6.3.4. Electrical System

A pneumatic system was used as the primary power source in early models in the operation of all auxiliary functions. It took the high-pressured hot air bled from the second stage compressor in each jet engine, and was transformed into electrical energy using air turbine driven power packs. The original electrical system of the B-52 consisted of four air turbine-driven 60 KVA alternators furnishing 200/115 volt three-phase 400 cycle alternating current. Transformer rectifiers converted this to direct current for all the major electrical functions.

In later models, primary and secondary distribution buses supply power to the aircraft. Primary power is supplied by four engine-driven generators. This 205/118-volt three-phase a-c power is used for many heavy loads such as fuel boost pumps, and wing flap motors. Secondary power is 28-volt nominal unregulated dc supply by transformer-rectifier units fed from the 205-volt three-phase a-c power of the primary system.

Two nickel-cadmium batteries provide an auxiliary source of 24-volt DC power which is supplied to essential equipment in case the AC or TR system fails to function. The batteries also provide power directly to emergency equipment through forward and aft battery buses. Both AC and DC power is distributed throughout the aircraft by buses located in junction boxes, shields, an panels. Circuit breakers and fuses are installed to protect aircraft wiring. AC and DC power may be obtained for ground operation through external power receptacles.

AC power requirements are provided from the aircraft through circuit breakers located in an AGM-69A system through circuit breakers located in an AGM-69A power distribution box installed in the forward wheel well. The DC power requirements for AGM-69A are provided from four AGM-69A TR units installed in the forward wheel well with circuit breaker protection in the AGM-69A

6.3.4.1 AC Power System

The AC power system, shown in Figure 26 and Figure 27, consists of four engine-driven generators, a flight gyro emergency power inverter, power distribution boxes, a central bus tie, bus tie and generator circuit breakers, power load boxes, and circuit breaker panels. An AC control panel at the co-pilot's station provides all the controls and indicators for operation of the system. The gyro power switch on the pilot's side panel controls the flight gyro emergency power inverter.

The Primary AC power supply is provided through four engine-driven 120 KVA (kilovolts-Ampere) generators located underneath the engines. Each generator is capable of carrying 120 KVA at a reasonable power factor.

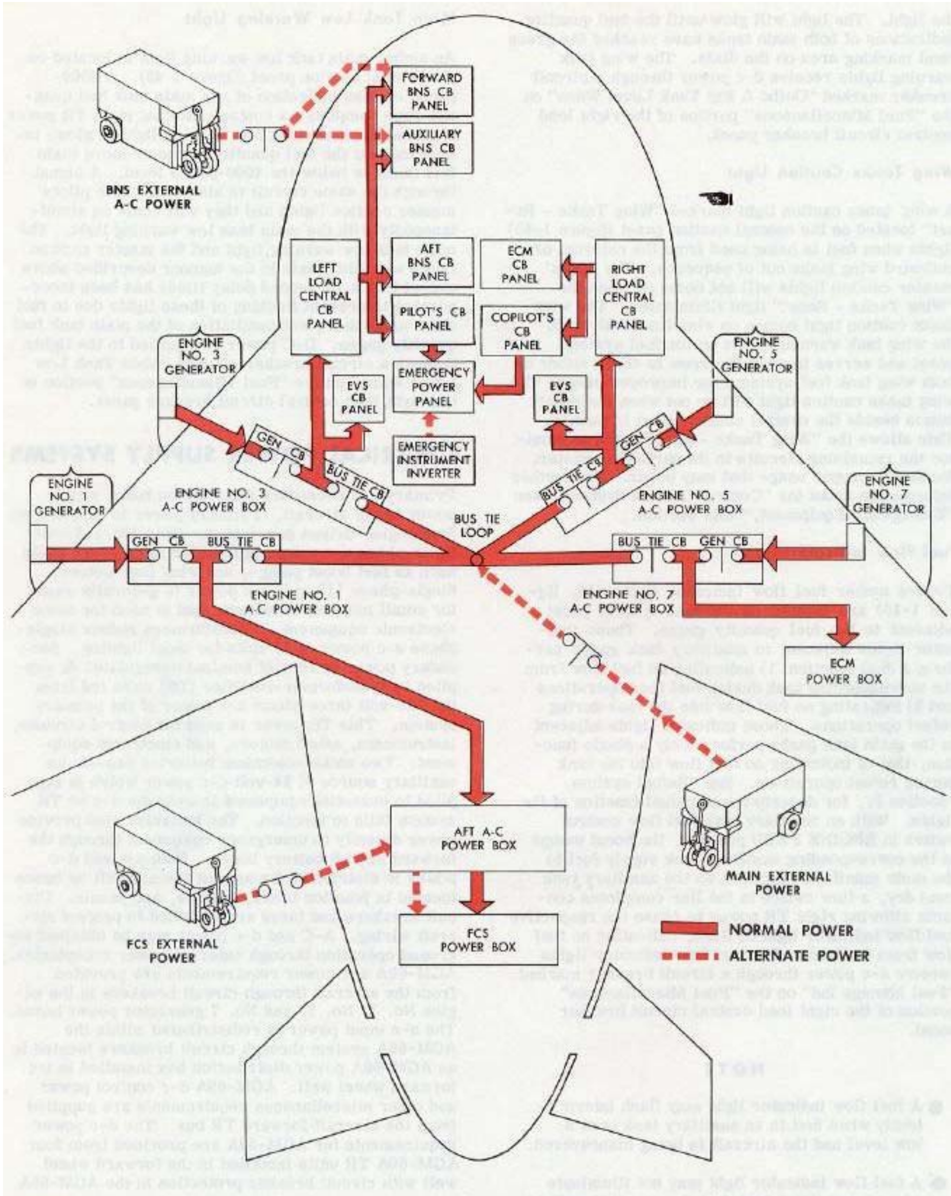


Figure 26. AC Electrical Power Routing, B-52H [27]

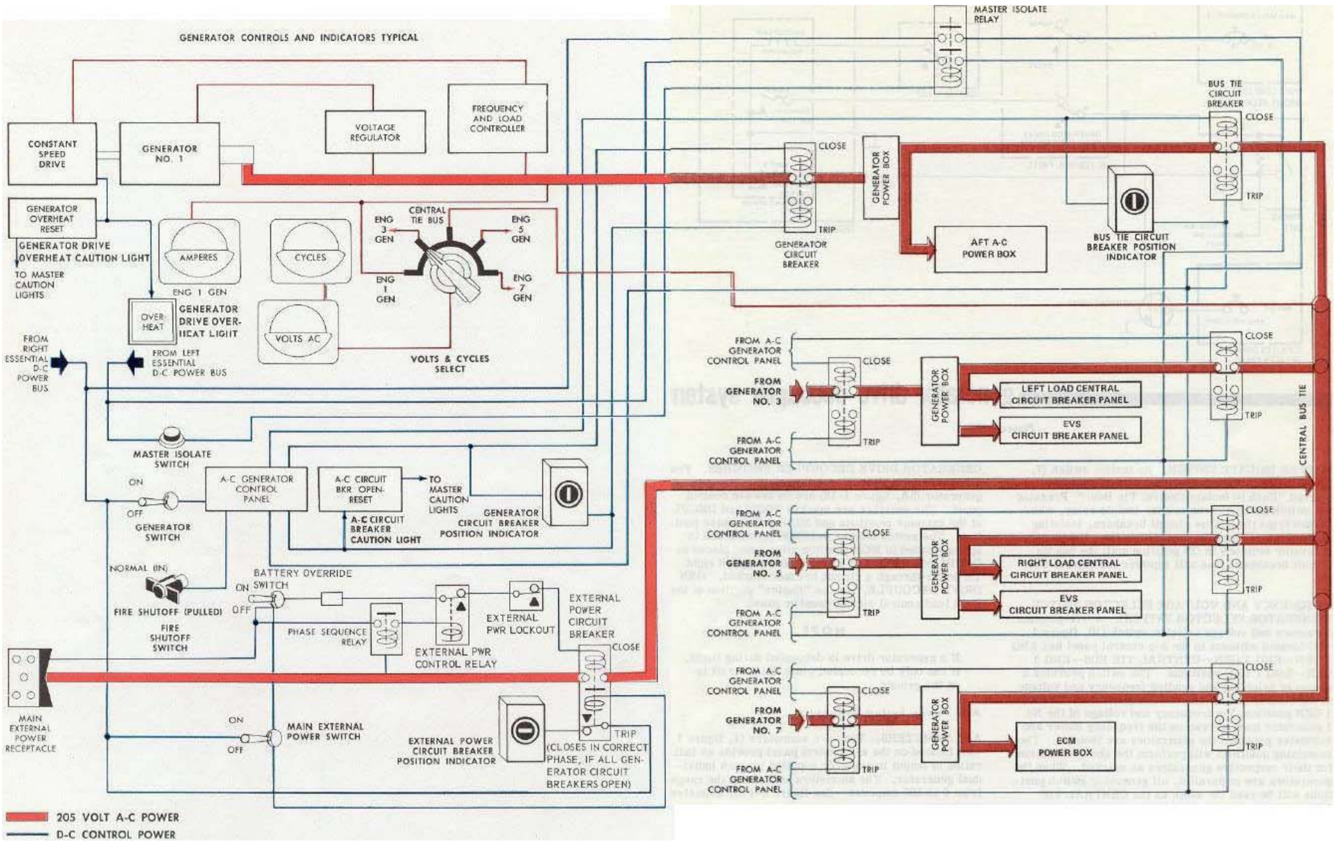


Figure 27. AC Power System, B-52H [27]

6.3.4.2 DC Power System

DC power is normally provided through transformer-rectifier (TR) units which are supplied AC power by the generators. Two 24-volt 22 ampere-hour nickel cadmium batteries are used as an auxiliary power source of DC power. DC power is supplied to various equipment from one of four sets of buses. The equipment will receive power from one of the buses according to the importance of the equipment. The two forward TR buses are inter-connected and will supply DC power as long as AC power is available. The DC power system is shown in Figure 28.

In the event of an AC power failure, DC power would not be supplied to the TR buses. The left essential and right essential buses normally received TR power but in the event of an AC system failure, these buses automatically transfer to battery power. These buses supply battery power to essential DC operated equipment which normally receives TR DC power. The aft battery bus and forward battery bus can supply direct battery power to emergency equipment. DC power is distributed and protected through boxes and panels located throughout the aircraft.

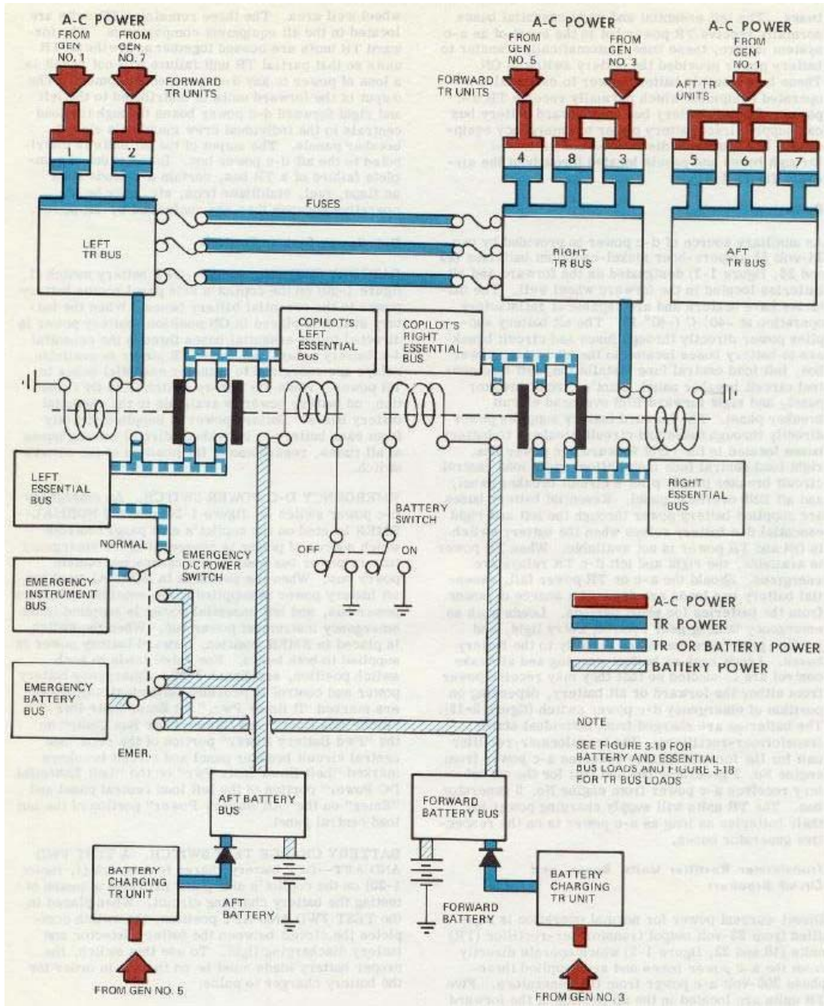


Figure 28. DC Power System, B-52H [27]

6.3.4.3 External Electrical Power System

Three external power receptacles are provided for energizing aircraft equipment from an external source: a main receptacle, a bombing systems receptacle, and a gunnery system receptacle. The main external power is routed to the central bus tie by means of an external power receptacle located on the right side of the fuselage adjacent to the forward wheel well.

