[From: "Death’s Twilight Kingdom: The Secret World of U.S. Nuclear Weapon ‘Design Data’ “
By Yogi Shan]

[September 2017 Update]


“I was sent on a classified mission.”

“Well, it’s not ‘classified’ anymore, is it?”

-- Col. Kurtz’s answer to Capt. Willard in “Apocalypse Now” (1979)

Basic A-Bombs

1. The dimensions and configuration of the Fat Man’s Urchin internal (\(\alpha, n\)) neutron initiator were:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer diameter of the hollow beryllium sphere</td>
<td>2.0 cm</td>
</tr>
<tr>
<td>Number of wedge-shaped grooves in outer shell</td>
<td>15</td>
</tr>
<tr>
<td>Radius of base of grooves</td>
<td>0.40 cm</td>
</tr>
<tr>
<td>Radius of apex of grooves</td>
<td>0.609 cm</td>
</tr>
<tr>
<td>Outside diameter of internal solid beryllium sphere</td>
<td>0.80 cm</td>
</tr>
</tbody>
</table>

**Amount of polonium-210 on surfaces of all grooves:** 30 Curies

**Amount of polonium-210 on surface of solid sphere:** 20 Curies (Total of 50 C = 11 mg). (8)

2. The later developed TOM internal (\(\alpha, n\)) neutron initiator was a Tungsten on Molybdenum Ball. (2)

3. The 1951 Operation Ranger, Event Able (yield of 1.2 kt) was a half-crit Oralloy (Oy) test. Tests Baker-1 and Baker-2 (both 8 kt) were both half-crit Pu tests of identical devices. (2)

4. The 1951 Operation Greenhouse, Event Dog was a proof-test of the new Mark 6, 54” dia. HE geometry design, and produced a yield of 81 kt. It was a split-levitated version of the 1948 Operation Sandstone, Event X-ray 37 kt composite solid core Mk 4, 54” diameter HE geometry, a yield improvement of 2.2x. (3)

5. The 1951 Operation Greenhouse, Event Easy, a proof-test of the 40” diameter Mk 5, was a split-levitated design, producing a yield of 47 kt, a 30% increase over the 54” dia. Mk 4 37 kt bomb. The Mk 5 was first tested with a 21 kt Fat Man core, producing double (2.2x) the yield (47 kt) when tested. (3)

6. The 30” dia. Mk 7 had a 6.5” thick HE layer, with an 8 kg Oy split-levitated core of outside dia. 8.5”. (3)

7. The 1952 Operation Tumbler-Snapper, Events Easy and How were tests of the new 22” dia. Mk 12, which used split-levitated, composite cores, one with the usual uranium reflector, and the other testing a new beryllium metal reflector:

<table>
<thead>
<tr>
<th>Test</th>
<th>Yield</th>
<th>Weight (lbs.)</th>
<th>HE</th>
<th>Initiator</th>
<th>Reflector</th>
</tr>
</thead>
</table>


Both devices had an **HE layer thickness of 8”**. (3)

8. The 1.7 kt, 17.4” dia. W-25 warhead used a **solid** composite core. (1)

9. The 67 kt, 22.2” dia., 372 lb. boosted W-30 had an **5” thick** PBX 9010/9404 HE shell, surrounding a **12” dia. hollow** all-Oy core. (2)

10. The 28” dia. boosted W-31 had an **8” thick HE shell surrounding a hollow core 12” in dia.** (2)

11. The W-44 ASROC warhead used the same **pit as the 17” dia. W-34**, with a smaller dia./lower weight of explosives used in the 81 lb., 13.75” dia., 5 kt W-44. (2)

12. The W-48, used in the 155 mm/6” dia. artillery shell, had a **72 ton yield**, dimensions of **5.5” x 21.1”**, 110 lbs. (3)

