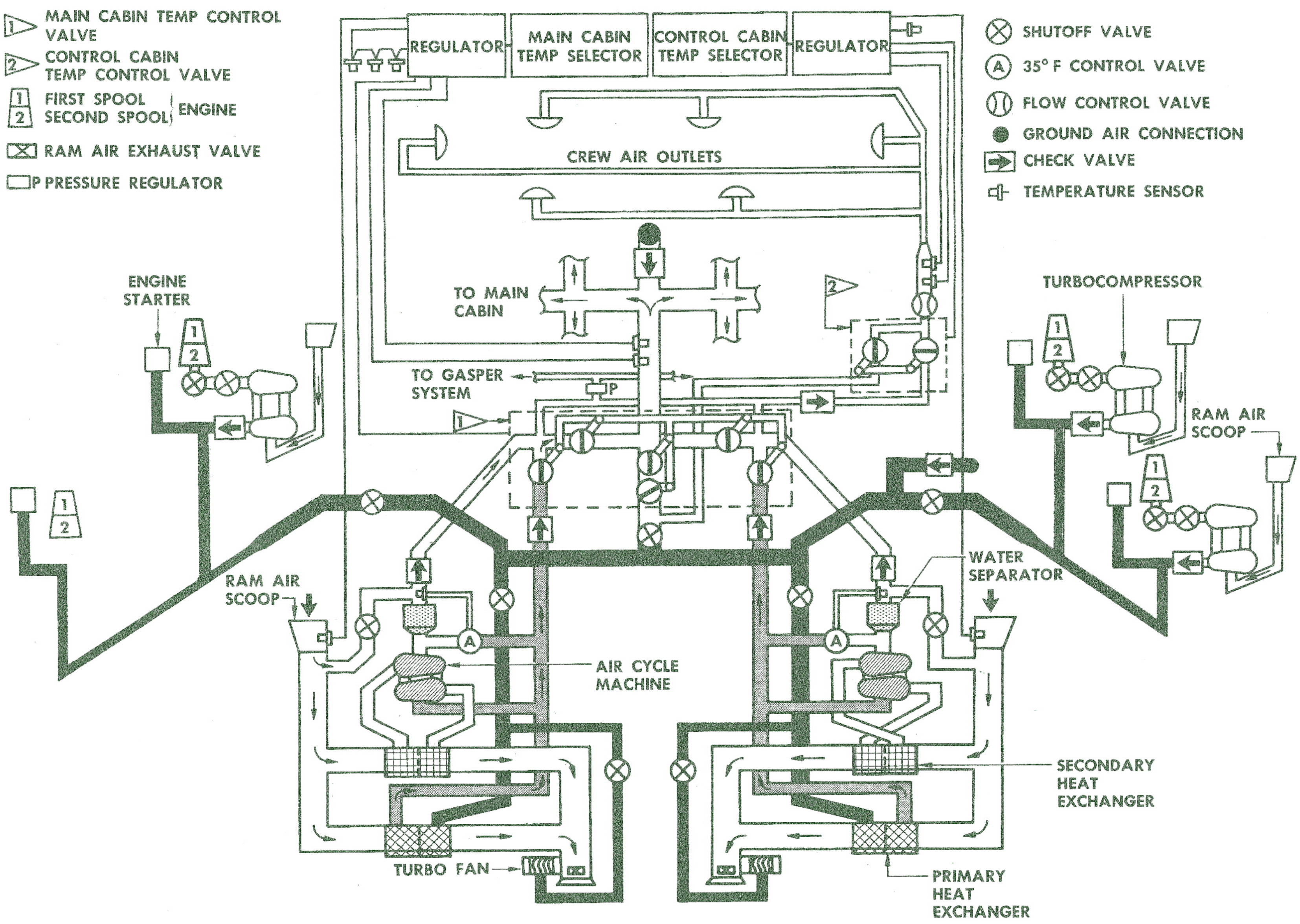
For ground operations and some alternate conditions where additional cooling is required, the air is automatically directed from the primary heat exchanger through the air cycle machine compressor, secondary heat exchanger, through the expansion turbine side of the air cycle machine, to the water separator and through the temperature control valve to the distribution system.

All heating is accomplished by routing the hot air from the turbocompressors directly into the temperature control valve, by-passing the air conditioning units. A shut-off valve in each system may be operated to provide ram air to the air conditioning distribution system if the airplane is unpressurized.

Individual conditioned air outlets are provided for each crew member and a "hot wall" type distribution system is used in the passenger compartment. Adequate ventilation is provided for personnel comfort and for control of odors. Airflow is exhausted from the cabin around and through the cargo compartments to provide temperature of not less than 60°F in the forward compartment and a 32°F minimum temperature in the rear compartment. This air is then exhausted overboard.

Controls and indicators for air conditioning are located on the flight engineer's upper panel. A temperature selector and a remote reading temperature indicator are in the main cabin. A separate temperature selector is in the control cabin. Temperature in both cabins is automatically controlled. Manual controls may be used for override of each system.

The air conditioning system is operable on the ground with the engines running, or from a suitable pneumatic ground cart. An air mover in the ram air outlet of each pack moves air through the heat exchanger for cooling during ground operation. An air connection on the under side of the airplane and forward of station 630 allows distribution of conditioned air supplied by a ground pre-conditioning unit.



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AIR CYCLE AIR CONDITIONING SYSTEM SCHEMATIC

Compartments for the crew, passengers, cargo and lower 41 section are pressurized to a normal maximum operating differential of 8.6 psi.

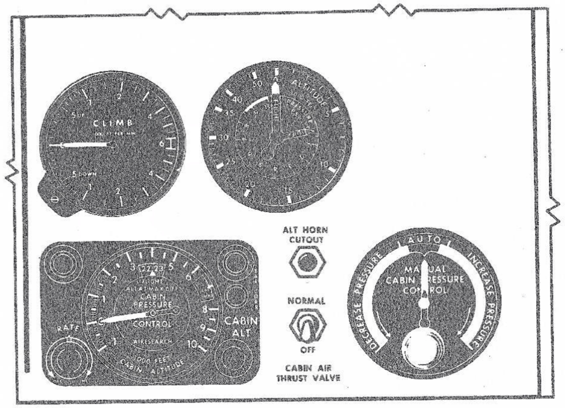
Pressurization is accomplished by controlling cabin air outflow. Three outflow valves are installed in the bottom of the body, they provide normal cabin pressure regulation, pressure relief and vacuum relief. Positive cabin differential pressure relief is set at 9.42 psi, and maximum negative relief pressure is .36 psi. A means is provided to lower the cabin-to atmosphere pressure to .17 psi with maximum air conditioning flow into the cabin.

The controls and indicators for pressurization are located on the Flight Engineer's upper panel. An automatic cabin air pressure controller contains controls for setting the cabin rate of climb and cabin pressure altitude. A cabin rate of climb indicator and a combination altimeter and cabin differential pressure gage indicate pressurization conditions. A manual pressurization control is provided to override the automatic controller.

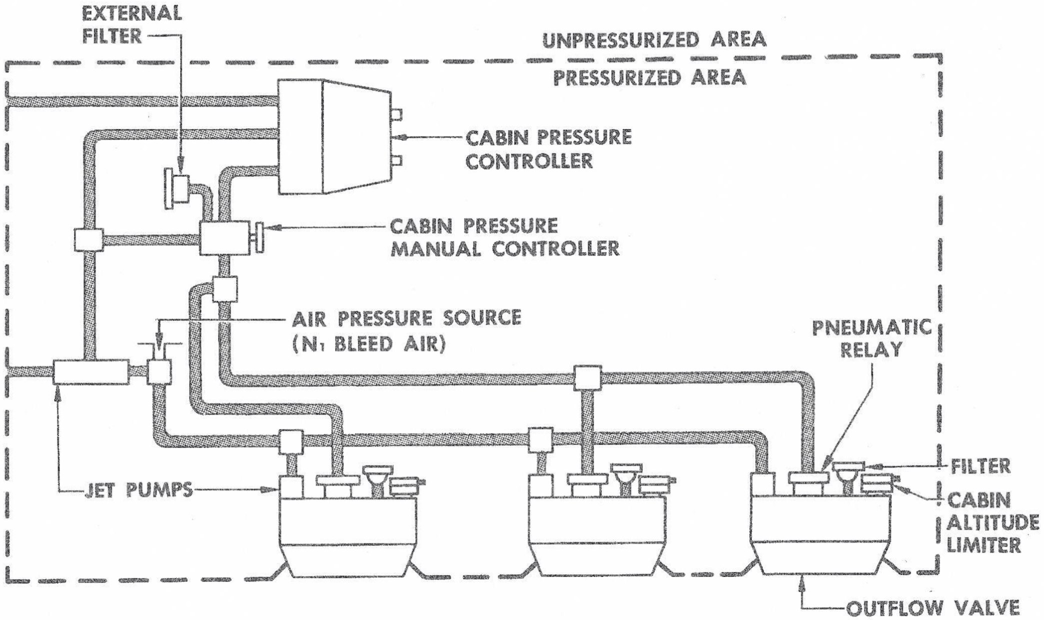
The normal cabin pressure control system is of the isobaric type. It provides a selective isobaric range of cabin altitudes from minus 1,000 feet to 10,000 feet and limits the maximum differential to 8.6 psi. The system is capable of maintaining a cabin to ambient pressure differential up to 8.6 psi at all flight altitudes between 22,500 feet and 40,000 feet. A sea level cabin pressure can be maintained up to 22,500 feet airplane altitude.

In the event of low cabin air inflow caused by the loss of one or two turbocompressors, air outflow should be restricted to a minimum.

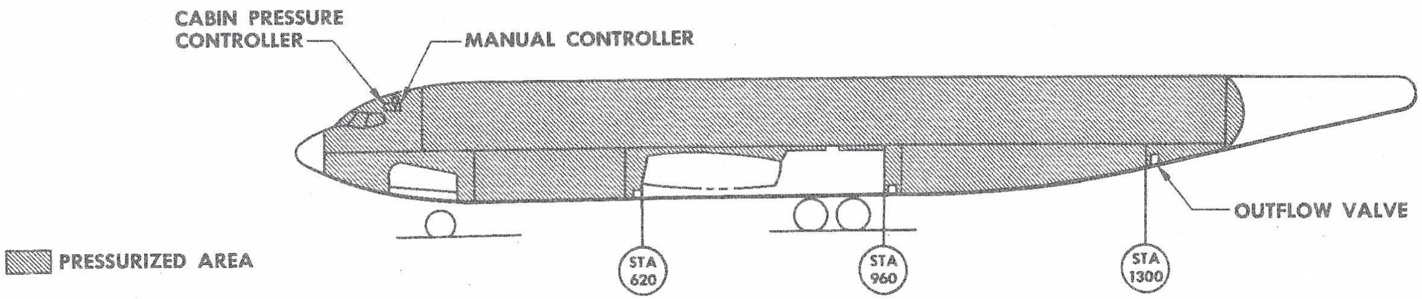
This can be accomplished by selecting the thrust recovery valves "off", thereby limiting the cabin air outflow.



FLIGHT ENGINEER'S PANEL



CABIN PRESSURE CONTROL SYSTEM



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PRESSURIZATION SYSTEM

The Anti-Icing System for the airplane includes thermal anti-icing for the wing leading edges, engine nose cowl, and engine inlet guide vanes. Also, the crew cabin windows are anti-iced or de-fogged by electrical heating. The empennage leading edges incorporate electrical de-icing equipment.

Ice protection controls and indicators are mounted on the overhead panel. Control for wing thermal anti-icing consists of a single switch having "ground test", "off" and "on" positions. Actuation of this switch to "on" position places the system in automatic operation by opening the hot air supply shutoff valves from each engine. An indicator and selector switch, located on the overhead panel, provide indication of duct air temperature on inboard and outboard engines as selected. An indicator light on the panel will illuminate when wing leading edge surfaces approach an overheat condition. Positioning of the wing thermal anti-icing switch to "ground test" will test the system at safe ground operating temperatures by automatically cycling the supply shutoff valves.

First spool engine bleed air is used for thermal anti-icing of the wing leading edges from the inboard fuselage fillet to the wing tip caps, with exception of approximately eighty inches at the intersection of the wing leading edge and each strut.