External power for the bombing and navigation system (BNS) is routed to the BNS circuit breaker panels by means of a double receptacle located on the right side of the fuselage adjacent to the forward wheel well just aft of the main external power receptacle. External power for the fire control system (FCS) is routed to the aft AC power shield by means of double receptacle located aft and adjacent to the right rear wheel well.

6.3.5. Air Bleed System

The air bleed system, shown in Figure 29, incorporates a wing leading edge manifold and controls for collecting and routing high pressure hot air. This air may be obtained either from the final stage compressor of each operating engine or from an auxiliary air source applied to a ground start connection on the underside of each nacelle. The air bleed system is the power source for engine starting and the air source for heating, cooling, and pressurizing the crew compartment.

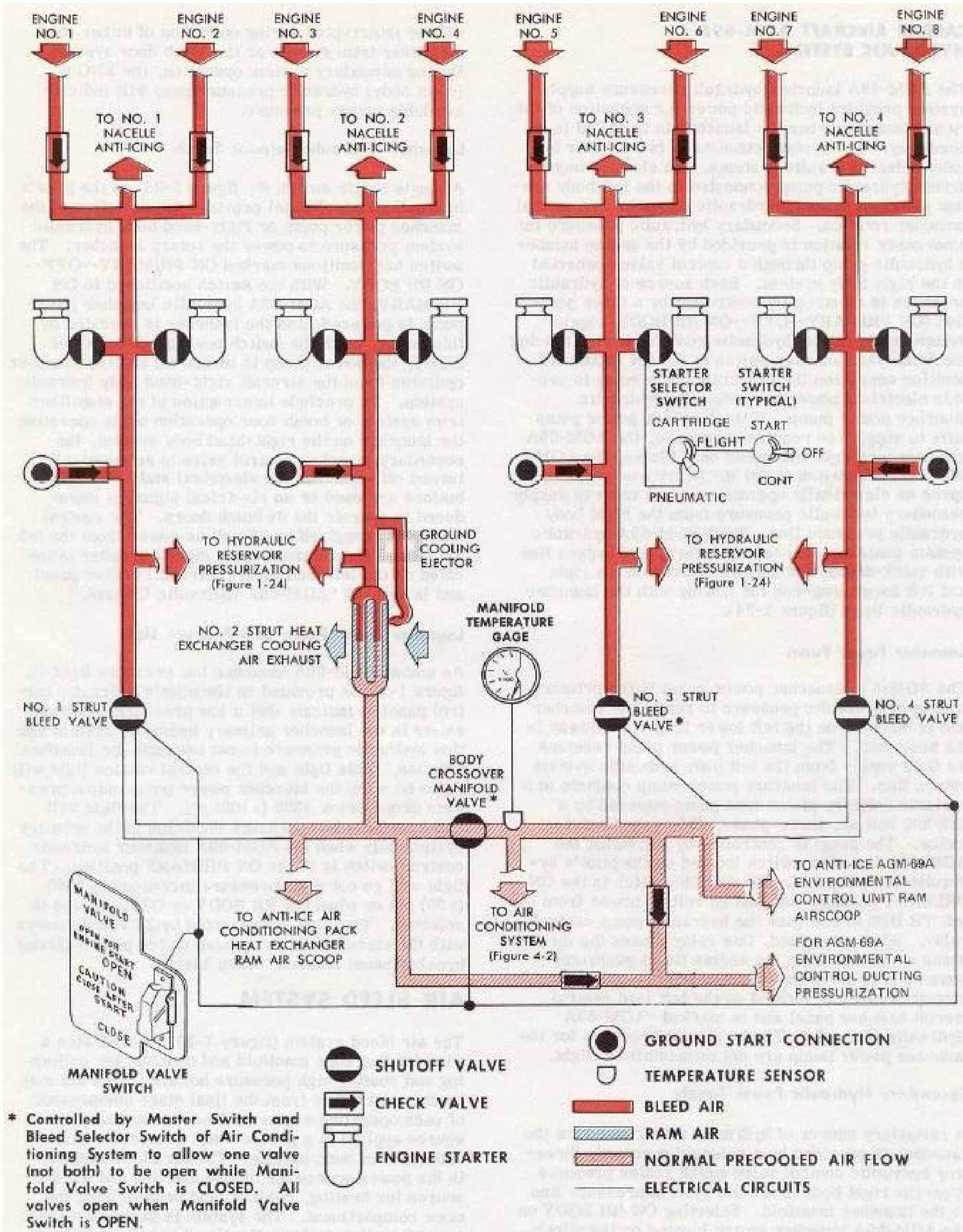


Figure 29. Bleed Air System, B-52H [27]

The system is designed so that normal airflow is from the No. 2 nacelle through a ram air heat exchanger (precooler) in the No. 2 strut into the distribution ducting in the wing leading edge and fuselage. A constant operating ejector system assures coolant airflow through the precooler during ground operations. In the event of failure of the bleed air supply from No.2 nacelle, either through duct failure or shutdown of engines 3 and 4, emergency airflow may be obtained from the No. 3 nacelle. This air does not pass through a strut mounted precooler and therefore may directly subject the distribution ducting and the air conditioning system to bleed air temperatures of 232º and 399ºC, depending on the engine thrust settings.

The distribution ducting and the routing it follows, particularly along the wing leading edge, are not designed for safe operation at temperatures above 246ºC when the aircraft is below 25,000 ft.

6.3.6. Hydraulic System

Unlike conventional hydraulic systems with a single main system, the hydraulic system of the B-52 is decentralized, with six independent engine-driven systems, as shown in Figure 30. They consist of the inboard and outboard wings (left and right), and the right and left body hydraulic systems. In addition there are two electric motor driven primary hydraulic systems consisting of the main No. 1 and No. 2 rudder/elevator hydraulic systems. The engine-driven pumps are mounted on the right sides of six of the eight engines. The electric motor driven pumps are located on the right aft side of the fuselage.

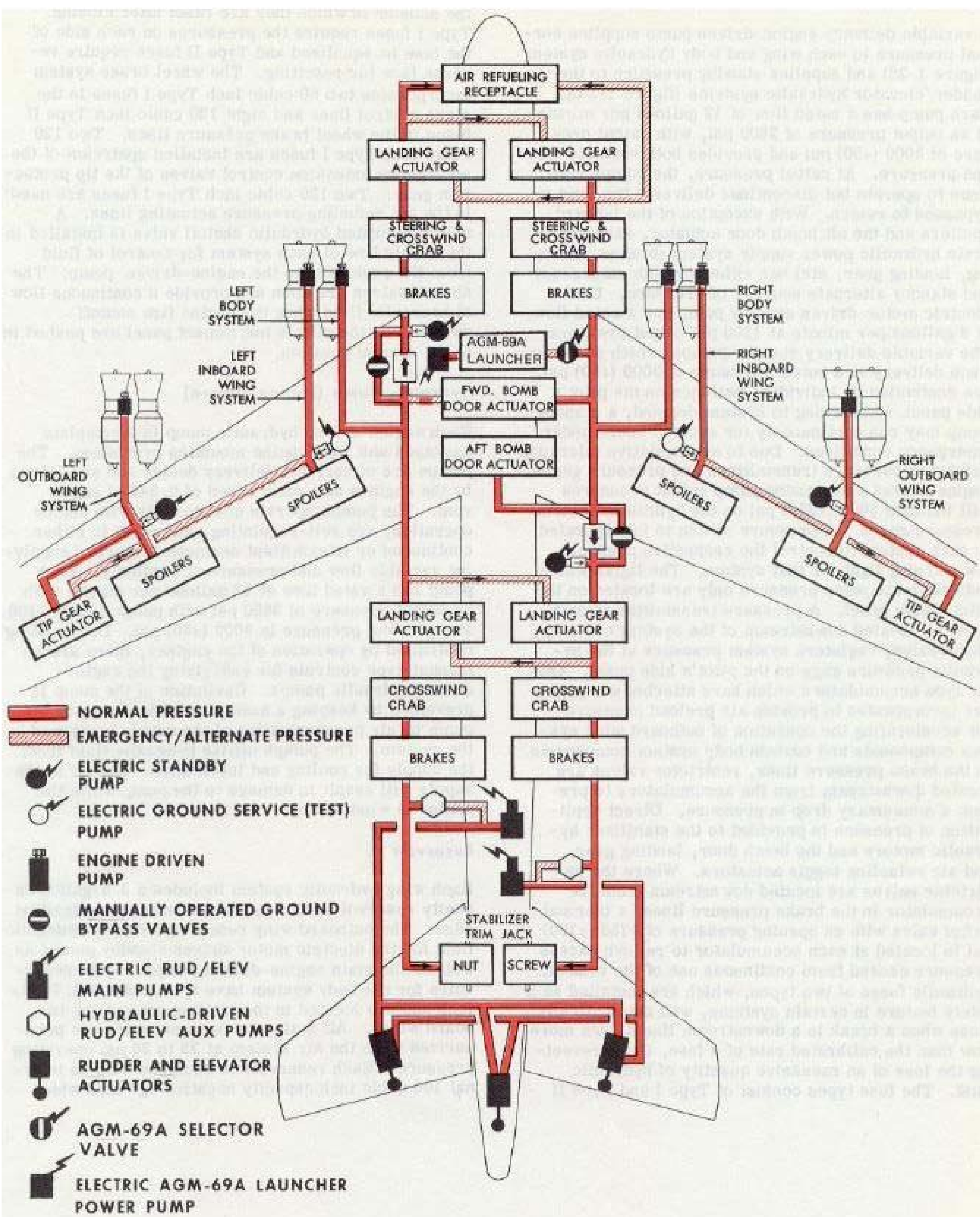


Figure 30. Hydraulic System Locations, B-52H [27]

6.3.6.1 Engine-Drvien Pump

A variable delivery engine-driven pump supplies pressure to each wing and body hydraulic system and supplies standby pressure to the rudder/elevator hydraulic systems. Each pump has a rated flow of 12 gallons per minute at an output pressure of 2800 pounds per square inch (psi) with cutout pressure of 3000 psi and provides both variable flow and pressure.

Each engine-driven hydraulic pump is a complete packaged unit with engine mounting provisions. The pumps are of variable delivery design and are driven by the engines at a ratio speed of 0.342 of engine revolutions per minute (rpm). The pumps operate continually with engine operation, are self regulating, and react to either continuous or intermittent demands of power, supplying variable flows and pressure accordingly.

Engine driven pumps mounted on engines 1 and 7 supply normal pressure to the outboard spoilers and tip protection gear. Engine driven pumps on engines 3 and 6 supply normal pressure to the inboard spoilers and provide emergency pressure for extension of the tip protection gear. The last two pumps mounted on engines 4 and 5 supply normal pressure to the body systems and standby pressure to the rudder/elevator systems.

6.3.6.2 Electric-Driven Pump

The left and right body location electric driven pumps provide standby pressure for the essential body systems normally serviced by engines 4 and 5 respectively. The left body system supplies normal pressure to the air-refueling system, left forward landing gear, brakes, steering and crosswind crab, left aft landing gear, brakes, crosswind and stabilizer nut. It also supplies emergency pressure to the right forward landing gear, forward bomb door, right aft landing gear and it supplies standby pressure to the rudder and elevator.

The right body system supplies normal pressure to the right forward landing gear, brakes, steering and crosswind crab, forward and aft bomb doors, right aft landing gear, brakes and stabilizer screw. It also supplies emergency pressure to the air refueling system, the left forward and left aft landing gear and it supplies standby pressure to the rudder and the elevator.

6.3.6.3 Hydraulic System Reservoir

Each wing hydraulic system includes a 3.5-gallon capacity reservoir which is located in the wing trailing edge. The outboard wing reservoirs supply hydraulic fluid for the electric motor-driven standby pumps as well as the main engine-driven pumps.

6.3.6.4 Standby Pumps

The electric motor-driven standby pumps in each of the four hydraulic systems (body and outboard wing) supplies sufficient pressure to operate the system should the engine driven hydraulic pump fail. The right body system standby pump supplies standby pressure to the No.2 rudder/elevator hydraulic system. The outboard left and right wing locations supply standby pressure to the outboard spoilers and the tip protection gear.

The left body standby pump supplies standby pressure to the air refueling system, left and right forward landing gear, steering and crosswind crab, and brakes. The right body standby pump supplies standby pressure to the right aft landing gear, crosswind crab, brakes, stabilizer screw and left aft landing gear. No standby pump pressure is available for the bomb doors.

