UK versus USA and USSR nuclear warhead designs history and its relevance for today's strategic and tactical nuclear weapons in East and West

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ABSTRACT

This paper reviews the declassified technical data in the official book "Britain and the H-Bomb". Secrecy-cleared UK thermonuclear warhead historian Lorna Arnold (and her assistant Katherine Pyne) in the UK official history "Britain and the H-Bomb" summarized Atomic Weapons Establishment secret data on UK thermonuclear warhead design tests up to the early interchanges of H-bomb data with America, in 1958-59. The book's information clarifies beyond any doubt the role of plastic foams in dispersing x-rays in the British type of weapon with an isotropically compressed spherical secondary stage, as opposed to the USA use of foam as simply a "radiation mirror" to re-radiate soft x-rays onto the cylindrical Teller Sausage secondary stage requiring only axial compression. Comparing this information to declassified double-primary Russian nuclear warhead design data (see nukegate.org for that) conclusively confirms the different merits of different approaches. This information should be available to inform public debate on not merely whether we have a nuclear deterrent that is efficient and cost effective, but the designs we really need; whether they come from a secrecy-obsessed groupthink culture that drives warhead design into an expensive, inefficient, incredible dead end; or radical, innovative, cheap, credible designs. A summary is given in Fig. 1 of this paper.

INTRODUCTION

"The Halliard 1 warhead - a triple bomb [fission primary "Tom", x-ray imploded fission second spherical stage "Dick", and x-ray imploded third spherical stage "Harry" containing a spherical fissile core surrounded by a layer of lithium deuteride fusion fuel and an outer ablator shell of fissionable U238] - excited technical interest ... The American scientists, Cook noted, used a cylindrical second stage, which the Americans considered more amenable to calculation. (This was surprising to the Aldermaston scientists; it was partly because of the difficulties of computation and their lack of computing power that they had decided on spherical secondaries which, despite their limitations, reduced the need for complex implosion calculations.) ...

"K. V. Roberts, the [UK Atomic Weapons Research Establishment] theoretical physicist, recorded his impressions after the meeting: 'US double bombs are like ours - Tom -> radiative implosion -> Dick. But ... their Dick is cylindrical not spherical ... We've always considered that with a spherical Dick a slight difference of time or pressure over the outer surface of Dick is unimportant and have not tried to correct for this. But with a cylindrical design the different sections of the Dick implode essentially independently and ... it is essential to calculate the pressure time curve accurately for several points along the axis and to allow for variation'.

"Teller ... thought cylindrical geometry was the natural geometry to use; it had the advantage of allowing a greater volume of material to be imploded in a case of given dimensions. Case weights were lower in American bombs, yet calculated compressions were greater. ... the American designs were not very superior to the British; their superiority had been achieved by careful optimisation of a design which offered more freedom."

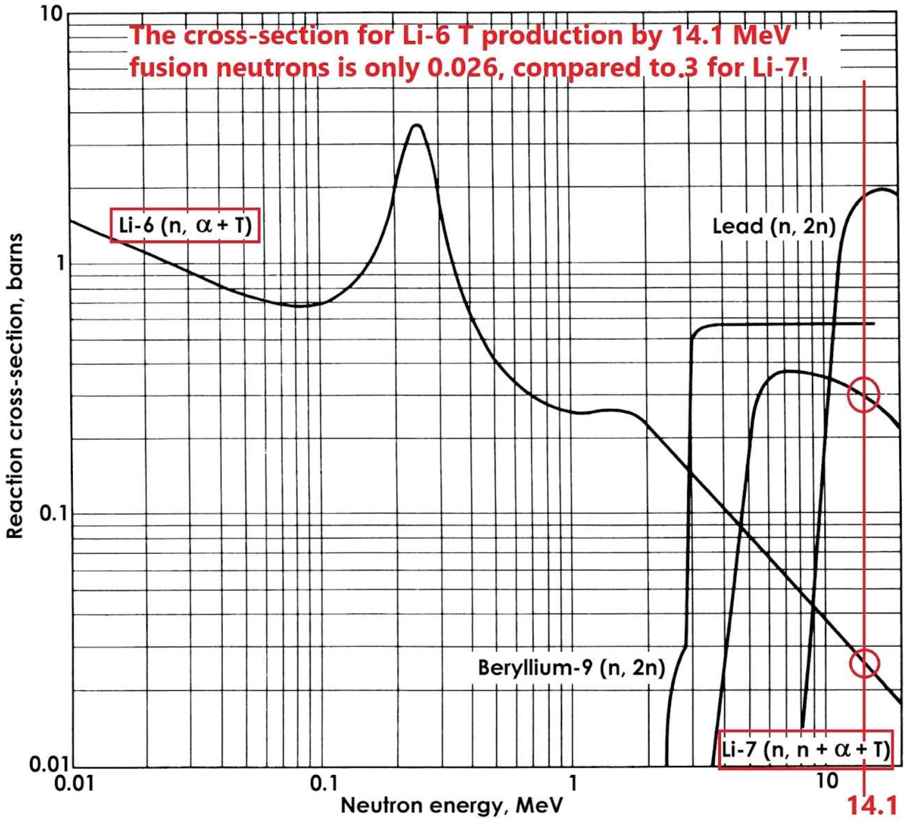
- Lorna Arnold, "Britain and the H-Bomb", Palgrave, 2001, pages 208-209 (Report by UK Atomic Weapons Research Establishment's Deputy Director Sir William Cook et al. on the Second UK-USA warhead designs exchange meeting, held at Sandia, 19 September 1958).

This quotation compresses a lot of previously top secret general thermonuclear design information, debunking nonsense and explaining differences in thinking about the drawbacks with computer models and with Teller's original 1946 cylindrical shaped fusion superbomb computational dogma. Both the UK and Russia went straight in with spherical secondary stages, now quid pro quo in Western compact MIRV warhead design. However, Arnold traces in detail how this amazing divergence in USA and UK approaches developed. Adding this to declassified US and Russian nuclear warhead design data, we get a complete understanding of the basic principles of evolution all employed nuclear design options. (This information is entirely in the public domain, and is all available already to potential rivals.)

RUSSIAN DEVELOPMENT OF CLEANER LOW YIELD TACTICAL NUCLEAR WEAPONS / PNEs

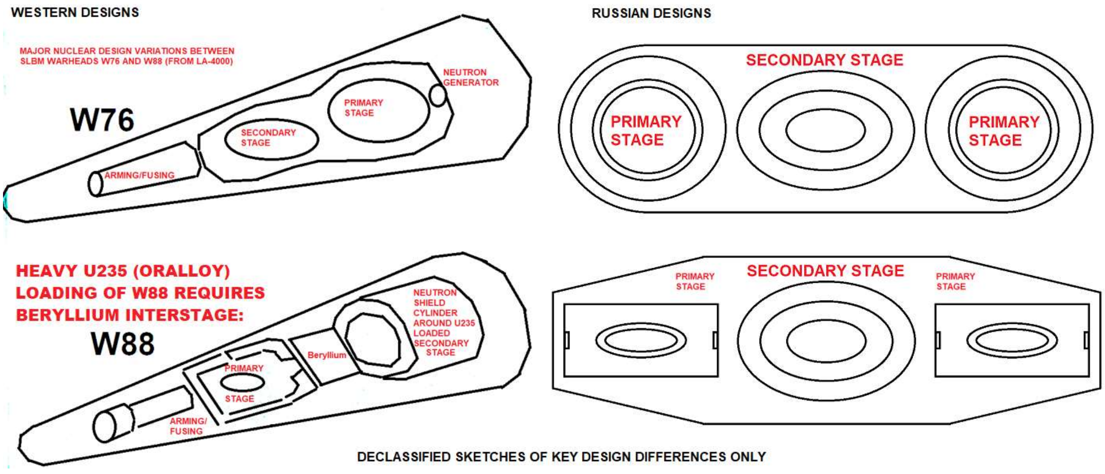
Испытания ядерных зарядов

TEST № по каталогу	DATE Число, месяц, год	PLACE Место проведения испытаний	KILOTONS Энерговыделение, кт ТЭ	Примечание	
245	13.02.1966	СИП шт.Е-1	125	Испытание заряда с термоядерным блоком, содержащим дейтерий под большим давлением	PURE DEUTERIUM GAS UNDER HIGH PRESSURE
280	07.01.1968	СИП шт.810	7.5	Физический опыт для определения минимального количества дейтерия, которое может устойчиво взрываться.	TEST OF MINIMUM YIELD FOR PURE DEUTERIUM FUSION CHARGE BURN
294	09.11.1968	СИП шт.606	4	С 1967 по 1970 гг. испытывался заряд с термоядерным блоком, дающим минимум наведенной активности. Всего проведено 8 таких опытов.	EXAMPLES OF NUCLEAR TESTS FOR DEVELOPMENT OF LOW YIELD CLEAN CHARGE
296	18.12.1968	СИП шт.508	8.9		
299	13.04.1969	СИП шт.24П	0,001-20		
302	04.07.1969	СИП шт.710	15		
333	22.03.1971	СИП шт.510П	67		
357	28.03.1972	СИП шт.191	6		
377	10.12.1972	СИП скв.1204	140	Испытание особо "чистого" заряда с высоким коэффициентом термоядерности (около 1%)	140 KILOTON TOTAL YIELD CHARGE OF ONLY ~1% FISSION YIELD
382	23.07.1973	СИП скв.1066	212		
400	31.05.1974	СИП скв.1207	71		
422	08.06.1975	СИП шт.165	32		
616	18.08.1983	СИПНЗ шт.А-40	0,001-20		
658	28.12.1984	СИП скв.1353	0,001-20		