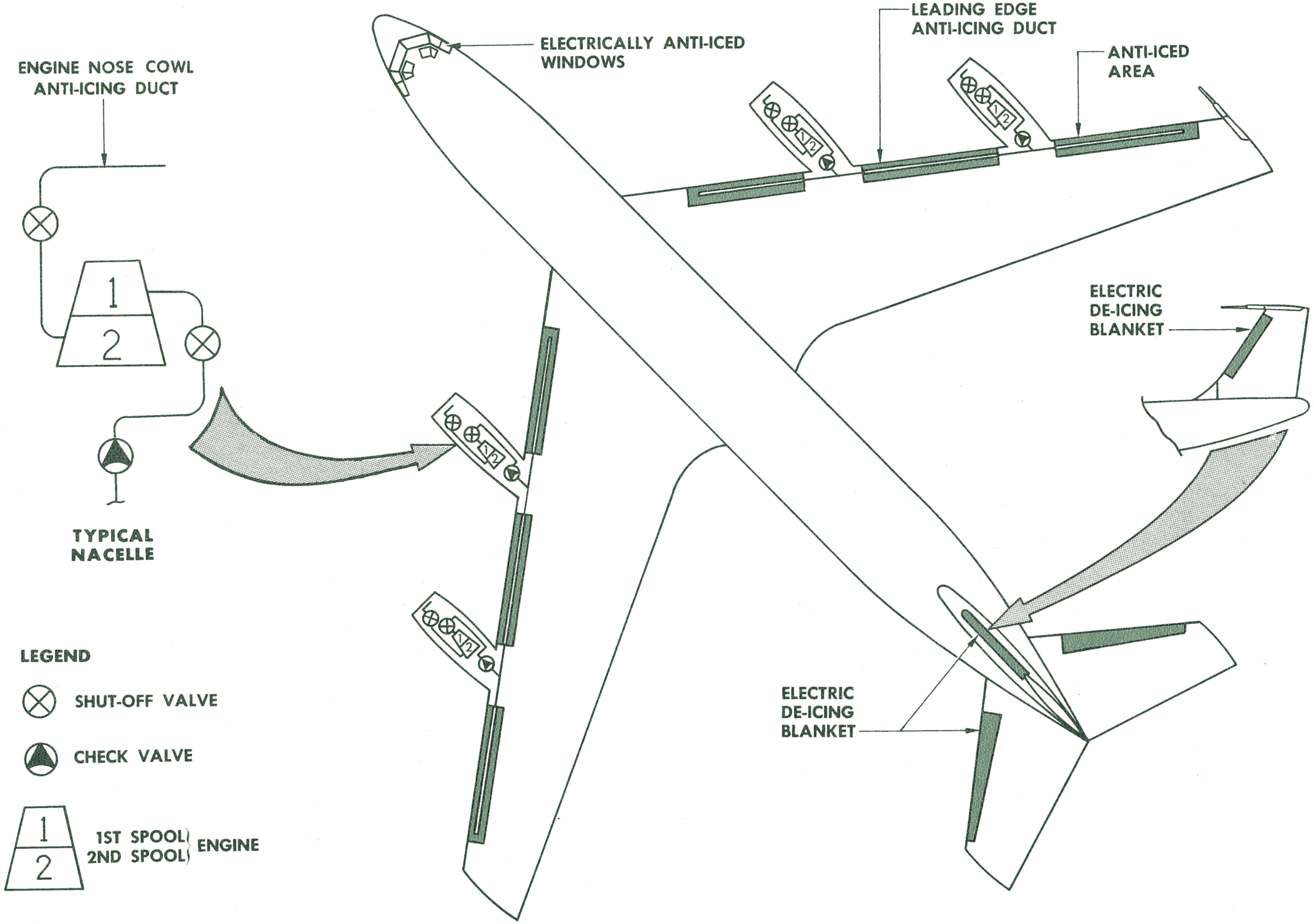
The engine nose cowl and engine inlet guide vanes are anti-iced by engine second spool bleed air. The air is ducted from the bleed port of each engine to the nose cowl and inlet guide vanes for that engine.

Shut-off valves located in each supply line are controlled by an individual switch for each engine.

The horizontal stabilizer and vertical fin are electrically de-iced utilizing 400 cycle, 115 volt AC power. Three electrically heated boots extend the full length of the removable leading edge sections of the horizontal stabilizer and vertical fin. Thermal switches are located in the leading edge parting strip of the boots to maintain a constant temperature throughout the full length of the parting strip of the boot. The boots are protected from exceeding safe operating temperature with overheat sensing devices which shut off electric power and turn on an overheat indicator light. Control of the tail surface de-icing system may be either manual or automatic. A selector switch is used for manual temperature regulation. An ammeter is provided on the control panel to indicate power supplied when the de-icing system is on.

The forward windshields in the control cabin are provided with anti-icing. The side and upper windows are provided with defogging protection by an electrically conductive coating in the glass. Window heat switches on the overhead panel provide low or high automatic temperature control.

Pitot heads are electrically heated. A heater switch is located on the overhead panel with warning lights to indicate interruption of pitot heating current.



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ICE ELIMINATION

The hydraulic system consists of two separate 3,000 psi systems. The Utility System supplies hydraulic pressure to the main and nose landing gear actuating mechanisms, outboard spoilers, trailing edge flap drive motors, leading edge flap actuators, nose wheel steering, engine start system air compressor and wheel brakes. The Auxiliary System supplies hydraulic pressure to the inboard spoilers. The Auxiliary System is normally "on" supplying pressure at all times during flight.

Two engine driven pumps, one mounted on each inboard engine, supply regulated hydraulic pressure at a flow rate of approximately 18.3 gpm each to the Utility System. Each pump has an individual shutoff control switch located on the main instrument panel. A shutoff valve controlled by the fire control switch is provided in each engine pump supply line. A filter and low pressure warning light switch are provided in each engine pump outlet line.

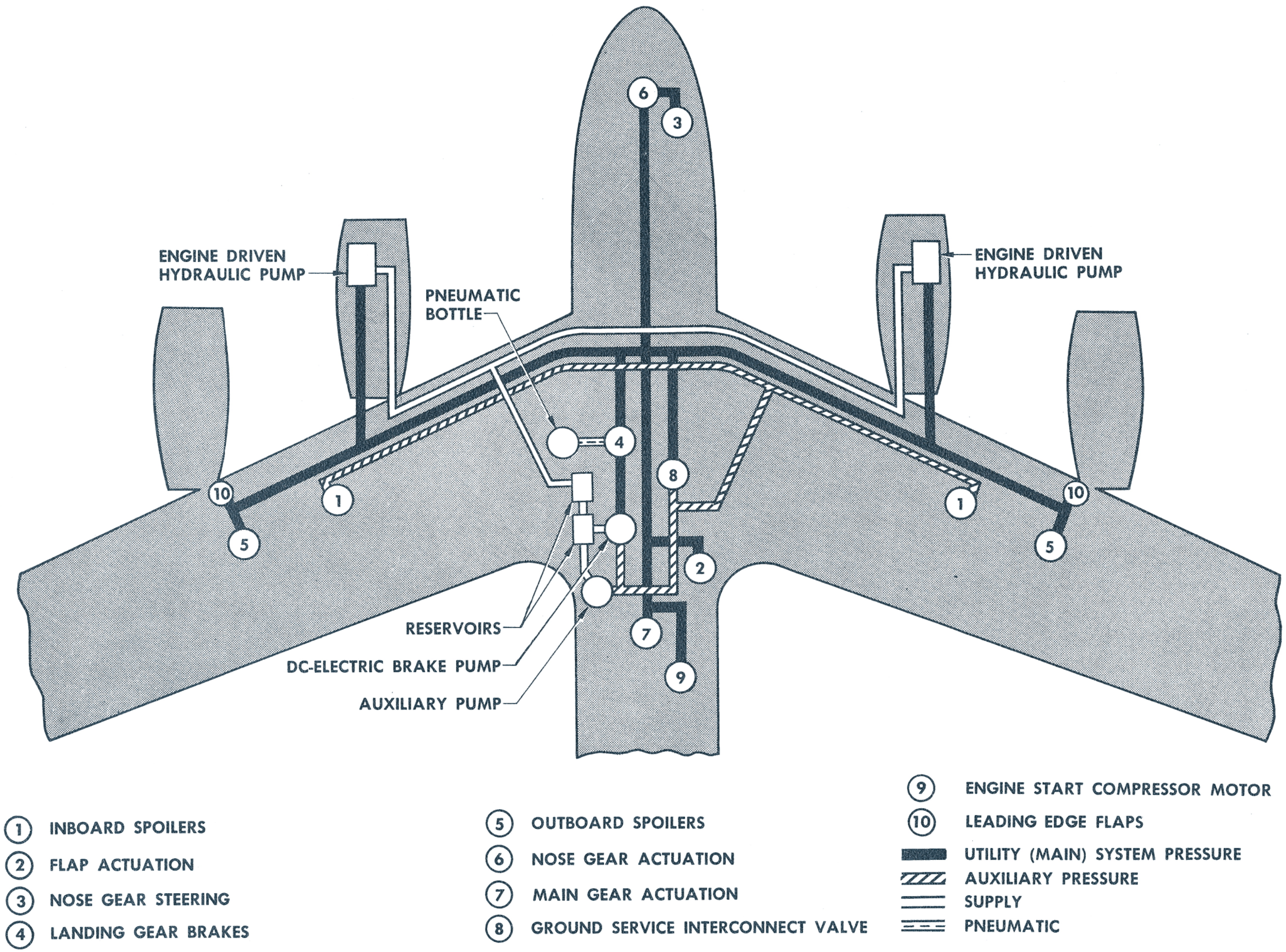
The Utility System reservoir, which has a fluid capacity of 4.6 Imperial gallons, is located in the left main wheel well area and is filled by gravity flow through a filter opening in the side of the reservoir. In addition to a sight gage on the reservoir, a fluid quantity indicator is located on the flight engineer's instrument panel.

The reservoir is pressurized to 45 psi by bleed air from the inboard engines. A pressure gage on the main instrument panel indicates the pressure in the Utility System accumulator which is a 25 cubic inch cylindrical type accumulator located in the right main wheel area. The Utility System has a pressure relief valve.

One AC electrically driven hydraulic pump which is located in the left main wheelwell area supplies regulated hydraulic pressure at a flow rate of 2.5 gpm to the Auxiliary System. The pump on-off control switch is located on the main instrument panel. A filter and low pressure warning light switch are provided in the pump outlet line. The Auxiliary System reservoir, which has a capacity of 1.25 Imperial gallons, is filled from the Utility System reservoir. The reservoir interconnect is located so that a failure of either system will not drop either reservoir level below a minimum operating level. The Auxiliary System has a 25 cubic inch cylindrical type accumulator and a pressure relief valve.

The Auxiliary System pressure can be diverted into the Utility System through an interconnect valve which can be actuated only when the aircraft is on the ground with the external electrical power supply connected.

One DC electrically driven hydraulic pump which is located on the right main wheel well can be used to supply pressure at .62 gpm from the auxiliary system to the wheel brakes only.



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HYDRAULIC SYSTEMS

The main landing gear consists of two four-wheel truck type gears. The main gear trunnion supports are located in the wing root trailing edge behind the aft wing spar. Retraction is inboard into the wheel well area of the lower body. The main landing gear is hydraulically actuated simultaneously with the nose gear by a common selector valve located in the right wheel well. The selector valve is cable connected to a control handle in the center of the main instrument panel. Hydraulic pressure is supplied from the Utility System for retraction and extension. The landing gear doors are closed and faired with the body whenever the gears are up and locked or down and locked. The doors can be opened on the ground for servicing and inspection by actuation of the door ground release handle in the strut fairing access opening for each main gear.

