B-52, The “StratoFortress”

Aerodynamics and Performance Build-up
Service

• Latest Model
  – B-52H
  – Last B-52H delivered in 1962
• Transonic Bomber
  – Nuclear Payload capable
  – 20 Cruise Missiles
    • AGM-86C
    • AGM-12 Have Nap
    • AGM-84 Harpoon
  – Up to 50,000 lb ordnance payload
  – 51 bombs of 750-lb class

• Crew
  – Upper Deck
    • 2 Pilots
    • Electronic Warfare Officer
  – Lower Deck
    • Bombardier
    • Radar Navigator

• Deployment
  – 102 B-52H’s
  – 192 B-52G’s
  – All in Service of USAF as far as we can tell
  – $53.4 million each [1998$]
Additional Payload

• In addition to attack ordnance, B-52H carries:
  – Norden APQ-156 Multi-mode targeting radar
  – Terrain Avoidance Radar
  – Electro-Optical Viewing System (EVS)
    • Infra-red and low light display used in conjunction with terrain
      avoidance sensors to navigate in bad weather at low
      altitudes, or with the nuclear windscreen shielding in place
  – ECM
    • ALT-28 jammer
    • ALQ-117, -115, -172 deception jammers
  – Optional Stinger Air to Air missiles in aft gun-turret
Weight Breakdown

• Max TOGW
  – 505,000 lb

• Fuel Weight
  – 299,434 lb internal
  – 9,114 lb on non-jettisonable under-wing pylons

• Ordnance Weight
  – 50,000 lb

• Airframe operational empty
  – 146452 lb
Basic Geometry

- **Length**: 160.9 ft
- **Wing**
  - **Span**: 185 ft
  - **Area**: 4000 ft$^2$
  - **Root Chord**: ~34.5 ft
  - **Mean Chord**: 21.62 ft
  - **Taper Ratio**: 0.37
  - **Leading Edge Sweep**: 35°
  - **AR**: 8.56
- **Tail Plane**
  - **Horizontal Tail Span**: 55.625 ft
  - **Horizontal Tail Plan Area**: ~1004 ft$^2$
  - **Vertical Tail Height**: 24.339 ft
  - **Vertical Tail Plan Area**: ~451 ft$^2$
Wing Geometry

• Wing Root: 14% thick NACA 63A219.3 mod
• Wing Tip: 8% thick NACA 65A209.5 mod
  – Paneling is unavailable for these specific airfoils,
  – To the left is a NACA 63A210, and the lift data for a 63A215
Wing Loading

• Cl for trimmed cruise at altitude ~0.37

  – $X_{CP}$ wing = -68.296 ft
  – $X_{CP}$ tail = -130 ft (tail average quarter chord)

  – Main wing carries 85.3% of Load
  – Tail carries remaining 14.7%
Span Loading and Cl Distribution

Load (local/total) and Cl vs Wing Station

- Span Load
- CL distribution
Wing Twist Distribution

Angle Relative to Body Angle of Attack [deg]

Y station (2y/b)
Propulsion

- 8 Pratt & Whitney TF33-P-3 Turbofans
  - Static Thrust: 17,000 each
  - TSFC: 0.52 (lb/hr)/lbf
  - Throughput: 450 lb air / sec each
  - Weight: 3,900 lb each
Performance

• Cruise
  – Ceiling 55,000 ft
  – Wetted Area: 23701 ft^2
    • $C_L$ min drag $\sim$0.3
    • $C_d$ friction $\sim$ 0.01429
    • L/D max $\sim$19
      – cannot fly here
      – Cruise at L/D $\sim$ 11
      – Due to wave drag from Mach 0.75+ flight
  – Range: 10,000 mi
  – Cruise Speed 442 kt
  – Max Speed 516 kt
  – Low altitude penetration speed 360 kt

• Take-off/Landing
  – Ground Roll: 9500 ft at Max TOGW
  – Rotation:
    • None, hence the long ground roll
  – Bicycle Landing Gear
    • 4 carriages with 8 wheels each
    • Outriggers to support wings when fully fueled
High Lift Devices

• The B-52 incorporates fowler flaps along the inboard 62% of the wing, terminating at the start of the exhaust from the outboard engines. It incorporates a gap for the exhaust of the inboard engines.

• When extended, they have ~30-35% local chord length, for a total area of ~1100 square feet.

• They are deflectable to ~40°

• Spoilers also used in high lift flight
Dynamics and Control

- Neutral point at $x = -76.2$ ft, just aft of the wing root
- Balanced slightly stable
  - CG $x = -78.5$
  - NP $x = -76.2$
  - Yields static margin of 2.3 feet
B-52 Control Surfaces

• The B-52H uses 7 spoilers above each wing for roll control.
• A fixed horizontal tail with trailing edge deflections for pitch control.
• Vertical tail with trailing edge deflections for yaw control.
Changes with Model

• Use of ailerons and 6 spoilers for roll control in the A-F models,

• G&H models use 7 spoilers and no ailerons