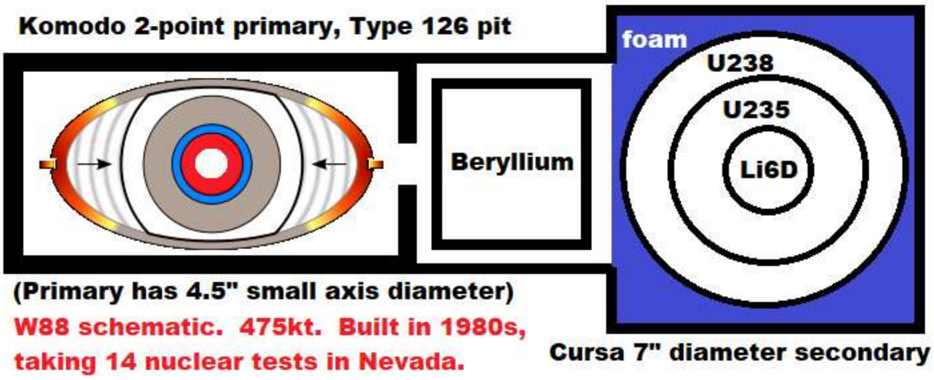


Proved in the successful 9.96 megaton Ripple II secondary stage test (99.9% clean bomb, employing 10 kt boosted Kinglet primary) by John Nuckolls; Dominic Housatonic, on 30 October 1962.

The Ripple II nuclear test secret: why lithium-7 is actually better in boosted clean secondaries than lithium-6! For 14.1 Mev neutrons from T+D fusion, lithium-7 has a 0.3 barns cross-section, compared to just 0.026 for lithium-6! Plus, it gives ANOTHER neutron UNLIKE lithium-6.



DECLASSIFIED SKETCHES OF KEY DESIGN DIFFERENCES ONLY



Change in entropy,

$$\Delta S = nC_v ln(T/T_o) + nRln(V/V_o)$$

Hence, for isentropic compression (no change in entropy):

$$\Delta S = 0$$

Therefore:

$$C_v ln(T/T_o) = -Rln(V/V_o)$$

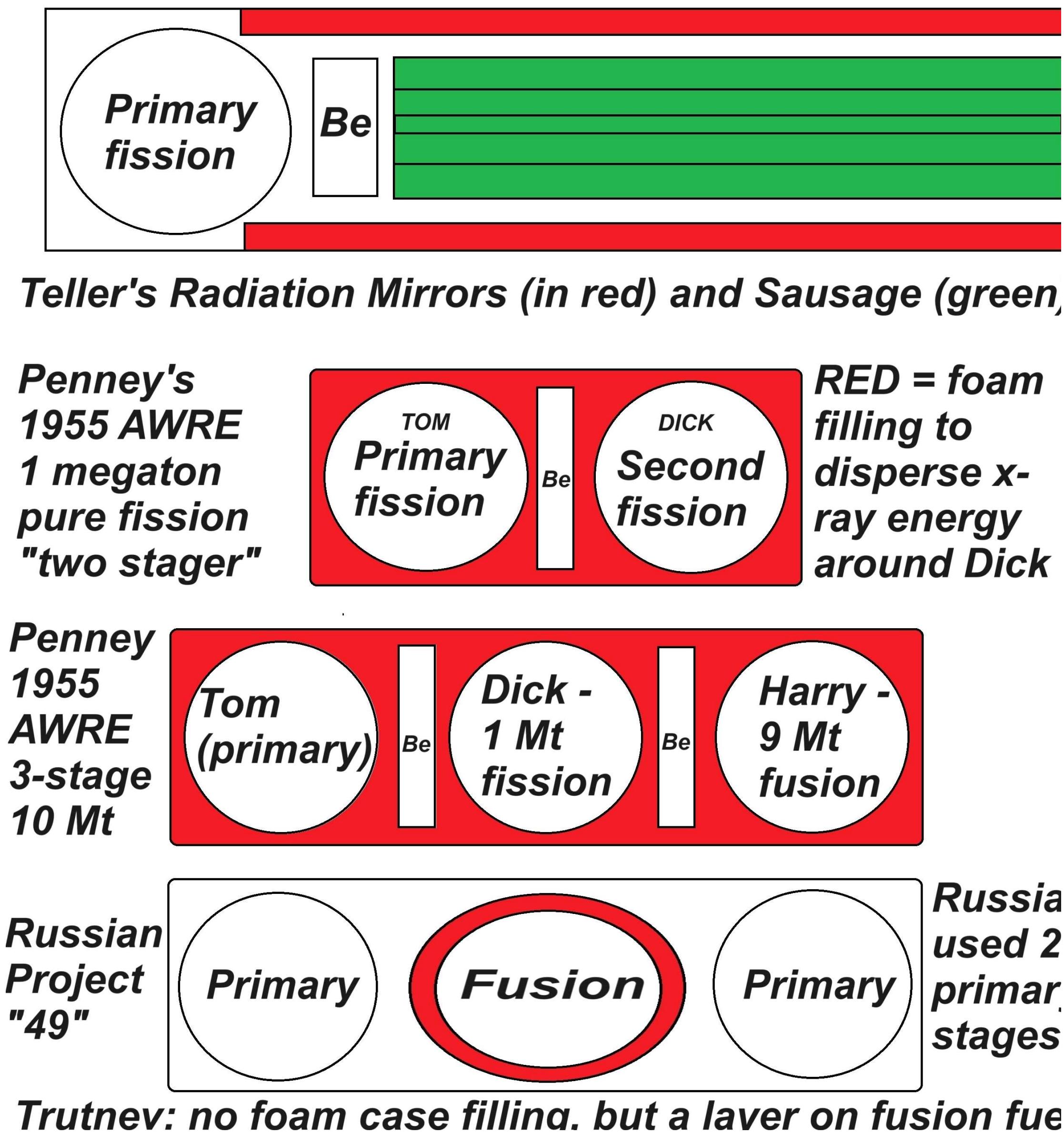
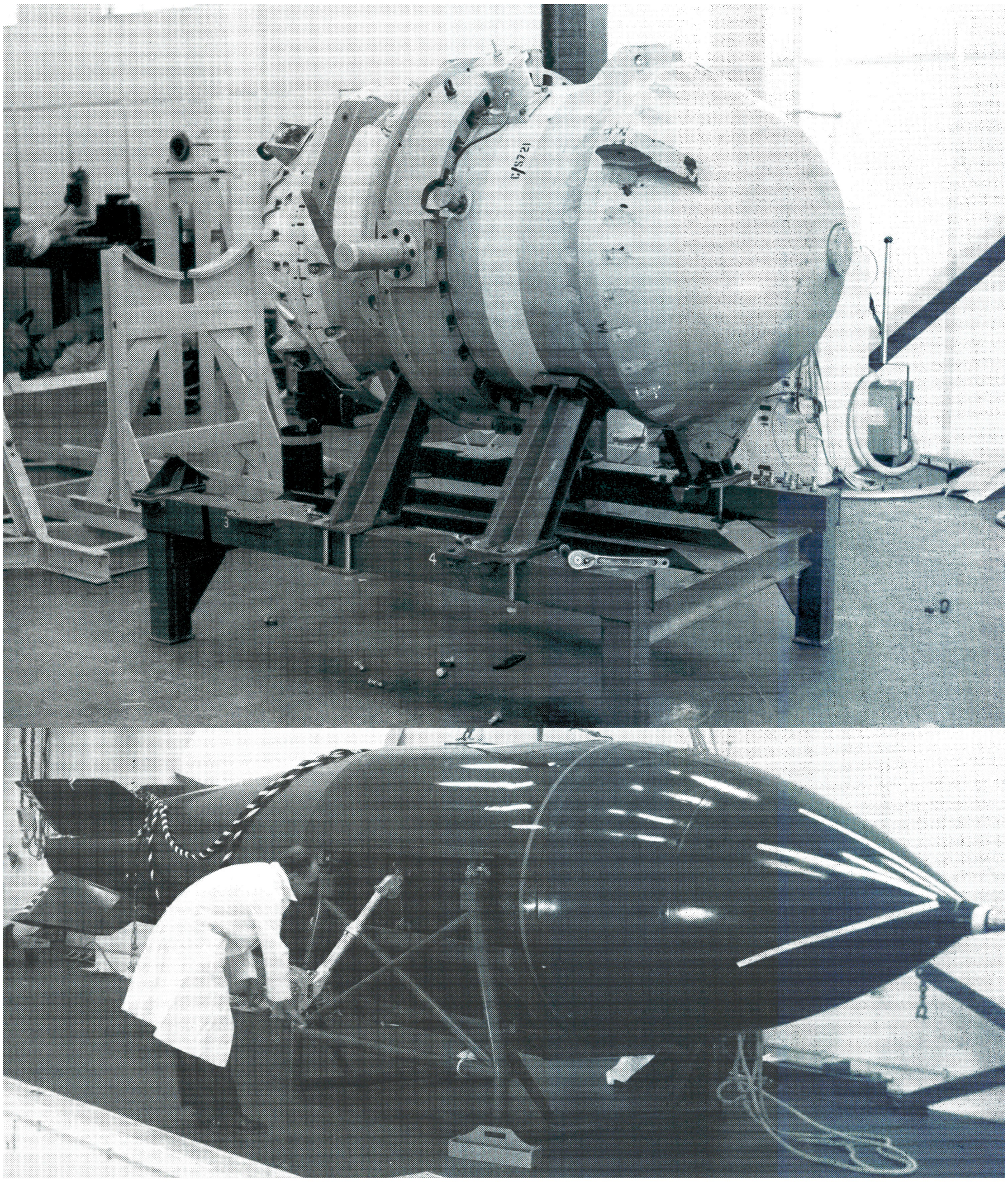