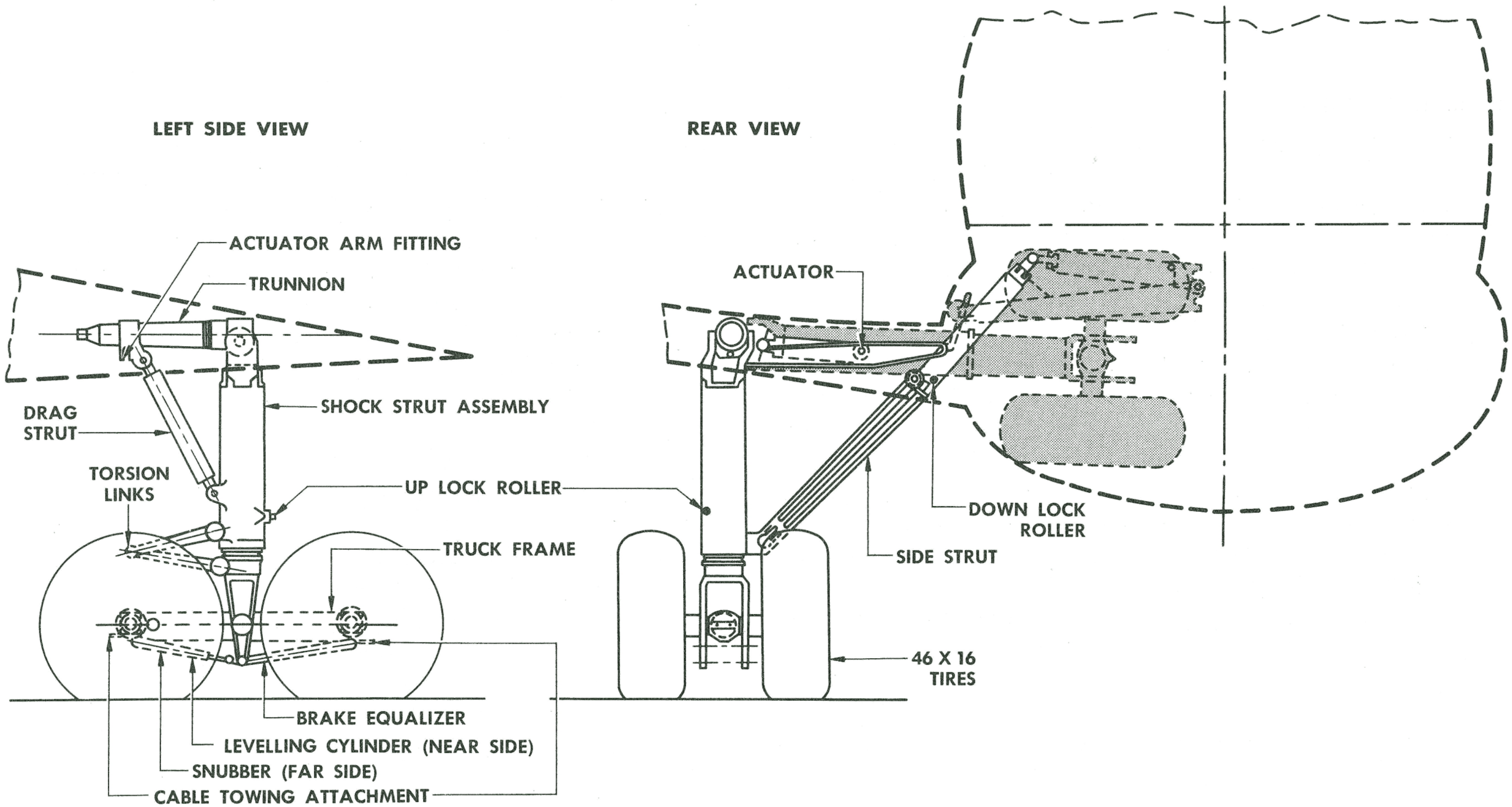
The main landing gear will retract in approximately 10 seconds. Extension time is approximately the same due to hydraulic snubbing of the gear.

The gear incorporates brake equalizer rods from the lower end of the shock strut to the aft brakes for maintaining equal tire-ground contact during brake operation. A snubbing cylinder is attached from the front end of the truck to the lower end of the shock strut. The snubbing cylinder dampens truck pitching. Also, a leveling cylinder is attached from the front end of the truck to the lower end of the shock strut. The leveling cylinder serves to level the gear for retraction into the wheel well.

A hydraulically actuated lock mechanism serves as a down lock and up lock. The main landing gear can be extended manually from the control cabin by use of a hand crank mechanism located in the floor with a cable control system to the main landing gear wheel well.

Safety features are incorporated in the gear control systems to prevent retraction on the ground. In flight, retraction is prevented until the gear shock struts are fully extended and the trucks are level with respect to the shock strut. Position indicator lights for the main gear and door are provided on the main instrument panel just above the landing gear control handle.

The landing gear brake system consists of four sets of multiple disc brakes on each main gear truck. They are hydraulically controlled by either the pilot or copilot through one set of metering valves. Hydraulic pressure for braking is supplied from either the Utility System or the DC powered hydraulic pump. A pressure gage on the main instrument panel indicates the pressure in the brake accumulator, which is a 100 cubic inch cylindrical type accumulator. Also available to the pilot is a manually controlled pneumatic system for brake application. The pneumatic control handle located on the main instrument panel operates a valve which directs a pneumatic charge through a shuttle valve to all wheel brakes simultaneously. A gage on the copilot's side panel indicates the pneumatic pressure available for braking.



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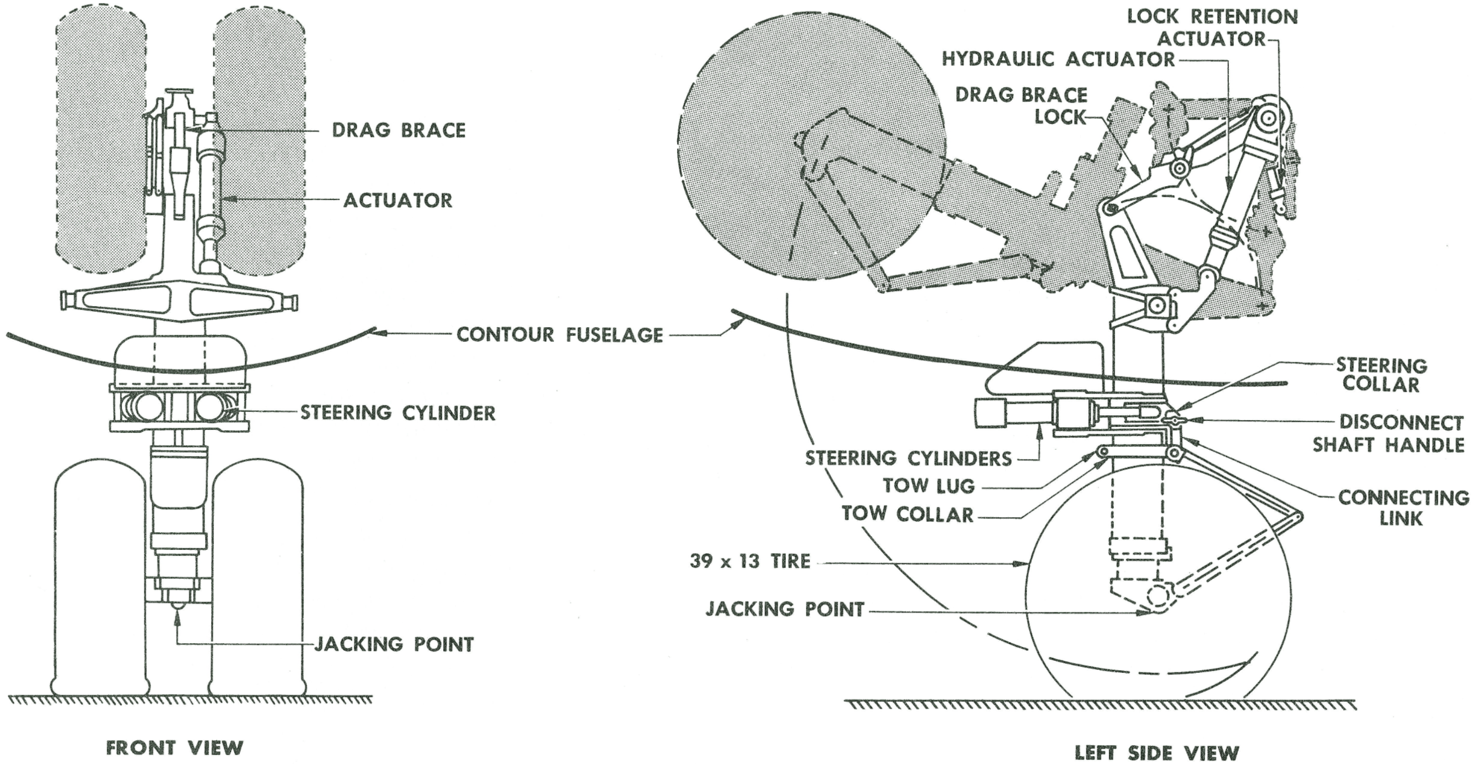
MAIN LANDING GEAR

The nose landing gear is a dual wheel, steerable installation which retracts forward into a wheel well in the fuselage nose area. The nose gear is hydraulically actuated simultaneously with the main gear by the same selector valve which actuates the main gear. Hydraulic system pressure is supplied from the Utility System for both retraction and extension. The gear can also be extended manually from the control cabin by use of a hand crank located in the floor. Normal retraction time is approximately 6 seconds. Extension time is approximately the same due to hydraulic snubbing provisions in the extension cycle. Nose gear door operation is the same as the main gear in that the doors are closed and faired with the body whenever the gear is down and locked or up and locked. These doors can be opened on the ground for servicing and inspection by actuation of a door control handle in the ground power receptacle.

Nose wheel steering is accomplished through a control wheel located forward and to the left of the pilot. Nose wheel movement either side of center is 55 degrees. Hydraulic pressure for nose wheel steering is supplied from the Utility System through the gear "down" position of the landing gear selector valve. A trunnion operated shutoff valve prevents the inadvertent turning of the nose wheels through the steering system until the nose gear is clear of the nose wheel well.

Safety features are incorporated in the gear to prevent ground retraction. On takeoff, retraction is delayed until the shock strut is extended and the nose wheel centered with respect to its wheel well. The gear is centered by a cam located inside the shock strut. Full extension of the strut is required to align the cam and center the gear. Nose gear position indicator lights are installed on the main instrument panel above the landing gear control lever.



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NOSE GEAR

The control surfaces consist of ailerons, elevators, rudder, wing flaps, spoilers (or speed brakes), horizontal stabilizer and control trim tabs.

The primary flight controls incorporate control systems for both manual and automatic pilot operation of the inboard and outboard ailerons, spoilers, rudder and elevators. These controls, except spoilers, are aerodynamically moved by utilizing differential pressures on balance panels forward of each surface hinge line. The differential pressures are initiated by control tab movement.

Four spoiler segments are located on each wing. Each spoiler is actuated by a hydraulic powered cylinder. The spoiler control system is designed so that when the inboard aileron on one wing goes up, the spoiler segments on that wing will go up also. On the other wing where the aileron has gone down, the spoiler segments receive a down directional signal. When the speed brake control handle on the pilot's control stand is operated, all spoiler segments actuate collectively as aerodynamic speed brakes.

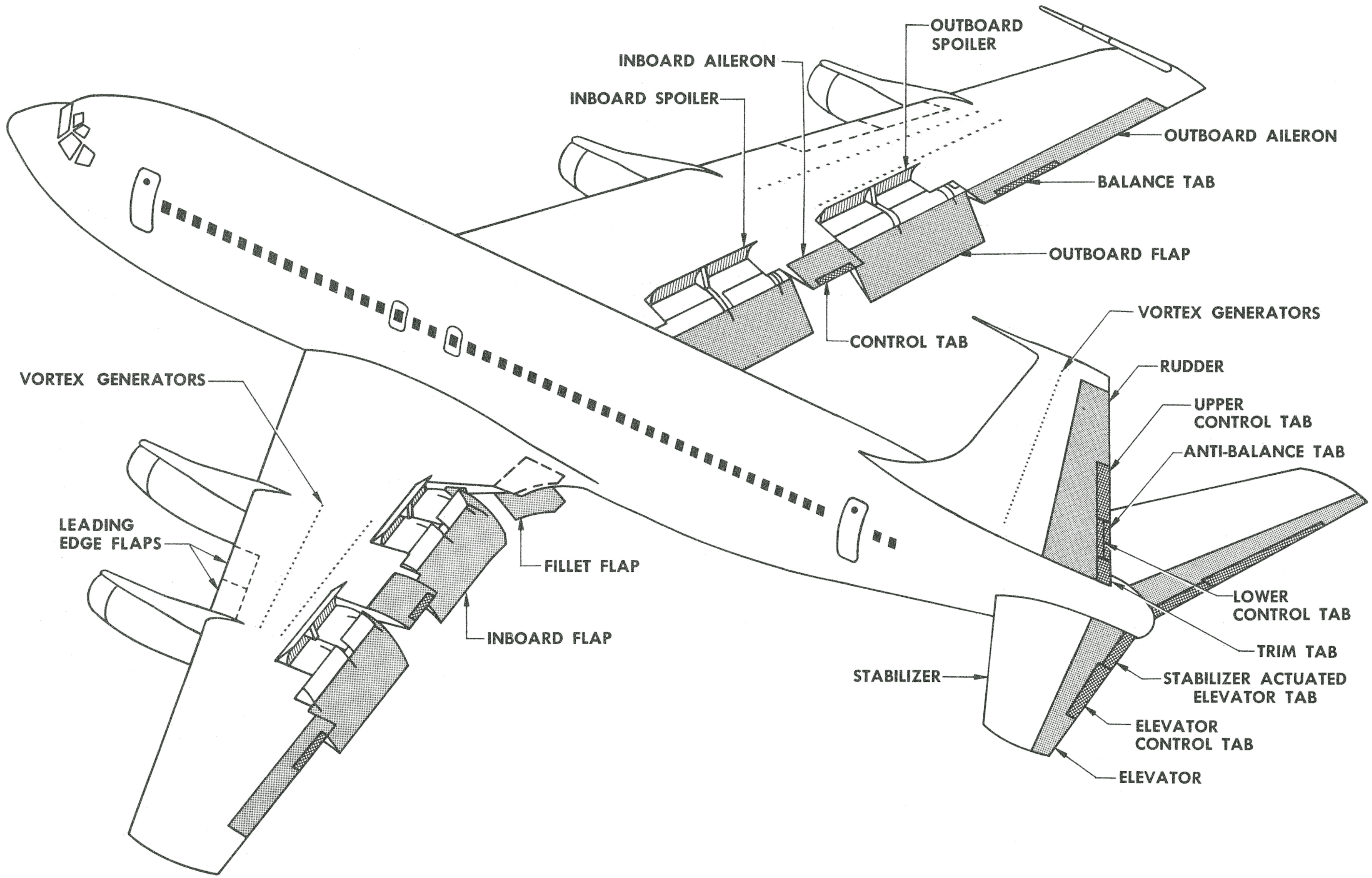
The outboard ailerons are actuated by a cable system which is connected to the inboard aileron control surfaces. The cable system moves the outboard ailerons only when the wing flaps are down or partially down.