6.3.7. Landing Gear and Brakes

6.3.7.1 Landing Gear

The landing gear consisted of a four strut, eight-wheel landing gear. The quadricycle main gear was quite light and provided a very short turning radius, shown in Figure 31. The tip protection gears (outriggers) could be retracted into the outer wing panels. These outriggers, shown in Figure 32, prevented the wing tips from dragging on the ground during a wing low landing, or high-speed ground maneuvers, especially with full fuel loads. The main landing gear, shown in Figure 33, utilizes power for operation from the left and right body hydraulic systems.

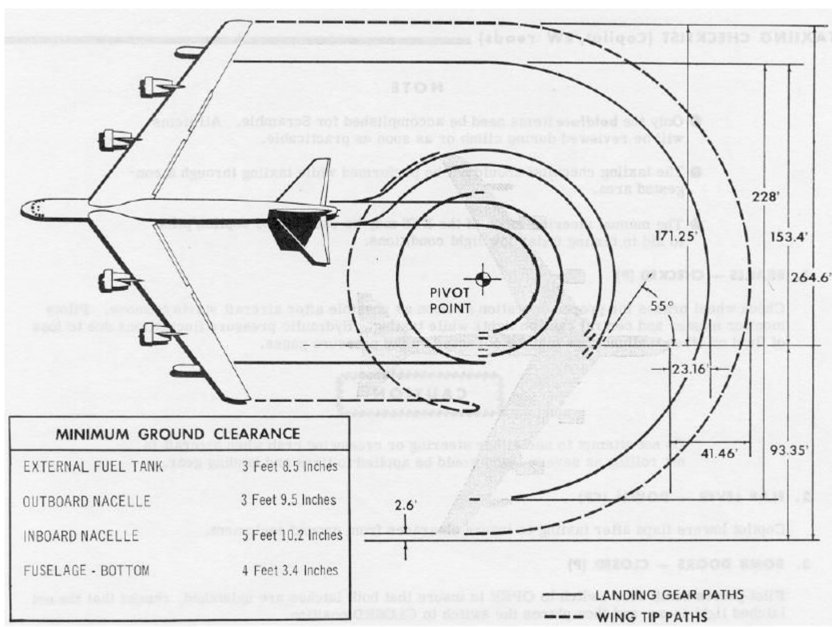


Figure 31. Turning radius of the B-52, showing landing gear and wing tip paths [27]

Figure 32. Outrigger gear located at the wingtips [29]

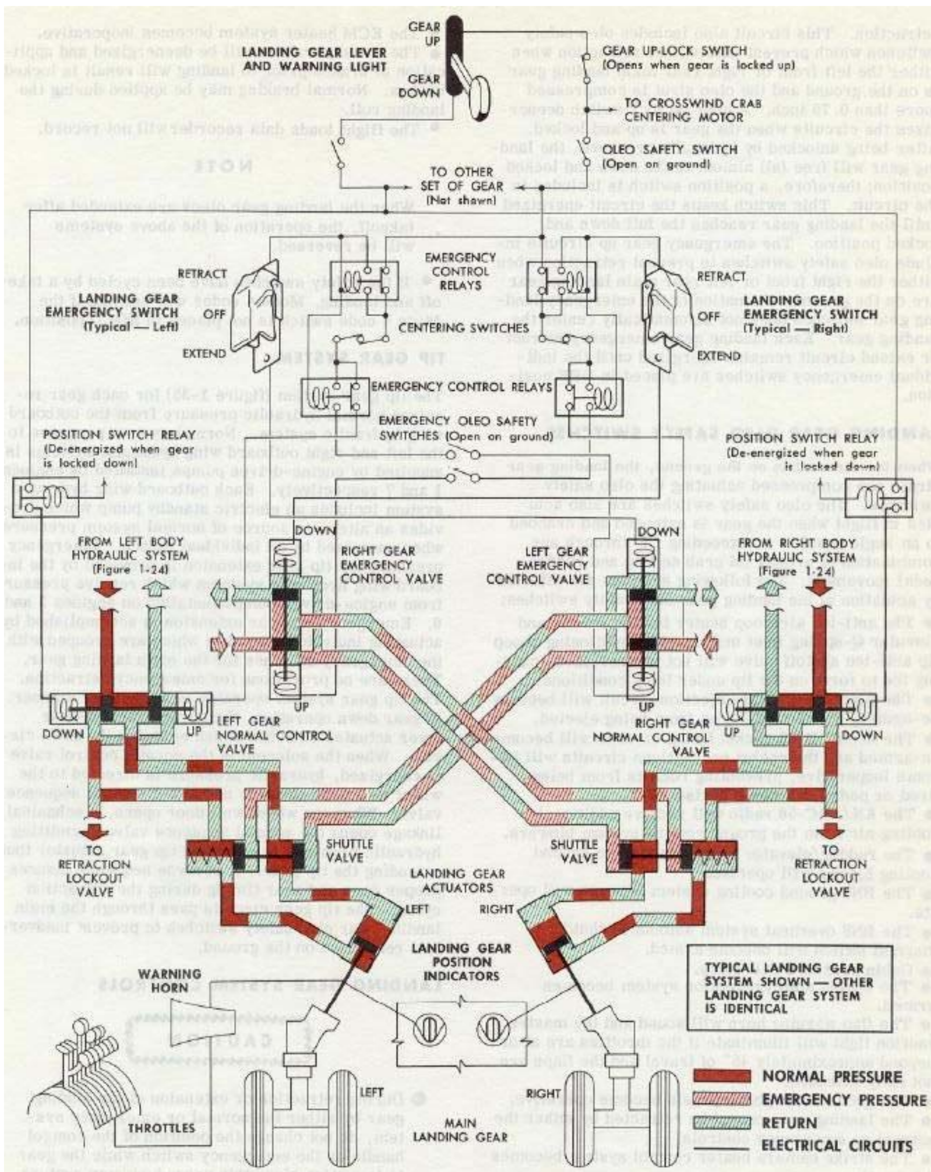


Figure 33. Main landing gear system [27]

The front main wheels were also steerable, and an excellent crosswind steering mechanism had 20 degrees of turn on either side, enabling the aircraft to be crabbed into the wind while the wheels remained aligned with the runway, as shown in Figure 35. This is achieved by two separate yet integrated systems known as the steering and crosswind crab system, shown in Figure 34. They are integrated through mechanical and cable linkage to a differential coordinating unit.

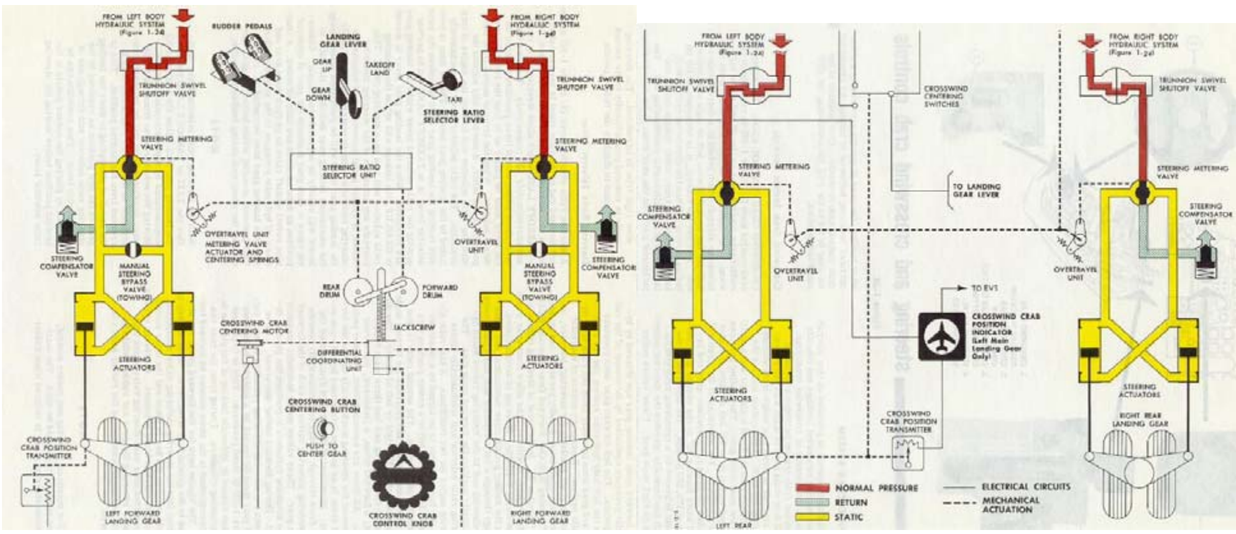


Figure 34. Crosswind landing gear architecture [27]

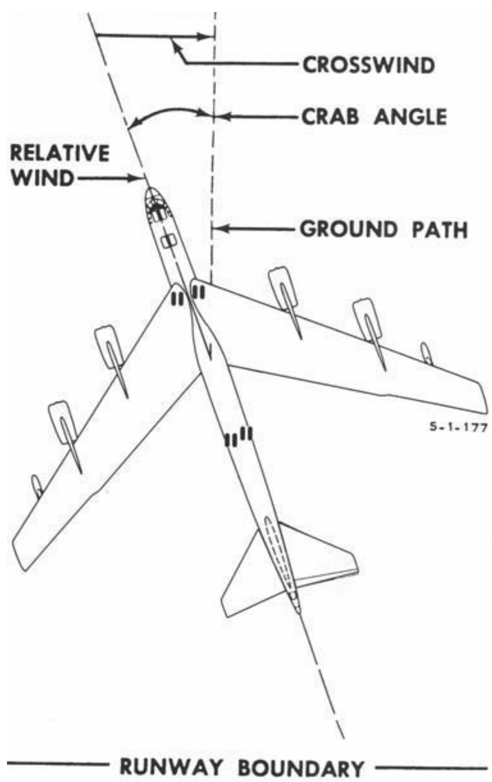


Figure 35. B-52 Crosswind Take-off Configuration [29]

6.3.7.2 Braking

The wheel brakes are actuated by any one of the four rudder pedals in the cockpit. The brakes are hydraulically driven and an antiskid system is in place on each wheel to correct for skid conditions. A parking brake holds the pedals in place as long as hydraulic pressure is available. The wheel breaking system is shown in Figure 36.

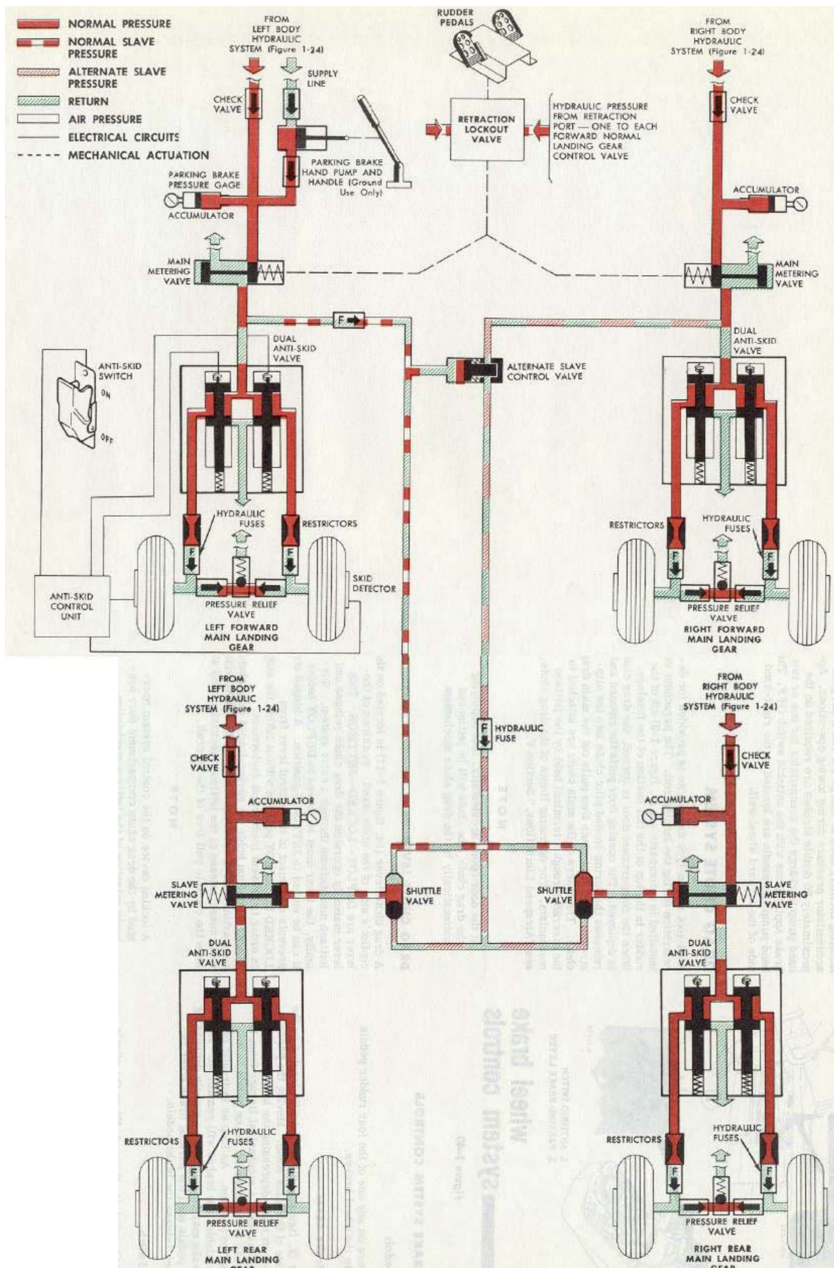


Figure 36. B-52 Wheel Brake System [27]

A 44-ft diameter, ribbon-type drag chute, stowed under the tail was routinely deployed during landing rollout, shown in Figure 37, to reduce brake and tire wear.