Fig. 1: Comparison of key differences in approach to nuclear warhead design by West and East. The layer of light material on the surface of the fusion stage in most Russian weapons tested and stocked since their first very bulky 1.6 megatons two-stage test in 1955 lends itself to a more efficient isentropic compression. That first Russian two-stage test used a massive pear-shaped casing to focus x-rays on the far side to fill the radiation shadow that would otherwise occur on the spherical secondary stage due to its own self-shielding of x-ray isotropy, instead of using a foam disperser to fill a smaller radiation channel, as used by UK and USA in weapons with spherical secondaries. Russia then miniaturised by simply avoiding the whole problem of a single primary x-ray being non-uniform due to self-shielding by the secondary (causing anisotropic compression of the spherical secondary and failure): it used a double-primary compression system with success on 23 February 1958. Thus, Russia does not need a radiation channel foam filling to disperse x-rays uniformly over the secondary. This efficient Russian double-primary design has neutron immunity without requiring expensive 12.3 half life T+D boosting, due to the smaller amount of fissile material

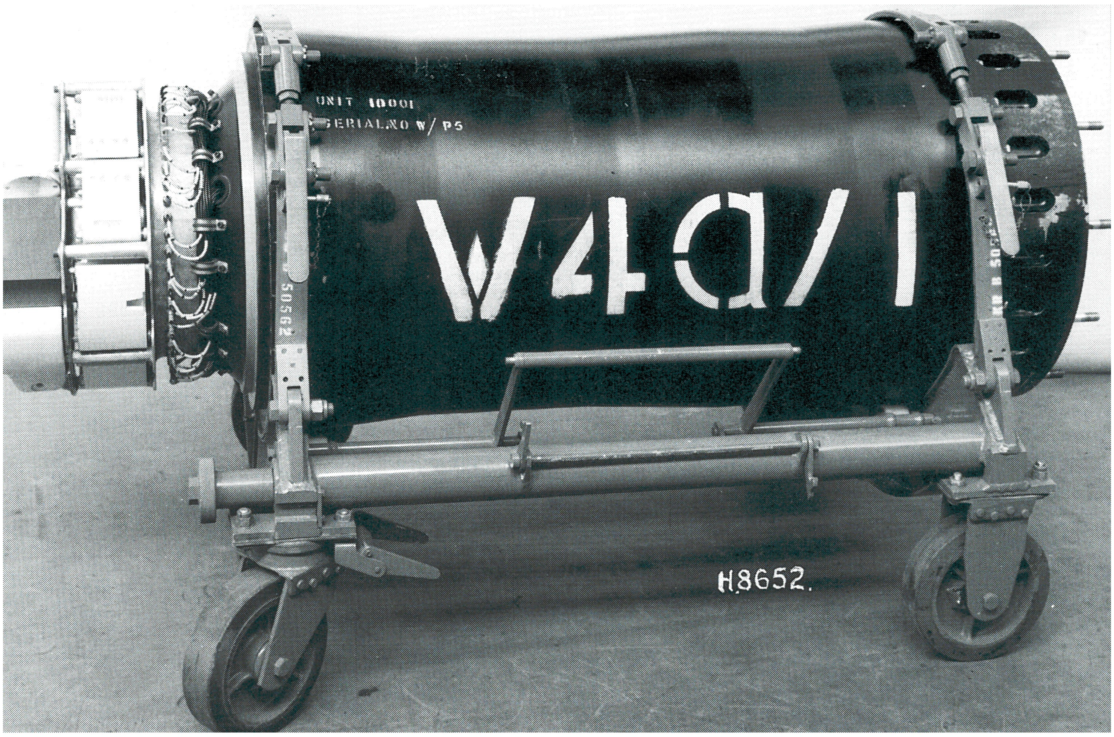
needed in each primary stage. (Boosting in Western primaries is used simply to half the fissile material needed for a given yield, thus reducing neutron multiplication ABM vulnerability.) By not requiring a foam filling, the Russian devices x-rays can deliver energy far more efficiently to compress a prolate-spheroid shaped fusion capsule into a sphere, allowing greater compression of easier-to-compress LiD than the dense oralloy used in the W88, providing a cleaner (lower fission yield, greater fusion yield) high neutron output warhead, of less cost, greater invulnerability to ABM, and long shelf life (no T!).

John H. Nuckolls has a freely available declassified data filled book describing some of the physics relevant to his 99.9% clean nuclear bomb design at his https://www.osti.gov/biblio/1016296 Nuckolls on 30 October 1962 tested a 9.96-megaton bomb isentropically and isotropically ignited using sub kev x-ray spectrum from a 10 kt Kinglet primary stage, delivered via foam baffle control in a specially shaped pulse history 100% clean (purely fusion) Ripple II spherical secondary stage, resulting in a 99.9% fusion, 0.1% fission detonation reported openly in the New York Times that day. The Ripple II nuclear test secret is shown in the graph above: why lithium-7 is actually better in boosted clean secondaries than lithium-6! For 14.1 Mev neutrons from T+D fusion, lithium-7 has a 0.3 barns cross-section, compared to just 0.026 for lithium-6! Plus, it gives ANOTHER neutron UNLIKE lithium-6. Below we shall see relevant UK nuclear wepon test data for a variety of spherical secondary stage designs, which provides hard evidence confirming the physics, e.g. see in particular paragraph 29:

"The next test, Grapple Y on 28 April 1958, the largest UK nuclear test ever conducted at 3 megatons, was K. W. Allen's idea to change the secondary design by reducing the U235 core to make more room for LiD which is easier to compress than U235, replacing most of the Li6D with a lot of Li7D, and replacing the outer U shell with thorium: 'Reducing the uranium-235 would make greater compression possible.' (Arnold, p167.) Reducing the amount of dense fissile material in the secondary to increase its compression may sound superficially counter-intuitive, but computer calculations plus actual nuclear testing proved it to be true!"

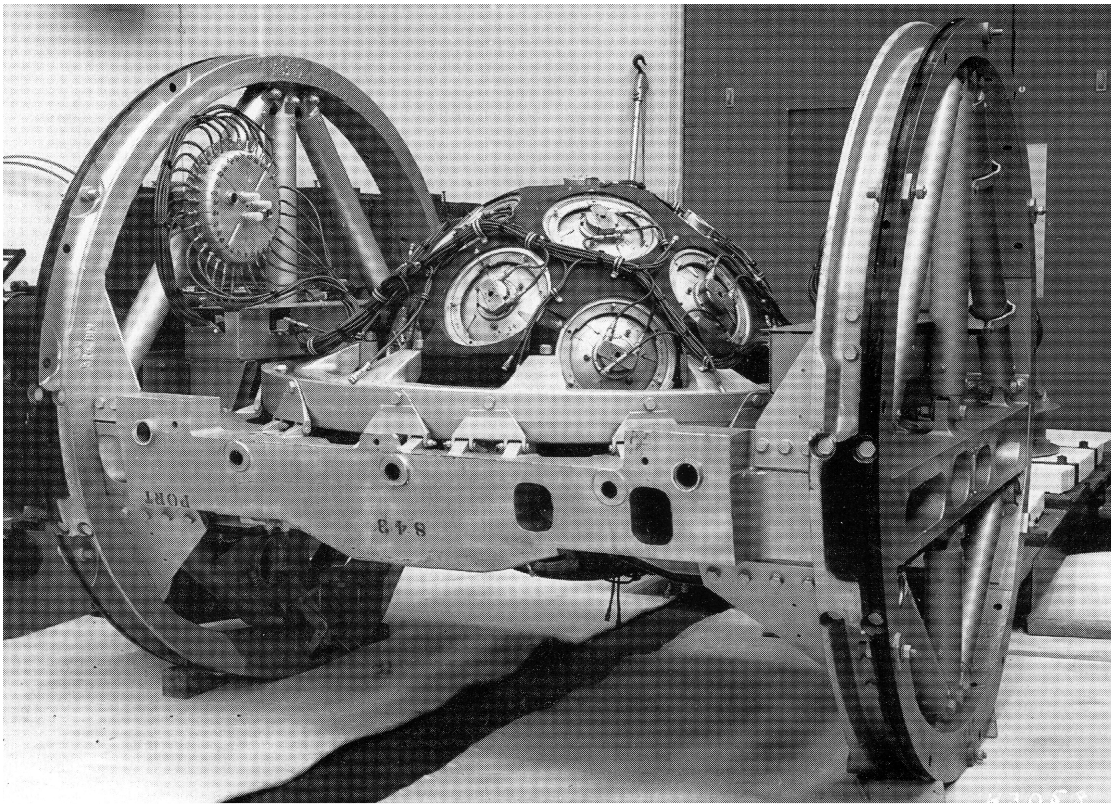


UK's 1957 two-stage radiation coupled 300 kt yield Short Granite and its 24 ft long, 5 ft diameter Blue Danube air burst drop casing

