New Nuclear-Weapon Developments in the USA

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Developments in the nuclear arsenals

Many believed that the nuclear arms race would end with the Cold War. They have been disappointed. In 1998, both India and Pakistan tested nuclear weapons, thereby joining the nuclear club. Israel has continued its nuclear-weapon programme. The five established nuclear-weapon powers, China, France, Russia, the UK, and the USA, known as the P-5, have continued to improve their nuclear arsenals, either by adding new nuclear warheads to their nuclear arsenals or by improving the quality of their existing nuclear warheads or both.

A large number of nuclear weapons have, however, been removed from the world's nuclear arsenals. The number of American nuclear weapons has decreased from a peak number of about 32,500 in 1967 to about 5,300 operational nuclear weapons in spring 2005 (4,530 strategic, 780 tactical), with some 5,000 additional warheads being held in reserve; the number of nuclear weapons in the Soviet arsenal peaked at 45,000 in 1986 and the number of operational nuclear weapons in the Russian arsenal in early-2004 was about 7,800 (4,422 strategic, 3,380 tactical), with about 9,200 Russian additional warheads being held in reserve or store; the number of British nuclear weapons peaked at 410 in 1969 and is now about 200; the number of French nuclear weapons decreased from 540 in 1993 and is now about 350; and the number of Chinese nuclear weapons peaked at about 450 in 1993 and is now about 400 (1). It is estimated that India and Pakistan have each deployed about 35 nuclear weapons. Israel has probably deployed about 200 nuclear weapons (2). North Korea has officially announced it has nuclear weapons. It is believed that they currently have enough separated plutonium to produce about 6 nuclear weapons, and have recently removed from their reactor 8,000 fuel elements which would provide enough plutonium for up to 3 or 4 more.

The USA produced a total of about 70,000 nuclear warheads between 1945 and 1992; the Soviet Union/Russia produced a total of about 55,000 between 1949 and 2003; the UK produced a total of about 1,200 between 1952 and 2001; France produced a total of about 1,260 between 1960 and 2003; and China produced a total of about 750 nuclear warheads between 1964 and 2003 (1). The grand total of nuclear warheads produced by the world's nuclear-weapon powers after the end of the Second World War is about 128,200. Currently, the number of operational nuclear weapons, tactical and strategic, in the world's nuclear arsenal is about 16,000; about 95 per cent of them are American or Russian. The size and composition of the Russian nuclear stockpile is hard to estimate. The best available information suggests that the Russians have about 7,800 operational nuclear warheads with about 9,200 additional intact warheads in the arsenal, giving a total of about 17,000 warheads (3).

Nuclear weapons are now back on the agenda to an extent reminiscent to that at the height of Cold War. For example, the US Nuclear Policy Statement, completed at the end of 2001, describes the role of nuclear weapons well into the future, not as part of a nuclear deterrent policy but as part of America's war-fighting strategy. Apparently, the Pentagon is preparing contingency plans to use nuclear weapons against targets in seven or more countries – including China, Iran, Iraq, Libya, Russia and Syria. And in March 2002, the British Minister of Defence announced, for the first time ever, that British nuclear weapons could be used in a first strike and against countries that used biological or chemical weapons against British forces or targets in the UK. Both the American and British governments have now reneged on their security assurance guarantees not to use nuclear weapons against countries that do not have them and are not allied to a nuclear-weapon power.

Although the Bush Administration has announced its willingness and intention to cut further the number of operational nuclear weapons it deploys, it is maintaining thousands of nuclear weapons in its core stocks and is planning the development of new strategic nuclear delivery systems – a new intercontinental ballistic missile to be deployed in 2020; and a new bomber to be operational in 2040 (4). There are also plans to build a new production facility to fabricate nuclear weapons, the Modern Pit Facility, with the capacity to manufacture between 250 and 900 nuclear components annually, beginning in 2018.

By turning its back on the Comprehensive Test Ban Treaty (CTBT), the US may have signalled an intention to start nuclear testing again. There is also talk of putting nuclear warheads on anti-ballistic missiles as part of the US National Missile Defence programme. The difficulty of developing a non-nuclear warhead for anti-ballistic missiles is likely to lead to the use of nuclear warheads for them.