Figure 37. B-52 Deploying Brake Chute [33]

6.3.8. Flight Control

Flight control of the B-52 was accomplished by the elevator, rudder, and lateral control systems. The lateral control systems consisted of ailerons and spoilers in earlier models of the B-52, but the ailerons were subsequently removed in later models.

The vertical fin stood 48 feet 3 inches off the ground and incorporated a rudder spanning nearly the entire length of the fin, but only 10% of the fin-chord. The fin was hinged at the base and could be folded sideways so the B-52 could fit into hangers with standard ceilings. Originally, the B-52 design called for an all-moving vertical tail, but doubts about the reliability of the hydraulic actuators needed for this caused Boeing to abandon this idea. The rudder had small operating hinge moments for an airplane of its size, which allowed for manual operation through a spring tab. Asymmetric thrust conditions, produced by shutting down an engine, were quite small, as the B-52 had eight engines. To deal with crosswind on takeoffs and landings, Boeing incorporated yaw-adjustable landing gear that allowed the plane to make ground rolls at zero sideslip and bank, as discussed in 6.3.3.1.

The longitudinal trim requirements of the B-52 were greater than those required of similar aircraft with lower performance, due to the large margin between stall speed and maximum speed. This led to the choice of an adjustable horizontal stabilizer for trim rather than elevator surfaces because an elevator designed for longitudinal control and longitudinal trim would be too large and the drag produced by holding the elevator in a trimming position would adversely affect the aircraft performance. An adjustable stabilizer was chosen that was fully-variable and could pivot through an arc of 13 degrees (+9/-4) measured at the leading edge. The stabilizer was driven by two independent hydraulic motors through an irreversible screw jack mechanism. One motor drives the jack screw, while the other drives the nut on the driven screw thread. A schematic of the B-52's stabilizer trim controls is shown in Figure 38. The elevators were relatively small and in some flight regimes did not have enough control authority to overcome the stabilizers. The fully-variable horizontal tail was an innovation, but because the elevators were so small, it caused occasional problems. Several accidents were caused when the stabilizers were not set properly on take-off, and the elevators were not powerful enough to correct the problem. The horizontal stabilizer is shown in Figure 39.

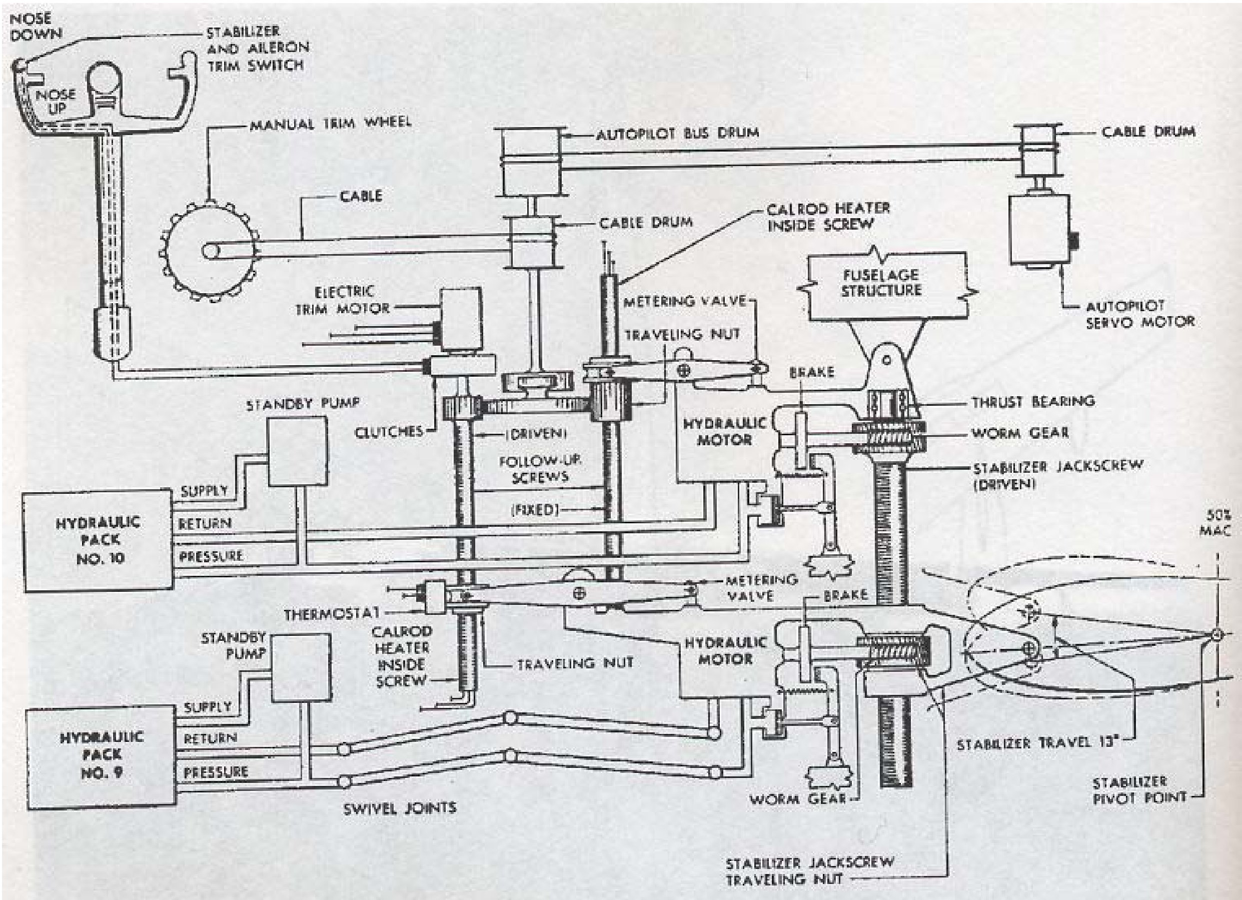


Figure 38. Stabilizer Trim Controls [4]

Figure 39. Horizontal Stabilizer of the B-52 [29]

The wings incorporated movable control surfaces, in the form of ailerons and spoilers, and flaps. Ailerons were located along the trailing edge, between the inner and outer flap sections. The seven-segment spoilers were located on the upper wing surface, slightly outboard of the ailerons. In normal flight regimes, the ailerons provided adequate roll control when operated differentially. During in-flight refueling, in combat situations, and on landing, the spoilers were sometimes needed for additional control. The spoilers could also be used as air brakes when deflected symmetrically, which eliminated the need for a deceleration parachute on final approach. In later models, the ailerons were dropped altogether, and the pilots simply used the spoilers for roll control. Each wing was equipped with two segments of Fowler-type flaps, with a total flap area of 797 square feet. The flaps had two settings: up or down with a deflection angle of 35 degrees. The flaps and spoilers are shown in Figure 40. Figure 41 depicts the spoiler system.

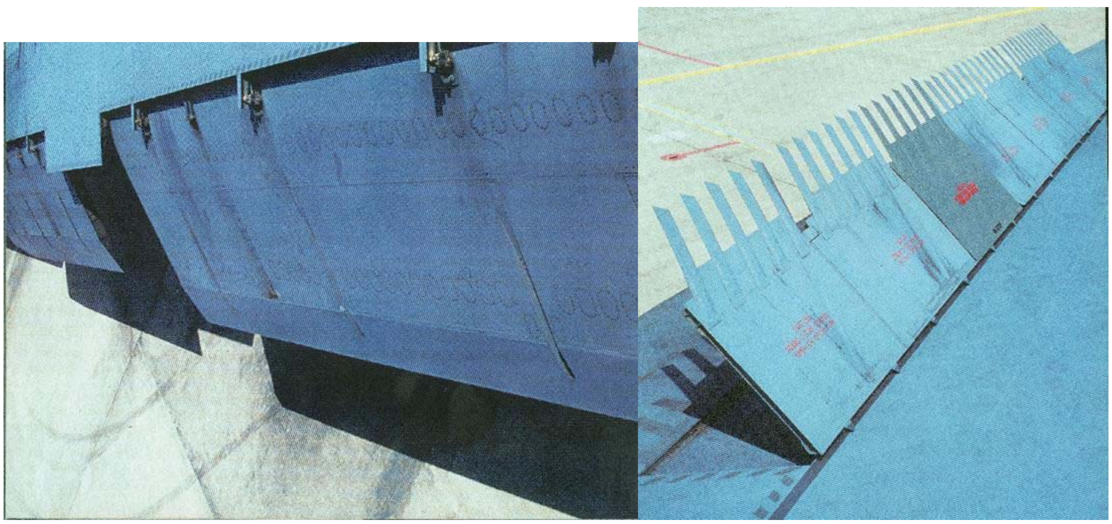


Figure 40. The B-52 was equipped with Fowler-type flaps (left) and spoilers (right) [29]

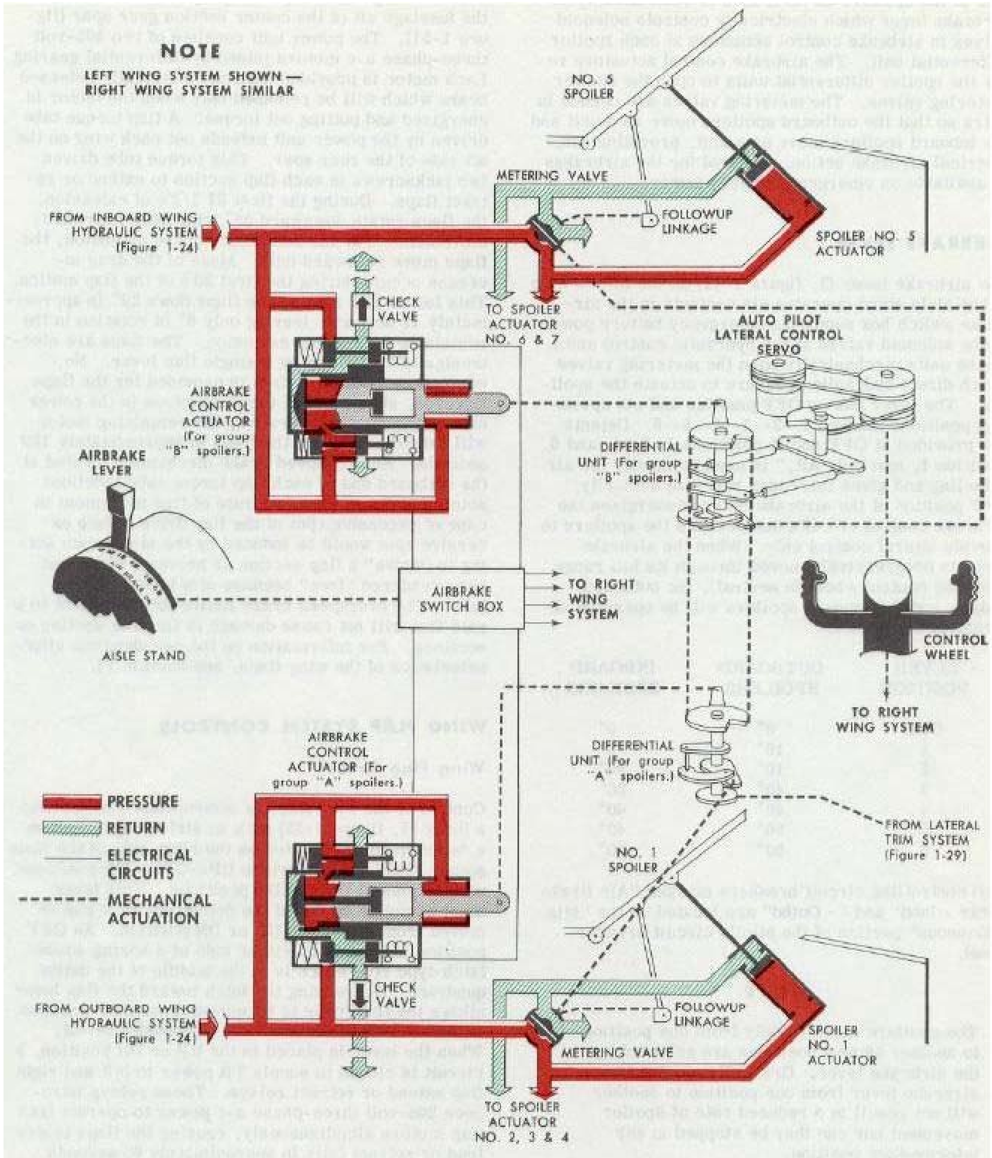


Figure 41. Airbrake/Spoiler system of the B-52 [27]

The B-52 had a large static stability margin. Depending on the weight of the aircraft, the acceptable center of gravity (CG) limits ranged from 16% mean aerodynamic chord (MAC) to 36% MAC. These CG limits were purely structural.