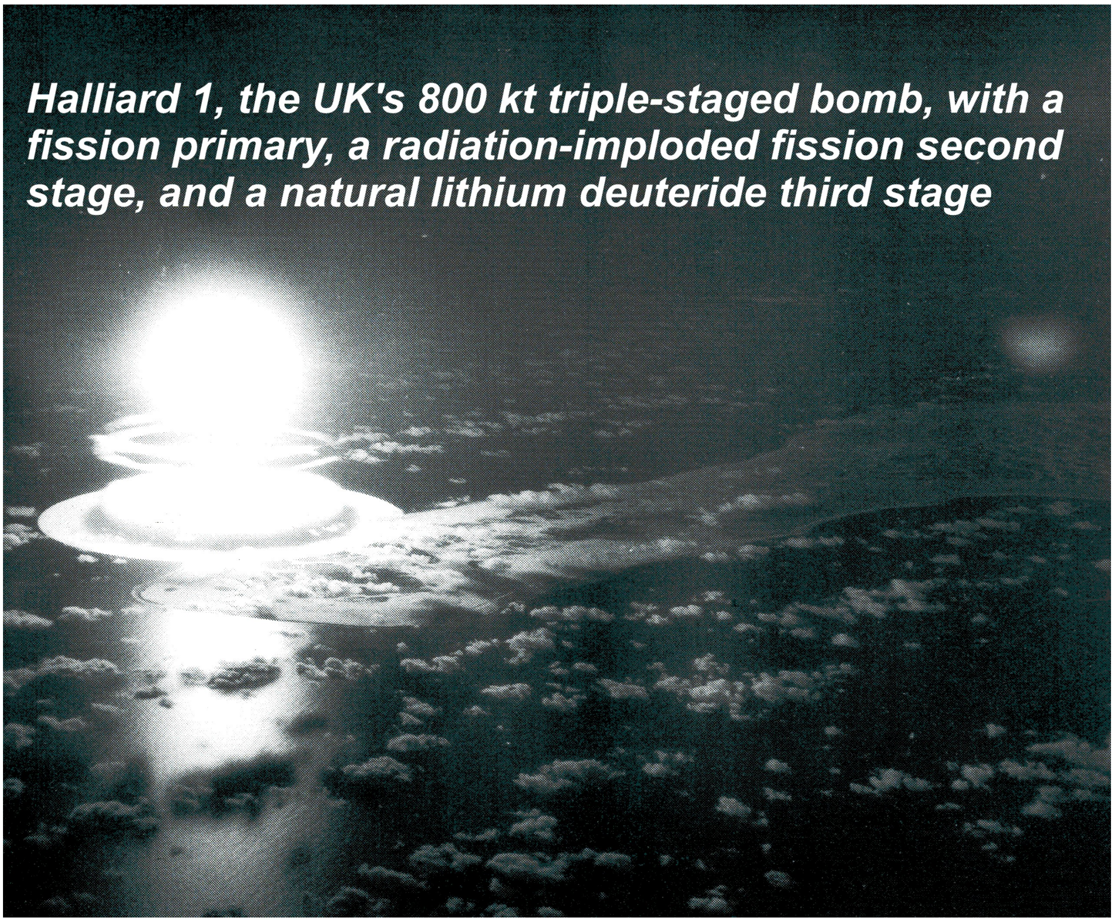


UK's 1.1 megaton Red Snow, the American B28 exchanged for test data on the UK's 800 kt Halliard 1 triple-staged bomb.

UK-USA September 1958 nuclear warhead design exchange at Scandia. L-R: Starbird, Henderson, Bradbury, Cook, Teller, Loper.



Orange Herald: physically small sized 700 kt U235 implosion bomb with a "very thin HE layer". Boosting failed.



THE HISTORY OF UK THERMONUCLEAR WARHEAD DESIGNS

Journalist Chapman Pincher's 1955 Discovery magazine biography, "Sir William G. Penney," states that when Penney attended the American nuclear weapon tests of Operation Teapot at the Nevada in May 1955 (the first American tests he had been invited to since Operation Crossroads at Bikini in 1946!), he stayed up all night drinking beer with key American nuclear testing personnel who knew the basic principles (but were not dedicated bomb designers). Nevada tests were regularly delayed while waiting for weather systems to deflect the prevailing Westerly winds blowing towards St George, to the East of Nevada. Frank H. Shelton and Alvin C. Graves were then both gratefully invited by Penney to attend the Australian-British Operation Buffalo nuclear tests the next year in Maralinga, Australia.

While testing physicists Shelton and Graves were barred (by the 1954 Atomic Energy Act) from discussing with Penney the "top secret" design of the cylindrical Sausage thermonuclear stage, they could informally discuss "secret" matters, and had since February

1954 been officially exchanging classified test effects data. Shelton describes his and Graves' 1956 visit to Maralinga, Australia to watch UK Operation Buffalo in his "Reflections of a Nuclear Weaponeer." (Shelton there describes in detail how Graves could explain interstage radiation coupling, without giving out top secret Sausage design details.)

Arnold does not mention Penney's fishing trip to Nevada in May 1955, but she does focus attention on the alleged role of quantum field theorist (Ward identity prover), John C. Ward, who really developed a cylindrical thermonuclear stage design including central U235 spark plug at Aldermaston in 1955, independently of Teller and Ulam! After a US cylindrical thermonuclear nomb design was openly published by Howard Morland in "The progressive" magazine in 1979 and then elaborated in his book, "The secret that exploded," Ward in 1985 wrote a letter to UK Prime Minister Thatcher claiming to have discovered this in 1955 at Aldermaston, and thus being the designer of the UK nuclear deterrent and entitled to patent royalties for the bomb! The UK government's refusal initially to disclose the truth, due to excessive secrecy concerns, then escalated Ward's charge into a large number of false claims about UK nuclear weapons designs and design history by quacks in the anti-nuclear biased "Nuclear Weapons Databook, v5" and newspaper plus magazine articles.

Arnold, as officially appointed UK thermonuclear warhead design historian, was therefore under pressure to investigate Ward's claim and the other nonsense in great detail using the secret reports on warhead design in the classified Aldermaston library archive. The key facts follow:

1. In 1920, Arthur Eddington told the British Association for the Advancement of Science that the stars must be powered by "subatomic enery ... the mass of the helium atom is less than the sum of the masses of the four hydrogen atoms which enter into it. There is a loss of mass in the synthesis amounting to 1 part in 120. ... the deficit can only represent the electrical energy set free in the transmutation. We can therefore at once calculate the quantity of energy liberated when helium is made out of hydrogen. ... it seems to bring a little nearer to fulfilment our dream of controlling this latent power for the well-being of the human race or for its suicide." (1)

2. In 1937, Ernest Rutherford suggested the fusion of deuterium and tritium in his last published paper, yielding 5 times the energy of the deuterium-deuterium fusion reaction and with a probability approximately 100 times greater (for typical nuclear explosion temperatures). After the discovery of uranium fission in Nazi Germany in 1938, the first actual suggestion to initiate a H-bomb using the explosive fission of uranium-235 was made by the Japanese physicist Tokaturo Hagiwara, at Kyoto University in May 1941 (2).

3. In May 1944, Manhattan Project physicist John von Neumann suggested placing deuterium and tritium gas inside a hollow fission bomb core to "boost" the efficiency, since 80% of the 17.6 MeV of energy per fusion would be released as 14.1 MeV kinetic energy neutrons, which would double the percentage of atoms fissioned, doubling the yield (3).

4. In April 1946 while British physicists were still contributing to Los Alamos (including

Penney and Tuck, who both made essential nuclear weapons effects measurements at the first postwar American nuclear weapon tests, Operation Crossroads at Bikini Atoll), a secret Superbomb Conference was held at Los Alamos, attended by 31 physicists, including two British Mission to Los Alamos physicists who later worked at Harwell, UK, namely Egon Bretscher and the infamous spy Klaus Fuchs. Bretscher made calculations of deuterium-tritium fusion, while Fuchs jointly patented (with John von Neumann) the 28 May 1946 thermonuclear weapon design, which invented a way get a gun-type uranium-235 fission bomb to initiate fusion in a large mass of deuterium, by using an intermediate stage consisting of a x-ray radiation-imploded beryllium oxide capsule containing a mixture of deuterium and tritium. In August 1946, Teller proposed a spherical external boosting system with alternating layers of fission and fusion fuels, called the "Alarm Clock"; as for von Neumann's internal boosting system, the "Alarm Clock" would use neutrons from fusion reactions to boost the efficiency of the fission reaction in implosion systems (4).