13. The Mk 54/Davy Crockett was a 10.9” dia., pure fission device, with an approx. **3 kg α-plutonium core**, with a beryllium reflector, **2.5” thick PBX HE**, and had an alpha of **2 every 10 ns** (1 generation every 5 ns). (5)

14. W-55 Subroc warhead was a **12.7” dia.**, 61.5 lb. gun assembly device, with a **6.4 kg U233 core**, with a beryllium reflector, thorium tamper; D/T gas boosting, and an **8.4 kt yield**. (8)

15. The generation time (alpha) for early plutonium implosion devices “varies from 1-6 “as [the] bomb goes from low yield to high yield.” “[F]or [the 1955 Operation Teapot] Wasp devices alpha = 4 unboosted, [and] alpha = 6 boosted.” Boosted fission generation time in 1955 was thus 1.7 ns. (3)

16. A **D-T boosted, fractional crit** A-bomb could use reactor-grade (25% Pu240) plutonium, instead of the normal 5.5% Pu240 Weapons-Grade Pu, with **no degradation of yield**. (4)

17. A Russian-designed 150 lb., 16” dia. A-bomb could give a yield of 0.25 to 15 kT (thus an increase in yield of 60x with D/T boosting), using basic spherical implosion, boosted A-bomb technology. (1)


19. **Prices** of Oy and Pu and tritium. (3)

The H-Bomb

20. 1) The H-bomb consists of “Primary” and “Secondary” stages, which are physically separate (i.e., separate units a distance apart).

2) The device works by the process of “radiation implosion”. The Primary, which consists of a small diameter (originally 10 – 60 kt), implosion A-bomb, is first detonated.

80% of the Primary’s yield is released as bomb-thermal x-rays, which radiates outwards, and are absorbed by the outer shell of the thermonuclear Secondary, which heats up, and **explosively ablates** (vaporizes), implosively compressing the lithium deuteride (LiD) fuel inside it, and
then compresses, heats, and ignites the small, centrally-located deuterium-tritium (D/T) gas “spark-plug”, which then ignites the fusion of the surrounding main charge of compressed LiD fuel.

3) The burning LiD fuel is finally further compressed and held together longer by the eventual timed (by using a long cylindrical outer casing) arrival of a shower of neutrons (from the exploding Primary), which fissions the Secondary’s outer uranium shell (and also further adds the majority of the weapon’s total yield). (9)

21. A beryllium metal reflector is essential for the best performance of an H-bomb Primary, due to beryllium’s x-ray transparency. (1)

22. Lowest weight, and especially smallest dia. Primary as possible is used to maximize its x-ray output. (2)

23. Dense plastic foam (they also used cardboard; but now use silica aerogel) holds the Primary in its central position in the case and absorbs, slows, and reduces its HE’s outward explosive force, allowing a smaller diameter outer casing. Early H-bombs had to have an outer casing of double the diameter of the Primary to avoid casing breech before the fusion reaction had ignited. (1)

24. The first Secondaries (1952 – 1980) were spherically-shaped. LLNL later (>1960) developed a cylindrical Secondary with a central hole running along its longitudinal axis. The modern (W80 and W84 warheads), more efficient Secondary fusion capsule is a torus (“doughnut”) shape. (3)

25. Thermonuclear weapons have a much higher fission than fusion yield. The fission/fusion ratio of standard H-Bombs is not the “official” value of 50% fusion and 50% fission, but more like one-third fusion, and at least two-thirds fission (except lower yield, lower fission “clean” weapons). (1)

26. The minimum yield required to initiate the D/T gas in the H-bomb’s boosted Primary or in boosted atomic weapons is only about 20 tons/0.02 kt. (1)

27. The ratio of D/T boost gas is listed as the unclassified 50/50 value, a rather convenient figure, and one that close examination would reveal is false. There is a large excess of deuterium in the mixture, to ensure that the tritium reacts with a maximum amount of deuterium easily and quickly. (1)