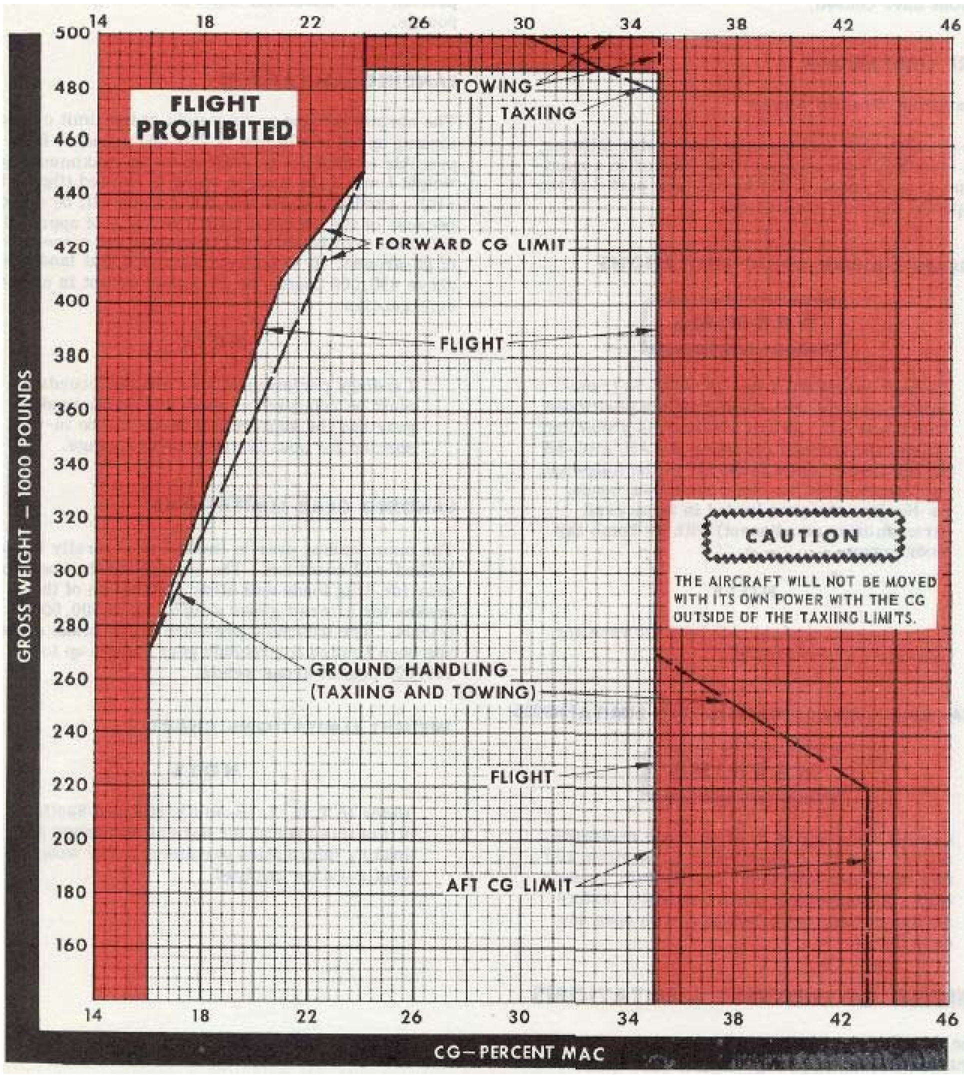


Figure 42. Structural Center of Gravity Limits [27]

6.3.9. Flight Deck

6.3.9.1. Cockpit

The cockpit of the B-52 prototype had a tandem seating arrangement. This was changed in production models to a side-by-side configuration at the request of General LeMay. In all production B-52s the forward fuselage section had a twin deck arrangement, with the pilot and co-pilot occupying the upper deck and the navigator and radar navigator on the lower deck. In the right-hand aft of the upper deck was a tiny cubicle where the Electronic Warfare Officer (EWO) sat. In early models, the tail gunner was isolated in a pod in the aft end of the fuselage. By the B-52G model, the tail gunner was been moved into the cockpit. The crew configuration for later models is shown in Figure 43.

Figure 44 and Figure 45 show the general arrangement of the upper and lower decks in the cockpit of a B-52G respectively, including relevant equipment. Figure 46 and Figure 47 show the pilot and co-pilot sides of the B-52B cockpit instrument panel.

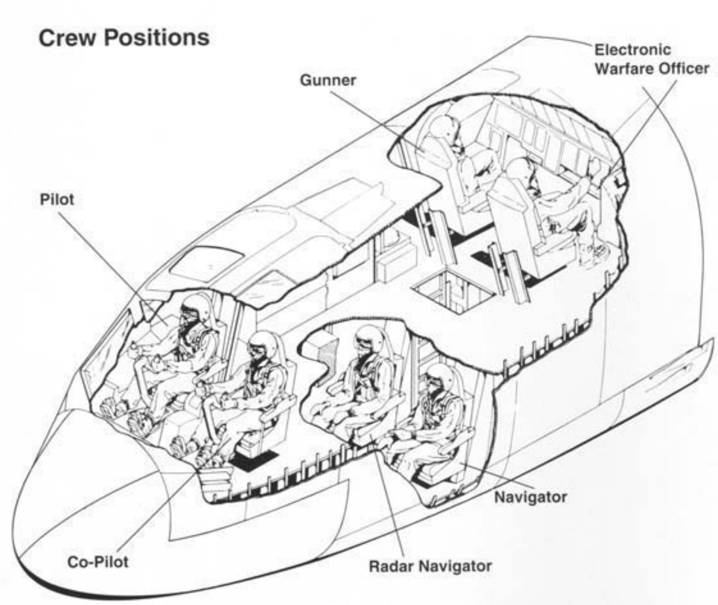
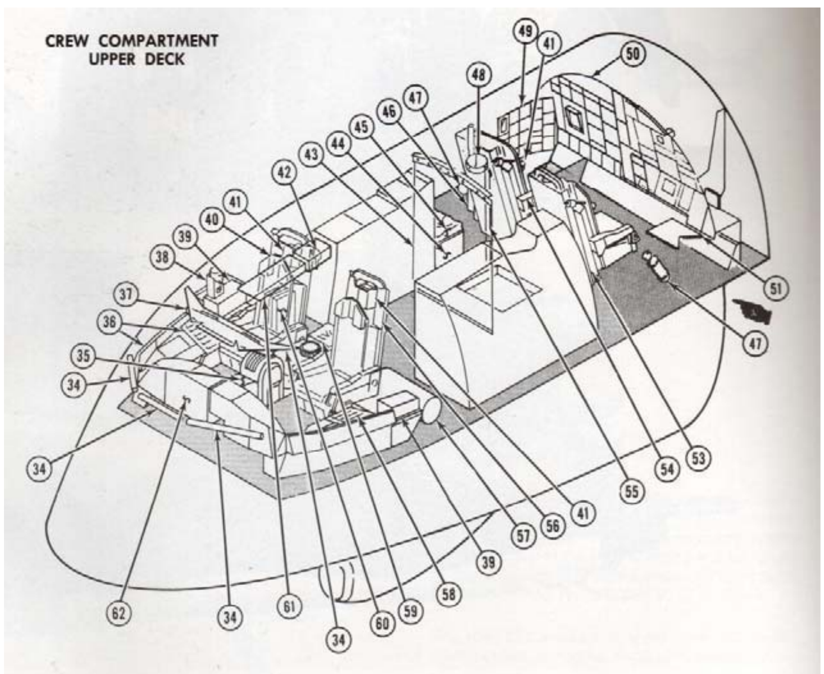


Figure 43. B-52 Seating Arrangement [29]

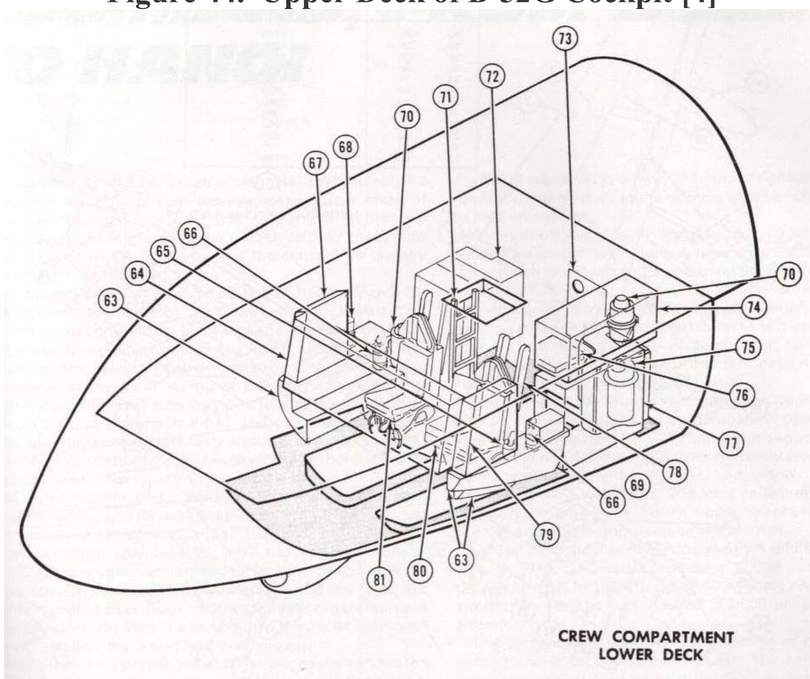


34	Thermal Curtain
35	Aisle Stand
36	Co-Pliot's Side Panel
37	Eyebrow Instrument Panel
38	Hot Cup
39	Food and Data Box
40	Co-Pliot's Seat
41	Station Urinal
42	Signal Light

49	EW Officer's Side Panel
50	Defense Station Instrument
51	Gunner's Pullout Table
52	(Deleted)
53	Gunner's Seat
54	EW Officer's Seat
55	Stanchion
56	Pilot's Seat
57	Mattress Stowage