5. In the period 1946-9, the Cold War intensified as wartime collaboration turned to confrontation; the Churchill's term "Iron Curtain" signified the Russian enforced separation of its occupied territories in Eastern Europe (including half of Germany) from the West. Finally, Russian tested a nuclear weapon in August 1949, and in response the American hydrogen bomb project was mentioned on TV on 1 November 1949. The hydrogen bomb debate quickly gripped the American media, but it was Fuchs' confession on 27 January 1950 of spying for Russia from 1942-9 which prompted the American atomic energy "General Advisory Committee" to conclude that Fuchs had probably given his and von Neumann's secret beryllium oxide x-ray imploded deuterium and tritium bomb design patent to Russia, as well as the fission bomb they tested in 1949. On 31 January 1950, President Truman publically announced that he was directing the US "Atomic Energy Commission to continue its work on all forms of atomic weapons, including the so-called hydrogen or superbomb." (5)

6. In consequence, two thermonuclear tests were soon planned for early 1951: "Greenhouse-Item" (von Neumann's fusion neutron "boosted" core, with double the yield of an equivalent bomb lacking the deuterium and tritium core gas) and "Greenhouse-George" (George Gamow's adaptation of the physically separated x-ray imploded beryllium oxide cased fusion capsule, but using a special cylindrical implosion uranium-235 weapon, rather than the gun-type weapon in the Fuchs-von Neumann patent). But on 25 June 1950, communist North Korea invaded South Korea in the first "hot" proxy war between East and West, leading to General MacArthur's calls for tactical nuclear weapons. As a result, tactical nuclear weapon tests were held in the Nevada desert to prepare troops for nuclear warfare.

7. In February 1951, Stanislaw Ulam suggested a brilliant way to get much higher yields from nuclear weapons without requiring fusion reactions or massive conventional explosives to compress cores: simply use energy from one small fission bomb to compress another physically separate fission core, located within the same reflective outer casing. Edward Teller, whose own uncompressed superbomb idea had failed under calculation, then quickly adapted Ulam's idea by pointing out that the second fissile ore could be replaced by layers

of fusion fuel and fissionable material, to achieve a compact, efficient thermonuclear weapon. The resulting "Teller-Ulam" report was issued on 9 March 1951. Rapidly, Teller went further, designing the first American "Sausage" secondary stage, a rod ("spark plug"), of fissile material in the core of a cylinder of fusion fuel, with an outer x-ray ablator of natural uranium.

8. Numerous articles and books contain claims made by Horward Morland, Chuck Hansen, et al., that Teller's idea is for primary stage x-rays to heat up "polythene" surrounding the thermonuclear stage, and for the "hot plasma of polythene" to then compress the thermonuclear stage. This is false because the energy of the primary stage x-rays is so low they would not penetrate more than a few millimetres into polystyrene, and in any case the density of the resulting plasma shock wave would be far below the density of the uranium pusher or jacket of the thermonuclear stage, so any compression would give rise to severe Rayleigh-Taylor instability (which occurs when a low density fluid exerts pressure on a higher density fluid).

9. Teller's actual idea (mentioned in the actual wording of the title of his and Ulam's 9 March 1951 paper), was polystyrene as a "radiation mirror," a layer inside the outer casing (not filling the entire radiation channel), to re-radiate ("mirror") primary stage x-rays hitting that lining, on the secondary stage.

10. Later, in British and compact American warheads when spherical secondary stages - requiring isotropic compression - replaced cylindrical Sausages in American warheads, especially low density plastic foams were indeed then used to fill the entire radiation channel to deliberately disperse x-ray energy into the "radiation shadow" on the far side of the secondary stage. But this is not to be confused with Teller's 1951 "radiation mirror".

11. Klaus Fuchs sold Russian agent Feklisov the Teller's April 1946 superbomb conference data and his and von Neumann's later beryllium oxide cased x-ray imploded fusion capsule patent, etc., in illegal meetings on 28 September 1947 and 13 March 1948. Russian's Sarov nuclear weapons physicist Goncharov stated that Fuchs: "handed over materials of paramount importance. Included in the documents was new theoretical information pertinent to the superbomb ... the two-stage configuration operating on the radiation implosion principle ... with a beryllium oxide tamper ...", which was translated into Russian and given to Beria, Molotov and Stalin on 20 April 1948 (6).

12. While Stalin literally had the top secret American H-bomb secrets in his hands on 20 April 1948 courtsey of Fuchs, Penney had been busy preparing for Operation Crossroads, and had not attended the April 1946 Superbomb conference at Los Alamos. The two British Mission to Los Alamos physicists who had attended it, Fuchs and Bretscher, gave their notes to their chief, Sir James Chadwick (discoverer of the neutron). Chadwick then in May 1946 wrote a secret-classified British report called "The Superbomb", containing a schematic diagram of a three stage heavy-cased weapon, in which x-rays from a gun-assembly fission weapon "detonator" compresses a physically separate "primer" (containing tritium and

deuterium), which in turn compresses a third stage "booster" (7).

13. After British Prime Minister Clement Attlee secretly ordered UK nuclear weapons in January 1948, the British nuclear weapons physicists John Corner and Herbert Pike investigated the design in Chadwick's Superbomb report, finding it impractical (8).

14. Churchill, re-elected prime Minister in late 1951, hoped that the first British fission underwater "Hurricane" nuclear test of 3 October 1952 would persuade Truman to repeal the 1946 Atomic Energy Act - drafted by the notorious American lawyer James Roy Newman for Senator McMahon, which illegally revoked the 1943 Roosevelt-Churchill Quebec Agreement for Postwar Nuclear Collaboration - to resume UK-USA nuclear weapons collaboration. But within weeks, Teller's 10 megaton device was tested; giving that to the UK in exchange for the 25 kiloton fission UK design would be "trading a horse for a rabbit".

15. UK Atomic Weapons Research Establishment Director William Penney wrote a report on the day of the American 15 megaton Castle-Bravo 1 March 1954 nuclear test, "Trip to Washington February 1954", describing the 1952 Mike device as a vacuum flash containing "a lot of deuterium" and an implosion fission bomb, but he could only speculate about the details because of American secrecy on the Sausage design (9). In a further report dated 12 March 1954, Penney wrote: "Of course, we do not know how to make any form of hydrogen bomb. Our expectation is that it will be based on a large spherical implosion with a tamper weighing about 1 ton, of either natural uranium or perferably thorium .. Inside the tamper is a large vacuum flask full of liquid deuterium." (10) Penney's theoretical dvision head, John Corner, had sent Penney a memo on 10 March concerning Penney's first hydrogen bomb design: "In the spherical scheme which you showed to Pike, Woodcock and I yesterday, most of the energy comes from fissions." (11) Corner's deduction was confirmed within days by the arrival in Japan of tuna fishermen with beta radiation burns, due to fission product fallout, 80 miles directly downwind of the 15 megaton Castle-Bravo "H-bomb" test.

16. The Japanese tuna trawler crew's fallout injuries (depressed blood counts and beta radiation skin burns, due to exposure for hours on the open deck while pulling in tuna nets *during fallout deposition with no protection whatsoever*) were seized, out of context, by political disarmament activists and the media, unopposed by the facts due to official secrecy on nuclear test effects data! As a result, on 5 April 1954 in the UK House of Commons, Labour Leader of the opposition Clement Attlee demanded an immediate UK government initiative to oppose the hydrogen bomb. Prime Minister Churchill in response revealed Attlee's supine acceptance of the 1946 Atomic Energy Act which ended UK-USA collaboration and said that "needless antagonism" of the USA could prevent Eisenhower and Congress from seeking latitude on future collaboration.

17. Penney's knowledge of the thermonuclear weapon design in March 1954 was based on Chadwick's 1946 Superbomb paper, with modifications such as an implosion primary and a fissionable jacket on the second stage. This changed after his informal late night drinking sessions with American nuclar testing personnel such as Alvin Graves during his trip to witness Operation Teapot at the Nevada in May 1955. Chapman Pincher's 1955 Discovery

magazine biography of Penney suggests that Penney gleaned relevant data at Operation Teapot.