The secondary flight controls include the flaps and the trim control systems. The wing flap system consists of two inboard flaps, two fillet flaps and two outboard flaps mounted on the wing trailing edge and two hinged leading edge flaps. Rudder and aileron trim are accomplished manually by cable systems. Rudder and aileron trim controls, with mechanically coupled trim position indicators, are located on the control stand. Stabilizer trim controls on the pilot's and copilot's control wheels actuate an electrically driven jack screw to change the stabilizer angle of incidence. Also, a cable system with control wheels located on the control stand may be used for manual operation.

Vortex generators are installed on the wing upper surfaces forward of the inboard ailerons and on the dorsal fin forward of the rudder. They are small individual airfoils which change the airflow pattern to gain maximum control effectiveness.

Stops are installed near the control columns, wheels and rudder pedals to prevent movement beyond that necessary to operate control surfaces to specified limits.

Energy absorption units in the form of hydraulic snubbers are installed in lieu of gust locks. Attached to primary surfaces, they absorb up to 70 mph air gust loads on the ground.



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CONTROL SURFACES

The main wing flap system consists of two independent drive systems; one for the inboard and fillet flaps and one for the outboard flaps. Normal operation is through a hydraulic actuation system. An electrical motor system is provided for emergency actuation.

Three steel tracks guide needle bearing rollers on each inboard and outboard flap during extension and retraction. The fillet flaps are of the plain hinge type.

The flaps are actuated by ball bearing screw actuators driven through gear boxes from transverse torque tubes. The inboard and fillet flaps on each wing are interconnected by a torque tube and driven by one hydraulic motor. The outboard flaps on each wing are interconnected by a torque tube and driven by a second hydraulic motor. A control lever on the control stand positions the flaps through a common cable system to the two hydraulic motor control valves. Mechanical feed-back of flap position is incorporated in the control valve mechanism so that flap extension is proportional to control lever movement.

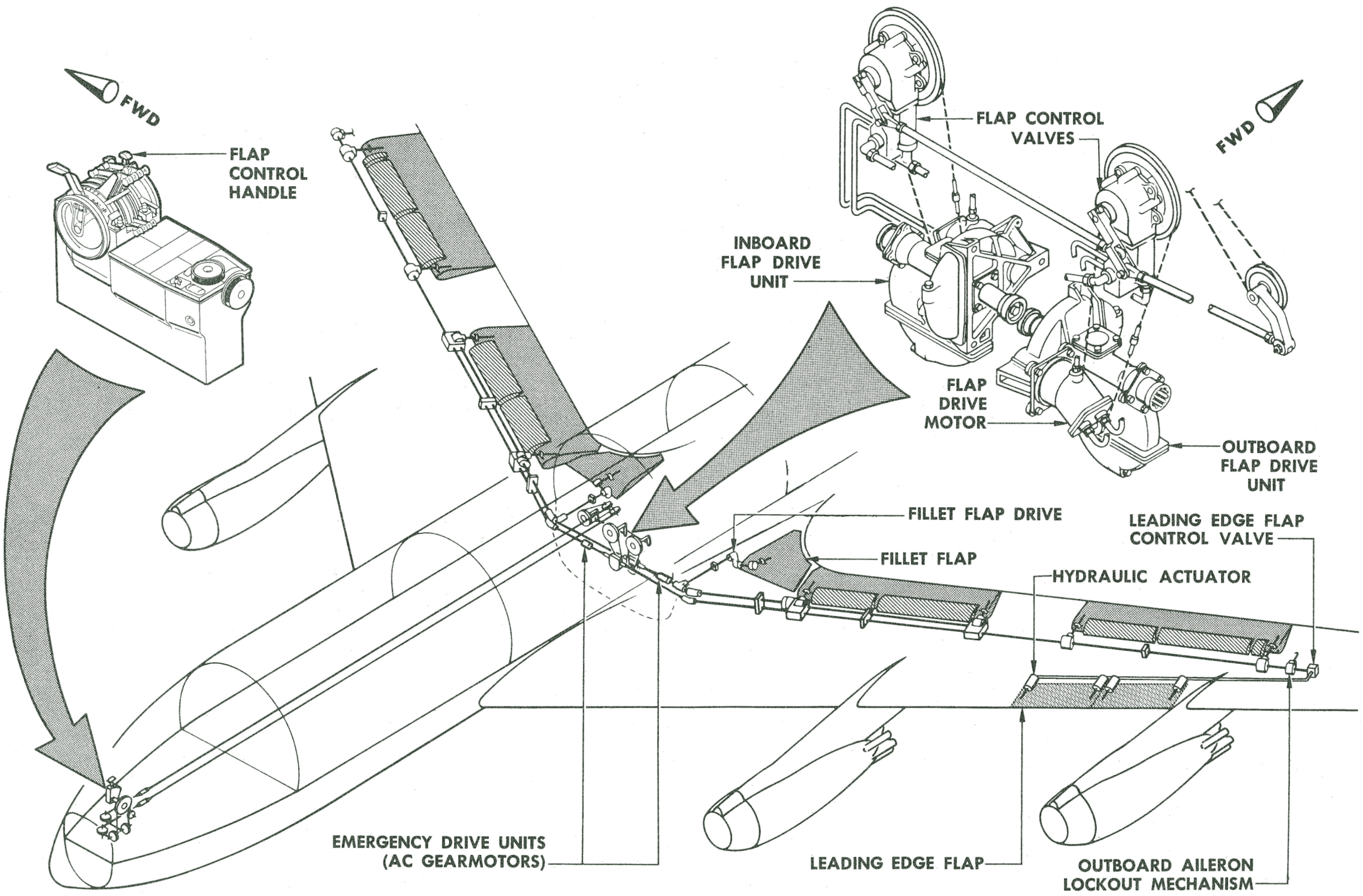
In the event of complete hydraulic failure, operation of the flap systems can be accomplished by electric motors geared to the flap drive system and controlled by switches mounted on the overhead panel.

Since the flaps are paired right and left wings, a failure of one drive would not fail all flaps on one wing. Only half of the flaps on one wing would fail. In the event of flap failure where asymmetrical flaps result, the operating flaps can be controlled to even up the flap positions. Using the emergency electric motor drive, the flaps can be positioned to have the failed flap and its mate paired at the failed down position. The operating pair of flaps can be driven up or down together.

Dual flap position indicators are provided on the main instrument panel. One instrument indicates the position of each outboard flap and another the position of each inboard flap.

In addition to the foregoing, hinged leading edge flaps are installed on both wings forward of the front spar and inboard of #1 and #4 engines for the purpose of increasing rate of climb at low air speeds. Their hydraulic actuation is coordinated with that of the main flaps. As the main flaps are lowered approximately 9.5 degrees the outboard aileron lockout mechanism positions the leading edge flap control valve for extension. They remain fully extended throughout the operating range of the main flaps until the 6 degrees from full "up" position is reached. At this time the control valve is repositioned for retraction.

Two lights on the main instrument panel illuminate when the leading edge flaps are fully extended.



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WING FLAP CONTROL SYSTEM

LATERAL CONTROL

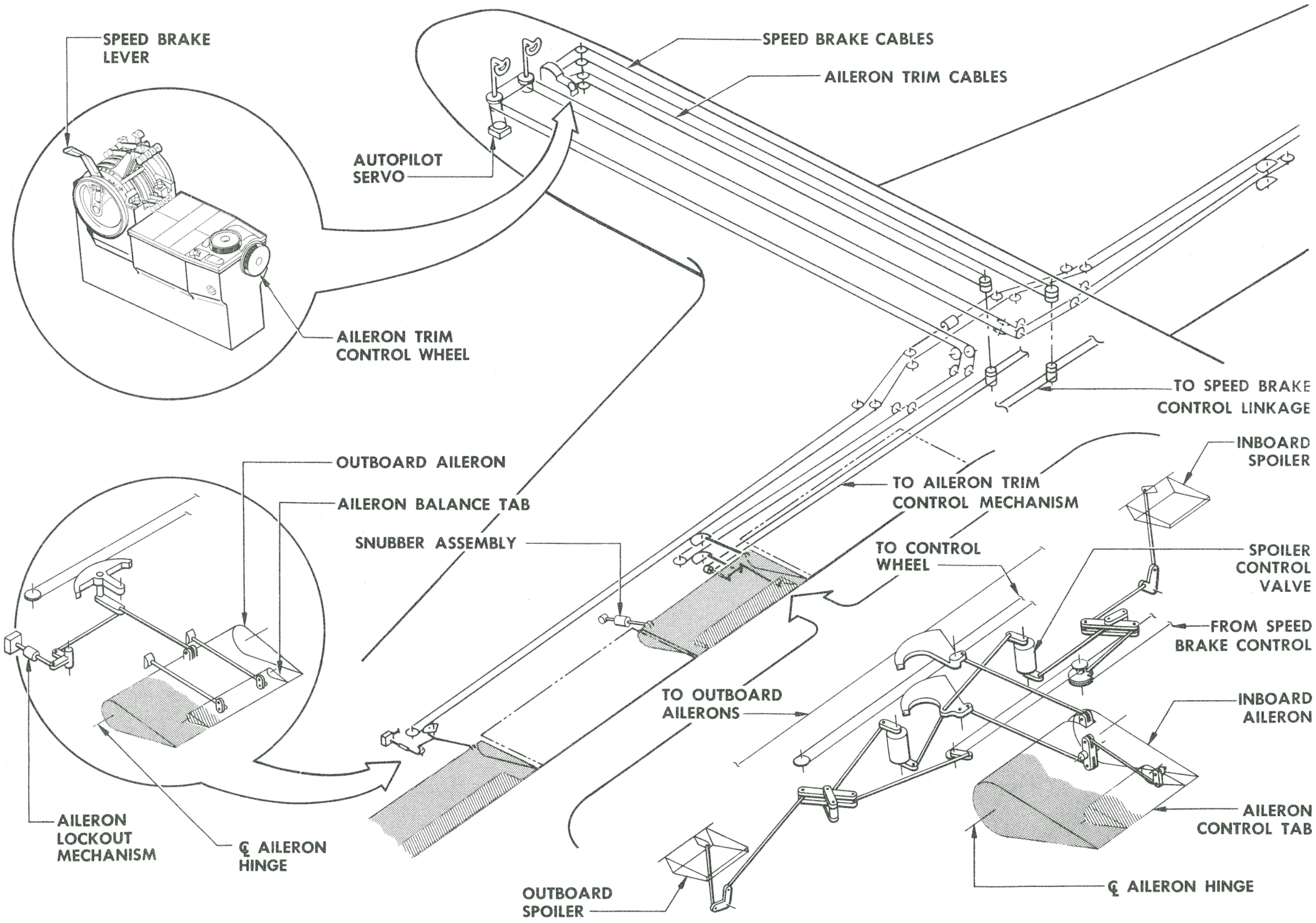
Lateral control is provided by inboard and outboard ailerons and spoilers. The outboard ailerons function only at low speeds and are automatically locked in neutral when the wing flaps are retracted. When the flaps are extended, the outboard ailerons are operated directly by a cable system from the inboard ailerons. The inboard ailerons are operated through control tabs which are actuated by the control column wheels.

Both control column wheels are interconnected so that any movement of one will cause a corresponding movement in the other. The aileron trim wheel on the control stand is used for lateral trim by moving the inboard aileron tab control rod forward or aft resulting in a repositioning of the control tab with respect to the wing chord line.

The spoilers are operated by hydraulic actuators controlled by valves which are linked to the inboard aileron control quadrant. Upward deflection of one inboard aileron results in a proportionate raising of the spoiler segments on that wing. On the other wing where the inboard ailerons have a downward deflection, the spoiler segments stay down or move downward if the spoilers are up. A mechanical follow-up system proportions the amount of spoiler movement. The inboard spoiler segments derive their hydraulic power from the Auxiliary Hydraulic System and the outboard spoiler segments derive their hydraulic power from the Utility Hydraulic System. The spoiler actuators are designed so that aerodynamic forces will limit spoiler movement at high air speeds.