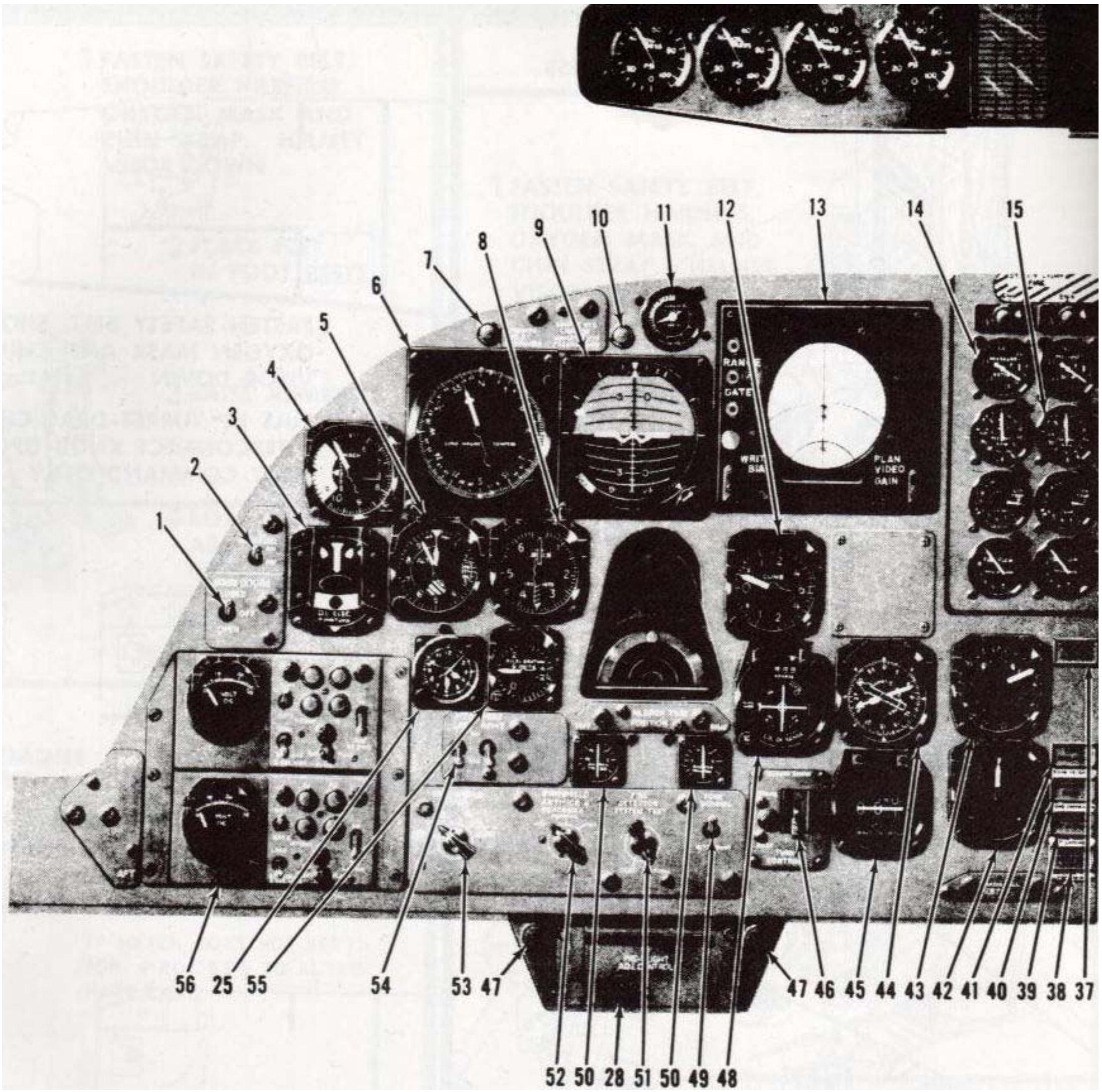
43	Night Flying Curtain	58	Pilot's Side Panel
44	Toilet	59	Instructor Pilot's Seat
45	Defense Instructor's Seat	60	Periscopic Sextant Carrying Case
46	Food Stowage Box	61	Pilot's Overhead Panel
47	Oxygen Bottle	62	Pilot's Instrument Panel
48	Periscopic Sextant Mount		

Figure 44. Upper Deck of B-52G Cockpit [4]



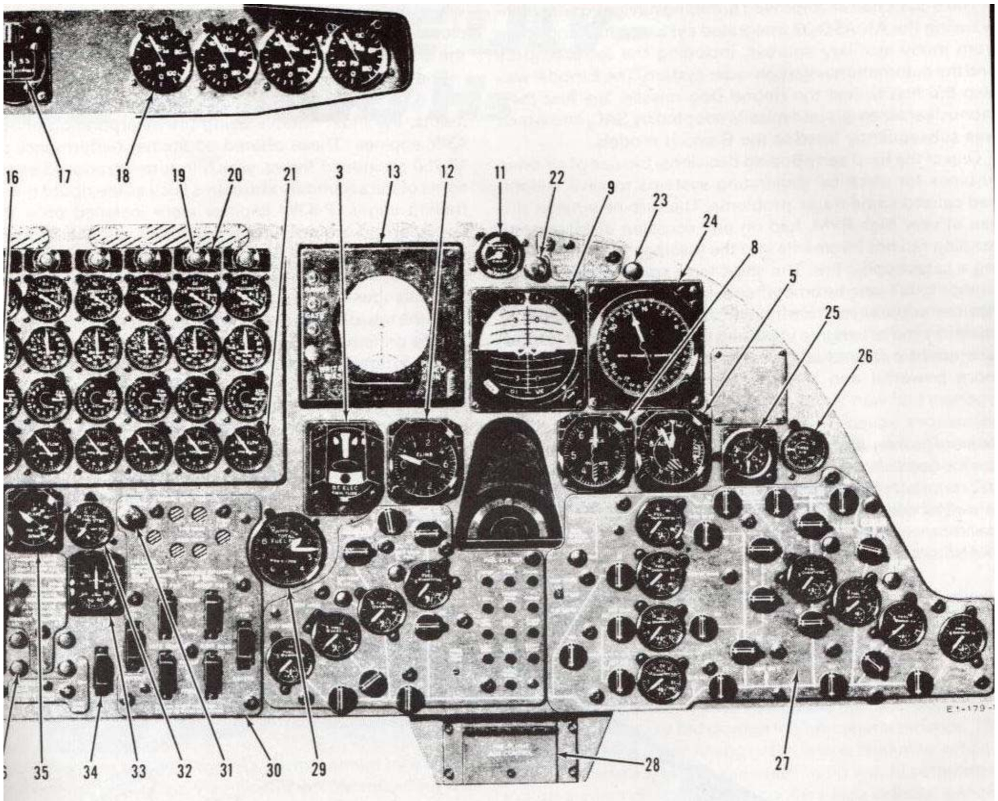
63	Miscellaneous Equipment Shelf	73	Pressure Bulkhead Door
64	Navigator’s Instrument Panel	74	Electronic Equipment Rack
65	Station Urinal	75	Central Urinal
66	Oxygen Bottle	76	Instructor Navigator’s Takeoff-Landing
67	Navigator’s Side Panel		Seat
68	Hot Cup	77	Power Supply Rack
69	Food Stowage Box	78	Radar Navigator’s Seat
70	Drinking Water Container	79	Radar Navigator’s Side Panel
71	Ladder	80	Instructor Navigator’s Duty Seat
72	Remote Modules Rack	81	Navigator’s Seat

Figure 45. Lower Deck of B-52G Cockpit [4]



1	Bomb Doors Switch	10	Hydraulic Pack Pressure Low Master Light
2	Mach Indicator Switch	11	Clearance Plane Indicator
3	Turn-and-Slip Indicator	12	Vertical Velocity Indicator
4	Machmeter	13	Terrain Display Indicator
5	Altimeter	14	Engine Pressure Ratio Gauges
6	Directional Indicator (N-1 Repeater)	15	Tachometers
7	Automatic Pilot Disengaged Light	16	Exhaust Gas Temperature Gauges
8	Airspeed Indicator	17	Magnetic Standby Compass
9	Pilots' Attitude Indicator	18	Oil Pressure Gauges

Figure 46. Pilot Instrument Panel (Left Side) [4]



19	Engine Fire Warning Lights	38	Hatches Not Closed and Locked Light
20	Firewall Fuel Shutoff Switches	39	Bomb Doors Not Latched Light
21	Fuel Flowmeters	40	Bomb Doors Open Light
22	Master Fuselage Overheat (Fire) Warning Light	41	Bomb Released Light
23	Gunner's Cabin Pressure Warning Light	42	Lateral Error Meter
24	Directional Indicator (Gyro)	43	Pilot's Data Indicator
25	Clock	44	Radio Magnetic Indicator
26	Outside Air Temperature Gauge	45	Distance Indicator
27	Fuel System Controls	46	Autopilot Turn Control Selector Switch
28	Terrain Preflight Adjust Control	47	Air Outlet Knob
29	Total Fuel Flow Indicator	48	Omni-Range Radio Course Indicator
30	Landing Gear Controls	49	Tone Scoring Interrupt Switch
31	Store Jettison Light	50	Aileron Trim Indicator
32	Total Fuel Quantity Gauge	51	Engine Fire Detector System Test Switch
33	Tail Compartment Altimeter	52	Windshield Anti-Ice and Defogging Switch
34	Antiskid Switch	53	Windshield Wiper Switch
35	Wing Flap Position Indicator	54	Pitot Heat Switches
36	Alternator Overload Lights	55	Accelerometer
37	Anti-icing Surface Overheat Light	56	T-1B Control Panels

Figure 47. Pilot Instrument Panel (Right Side) [4]

6.3.9.2. Crew Escape

The B-52 has both upward and downward firing seats. The pilot, copilot, gunner, and electronic warfare specialist are ejected through the top while the radar navigator and navigator go through the bottom. In older models, the gunners performed a manual bailout following removal of the gun compartment. An example upward firing ejection seat is shown in Figure 48.

Figure 48. Upward ejection seat from the B-52 [27]

The B-52 does not employ command ejection. Each occupant is responsible for initiation of the ejection event. A light on the panel in front of the crew states "alert" or "abandon". The "alert" mode is used to prepare the crew for a crash landing or ditching. An "abandon" light means it is time to leave the aircraft. It is either activated by flipping the switch or activation of the pilot/copilot arming levers. The ejection procedure is depicted in Figure 49.

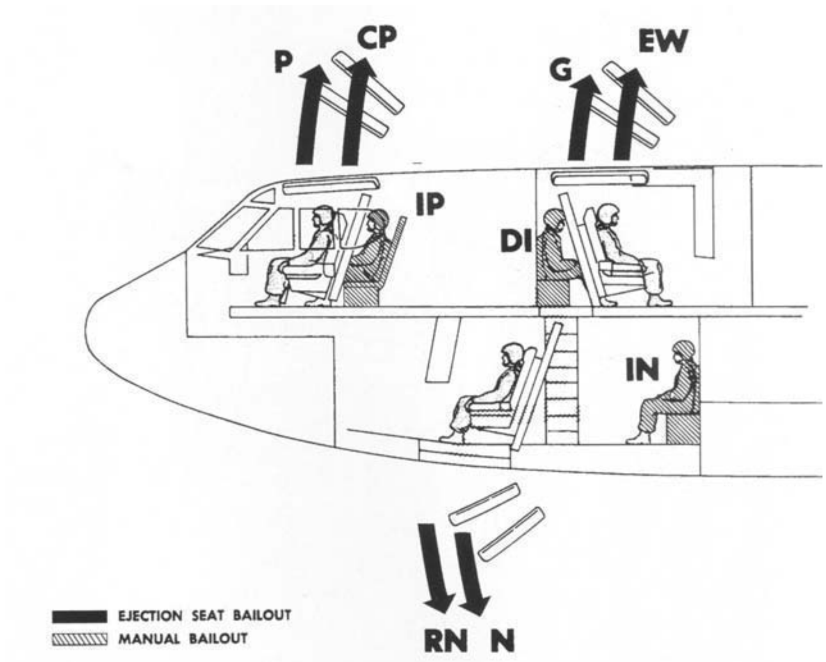


Figure 49. Ejection procedure [29]

6.3.10. Navigation and Targeting

The SAC had decided that some of the early production B-52B aircraft were to be equipped with the Sperry K-3A system that was used by the B-36. The B-52B had originally been intended to carry the MA-2 bombing/navigation system, which combined an optical bombsight, a radar presentation of target, and an automatic computer, together with radar modifications designed for use in a high-speed aircraft.

However, the development of this package had been delayed. The K-3A system was found to be almost totally ineffective at heights of 45,000 feet, where the B-52B typically operated. Poor resolution qualities and a loss of definition made it almost impossible to identify targets with any degree of certainty. The Philco Corporation developed a temporary fix in which power output was increased by about 50 percent, but this was not really much of a solution and things really did not improve very much. Significant improvement was only made when the IBM MA-6A system was finally available during the latter stages of the B-model production run. Figure 50 shows the layout of navigational, avionics and other information subsystems of the present-day B-52.

A standby navigational system was used on later derivatives of the aircraft. The J-4 standby heading system is a remote indicating gyro-stabilized compass system designed for use in all latitudes and provides heading information in the event of the failure of the AN/AJN-8 (in the B-52H models).

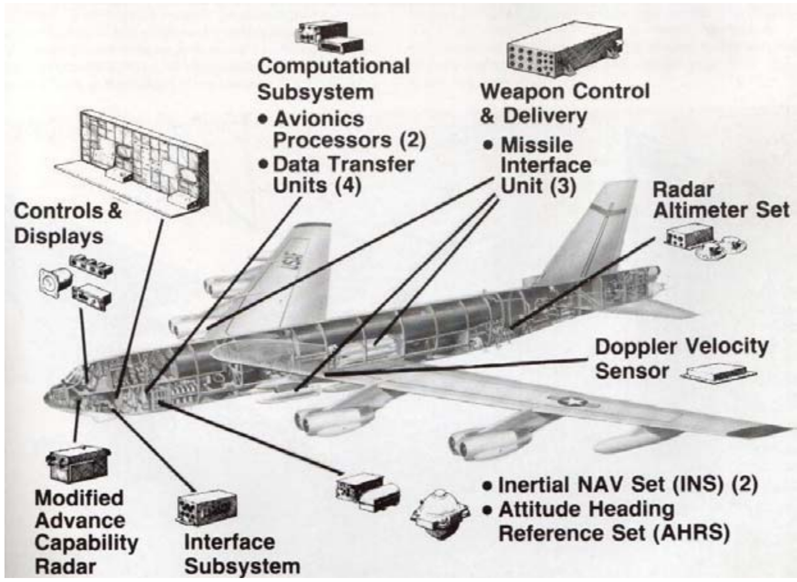


Figure 50. Layout of Avionics, Navigational and Other Information Subsystems [4]

6.3.11. Payloads and Armaments

6.3.11.1. Bomb Payload

The bomb payload of the B-52 has grown significantly over its 50 years of service. The payload of the B-52 was mainly nuclear bombs because of its role in the Cold War. With end of the Cold War, the B-52 was used primarily as a "bomb truck". The B-52 had a 27-foot long bomb bay [23] with a bay volume of 29.53 cubic meters [24], shown in Figure 51. As time passed, these bombs became much smaller in size and weight. The B-52's huge bomb bay was reconfigured to carry other weapons to fight conventional warfare in Vietnam, the Persian Gulf War, and now the war in Afghanistan. The plane can carry a payload of 500-pound bombs for "carpet bombing" runs.