18. In August 1955, Penney held a meeting in his office to give new information to staff members John Ward, Bryan Taylor, William Cook, and Keith Roberts, where he "revealed what he thought he knew so far - that the H-bomb had a primary and a secondary, that the secondary was in two pieces, and that [neutron] shielding was required. ... On the basis of this information, Ward recalls, he was asked to 'come up with something'." Ward then spent the next four months in Aldermaston independently developing his "Harry" version of Teller's Sausage design, a 1 megaton yielding, 1 m long cylindrical thermonuclear stage with a central fissile "U235 rod" or spark plug which would give a yield of 100 kt (thus 10% fission yield) surrounded by lithium deuteride, which would provide 900 kt (thus 90% fusion yield). This is in Keith Roberts' report, "An elementary theory of detonations I", AWRE TPN 123/55, dated December 1955 (UK National Archives Discovery catalogue reference: ES 10/173). Roberts' report on Ward's theory, however, noted that his cylindrical Harry would be "initiated at one end" (the end closest to the Tom or primary) and "it was necessary for neutrons to diffuse ahead quickly enough to keep up with the pressure pulse [as it propagated along the cylinder] if the [fusion burn] wave was to be maintained ...". On 2 December 1955, a H-bomb progress meeting at AWRE Aldermaston by Penney and his deputy Cook was attended by Corner, Pike, Ward and others. Ward and Corner gave differing accounts of the meeting to historian Lorna Arnold. According to Corner: "Cook said, 'Well, does anybody know how it's done?' There was an embarrassed silence for two or three minutes, and then Ward drew a staged device - including a primary - on the blackboard ... Cook asked about the [neutron] shielding. Ward had not had time to calculate the shielding. Another deadly silence: then Penney said, 'Well this is too much like a piece of clockwork. If this were wartime we might consider something along these lines.' The drawing was rubbed off the blackboard ... Soon after ... there was another meeting to which Ward was not invited. A week later ... [Ward] told Cook he was leaving and returned to the United States. Ward had already been talking to Pike and Roberts about radiation implosion, and had suggested to the latter a calculation ... Roberts did it in a few days ... Ward ... was 'quite impressed'." So Ward did contribute in that sense, and by complaining openly in a 1985 letter to Thatcher (30 years later) about his treatment by Penney, he did eventually ensure that the relevant details were declassified and published in Arnold's history. It appears from Corner's account that there was a personality clash on 2 December 1955, and that Ward, who was so slow and incredibly diffident in presenting his design and arguments to Penney, was naturally disappointed that his design was dismissed as too sophisticated or complex ("clockwork"), i.e. too speculative (12). As the next paragraph explains, Penney had already helf a conference outlining his own ideas without inviting Ward, so suggesting a case of buraucratic hubris by the AWRE's top dog.

19. In September 1955, Penney had held a meeting with another four Aldermaston staff, Sam Curran, John Corner, Herbert Pike and Ken Allen (Keith Roberts who had attended the August meeting, was also again present, but not Ward). Penney said he believed from 1954 Castle data acquired by AWRE long distance measurements that America had two types of

megaton weapons: two-stagers where a fission bomb or "Tom" releases radiation which compresses a secondary U235 fission device called a "Dick" yielding around 1 megaton, and three-staged devices in which a third (thermonuclear) stage "Harry" was added, yielding about 10 megatons. Herbert Pike, who was present, explained this to Lorna Arnold in his 9 June 1995 letter: "The names Tom, Dick and Harry originated when it was thought that a simple fission device was inadequate for compressing thermonuclear fuel, but could be used to implode a much more powerful U235 device. This idea was soon dropped, but the names remained." (13)

20. In a note dated Tuesday 20 September 1955, Penney calculated that the radiation from a primary stage would compress and fully implode the secondary stage, before the arrival of the debris shock wave from the implosion system of the primary stage which fills the radiation channel with debris and disrupts the isotropic compression of the secondary (14).

21. Penney knew from UK collected fallout samples from the first 400 kt Russian single-stage externally boosted thermonuclear test of 1953, that external fissile core fusion boosting was possible in single-stage devices, so this was also studied at Aldermaston and proof tested in 1956 at the two shots of Operation Mosiac, Monte Bello. The Aldermaston physicist Keith Roberts in October 1955 wrote a paper on internal and external boosting, arguing for the use of a mixture of the solid salts lithium deuteride and lithium tritide (LiD and LiT) in a hollow fissile core for internal boosting (rather than the use of D+T gas, used to boost cores of some American weapons since 1951). This boosted device was "Orange Herald". For external boosting, a device called "Green Bamboo," Roberts suggested a layer of LiD between the fissile core and its uranium tamper: "to catch neutrons as they come out of the core, convert them into 14 Mev neutrons, and burn up the tamper." (15)

21. The first problem with this Green Bamboo idea is that LiD around the fissile core acts as a neutron absorber (instead of a reflector like uranium or beryllium), and therefore increases the critical mass needed (or the amount of compression needed, requiring more conventional explosives around the pusher to squeeze it plus everything else such as LiD to higher density, just to achieve core supercriticality). The second problem is that the fusion rate in the external LiD layer is determined by its compression, and this is weaker for the core which is pushing something outwards in all directions and thereby dispersing it, than if you are compressing it (when it has nowhere to go but in upon itself). By the time the core begins to expand, the inward compressive shock wave from the conventional explosives has long since passed through the tamper and into the core, where it reflects. There is a small inertial retardation to outward LiD dispersion from core expansion, due to the heavy uranium tamper surrounding it, but numerically this is like using layer of duct tape to delay a hand grenade exploding. The inertial delaying effect of the tamper is simply too small. The tamper's expansion-delay time is trivial unless the uranium tamper is made so thick that you need many tons of conventional explosives to compress the mamoth device in the first place. The bomb would then be undeliverably large and heavy. Nevertheless, since the Russians had used this scheme as "Joe 4" in August 1953, it was investigated by the UK. Ken Allen in his 14 February 1956 Nuclear Physics Branch Note AWRE-NPBN 56/1 estimated that

the externally boosted single-stage Green Bamboo design would have an efficiency of U235 fission 5-10 times less than a two-stage radiation coupled bomb in which the second stage is U235 imploded by x-rays from the primary stage. Two externally boosted bombs were tested during Operation Mosiac at Monte Bello to check and confirm Allen's theoretical assessment that they would not work: G1 with a lead tamper which yielded 15 kt, and the larger G2 containing a uranium tamper which yielded 60 kt. It was found that the external boosting only produced "a few percent change in the yield." (16)

22. AWRE also gained data from the analysis of long-range blast and fallout from the 5 and 22 November 1955 Russian nuclear tests, Joe 18 (215 kt, a likely primary stage test for the H-bomb) and Joe 19 (1.6 megatons, the first Russian two-stage test). When the isotopic composition of the uranium in the fallout from Joe 19, the 1.6 megaton test, was determined, it contained large amounts of uranium-233: "much too large to be accounted for by fast neutron reactions on uranium-235. The most probably explanation the british representatives could advance was that the Soviet weaponeers had used uranium-233 to differentiate between the behaviour of uranium components in two separate parts of the test device. This interpretation clarified British ideas on the mechanism of a two-stage device." (17)

23. Penney during a 15 March 1956 meeting with Cook, designed a three-stage "Green Granite" bomb, with a steel clyindrical casing, a fission primary "Tom", a lithium deuteride internally boosted large U235 fissile secondary spherical stage "Dick", and a final stage "Harry" consisting simply of a small unboosted U235 core surrounded by a thick LiD shell and then a thick outer U238 tamper. However, on 4 April 1955 Penney simplified this to just two stages (the primary and final stage), which was justified by a report by R. A. Scriven of the theoretical physics division of AWRE. The shortened version of Green Granite was to be called Short Granite. Arnold describes the result as a very modern design: "This was not the design used for the Granites fired as Grapple (they had many shells in Dick), but seems to resemble the simpler [more successful, 1.8 megatons] Grapple X device." (18)

24. But, instead of stopping there, a disastrous "Alarm Clock" type many-shelled (and thus Rayleigh-Taylor instability prone) secondary stage for Short Granite was then designed on 27 April 1956. Some 14 concentric thin shells ranging in thickness from 0.034 to 0.971 inch, alternating between low density LiD and high density U, first proposed by Ken Allen in his paper dated 14 February 1956, were in the secondary of Short Granite, and it would require poor nuclear test results to kill them off and return to the simplicity of the 4 April 1955 design for Grapple X. Immediately after Short Granite yielded 300 kt, Penney tried to improve that design in a new bomb, Purple Granite, identical to Short Granite apart from adding "extra U235 and with the outer layer replaced by aluminium". This yielded even less energy, just 200 kt, poving that the low density outer shell of aluminium produced Taylor instability when compressing the denser U235 layers within it. The Granite design fault was Taylor instability in the many layers of varying densities, a fault easily corrected by simplifying the secondary (dense U tamper on the outside, lower density Li6D inside, and central U235 sphere to emit neutrons and start the fission of lithium-6 to yield tritium for

fusion when compressed), i.e. simply reverting back to Penney's simple 4 April 1955 design (the fully successful 1.8 megaton Grapple X device). (19)

25. John Corner summarized the situation in his "History of British R&D", given to America on the second day of the first official postwar UK-USA nuclear weapons design collaboration conference, 28 August 1958: "By late 1955, we were working on a simple system by which a trigger bomb and a thermonuclear bomb were placed inside a common outer case, with a radiation-transmitting material surrounding them." (20) This "radiation-transmitting material surrounding them" distinguishes clearly the UK spherical secondary stage system from the 1956 spherical stage tests by Russia (1.6 megaton RDS-37) and America (250 kt Egg device tested during Operation Redwing shot Huron): both the spherical secondary stages in these Russian (RDS-37) and American (Egg/Huron) 1956 nuclear tests were compressed isotropically by x-rays focussed by a large outer casing (pear shaped for 1.6 megaton RDS-37, egg-shaped for 250 kt Huron). The UK use of "radiation-transmitting material" allowed the outer case size be minimised as it was not being used to focus x-rays, a vital consideration for miniaturising such a two-stage single-primary warhead to fit into a MIRV warhead for an ICBM or SLBM. For a discussion of the role the Los Alamos Redwing-Huron's Egg device's spherical shaped secondary, which was discarded by Los Alamos but developed into the "TUBA" spherical secondary by Lawrence Livermore in 1958, which - due to the testing moratorium of 1958-1, was aided by a study of exchanged results of very similar UK Grapple X, Y and Flagpole nuclear test data as we will see later - and is referred to as the "L-3" concept to avoid classification problems by S. Francis in "Warhead Politics", at https://www.osti.gov/servlets/purl/274149 (document pagination pp138-1399 and PDF pp142-143):