Use of the spoilers for speed brakes is accomplished by the actuation of a handle on the control stand. This handle is connected to a cable system, which displaces the spoiler hydraulic control valve, thus raising all spoilers for speed brake operation. When the spoilers are all raised for aerodynamic braking, the aileron control system will continue to act to raise and lower the appropriate spoilers.

The aileron autopilot servo is connected to the aileron control system in the control column area.



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AILERON AND SPOILER CONTROL SYSTEMS

DIRECTIONAL CONTROL

An aerodynamically balanced rudder, equipped with control, antibalance and trim tabs, is used for directional control.

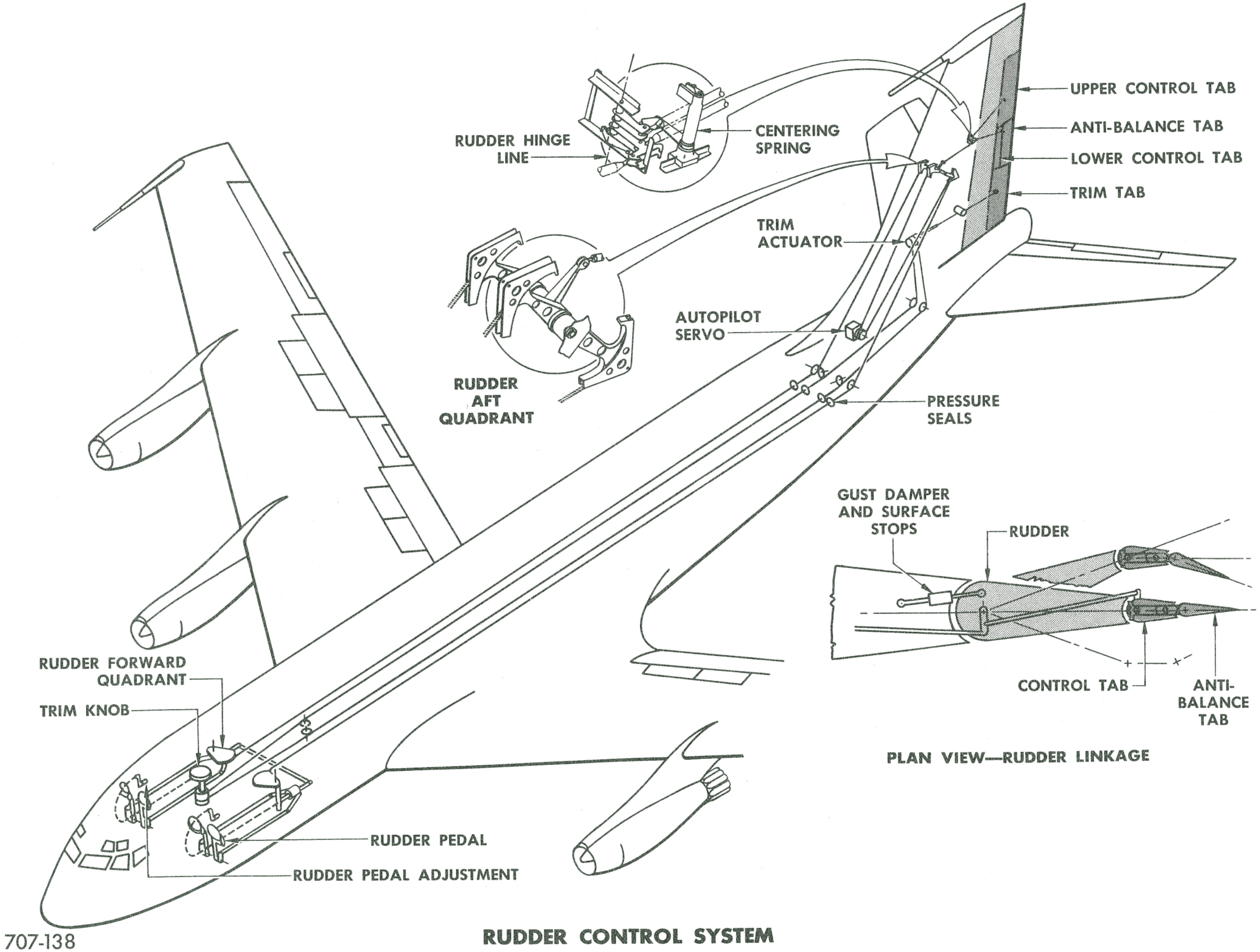
The rudder control tab installation consists of an upper and lower section. The lower section is fitted with an antibalance tab designed to increase control tab hinge moment at extreme tab deflections.

The rudder control system is actuated by the pilot's or copilot's rudder pedals which, through tension rods and bell cranks, operate a cable system extending aft to a rudder quadrant located in the fin. A push-pull rod system extends from the quadrant through cranks in the fin, and through a preload torsion bar mechanism in the rudder at the rudder hinge line, to the rudder control tabs.

Rudder trim is accomplished by a trim tab operated through a cable system from the control stand.

The pilot and copilot each have a conveniently located rudder pedal adjustment knob for adjusting rudder pedal position with regard to leg reach.

The rudder autopilot servo is connected to the aft quadrant in the empennage.



RUDDER CONTROL SYSTEM

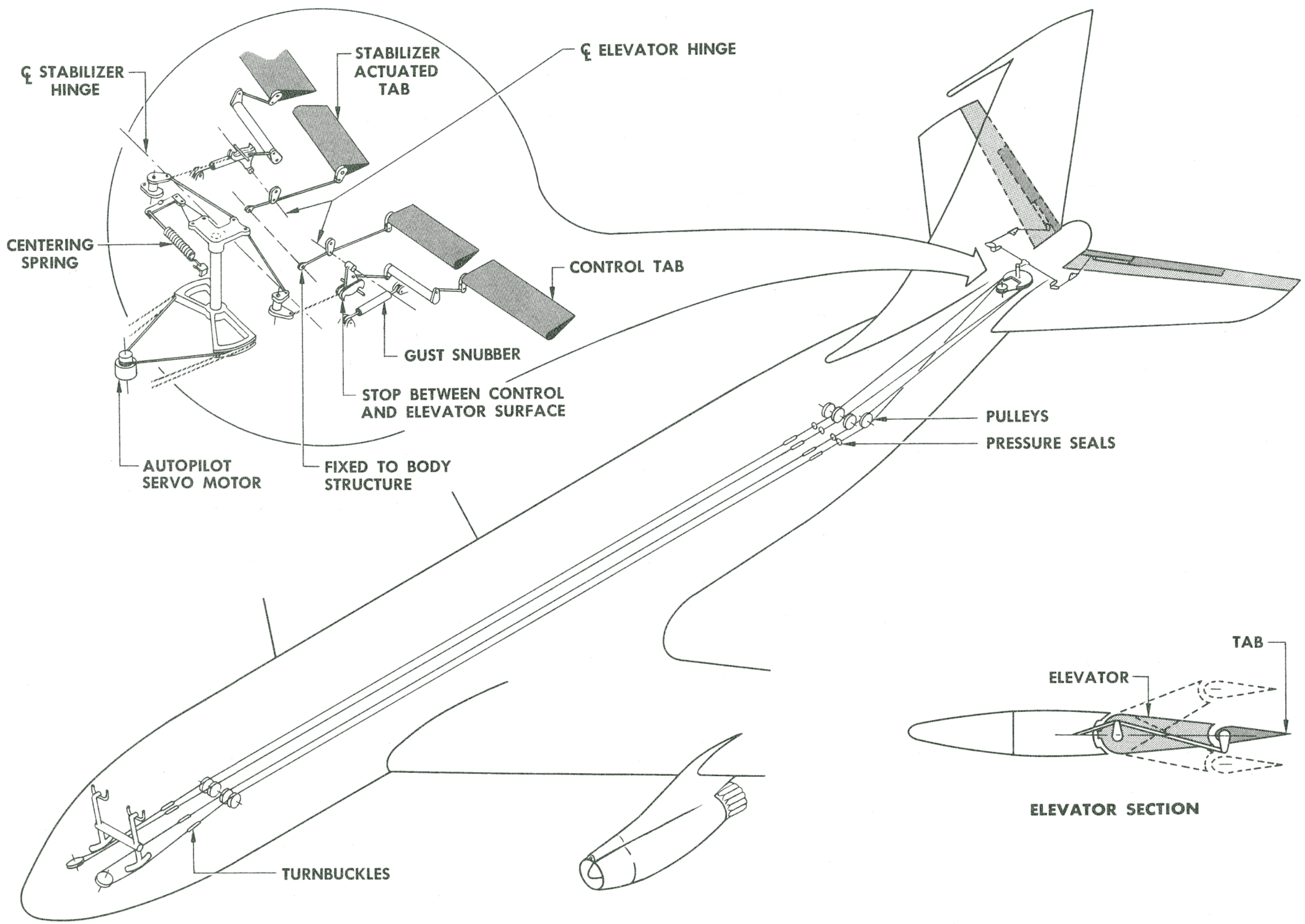
PITCH CONTROL

The elevators extend the full span of the stabilizer from the sides of the body to the stabilizer tips, but are not structurally interconnected. An internally sealed aerodynamic balance is incorporated. The elevators are positioned by means of control tabs manually operated by dual cable systems connected to the control columns.

The cable systems terminate at a cable quadrant in the tail section of the body. A system of torque tubes, cranks and push-pull linkages connect the quadrant to each elevator control tab. A centering spring acting on the quadrant torque tube returns the control tabs and system to a neutral position.

A tab on the inboard trailing edge of each elevator is actuated by the stabilizer when the stabilizer trim position is being changed. These tabs provide the necessary force to center the elevator to the changed reference chord of the trimmed stabilizer.

The elevator autopilot servo is connected to the aft quadrant in the empennage.



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ELEVATOR CONTROL SYSTEM

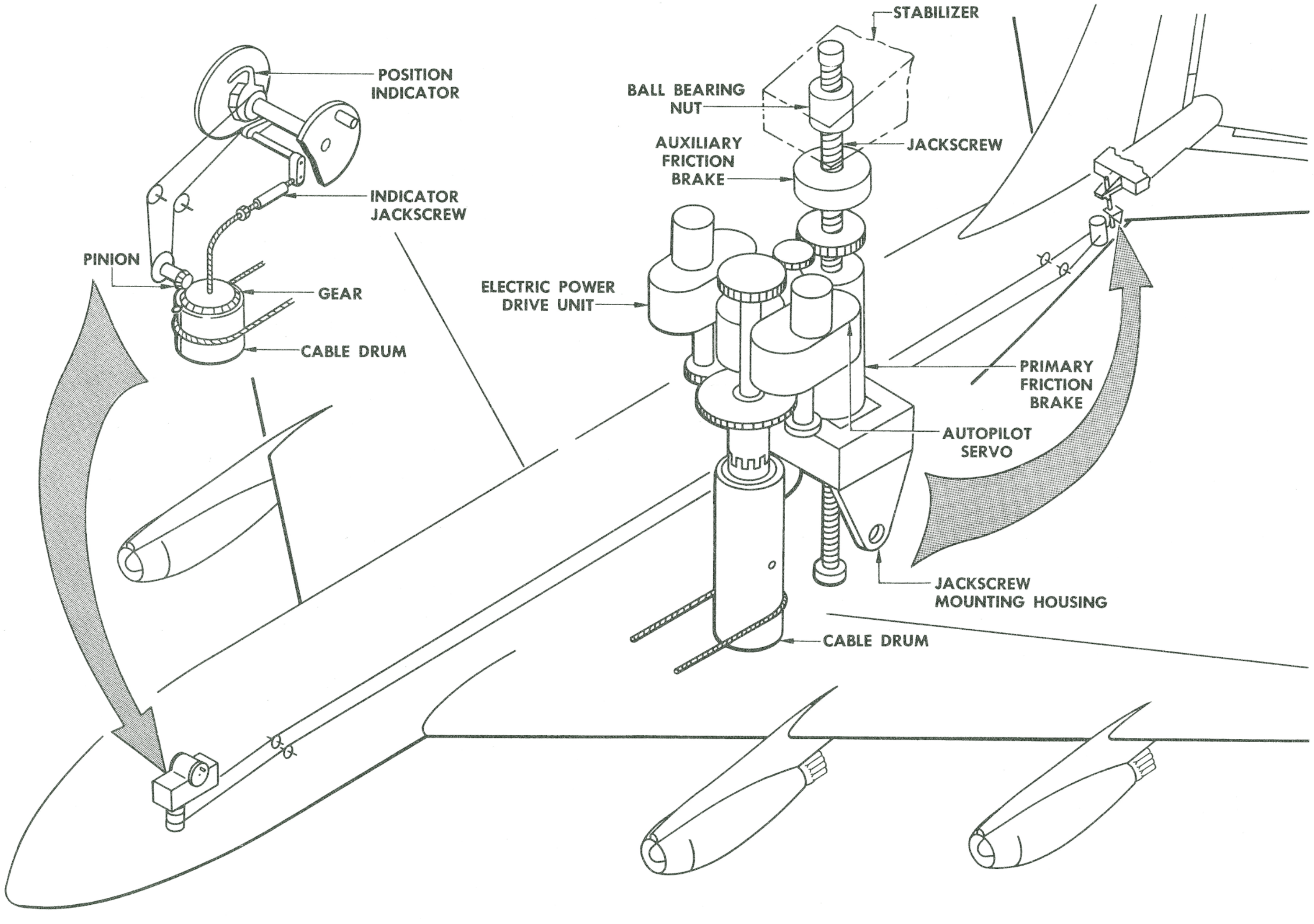
STABILIZER TRIM

An adjustable stabilizer is employed for airplane pitch trim. The stabilizer angle is adjusted by action of an electric motor, a manually operated cable system or an autopilot servo which drives a multiple race ball bearing jack screw mechanism attached to the stabilizer.