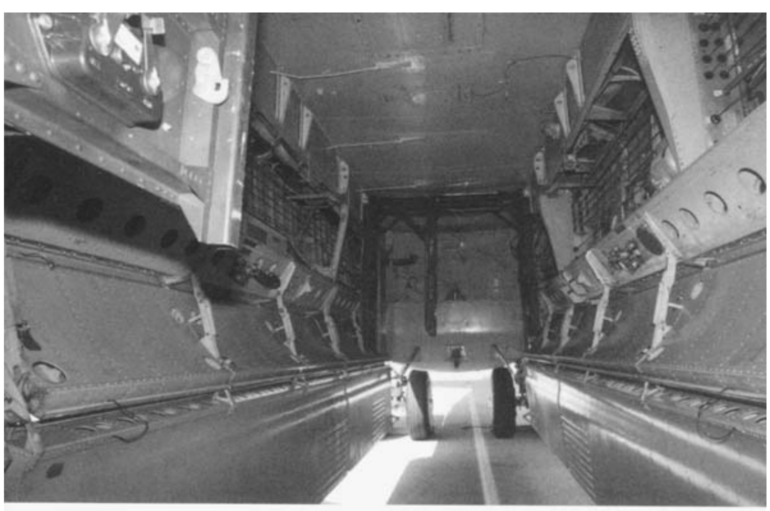


Figure 51. The B-52's Massive Bomb Bay [29]

The payload of the B-52 has increased over time from 43,000 lbs to 70,000lbs, as shown in Table 5. The payload of the B-52D was significantly higher than the newer derivatives because of the Big Belly project modification. Less than 6 months after the B-52F became involved in combat in Vietnam, the Air Force decided to convert most of its B-52Ds to conventional warfare capability for service in Southeast Asia. Foremost among the changes needed was to give the B-52D the ability to carry a significantly larger load of conventional bombs. This led to the Big Belly project which was begun in December of 1965. The project increased the internal bomb capacity from just 27 weapons to a maximum of 84 500-lb Mk 82 or 42 750 lb M117 conventional bombs. This was done by careful rearrangement of internal equipment, and did not change the outside of the aircraft. In addition, a further 24 bombs of either type could be carried on modified underwing bomb racks (originally designed for the carrying of Hound Dog cruise missiles and fitted with I-beam rack adapters and a pair of multiple ejection racks), bringing the maximum payload to 60,000 pounds of bombs, about 22,000 pounds more than the capacity of the B-52F.

Table 5. Table of Maximum Payloads of B-52 Derivatives [10]

Model	Maximum Payload lbs)
B-52A	43,000
B-52B	43,000
B-52C	43,000
B-52D	60,000
B-52E	43,000
B-52F	43,000
B-52G	50,000
B-52H	70,000

The payload of the B-52H is comparable with the B-1B and 32,000 lbs more than that of the B-2A. Compared to the other bombers in the past, the payload of the B-52 exceeds the others by 2-3 times, as shown in Table 6.

Table 6. List of USAF Bomber Maximum Payloads [34]

Bomber	Maximum Payload lbs)
B-29	20,000
B-47	25,000
B-50	28,000
B-52H	72,000
B-58	20,000
F-111	25,000
B-1B	80,000
B-2A	40,000

Today the B-52H can carry 51 smaller munitions or 30 larger munitions. This would include a significant array of nuclear, conventional and precision missiles and bombs.

Table 7. Table of Payload Capabilities of the B-52 [35]

Type		Maximum Payload
Nuclear		
	AGM-86B Air Launched Cruise Missile	20
	AGM-69 Short Range Attack Missile	12 (mounted externally)
	AGM-129 Advanced Cruise Missile	12 (mounted externally)
	B-53 Gravity Bomb	2 (mounted internally)
	B-61 Mod 11 Gravity Bomb	8 (mounted internally)
	B-83 Gravity Bomb	8 (mounted internally)
Conventional	CBU-52/B Cluster Bomb	45 (27 internal, 18 external)
	CBU-58/B Cluster Bomb	45 (27 internal, 18 external)
	CBU-71/B Combined Effect Munitions	45 (27 internal, 18 external)
	CBU-87/B Combined Effect Munitions	24 (6 internal, 18 external)
	CBU-89/B Gator	24 (6 internal, 18 external)
	Mk 20 Rockeye	18 (external)
	Mk 36/Mk 62 Destructor Mine	51
	Mk 41/Mk 64/Mk 65 Destructor Mine	8
	Mk 52 Mine	12
	Mk 55 Mine	8
	Mk 56 Mine	8
	Mk 60 Encapsulated Torpedo Mine	8
	Mk 82 General Purpose Bomb	51
	Mk 84 General Purpose Bomb	18 (external)
Precision	GBU-29/GBU-30/GBU-31/GBU-32 JDAM	18 (12 mounted externally)
	Wind Corrected Munitions Dispenser WCMD	30 (16 mounted externally)
	AGM-84 Harpoon	8
	AGM-86C Conventional Air Launched Cruise Missile	20
	AGM-142 Raptor	8 (3 mounted externally)
	AGM-154 Joint Standoff Weapon	18 (12 mounted externally)
	AGM-158 Joint Air to Suface Standoff Missile	12

Figure 52. The Array of Payload for the B-52 [33]

6.3.11.2. Tail Mounted Defensive Armament

Four 0.50 caliber machine guns were designed to fit in a radar controlled tail turret. The gunner would sit in a separate pressurized compartment that could be jettisoned on a bailout. Nine of the first ten RB-52Bs used a A-3A fire control system which operated the machine guns. However, one early RB-52B was fitted with the alternative MD-5 fire control system that incorporated a pair of M24A-1 20-mm cannons.

In the B-52G and H models, the tail guns were equipped for remote control operation with a video link and the tail gunner was moved to the cockpit.

6.3.12. Reconnaissance System

The B-52 came in both bomber and reconnaissance versions with the prefix R designating the reconnaissance models, e.g. RB-52B. The RB-52Bs carried out its reconnaissance mission via a two-man pressurized capsule installed in the bomb bay that could perform electronic countermeasures or photographic reconnaissance work. The capsule included downward-firing ejector seats in case of an in-flight emergency. Equipment inside the capsule included long-focal length and panoramic cameras, plus photoflash bombs, mapping radars, receivers, pulse analyzers and recorders. For search operations, the pod had one AN/APR-14 low-frequency radar receiver and two AN/APR-9 high-frequency radar receivers. Raytheon and Belmont Radio manufactured the AN/APR-14. The AN/APR-9 is a D- through I-Band radar intercept receiver; mainly manufactured by AIL, Collins. Each station had three AN/ARR-88 panoramic receivers and all electronic data was recorded on an AN/ANQ-1A wire recorder. Photographic equipment could include 4 K-38 cameras at the multi-camera station plus one T-11 or K-36 at the vertical camera station. The pod could also carry three T-11 cartographic cameras.

The B-52 was finally modified to function as a dedicated bomber in the B-52D variant. The B-52D outlived both the E and F versions, remaining in operation well into the 1980s. One possible reason is because of its dedicated design to being a heavy bomber.

6.3.13. Other Systems

6.3.13.1. Anti-Ice

Bleed air was initially used to de-ice the leading edges of the winds, horizontal stabilizer and vertical fin. De-icing was eliminated in all but the nacelles and engine inlets because it was found that it was almost impossible to accumulate structural ice on the B-52, because of constant flexing of its surfaces removed the ice as fast as it was formed.

6.3.13.2 Pitot-Static System

Four pitot tubes, two pitot-static tubes, and six static ports provide pressures needed to operate the pitot-static instruments: altimeter, airspeed indicator, vertical velocity indicator, true airspeed indicator, and mach indicator. Two pitot tubes are located on the lower left and lower right of the cockpit, with two more just below and aft of them. These four pitot tubes are shown in Figure 53. The remaining two pitot-static tubes are located on the upper left and right of the cockpit just forward of the wing leading edge. Three static ports are located on each side of the cockpit. The pitot-static system is depicted in Figure 54.

Figure 53. Two pitot tubes located on the starboard side of the B-52 [29]

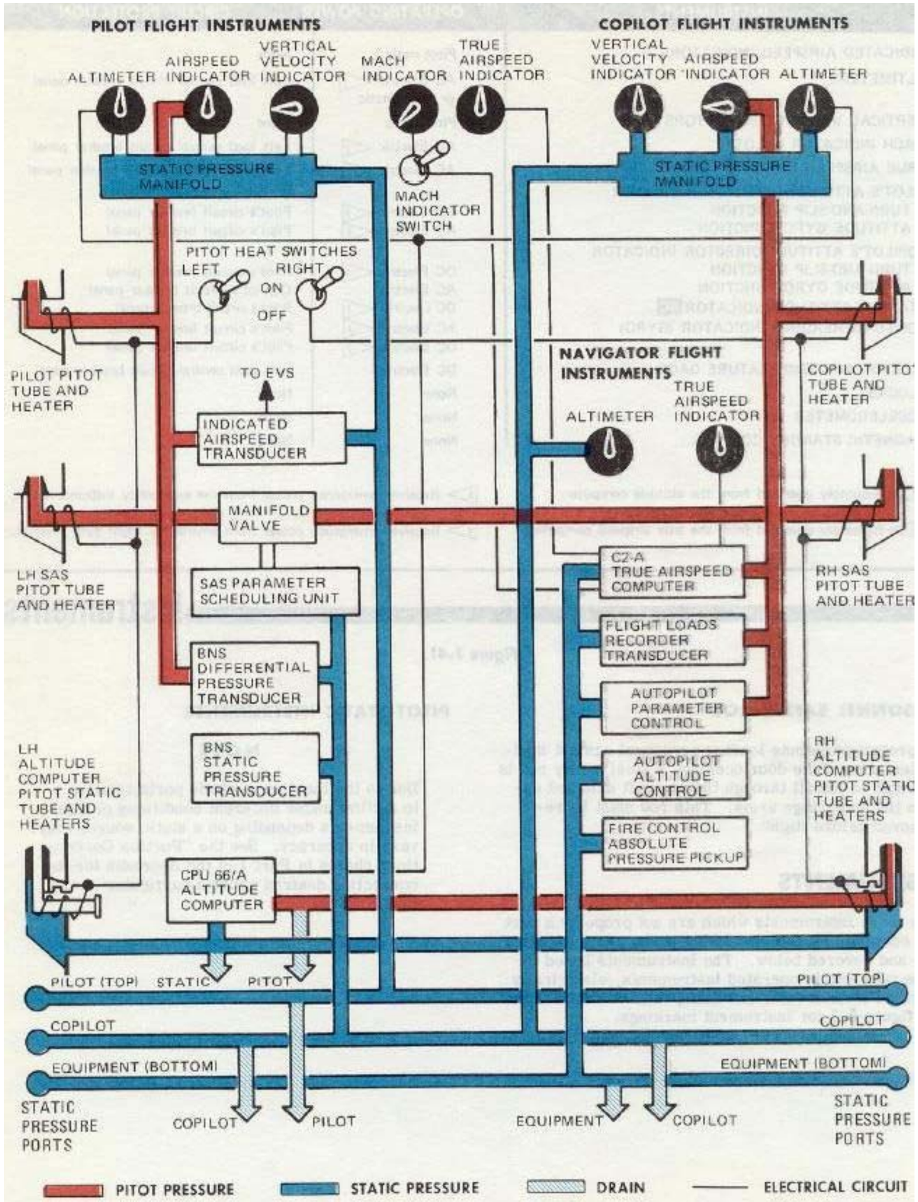


Figure 54. Pitot Tube System [27]

6.4. Subsystem Interfaces

An N^2-diagram is used to depict the interfaces and interaction between all of the various subsystems. Although the diagram illustrates many connections between the different subsystems, the complexity of their interactions is light compared to today's advanced aircraft. The different subsystems can be thought of as more or less modular, whereas a Boeing 777 has many subsystems interwoven into one another. This level of subsystem interface complexity is also manifested in the design process. The B-52 configuration was dictated mostly by aerodynamicists, who worked independently in the wind tunnel. They later passed their configuration onto others to draft the actual drawings and manufacturing instructions (see Section 3.3). In contrast, modern aircraft design programs consist of Integrated Product Teams, where aerodynamic, structural, manufacturing and avionics engineers all come together to design one subsystem.