"Livermore's quest for a thermonuclear warhead with a high yield-to-weight ratio had come to fruition in 1958 when Livermore tested a new class of secondary design, which for classification purposes this study will refer to as the L-3. The 1958-1961 nuclear test moratorium intervened, so warheads incorporating L-3 secondaries were not deployed until 1963, on the Minuteman II and Polaris A-2 missiles. L-3 designs proved long-lasting ... Their principal advantage lies in high yield-to-weight and yield-to-volume characteristics. L-3s were particularly well suited to the size and weight constraints of multiple reentry vehicles ... One important L-3 design feature ... was first tested by Los Alamos in 1956 [Redwing-Huron]. This concept involved a configuration more difficult to model than other Los Alamos designs with the computational power then available. Although it worked, Los Alamos successfully pursued the more conservative [cylindrical secondary] approach. Pressure to get workable H-bomb designs into the stockpile encouraged Los Alamos scientists on this path, despite the potential advantages of the more daring design. Livermore revived the idea two years later in [TUBA spherical secondary] L-3s, an example of what Livermore director John Foster later described as his laboratory's role in pursuing ideas initially bypassed in the 'frantic race to get something in [the stockpile]'. L-3s achieved their high yield to mass ratio by using oralloy, or enriched uranium, in a new way [as the pusher, forming an external spark plug surrounding lithium deuteride]. Greater yields in weapons of comparable weights was the outcome."

26. At shots 1 and 2 of Operation Antler at Maralinga, Australia, in 1957, full two-stage weapons with standard primaries but inert (lead and cobalt) secondaries were tested. (21) Cobalt-60 production in the secondary stage apparently acted as a diagnostic tracer to determine neutron exposure from the primary stage, determining the neutron shielding required to prevent secondary pre-initiation.

27. After the low 300 kt and 200 kt yields of Short Granite and Purple Granite, which had low yield 30 kt primaries, an improved 45 kt primary employing a beryllium tamper was developed for Grapple X and further H-bombs. Aditionally, even the plastic foam filling was replaced by air to disperse X-rays around the secondary in successful Grapple Z: "Various ideas were discussed ... reducing the amount of filling in the casing ... It might even be possible to eliminate the filling altogether. Might not an air gap transport enough energy from the Tom to implode the Dick? This idea was later to be tried successfully at Grapple Z." (22) This is again essential evidence of the AWRE perceived need to have something - foam, or air - filling the x-ray radiation channel. Since x-rays go best through a vacuum (nothing at all!), this proves beyond any doubt that the role of foam as a casing filler in UK weapons was to disperse x-rays into shadows around the secondary stage for isotropic compression, rather than focussing x-rays.

28. The physics of the detonation of the successful 1.8 megaton Grapple X on 8 November 1957 are described in detail by Arnold (2001, pp160-161). Grapple X was a Short Granite-sized double bomb but containing the improved Red Beard beryllium tamper composite core primary with a Po210-Be Urchin neutron initiator yielding 45 kt, and a simplified three layer secondary stage (U235 core, Li6D layer and U tamper). Arnold states the secondary stage was compressed to 5% of its original volume within 2 microseconds. The yield at 1.8 megatons was 80% greater than the predicted 1 megaton. (23) (Arnold on p238 quotes Corner's statement that IBM 704 simulation of Grapple X predicted a 25-fold secondary volume compression.)

29. The next test, Grapple Y on 28 April 1958, the largest UK nuclear test ever conducted at 3 megatons, was K. W. Allen's idea to change the secondary design by reducing the U235 core to make more room for LiD which is easier to compress than U235, replacing most of the Li6D with a lot of Li7D, and replacing the outer U shell with thorium: "Reducing the uranium-235 would make greater compression possible." (Arnold, p167.) Reducing the amount of dense fissile material in the secondary to increase its compression may sound superficially counter-intuitive, but computer calculations plus actual nuclear testing proved it to be true! It was dropped from a Valiant flying at 46,000 feet, exploding 53 seconds later at 8,000 feet altitude. (24)

30. The final UK thermonuclear tests, Grapple Z, were the first two stage UK weapons to use primary stage boosting, not to increase their efficiency but to produce a similar ~50 kt yield with less fissile material. The only reason the UK wanted fusion boosted primary stages was to get the same yield with less plutonium, not for reasons of efficiency, but to so-called

radiation immunity or "RI", when Moscow deployed defensive neutron bombs to melt down the fissile material of incoming warheads. This neutron multiplication problem for large fissile cores had been discovered at AWRE by K. V. Roberts and J. B. Taylor in early 1956. (25)

31. External neutron initiators had first been used for the large 700 kt single-stage internally boosted Orange Herald test in 1957, a hollow core U235 bomb with a "very thin HE [high explosive] layer" (26). However, Arnold reports that this shot only achieve the predicted **UN**boosted yield, so that boosting failed to achieve anything. This was the second failure of boosting for the UK, since Dr John Corner's 28 August 1958 report at the UK-USA bilateral Sandia meeting (Arnold's Appendix 3, at p239) states that the UK wanted to: "boost ordinary kiloton weapons with the aid of a gram or two of T. This first amount of T was therefore put into one of the weapons to be fired at Buffalo [Maralinga, 1956]. Unfortunately, the Buffalo weapons use a central initiator, and the presence of the deutero-tritide in the centre of the fissile core lowered the unboosted yield by a factor of order 2. ... This reluctance to redesign completely a weapon for the use of T persisted into 1957, when T was used on a fairly massive scale ... without on balance, improving on the result we would have got if a core had been used which contained no tritide (and no empty space for tritide). The desire to develop a strong source weapon [neutron hardened primary] ... led to a study of hollow gadgets. ... It was found theoretically that such a weapon would be extremely suitable for boosting with T, either as a deutero-tritide or as a gas. This has led to the [solid LiD + LiT boosted, 24 kt] Pendant and [T + D gas boosted, 25 kt] Burgee rounds."

32. The UK was so desperate to overcome neutron vulnerability, Arnold states on p181, that the UK decided to overcome the problem by using a double-primary system to compress a secondary: "This other round, to be tried if [solid LiD + LiT boosted, 24 kt] Pendant failed, was a novel concept - a triple, or three-stage, bomb which would, in effect, have two small, immune primaries with a combined yield sufficient to ignite thermonuclear fuel in the third component." In other words, the UK seriously considered testing a double-primary weapon, very similar to the Russian "Project 49" weapons first tested in February 1958, simply in order to reduce fissile core sizes to overcome neutron vulnerability to defensive ABMs.

33. The long held UK obsession with solid fissile cores is due to the fact that they were originally invented at Los Alamos by British Mission physicist Peierls, before being developed by Christy and named after him. Likewise, British Mission physicist James Tuck, who had been the physics assistant to Churchill's adviser Professor Lindemann, introduced the explosive lens system - adapted from British explosives research - to the implosion bomb, as well as working with Bethe on the Po210-Be central urchin initiator in the core. These UK developments became hardened orthodoxy Gospel at AWRE - hence the proverb, if it ain't broke, don't fix it - until the neutron vulnerability forced the change to hollow cores and external neutron initiators, just to allow boosting to halve the fissile mass for a given primary yield! The long delay in UK investigations of hollow cores and external neutron initiators to permit successful boosting is reflected by John Corner's comment to Arnold (quoted by Arnold in her endnote 12 on p261): "... Corner was greatly impressed by the

speed of the American development, from the Ulam-Teller breakthrough to the Mike shot. He thought the British lost too much time 'piddling about' (interview, March 1995)".

34. In the event, both solid boosted Pendant and gas boosted Burgee neutron-hard primaries worked during Grapple Z in 1958, so the unboosted double-primary design that Russia used from 23 February 1958 was never tested by the UK. The research done on it, howver, throws light on the Russian decision to use it, particularly as gives a compact neutron-hard thermonuclear weapon which requires no tritium for boosting (it is unboosted), an advantage for avoiding replenishment due to the 12.3 years half life of tritium! The two high yield UK atmospheric tests during Grapple Z in 1958 were 1.21 megaton Flagpole (a scaled down version of the highly successful 3 megaton Grapple Y bomb which used mostly natural unenriched lithium deuteride and an unboosted Indigo Hammer primary stage), and Halliard 1, a heavy cased triple-bomb which had a predicted yield of 750 kt but yielded 800 kt (27).

35. UK Prime Minister Harold Macmillan noted in his diary entry of 1 September 1958 (published in 1971 as "Riding the Storm 1956-1959", at page 563): "In some respects we are as far and even further advanced in the art than our American friends. They thought interchange of information would be all give. They are keen that we should complete our series, especially the last megaton [the triple-bomb Halliard 1, fired on 11 September 1958], the character of which is novel and of deep interest to them." In fact, America made the UK's testing of Halliard 1 a condition for transmission of America's 1.1 megaton Mk28 and 400 kt Mk47 data (Mac had wanted to scrap Halliard 1 testing, as part of an international testing moratorium).