For normal trim operation, electrical control circuits are energized by a switch on either the pilot's or copilot's control wheel. One circuit energizes a single direction electrical alternating current motor. At the same time, one of two circuits energize a clutch which moves the stabilizer nose up or down from the single direction motor.

A cable system for manual operation extends from the pilot's control stand to the jack screw actuator at the stabilizer. This cable system operates a stabilizer trim position indicator on the control stand.

The stabilizer trim autopilot servo is connected to the jack screw mechanism.



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STABILIZER TRIM CONTROL SYSTEM

Electronic equipment for communication, navigation and automatic flight controls are listed below by location. Antenna installations are shown in the diagram on the opposite page.

MAIN INSTRUMENT PANEL (including radar panel)
- Autopilot Trim Indicator and Disengagement Light, and Glideslope "Engage" Indicator.
- Marker Beacon Receiver Controls and Indicator Light
- Weather Radar Controls and Scope Indicator
- ATC Radar Beacon Controls
- HF Communications No. 1 and No. 2 System Controls
- Audio Selector Panel (2)
- Selcal No. 1 and No. 2 System Controls

CONTROL STAND
- VOR Navigation No. 1 and No. 2 System Controls (with associated control of glide slope receivers)
- VHF Communications No. 1 and No. 2 System Controls.
- Autopilot Flight Controller Panel
- DMF Navigation System Controls
- ADF No. 1 and No. 2 System Controls
- Pilot's Overhead Panel
- Doppler No. 1 and No. 2

NAVIGATION PANEL
- Loran Receiver-Indicator
- Audio Selector Panel (Observers)
- Radar Altimeter Indicator
- ADF Control Panel

LEFT AND RIGHT RADIO RACKS
- Marker Beacon Receiver
- Glide Slope Receiver (2)
- ADF Receiver (2)

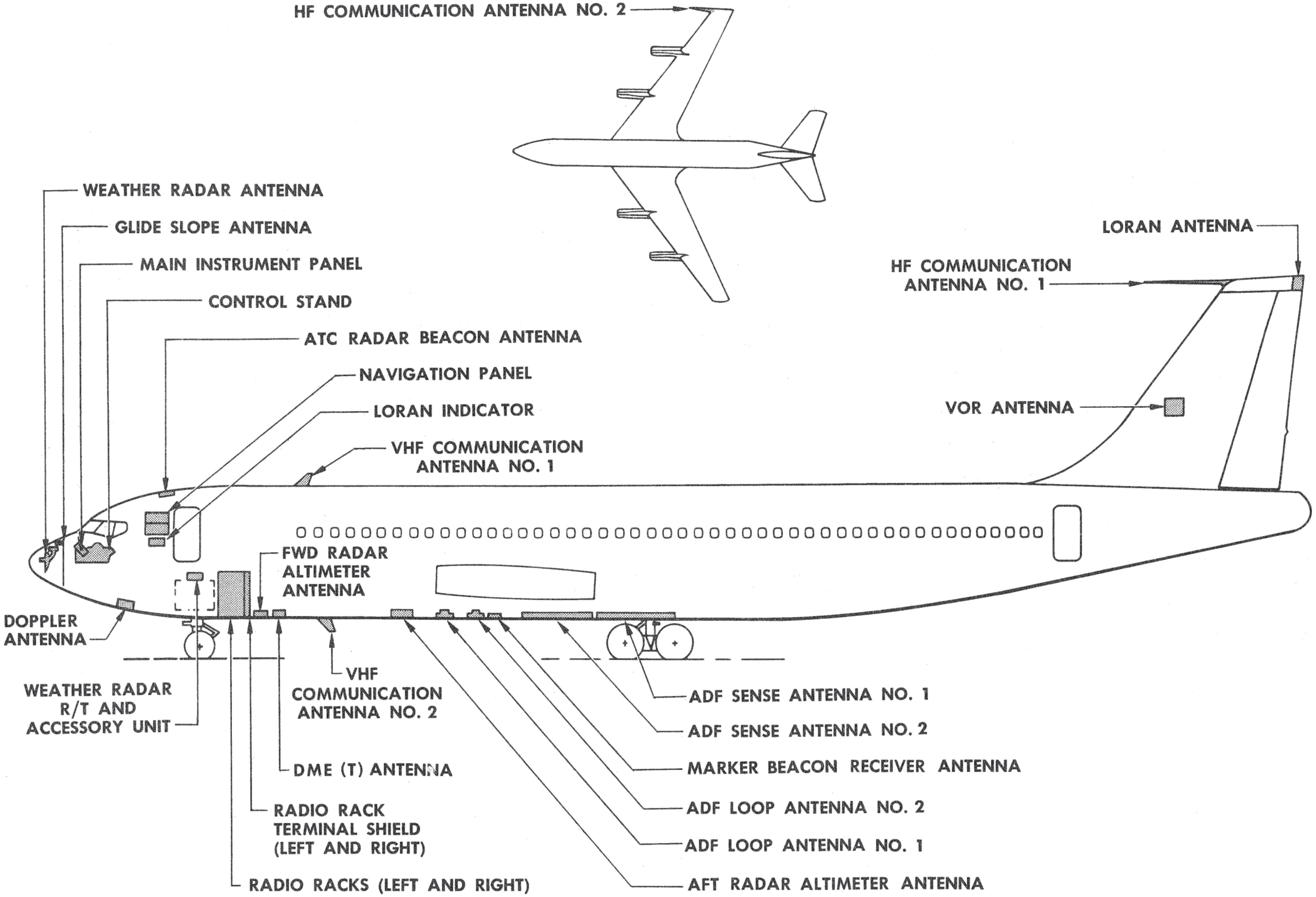
LEFT AND RIGHT RADIO RACKS (Continued)
- Integrated Instrument System Computer
- Integrated Instrument System Amplifier (2)
- Service Interphone Amplifier
- Passenger Address Amplifier
- Autopilot Units
- VOR Receiver (2)
- VOR Accessory Unit
- ATC Radar Beacon Transmitter-Receiver
- VHF Communications Receiver (2)
- VHF Communications Transmitter (2)
- HF Communications Receiver (2)
- HF Communications Transmitter (2)
- HF Communications Power Unit (2)
- Radar Altimeter Transceiver
- DMET Transmitter Receiver
- ATR Long Range Doppler (4)

Weather radar receiver-transmitter and accessory units are mounted on top of the nose wheel well. Space provisions have been made in the radio racks and pilots' overhead panel for future navigation radar equipment.

Interphone headphone and microphone jack outlets are furnished at the following stations.

+*Pilot	Nose Wheel Well	(1)
+*Copilot	Nacelle	(4)
Flight Engineer	Body Tail Cone	(2)
*Navigation	Fueling Stations	(2)
Cabin Attendant (2)	Main Wheel Well	(2)
*Radio Rack	Observer (Headset)	

Legend
- *Selector Panel
- +PA Systems Connection thru Selector Panel



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ELECTRONIC EQUIPMENT LOCATIONS

Location of doors and service accesses allows simultaneous coordination of passenger loading and ground servicing operations. Passengers enplane and deplane at forward and aft doors on the left side. Cargo loading, galley service and miscellaneous servicing functions are primarily accomplished on the right side.

Illumination is provided for the passenger loading ramps, cargo handling areas, galley service platform areas and wheel wells. Wing illumination lights, installed in the side of the body, aid ground servicing of the airplane by flood lighting the wing leading edges and nacelles.

Two fueling adapters are located between nacelles on the lower surface of each wing for the pressure fueling system.

A two way call buzzer and interphone system is provided in the cockpit and the nose wheel well area. Numerous other interphone stations are described on page 52.

Two side cowl panels with quick disconnect latches swing up for access to the engine compartment.

An air bottle for combustor starter operation is installed in the right trailing edge wing-body fairing. The air storage system is automatically recharged by a hydraulically operated air compressor. It may also be charged through a ground service air connection.

The engine water injection system tank is serviced at a filler opening with access outside the body near the right wing trailing edge. Water level is indicated by a sight gauge on the tank and a remote indicator in the control cabin.

The hydraulic fluid supply tank with sight gauge is installed in the left main wheel well area.

An external AC power receptacle located forward of the nose gear door, connects to the generator synchronizing bus.

Accesses to radio rack, certain antenna equipment, heater and air conditioning units, are located under the body.

Miscellaneous maintenance and inspection openings are provided in the airplane structure. Metal name plates are permanently installed at these accesses as required to indicate types of fluid, pressures, and volumes for servicing the airplane.

The airplane structure may be jacked at three main jack points and three auxiliary or stabilizing jack points. Jacking provisions are also included on each landing gear axle.

A towing attachment collar for towing or pushing is installed on the nose gear. The main gear has fittings on each axle of the landing gear truck for cable towing.

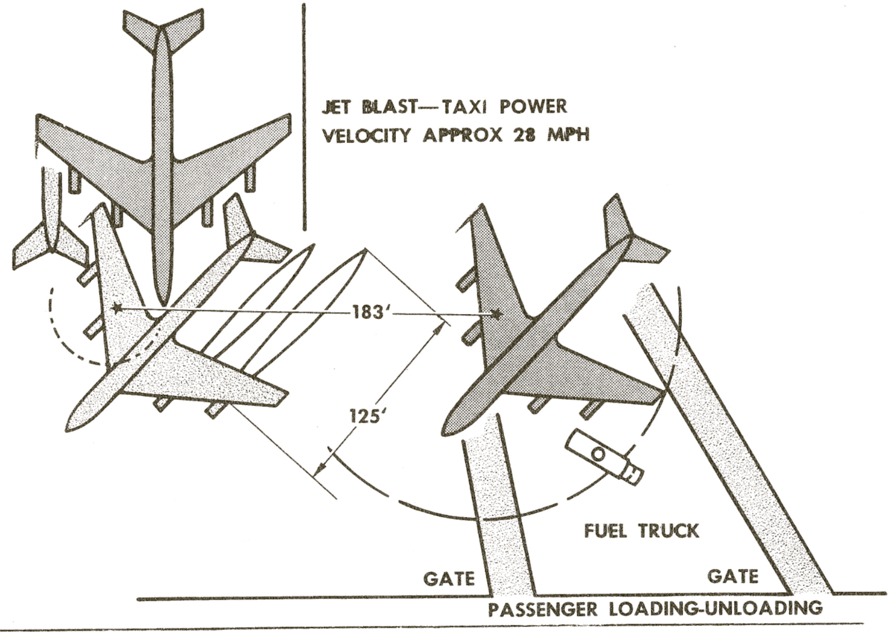
CANTED PARKING NOSE IN

ADVANTAGES:

1 NO STARTING BLAST TO AFT AIRPLANES

2 PASSENGER LOADING FROM ONE GATE IF DESIRED

3 ADEQUATE AREA FOR REFUELING WITHOUT PASSENGER LOADING CONGESTION

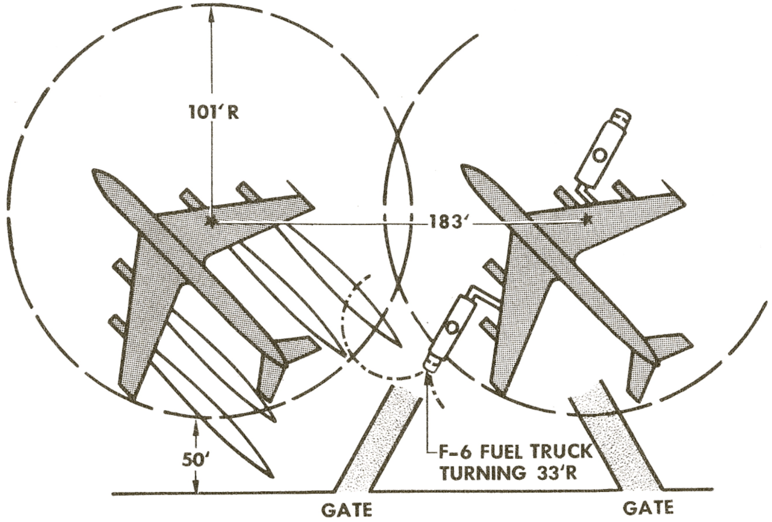


CANTED PARKING NOSE OUT

ADVANTAGES:

1 RAPID DEPARTURE

2 TAXI BLAST CONFINED TO RAMP AREA OF DEPARTING AIRPLANE ONLY



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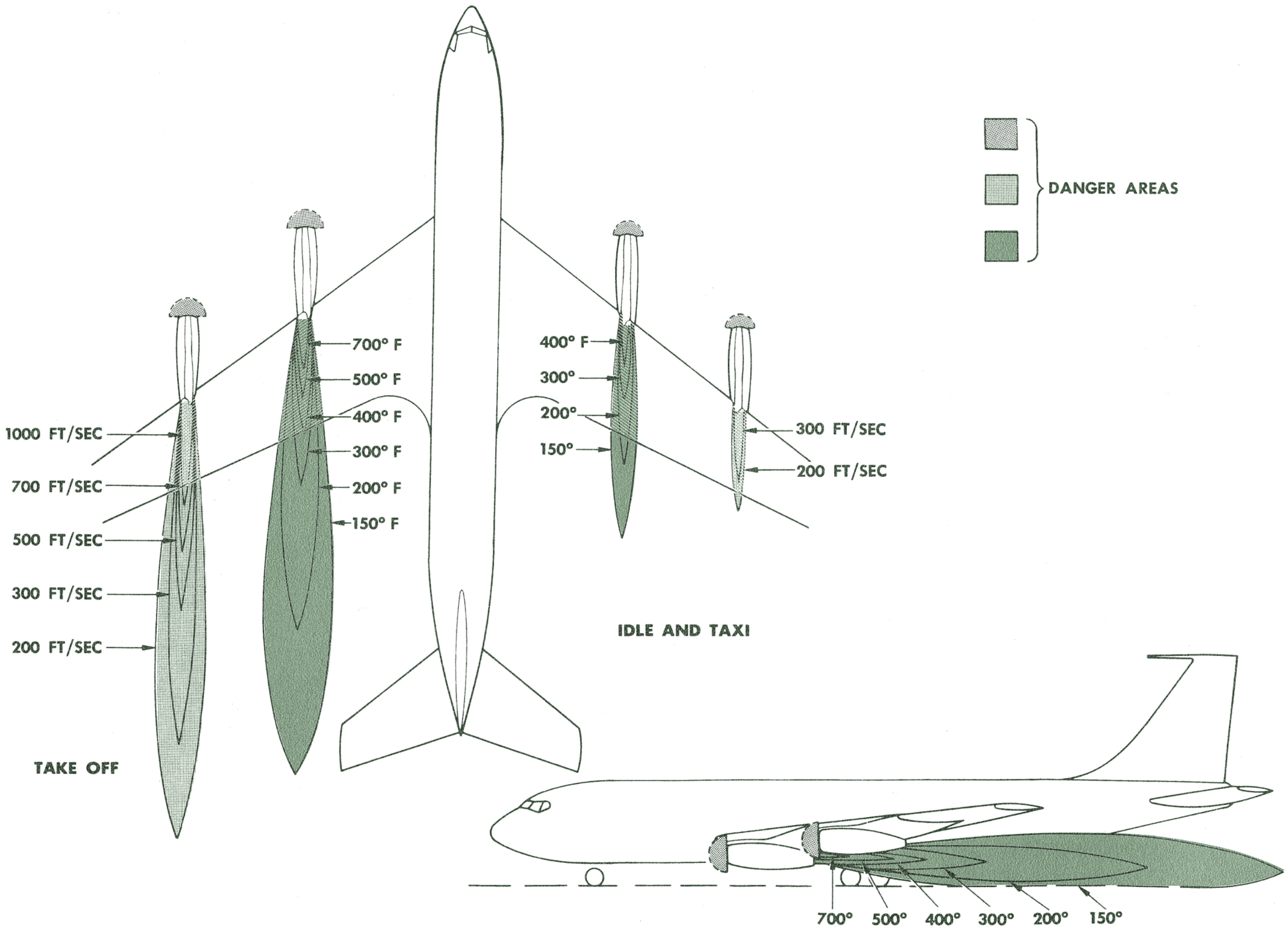
TYPICAL PARKING



ENGINE RUN GROUND CLEARANCE

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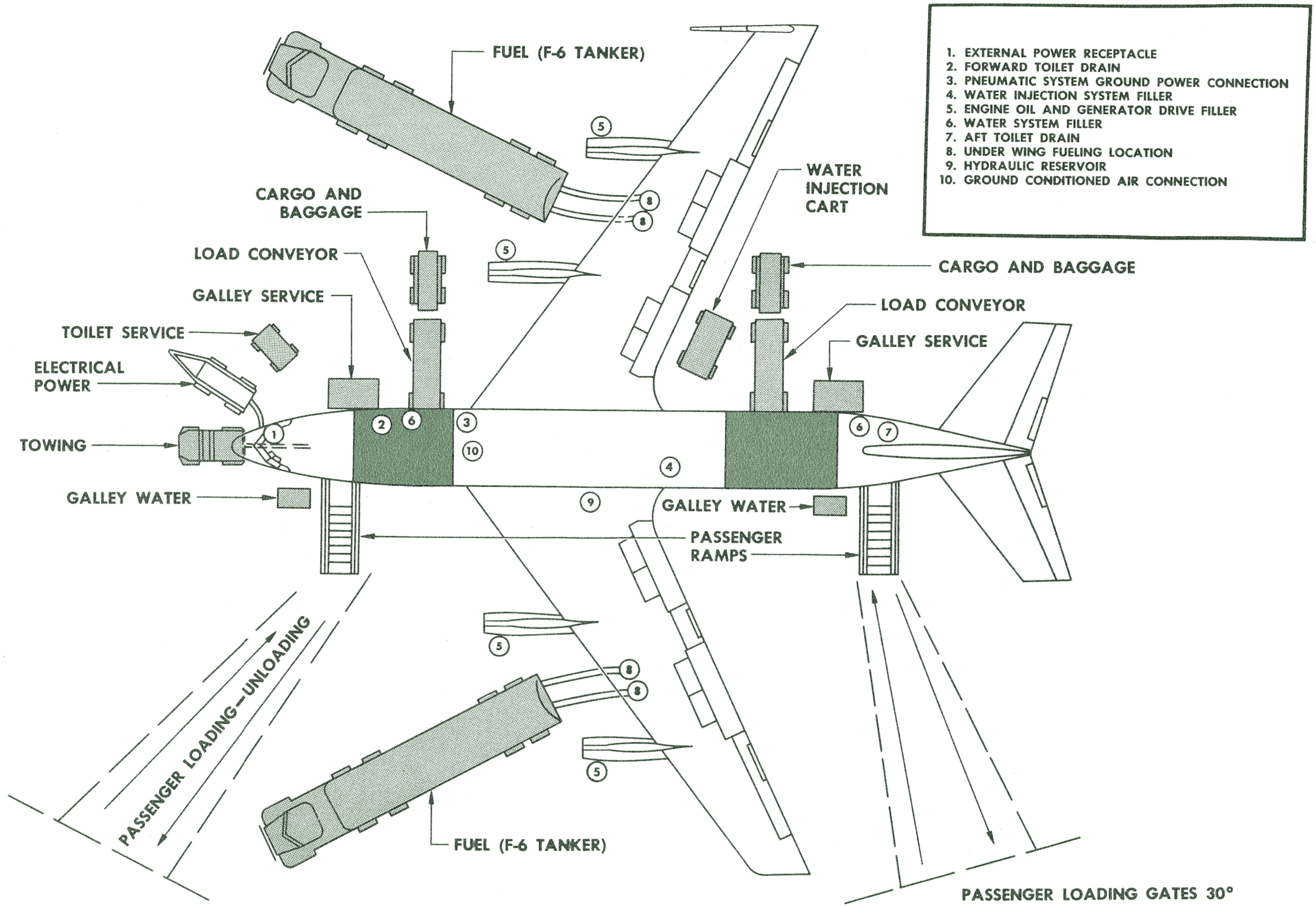

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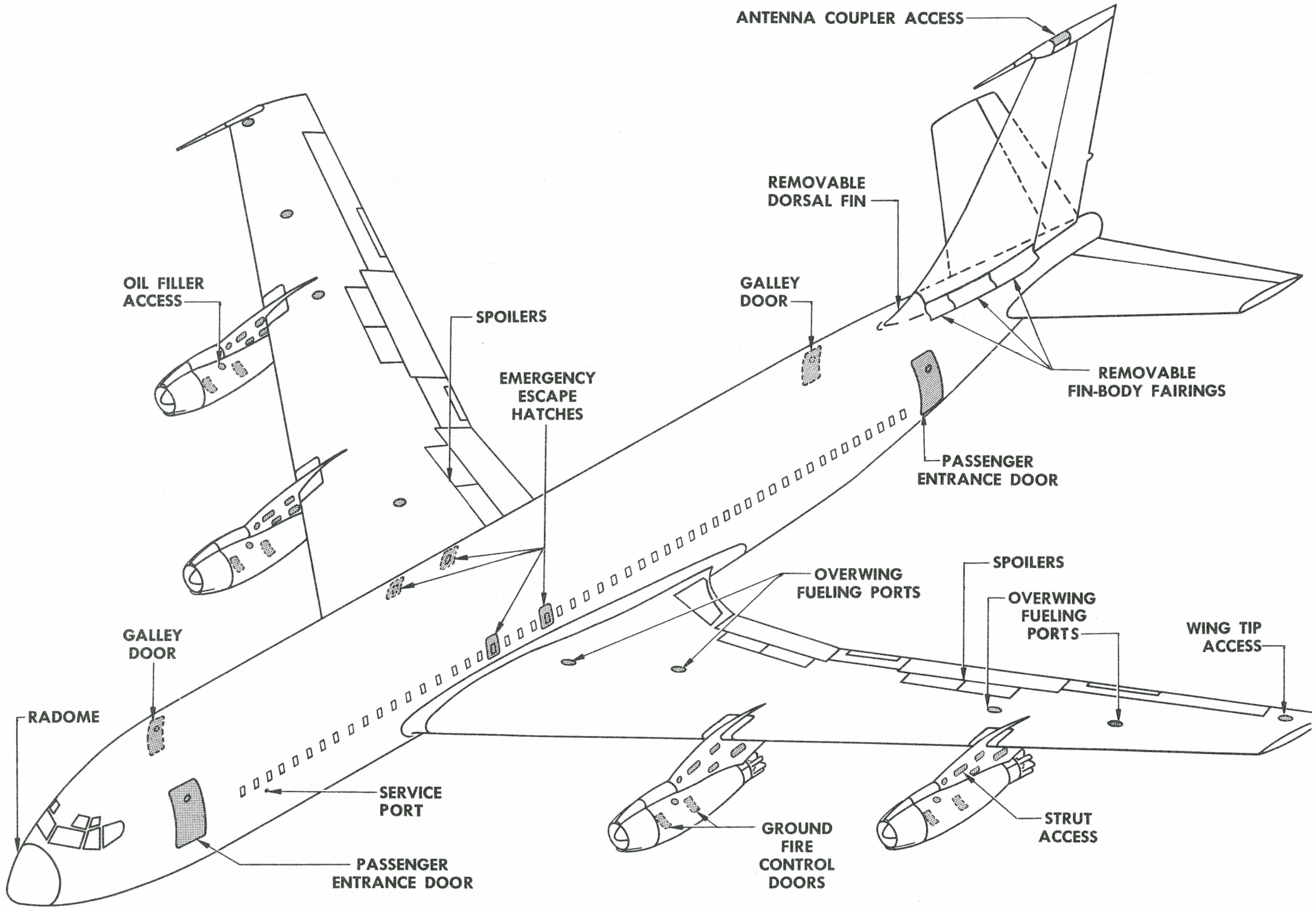
TYPICAL TERMINAL SERVICING ARRANGEMENT

Access doors and hatches are arranged to provide maximum safety and ease of maintenance. Walkway areas are marked on the wings, stabilizer and vertical fin.

The two main entry doors are located on the left side of the body and are of the inward-outward opening plug type. This type of door does not require direct preflight visual inspection of the locking mechanism. The door openings are 34 inches wide and 72 inches high. Galley service and cargo loading doors are on the right side. The two galley service doors, also of the inward-outward opening plug type, are 24 inches wide and 48 inches high. The cargo compartment doors are of the sliding plug type. The forward cargo compartment door is 48 inches wide and 50.5 inches high. The aft cargo compartment door is 48 inches wide and 49 inches high. Four over-wing emergency exit hatches, 20 inches wide and 38 inches high, open inwardly from either inside or outside of the airplane. Main entry, galley service, and cargo doors are held in the open position by stops and catches. Warning lights on the main instrument panel are illuminated when the main entry, galley service or cargo doors are not closed and locked.

Access panels are installed on all cargo doors to permit mechanical withdrawal of the latch pins in the event of a latch mechanism malfunction.