28. The use of 40% enriched Li6D doubled the yield of the same-sized device over natural 7% Li6D. The use of 96% enriched Li6D increased the yield by four times over natural LiD. (2)

29. Using Oralloy (U235) instead of natural uranium (U238) in the Secondary triples the yield. (1)

30. From the outside going in, the layers that make up an H-bomb’s spherical Secondary are:

1) a thin beryllium outer layer,

2) a solid 60% mercury – 40% thallium alloy ablation layer,

3) a thin graphite insulating layer,

4) a thick Uranium pusher layer that also fissions in synergy, well after fusion starts in the Li6D,
5) the main Li6D fusion fuel layer, containing most of the make-up of the Secondary sphere,

6) beneath the main Li6D charge, a thin inner shell of Li7D,

7) the metallic thin spherical beryllium external spark-plug container for the D/T gas boost of the spark-plug,

8) the spark-plug: a hollow Be core until filled with a gaseous mixture of tritium and considerably more deuterium. (6)

31. The 1951 Operation Greenhouse, Event George used a cryogenically-liquefied D/T gas mixture. The test produced a yield of 225 kt, probably indicating the fusion of about 150 g of tritium (mixed with an excess amount of 600 g of deuterium), which then fissioned 11 kg of U238 (natural uranium).

The George shot probably used a 15 kt gun assembly Oralloy fission A-bomb to initiate the fusion of the D/T mixture. (2)

32. The 1952 Operation Ivy Mike H-Bomb prototype’s 10.4 MT total yield was 77% fission and 23% fusion. It used an estimated 250 - 300 g of Tritium in its D/T spark-plug in the center of the main liquid deuterium charge, to initiate ignition of it. Detonation of its 40” dia. Mk 5 Primary compressed the liquid deuterium to 700x its normal density (0.14 g/cm3 to 98 g/cm3). (4)

33. A Mk 7, 28” dia. Primary was used in the 1954 Operation Castle (Events Bravo, Romeo, Union, and Yankee) 60” and 54” dia. H-bombs. (2)

34. 1954 Operation Castle:

<table>
<thead>
<tr>
<th>Event</th>
<th>Fission Yield</th>
<th>Fusion Yield</th>
<th>Fission % of Total Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bravo</td>
<td>10 MT</td>
<td>5 MT</td>
<td>67% fission</td>
</tr>
<tr>
<td>Romeo</td>
<td>7 MT</td>
<td>4 MT</td>
<td>64% fission</td>
</tr>
<tr>
<td>Union</td>
<td>5 MT</td>
<td>1.9 MT</td>
<td>72.5% fission</td>
</tr>
<tr>
<td>Yankee</td>
<td>7 MT</td>
<td>6.5 MT</td>
<td>52% fission</td>
</tr>
<tr>
<td>Nectar</td>
<td>1.35 MT</td>
<td>0.35 MT</td>
<td>80% fission</td>
</tr>
</tbody>
</table>

10% of Castle Bravo’s fission yield (6.7% of its total yield) was produced by 14 MeV neutrons generated by fusion. (6)

35. 1955 Operation Teapot Primary yield from mockup test:

Apple-2 29 kt 29.5” x 75” 2,300 lbs. (2)

36. 1955 Operation Teapot, Event Turk, held by UCRL, was of a Mk 27 mockup, using an 8 kt, 17” dia. boosted A-bomb Primary with a 3.5” thick HE shell:

Turk 43 kt 30.5” dia. x 61.3” long 2,335 lbs.