36. Arnold continues to document the exchanges of nuclear warhead designs: "On 17-18 November [1958] in a meeting at Aldermaston on exchange of nuclear weapons design information, Penney and his senior staff met ... Brigadier-General Starbird, Norris Bradbury and Edward Teller. They brought up to date ... the Livermore TUBA design for a double bomb with a spherical secondary, which Teller said was very similar to British designs ... Pike and Schofeld, visiting Los Alamos and Livermore in February 1959 to discuss weapon pysics ... noted that both the American laboratories had done calculations on the Grapple Z Flagpole shot [the scaled-down 3 megaton Grapple Y success, with low-enrichment lithium and reduced U235 in the secondary stage], and had predicted substantially the same fusion and fission yields as had Corner's staff." The American Mk28 became the UK's megaton Red Snow (28).

37. Arnold's book finally, at page 227, addresses the only aspect of the UK (or any other) nuclear weapons tests considered worthy of mention in "science" and "news" media: alleged cancer induced by radiation effects to personnel: "A very comprehensive study of 21,358 test participants (estimated at 85% of the total) and 22,333 controls was carried out by an independent expert team, led by the eminent epidemiologist Sir Rochard Doll. ... The study examined mortality rates, the incidence of leukemia and 26 other forms of cancer, and 15 other causes of death. It found that there was no significant difference between the participants and the controls ... The team detected little evidence to relate cancer incidence

to recorded dose; indeed, incidence tended to DECREASE with higher recorded doses." The highest fallout radiation doses received in any UK test were over 25R, by Canberra fallout sampling aircrew who spent 11 minutes flying 6 times through the 1.21 megaton Flagpole test mushroom cloud at 53,700 feet altitude after their radiation meter malfunctioned! Because all the UK H-bombs were air bursts at altitudes of 2.2-2.8 km, there was no local fallout at Chrismas island. However, many personnel were close enough to receive relatively small doses of initial nuclear radiation, and were not provided with dosimeters or health checkups after some of the tests. For example, 300 kt Short Granite was dropped 418 yards short of its target on 15 May 1957, just 1.5 miles from Malden Island.

38. Russian double-primary nuclear weapons development and their implications for modern Russian neutron bombs (i.e. low yield cleaner bombs for "peaceful uses" like deterring invasions, or deterring legal re-occupations of illegally seized territory) have been declassified by Russia (see nukegate.org for full details and source extracts; Fig. 1 below summarizes this).

39. The older single primary designs used in the West dating from an original test in late 1952 require a tritium and deuterium gas capsule in the secondary stage if the total yield is very low, making them expensive and in need of regular tritium replacement (half disappears by radioactive decay each 12.3 years!).

40. Trutnev's double-primary, double-approach Russian system, which didn't need foam to slow and disperse x-rays into the "shadowed area" on the far side of the secondary (furthest from the primary), was first tested on 23 February 1958, and has obvious much better isotropy and so doesn't require the Western channel foam filler. (See Fig. 1, below.) Foam in UK and USA designs was used for x-ray diffusion to make a spherical secondary isotropically exposed to x-rays for compression (this problem was why Teller only used axial compression in the original foamless Teller-Ulam based Mike device of 1952 and other sausage or cylindrical secondary devices). It turned out that America peremptorily discarded such ideas (despite the original 1951 Teller-Ulam paper suggesting that more than one primary stage may be used!), and has always used only a single primary for groupthink delusion reasons, never even testing the Russian idea. But the double-approach makes it far more efficient on a yield-to-mass basis at compressing the secondary, thus cheapening and cleaning up the secondary design because you get better compression and don't need oralloy or tritium-deuterium boosting. Russian information suggests that with the dual approach (two primaries, one each side of the secondary) and isentropic compression (using a foam coating on the secondary stage, etc.), it is possible to obtain compressed gaseous deuterium fusion without tritium, something impossible with the smaller compressions of heavy oralloy secondary shock compression systems because the D+D fusion cross section is about 100 smaller than that for D+T.

41. Thus Trutnev's double primary system was more efficient at compression because it didn't need foam to slow and disperse x-rays into "shadows" on the far side of the secondary. So it was scaled down in the 1960s for cleaner low yield weapons, thus yielding enhanced neutron effects without needing tritium gas in the secondary stage (with the

better compression in Trutnev designs, you can use a Li6D secondary even at low yield). Therefore, Western secrecy, even in weapon design, is a fallacy if the enemy is way ahead of you; then the secrecy stamp is just being used to dogmatically cover-up a scandal, and perpetuate your own expensive mistakes of ideology, which hardens into an orthodoxy of rigor-mortis.

42. For this very reason, Edward Teller was constantly complaining during the first Cold War that there was too much conformity in Western nuclear warhead design, that semi-empirical computer models based on one type (single primary) of design were being used to prevent the exploration of totally new ideas, etc: you can't get backing to test anything at extreme variance with "established wisdom". Every new Western design must be an incremental improvement on a previously validated Western design (because it must be evaluated using semi-empirical computer codes based on the single-primary framework of previous designs); thus, every "new" idea is limited perforce to containing the basic two-stage, single-primary assumption of previously tested designs as their basis. A "radical" design is one which changes the design of the primary or the secondary, but not one which changes the entire framework of design by introducing a second primary stage! Dogma is self-perpetuating, as it is in the routine development of physical theories (where every new theory must contain the previously validated theory as a subset, rather than being completely radical in which the previous theory is shown to just be a approximation contrived to fit the data and extrapolate a little). Declassification won't allow Russia to do anything if they have tested better designs already, and they can't afford Western designs that contain exorbitant amounts of tritium and oralloy.

CONCLUSION

43. We must now design and prepare samples for testing of clean, cheap double-primary based neutron bomb designs of the Russian type, ready for mass-production in the event of the resumption of nuclear testing or a major provocation, e.g. attacking or invading further territories to support their Ukraine campaign - or even for an expanded campaign aided by Russia's 2000+ tactical nuclear weapons for a restoration of their Cold War territories in Europe, or beyond - by Russia or its allies North Korea, Iran, China, et al. In any event we should be ready to escalate by means of a new arms race, testing regime, and stockpile cleanerr, cleaner tactical nuclear weapons for delivery by drones, SLBMs, ICBMs, and cruise missiles, instead of asking for escalatory retaliation by escalating by using strategic weapons on cities. The current situation has been engineered by anti-Western anti-nuclear bigots plus openly Russian-biased "arms control and disarmament" bigots, in a mirror to Nazi tactics in the 1930s which enginneered an appeasement era leading to WWII.

44. We have earned of how their fake news on nuclear weapons capabilities, effects and designs has been undermining Western deterrence and encouraging energy aggression since 2006 at nukegate.org. As in the 1930s analogy to the present, the West disarmed in good faith while the enemy exploited this while illegally using chemical weapons and

annihilation threats to engineer our appeasement of terrorism. Herman Kahn's 1960 On Thermonuclear War describes the cause of world war as a failure to deter not a direct attack, but major provocations (invasion of third party Belgium in 1914 and invasion of third party Poland in 1939 plus of course the 1941 surprise military attack on the US Naval base at Pearl Harbor). The implication is that we can't credibly deter such "provocations" by targetting Russian cities (which have shelters anyhow, see nukegate.org for evidence suppressed by Western fake news outlets like the bigoted pro-disarmament Scientific American magazine). At any time Putin or his successor an ally could undertake experimentally to test our resolve. If we wich to deter, we must openly make it clear what our policy is, not procrastinate like the UK Cabinet in August 1914 until it was too late, or like the disarming and then (after 1935) very slowly-rearming Baldwin/Chamberlain wets. Public opinion can only be gained by extreme means, declassifying the full evidence and publishing it.

45. If we are not to get more credible, cheap, enhanced neutron nuclear weapons to fight at the front, we need to at least make the existing strategic weapons more credible by preparing for launching a new civil defense campaign to evacuate and/or shelter city folk under a major enemy provocation or threat. Arms controllers want us to have a white flag.

REFERENCES

(1) - L. Arnold, Britain and the H-Bomb, Palgrave, 2001, p3.

(2) - Ibid, p4.

(3) - Ibid, p6.

(4) - Ibid, pp7-8.

(5) - Ibid, pp11-12.

(6) - Ibid, p25.

(7) - Ibid, p38.

(8) - Ibid, p41.

(9) - Ibid, p42.

(10) - Ibid, p43.

(11) - Ibid, p44.

(12) - Ibid, p85, 87-88, 90.

(13) - Ibid, p85.

(14) - Ibid, p86.

(15) - Ibid, p87.

(16) - Ibid, p92, 137, 238.

(17) - Ibid, p91.

(18) - Ibid, p93, 140-141, and endnote 18 on p256.

(19) - Ibid, p93, 140-141, p146, and endnote 18 on p256.

(20) - Ibid, p238.

(21) - Ibid, p141.

(22) - Ibid, p152, 155.

(23) - Ibid, pp160-161.

(24) - Ibid, pp166-167, p173.

(25) - Ibid, pp176-177.

(26) - Ibid, p178 and p238.

(27) - Ibid, p182 and pp187-188.

(28) - Ibid, pp211-212 and p214.