Table 8. N^2-Diagram

Outputs

Inputs

	Structure	Wings	Engine	Landing Gear	Pneumatic	Hydraulic Pumps	Electric Alternators	Bomb Bay	Control Surfaces	Tail Defense	Avionics
Structure		Holds System in Place →	Holds System in Place →	Holds System in Place →	Holds System in Place →	Holds System in Place →	Holds System in Place →	Holds System in Place →	Holds System in Place →	Holds System in Place →	Holds System in Place →
Wings	Provide Lift ↑		Holds System in Place Hold fuel →	Houses Landing Gear →					Holds System in Place →		
Engine	Determines Weight of Structure ↑	Determines Wing Structure ↑			Provides Bleed Air →	Drives Pumps →	Determines need for APU (quick start) →				Return condition data →
Landing Gear		Supports Wings ↑				Steer wheels and brakes →					Return condition →
Pneumatic						Drive turbine →	Drive alternators →				Return condition →
Hydraulic Pumps				Folds in Landing Gear ↑				Open doors →	Actuate surfaces →		Return condition →
Electric Alternators			Provides Power for Engines ↑		Provides Power for Pneumatics ↑	Provides Power for Pumps ↑				Provide power	Return condition →
Bomb Bay											Return condition →
Control Surfaces			Detection of Engine Failure ↑								Return condition →
Tail Defense											
Avionics			Give commands ↑	Give commands ↑	Give commands ↑	Give commands ↑	Give commands ↑	Give commands ↑	Give commands		

The vertical and horizontal arrows in the cells depict, respectively, inputs and outputs of the subsystem listed on the vertical axis to the subsystem on the horizontal axis. For example, the electric alternators provide power for the engines and in turn, the engine produces bleed air.

6.5. Weight Breakdown

The weight breakdown for the preliminary design of the B-52, as outlined in D-10,000 is shown in Table 9. This breakdown is very similar to the typical "Summary Group Weight Statement" given in Raymer [13]. Empty weight is divided into three subsections: structure, propulsion, and other equipment. After the initial design, an increase in range was desired. The maximum gross takeoff weight was increased with an extension of the fuselage to allow for increased fuel capacity. This change in reflected in the maximum gross takeoff weight of the YB-52. Table 10 shows the empty weight, combat weight, and maximum takeoff weight for each B-52 derivative.

Table 9. Weight Statement from D-10,000 [12]

Model 464-49-0	
Wing	41,000
Empennage	7,000
Body	21,915
Alighting Gear	13,300
Nacelle	7,100
Structure	**89,315**
Engine	36,560
Engine Accessories	500
Controls	300
Starting System	100
Lubricating System	50
Fuel System	10,000
Total Power Plant	**47,510**
Instruments	380
Surface Controls	2,925
Hydraulic System	1,530
Electrical	3,800
Communicating	500
Armament Provisions	2,440
Furnishings	1,940
Anti-Icing	1,130
Total Fixed Requirements	**14,645**
EMPTY WEIGHT	**151,470**
Crew	1,250
Unavailable Fuel	700
Oil	400
Guns and Ammunition	500
Bombs and Racks	10,000
Equipment	280
Fuel	165,400
Design Useful Load	**178,530**

Design Gross Weight	**330,000**

Table 10. B-52 Derivative Weights (lbs.) [4]

Derivative	Empty Weight	Flight Design Weight	Max Takeoff Weight
YB-52	155,200	Not available	405,000
B-52A	Not available	Not available	420,000
B-52B	164,081	272,000	420,000
B-52C	164,486	293,100	450,000
B-52D	164,486	293,100	450,000
B-52E	174,782	292,460	450,000
B-52F	173,599	291,570	450,000
B-52G	168,448	302,634	488,000
B-52H	172,740	306,358	488,000

Chapter 7. Aircraft Lifecycle

This chapter outlines the extensive lifecycle of the B-52 Stratofortress, which contains its initial prototyping, manufacturing, testing and support, verification, validation and certification, disposal and derivatives. A special section on the future of the B-52 aircraft is also included to discuss the prospects for this aircraft as it enters the second half of its projected 100-year lifespan.

7.1. Procurement Cost

Using the DAPCA IV model outlined in Raymer [13], the overall cost of the B-52 program was estimated to be approximately $5.87 billion USD (1957 dollars). This includes research, development, testing, and evaluation costs, as well as the manufacturing cost of each aircraft. The total development costs of the B-52 program were approximately $88.7 million USD (1957 dollars). To determine the development costs of the B-52, the total flyaway, or procurement, cost of the bombers was subtracted from the total program costs. The total procurement costs per aircraft are listed in Table 11 in then-year dollars. A total procurement cost of $5.78 billion USD (then-year dollars) for all 742 aircraft produced was determined by multiplying the average procurement cost times the number of aircraft produced for each model type. The DAPCA IV model accounts for test aircraft as part of development, which is why only 742 aircraft are considered. Aircraft were produced between the years of 1952 and 1962, so the 1957-dollar was chosen as a middle ground for calculating estimated development costs.

Table 11. Average Unit Costs of B-52 Aircraft [4]

TMS	Airframe	Installed Engines	Electronics	Other Including Armament	Total	Number of Aircraft
B-52A	$26,434 K	$2,842 K	$50,761	$48 K	$29,383 K	3
B-52B	$11,328 K	$2,547 K	$61,198	$482 K	$14,431 K	50
B-52C	$5,359 K	$1,513 K	$71,397	$293 K	$7,248 K	35
B-52D	$4,654 K	$1,291 K	$68,613	$548 K	$6,581 K	170
B-52E	$3,701 K	$1,257 K	$54,933	$932 K	$5,948 K	100
B-52F	$3,772 K	$1,787 K	$60,111	$863 K	$6,485 K	89
B-52G	$5,352 K	$1,428 K	$66,374	$840 K	$7,693 K	193
B-52H	$6,076 K	$1,640 K	$61,020	$1,501 K	$9,286 K	102

7.2. Prototyping

Two prototype B-52 aircraft were built for demonstration and testing. The design of the B-52 called for numerous innovations, so prototyping and testing were absolutely necessary. The XB-52, the first of the prototype aircraft, was completed on November 29, 1951 in a shroud of secrecy. During preparation for its maiden flight, a full-scale pressure test of the pneumatic system resulted in a catastrophic failure, shredding the trailing edge of the wings. The XB-52 was returned to the construction hangar for repairs, while the second prototype, the YB-52 was completed. The YB-52 had the honor of the maiden flight of the B-52 on April 15, 1952 with a total flight duration of two hours and fifteen minutes.

7.3. Manufacturing, Testing and Support

Boeing had extensive experience building bombers during World War II, and it needed all of its experience to orchestrate the B-52 production program. The B-52 production became the largest manufacturing project ever undertaken at that time. The project was so demanding that a second production center was needed. The Boeing factory in Wichita, KA eventually assumed primary responsibility for turning out the B-52.

Boeing relied heavily upon subcontractors to furnish components of the B-52. For the prototype aircraft, subcontractors contributed about one-third of the aircraft by weight, but that percentage increased to 57% by the B-52D models.[6] In total, there were more than 5000 different companies involved in the B-52 production effort.

Despite Boeing's extensive experience, some problems were encountered in the production of the B-52. While Boeing encountered little difficulty building and integrating the airframe, some of the suppliers experienced frustrating problems with some of the subsystems. The electrical, hydraulic and pneumatic systems all differed from previous aircraft and required some innovation. The redundant sleeves of the fuel cells which sealed the cells in case of puncture were particularly intractable. The fuselage fuel cells were produced by Goodyear and the wing fuel cells by Firestone.[6] Eventually all of the problems were resolved. In some instances, Boeing sent its own engineers directly to the subcontractors to resolve the manufacturing obstacles. The lead project engineers at Boeing for the B-52 also kept a meticulous eye on every pound, as weight was especially critical to meeting its mission requirements.

7.4. Verification, Validation and Certification

Flight tests of the XB-52 and YB-52 unveiled a few problems with the aircraft. On the maiden flight, one of the main landing gears failed to retract and leaks in the engine oil system were isolated. Boeing aerodynamicists were initially concerned with overbalance of the ailerons, but initial flights of the YB-52 helped to adjust the controls to the proper settings. In general, problems with the preliminary tests were sparse. Boeing even discovered that the drag of the prototype aircraft was 11% lower than predicted, a pleasant surprise for the design engineers.[4] The first week of flight-testing proceeded well ahead of schedule, indicating the Boeing had indeed developed a superb aircraft.

By March 15, 1953 the second phase of testing was completed, but certain flaws had been uncovered. First, the J57 engines had a predilection towards surge during standard throttle adjustments at high altitudes as well as flameout. Additionally, the aircraft demonstrated some pitch and roll stability problems when approaching stall. Finally, the braking distance on landing did not meet predicted performance. These problems were ironed out in the later testing phases.

During the 1950s time, USAF aircraft went through eight phases of testing. The first three phases focused on simple tasks, such as takeoff and landing, landing gear deployment, the fuel system, etc. The description of the subsequent phases follows,[6]

- Phase IV - performance and stability throughout entire flight envelope
- Phase V - All weather operability
- Phase VI - functional development (weapons system)
- Phase VII - Operational suitability
- Phase VIII – Unit operational employment tests (integration with combat forces)

Even after the B-52 was delivered to the USAF, flight and mission testing continued. The USAF used the B-52 to conduct freefall airdrop delivery of both simulated and actual nuclear bombs in Pacific island atolls.

While much attention was given to the two flying prototypes and the B-52As during the test phase, ground testing was conducted on non-flying models. These tests were primarily structural and intended to evaluate fatigue life.

The lessons gleaned from all of these flight and ground tests were invaluable. While some Boeing engineers were busy solving problems with the two prototypes and the B-52As, other Boeing engineers were designing improvements into later models on the drawing board. For instance, the results of structural tests and operational experience of earlier models led to a modification of the wing structure for the G and H models.

By the summer of 1955, Boeing and the SAC were satisfied that sufficient testing and rectifying of problems had been completed. The engines were particularly frustrating as their performance and reliability fell a little short of expectations. The water injection used at takeoff to augment the thrust accelerated fatigue damage of the flaps and the water pumps themselves were unreliable. Nevertheless, although many years since the climactic weekend in Dayton, OH, the USAF was eager to use its hands on its new and extremely capable bomber.

7.5. Disposal

At the height of its strength in 1963, the SAC possessed nearly 650 B-52s distributed amongst 42 squadrons at 38 different bases. The first B-52 was retired from operational status on March 8, 1965. This first retiree became an instructional aid with the Air Training Command at Chanute AFB, IL, but not all the retired B-52s have been so lucky. Most retired B-52s found their way to the Military Aircraft Storage and Disposition Center (MASDC) at Davis-Monthan AFB, AZ, which was renamed the Aerospace Maintenance and Regeneration Center (AMARC) in October 1985 [6].

Today, all but 76 of the original 744 Stratofortresses have been retired. The bombers were retired for a number of reasons. Some aircraft were retired upon reaching the end of their fatigue life, as was the case with the B-52Bs. Some aircraft were replaced with bombers such as the F-

111 or the B1. Other bombers were retired for budgetary reasons, even though they could have been upgraded and still had useful life left in them.

As part of the Strategic Arms Limitation Treaty (SALT) and the 1991 Strategic Arms Reduction Treaty (START), most B-52C, D, E, F, and G models were flown to AMARC at Davis-Monthan AFB and parked in what is commonly known as the "Boneyard." Useable parts were salvaged from each aircraft, which were then systematically destroyed. To disable the bombers permanently and in a way that was visible to orbiting satellites, AMARC personnel used a crane to drop a six-and-a-half-ton steel blade from a height of 80 feet to chop the B-52 into five pieces, as shown in Figure 55 and Figure 56. Figure 55 depicts crews aligning the blade before chopping off the tail of a B-52 at AMARC. The cuts were made at four points on the bomber – the tail, each wing, and the fuselage section just aft of the wings. The wings were then bulldozed so they were parallel to the fuselage, as shown in Figure 56. The remains were left in place for 90 days so that the orbiting satellites of the treaty signatories could verify the destructions. After 90 days, scrap dealers could buy the bomber carcasses for 18 to 30 cents a pound and haul them away [15].

Figure 55. Destruction of a B-52 at AMARC [24]

Figure 56. Demolished B-52 with Wings Parallel to Fuselage [24]

7.6. Derivatives

This section outlines the various derivatives of the B-52, from the experimental XB-52 to the B-52H, which still serves the US Air Force today. Each derivative of the B-52 is discussed in detail below. Appendix B Table 19 provides a detailed description of the differences between the models. Table 12 provides a summary of these differences and Table 13 lists the important dates associated with each derivatives.