The Mk 27 had a 1” thick outer casing, and used solid foam blocks to hold its A-bomb Primary 9.5” from the inside of the hemispherical casing end, and 5.5” from the inside of the outer cylindrical casing walls. (6)

37. An estimated 6 g Tritium used on average per boosted Primary shot and almost 2 g Tritium per 40% Li6D Secondary spark-plug around 1955/1956. (2)
38. A boosted 17" dia. Primary was used in the 1956 Redwing Cherokee test of the 34.5" dia. Mk 39 which had a yield of 3.9 MT. (1)

39. The 1958 20" dia. Mk 28 uses a boosted 10" dia. spherical Primary with a core of 1.5 kg Pu + 4.5 kg Oy + 3 g D/T, with a yield of approximately 14 kt, and a Secondary using 8.5 g D/T. (6)

40. The Mk 28 had an outer casing starting with an outer corrosion-resistant layer of 0.029" (29 mils) thick AISI 304 stainless steel, then a 0.281" thick aluminum layer, the structural material of the casing. From the outside Al layer going in, was then a layer of 0.040" (40 mils) thick uranium, followed by the innermost layer of 0.082" (82 mils) thick beryllium. The U238/Be layers were the “radiation case”/hohlraum. The beryllium layer’s function is to temporarily inhibit the heated plasma “blow-off” from the uranium layer below it. (10)

41. The Mk 36 had a yield of 19 MT. (1)

42. The 1960 Polaris A-1’s W-47Y1 warhead had a 400 kt yield using a U238 Secondary; the 1962 Polaris A-2’s W-47Y2 had a 1.2 MT yield using an Oy Secondary. (4)

43. The Russian Tsar Bomba, fired in 1961 at a reduced yield of 58 MT with a non-fissile Secondary tamper, had a full fission design yield, using a U238 Secondary tamper, of 150 MT. It used a 30" dia. boosted Primary and had an external casing O.D. of 2.1 m/6.9’. (3)

44. The W-56 Minuteman I & II warheads had a yield of 1.3 MT, dimensions of 17.1” x 38”, and weighed 564 lbs. (3)

45. The Mk 57 bomb had a 10 kt yield. (1)

46. The W-58 Polaris A-3 MRV warhead had a yield of 200 kt, dimensions of 12.6” x 32”, and weighed 220 lbs.; used a 96% Li6D Oy Secondary; and used a 4” thick Primary HE Shell. (6)

47. The 1962 W-59 initial Minuteman I ICBM warhead had a yield of 870 kt, dimensions of 15.75” x 48”, and weighed 553 lbs. (3)

48. The B61 bomb had a 330 kt yield. (1)

49. The W-62, the MM III’s initial warhead, had a yield of 170 kt, dimensions of 8” dia x 18”, weighed 125 kg, with a CEP of 0.25 nm. (3)

50. The W-68 Poseidon SLBM warhead had a yield of 40 kt, 8” dia. x 24” long, weighing 60 lbs., with a CEP of 0.5 nm. (3)

51. The 1975 Spartan ABM missile’s W-71 warhead used metallic gold (100% Au197 isotope) surrounding the Secondary, that reacts with neutrons to produce 0.4 MeV gamma rays through the reaction Au197 (n,γ) Au198 and makes the warhead “hotter”. (1)

52. The 1979 W-78 MM III upgraded warhead has a yield of 500 kt, is 8” dia. x 18” long, and weighs 275 lbs. (2)

53. The 18” dia. B83 bomb has a yield of 3.2 MT. (1)

54. A 15 kt Primary for a 365 kt Mk 28Y1 (20” dia. x 55” long).

A 25 kt Primary for a 400 kt W-47Y1 (18” x 34” small size warhead) and 1.2 MT W-47Y2 (18” x 47”).

An 8 – 40 kt Primary for a 1.85 MT Mk 27 (30.5” dia.) & 3.8 MT Mk 39 (34.5” x 100”).

A 81 kt Primary for 9 MT W-53Y2 (37” x 103”) & 25 MT Mk 41Y1 (48” x 112”). (10)
55. The more modern W80 and W84 (the latter weighing 24 kg/53 lbs.) cruise missile H-bomb warheads use super-grade plutonium (97 - 98% Pu239) in the Secondary instead of Oy. (3)

56. As low as 2 - 3 kg of α-plutonium is used as the total fissile material in the modern hollow cylindrical Primary core. (2)