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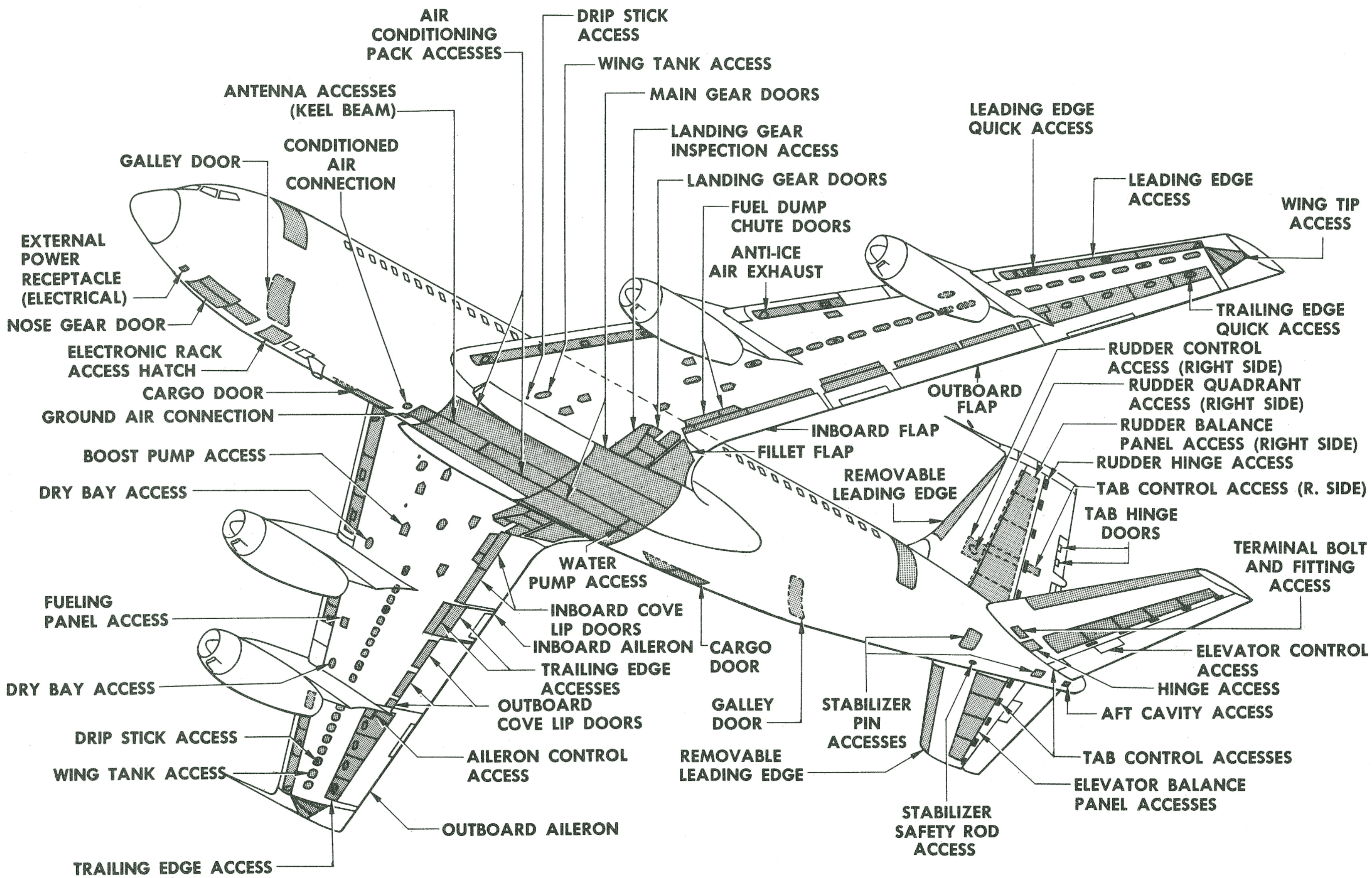
ACCESS DOORS AND INSPECTION OPENINGS—TOP VIEW

ACCESS DOORS AND INSPECTION OPENINGS

The doors and inspection panels, which are removed during normal maintenance are numbered as to location. The numbering system includes 100 through 700. The 100-199 series covers the fuselage, 250 through 399 lower wing, 400 through 499 upper wing, 500 through 599 vertical fin, 600 through 699 stabilizer and 700 through 799 nacelles. Production station numbers are marked on all body frames to facilitate maintenance.

A pull cable system is installed for opening the nose and main wheel doors from the ground. A ground safety lock is used to prevent inadvertent closing of the door. The main gear doors are usable as work stands when open.

The integral fuel tanks are completely accessible through openings in the lower wing surface and through crawlways located in the wing ribs. All sealed internal joints are readily available for inspection and resealing when required. Fuel cell cavities in the wing center section are accessible through two openings in the lower surface and crawlways through the spar wise beams.



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ACCESS DOORS AND INSPECTION OPENINGS—BOTTOM VIEW

All performance data unless otherwise specified are based on standard atmospheric and no wind conditions. Fuel consumption is that of the Pratt and Whitney JT3C Series turbojet engines and shown in units of Imperial gallons.

WEIGHTS

Maximum design gross weight for taxi	= 248,000 lb.
Maximum take-off weight	= 247,000 lb.
Maximum landing weight	= 175,000 lb.
Maximum allowable weight without fuel	= 160,000 lb.
Approximate Qantas operating weight empty	= 118,000 lb.
Approximate empty weight	= 110,600 lb.

SPEEDS AND ALTITUDES

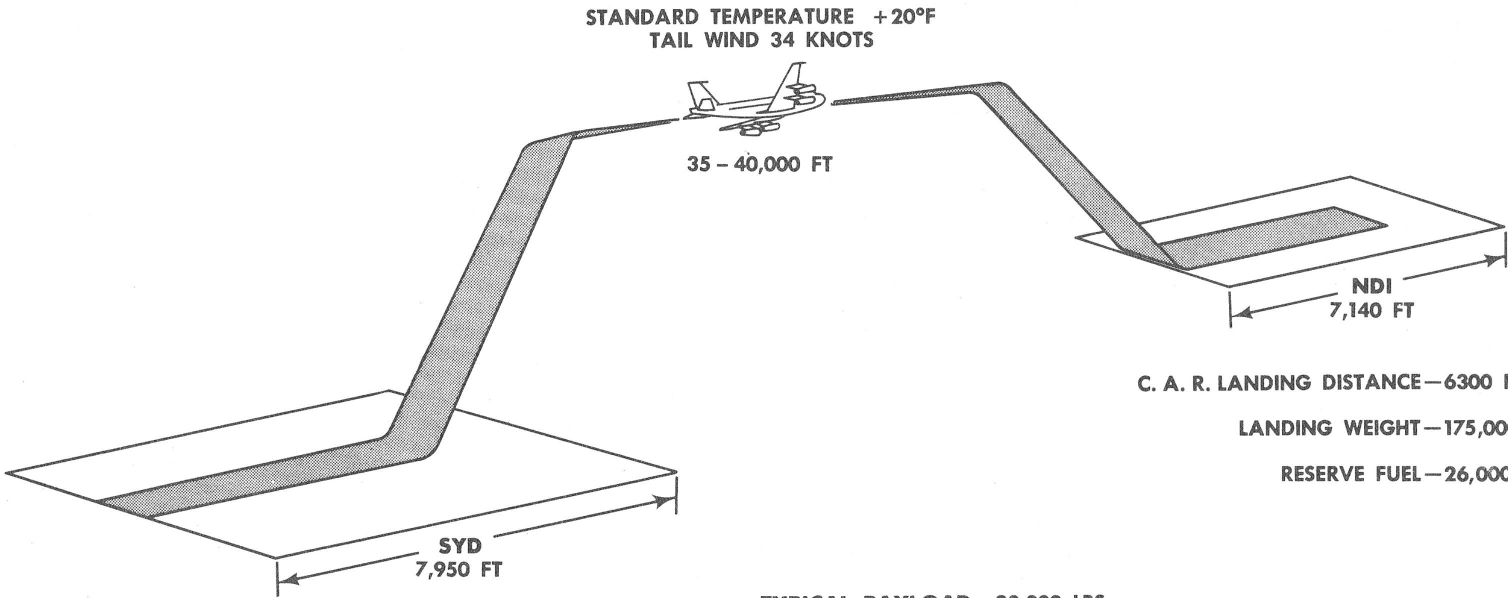
Average long range cruise speed = 454 Kt. TAS
Average long range cruise altitude = 38,000 Ft.
Maximum (never exceed) speed, V_{NE} = 383 Kt., EAS M_{NE} = .895 (C.G. aft of 17% M.A.C.)
Maximum (normal operating) speed, V_{NO} = 340 Kt. EAS @ S.L., V_{NO} = 360 Kt. EAS @ 24,200 Ft., M_{NO} = .88 (C.G. aft of 17% M.A.C.)
Maximum landing gear speed (gear down, wheel doors up) = 320 Kt. EAS, M = .83.
Maximum speed brake speed = NO LIMITATIONS
Speed brake angle decreases due to increasing air loads as speed increases.
Maximum flap extend speeds
Flap position 10° = 230 Kt. EAS
Flap position 20° = 220 Kt. EAS
Flap position 30° = 210 Kt. EAS
Flap position 50° = 185 Kt. EAS

TAKE-OFF (Sea Level)

At maximum take-off weight
Take-off distance, 4 engines = 6,850 Ft.
Balanced field length to 35 ft., 3 engines from V_1 = 9,050 Ft.
Approximately 124 Imperial gallons (1,000 lb.) of fuel will be required for engine check-out and taxi to take-off point.
The take-off fuel consumption = 5,900 G.P.H.
To maintain the take-off thrust at temperatures between 40° and 92°F, demineralized water is injected in the engine during the take-off, at 16,000 G.P.H. Sufficient water is carried to reach a height of 400 feet. Approximately 250 gallons are required.

CLIMB

There is a great difference in climb fuel flow between sea level and altitude, ranging almost linearly from 3360 G.P.H. at sea level to 1530 G.P.H. at 35,000 feet.



C. A. R. LANDING DISTANCE—6300 FT

LANDING WEIGHT—175,000 LBS

RESERVE FUEL—26,000 LBS

C. A. R. TAKEOFF FIELD LENGTH—7850 FT

TAKEOFF WEIGHT—224,700 LBS

TYPICAL PAYLOAD—28,000 LBS
80 PASSENGERS PLUS 10,200 LBS OF CARGO

DISTANCE—1720 N. M.

BLOCK TIME—4:03

AVERAGE CRUISE SPEED—470 KTS TAS

707-138 **TYPICAL FLIGHT PROFILE SYDNEY TO NADI**

CRUISE

Fuel consumption at maximum cruise thrust:
35, 000 feet altitude = 1, 495 G.P.H.
30, 000 feet altitude = 1, 735 G.P.H.
25, 000 feet altitude = 1, 820 G.P.H.

At typical gross weight, the best initial altitude for cruise mileage is 35, 000 feet, using less than maximum cruise thrust.

Temperature differences have a small effect on cruising efficiency since the engine specifics are constant over a large range of thrust settings. Also, humidity does not influence performance since it does not affect the thrust measurably.

HOLDING

At maximum landing weight, the maximum holding time would be obtained at approximately 32, 000 feet.

The fuel consumption for this condition is 1, 020 G.P.H. (8, 200 lb/hr). Fuel consumption increases at lower altitudes reaching 1105 G.P.H. (8, 900 lb/hr.) at 15, 000 feet.

An additional 223 gallons (1, 800 lbs.) would be required for a ten minute instrument approach and landing.

DESCENT

Approximately 149 gallons (1, 200 lbs.) are required for a descent from 40, 000 feet to sea level.

Time to descend from 40, 000 feet is 24 minutes.

Emergency descent from 40, 000 feet to 10, 000 feet can be made in 3.5 minutes.

TYPICAL FLIGHT PROFILE

Page 63 shows a typical medium range profile for the 707-138.

CENTER OF GRAVITY LIMITS

The C.G. limits (% of M.A.C.) of the airplane are as follows:

Aft Limit:

35 $\pm$ 1% M.A.C. up to 238, 000 lbs. gross weight.
27 $\pm$ 1% M.A.C. at 248, 000 lbs. gross weight.

A straight line variation of C.G. limits between 238, 000 and 248, 000 lbs. gross weight.

Forward Limit:

17 $\pm$ 1% M.A.C. up to 175, 000 lbs. gross weight.
14 $\pm$ 1% M.A.C. from 190, 000 to 248, 000 lbs. gross weight.

A straight line variation of C.G. limits between 175, 000 and 190, 000 lbs. gross weight.

The cargo and passenger accommodations are so arranged that with proper load distribution between the forward and aft cargo compartments, the C.G. position is within the limits allowed without the necessity of passenger seating assignment.