These new developments are planned to revitalize American nuclear forces to include a "new Triad of nuclear capabilities that combine nuclear and conventional offensive strikes with missile defences and nuclear-weapons infrastructure". They demonstrate that the Bush Administration believes that nuclear weapons will be an integral part of US military forces for at least the next 50 years.

The Americans have officially announced that they would like to reduce the number of their deployed strategic nuclear weapons from the current 4,500 or so nuclear warheads, most of which are on alert status able to be fired on 15 minutes notice, to between 1,700 and 2,200 deployed strategic nuclear weapons. But they are, in addition, likely to retain a stockpile of whole weapons and components that will allow them to deploy about 16,000 more nuclear weapons very rapidly if they take the political decision to do so (4).

There are no reasons to believe that any of the P-5 powers plans to stop improving the quality of their nuclear weapons. This is in spite of the fact that each of the P-5 powers, as Parties to the 1970 Non-Proliferation Treaty, is committed under Article VI of the Treaty, "to pursue negotiations in good faith on effective measures relating to the cessation of the nuclear arms race at an early date and to nuclear disarmament". The on-going quantitative and/or qualitative improvements the P-5 powers are making to their nuclear arsenals are, at least in their spirit, violations of their commitments under Article VI.

A new generation of American nuclear weapons

Although all the P-5 powers are improving the quality of their nuclear weapons, recent moves in the USA to develop new or modified nuclear weapons are causing the greatest concern, possibly because the USA, as the world's sole nuclear superpower, sets the pace of the nuclear arms race. The US has not developed a new nuclear weapon since 1988 and has not conducted a test of a nuclear weapon since 1992. That the USA is taking new nuclear-weapon initiatives is shown by the approval in the US defense budget for Fiscal Year 2004 of US efforts to design a new generation of low-yield nuclear weapons.

The first move in this direction occurred in May 2003 when the Senate overturned the so-called Spratt-Furse Law, stating that the US may not conduct research and development that could lead to the production of low-yield nuclear weapons, weapons with explosive yields less than the equivalent of the explosive yield of 5,000 tonnes of TNT (5 kilotons {kt). The law, named after the legislative authors Representatives John Spratt and Elizabeth Furse, was adopted as part of the Fiscal Year 1994 Defense Authorisation Act (5).

The 1994 Act stated that: "It shall be the policy of the United States not to conduct research and development which could lead to the production of a new low-yield nuclear weapon, including a precision low-yield weapon". The limitation was defined as a "low-yield weapon which, as of the date of the enactment of this Act, has not entered production". The Act defined a "low-yield nuclear weapon" as "a nuclear weapon that has yield of less than five kilotons". The Spratt-Furse Law was finally repealed in the Fiscal Year 2004 Defense Authorisation Bill.

The Spratt-Furse Law was a response to arguments of some in the Pentagon and some other policy makers for developing low-yield nuclear weapons and developing roles for them in the US post-Cold War arsenal. Representatives Spratt and Furse believed that these weapons would blur the distinction between conventional weapons and nuclear ones and that their deployment would significantly increase the probability that nuclear weapons would be used (4).

Funding the Administration's new nuclear-weapon initiatives

In 2003, the Bush Administration asked the Congress to remove the ban in the Spratt-Furse Law. For Fiscal Year 2004, it requested funds for the Advanced Concepts Initiative (ACI) – for the Robust Nuclear Earth Penetrator (RNEP), for computer modelling, remotely monitoring warheads and controlling their firing systems, and for studying how to design warheads with specific radiation outputs and other effects. The request for the RNEP is to continue the study of modifying an existing weapon to penetrate completely into the ground before detonating, increasing its ability to destroy buried targets. Finally, the Administration requested funds for Nuclear Test Readiness to reduce the maximum time between a presidential order to conduct a nuclear test and the test itself. Since 1996, this time has been 24 to 36 months. The Administration asked for money to maintain this readiness and to begin reducing the time to 18 months. President Bush signed the Defense Authorisation Bill into law on 24th November 2003 (6).

The Administration requested $21 million for the ACI, $15 million of which is to continue a study of the RNEP, started in May 2003 and the remaining $6 million for other advanced weapon concepts. The request for nuclear test readiness was $24.9 million. (6).

However, in an unexpected move, Congress ultimately decided to cut or significantly curtail funding for all these initiatives, including the elimination of the ACI and RNEP budgets.

The administration has made restoration of RNEP funding a top priority for 2005, and through Congressional action, ACI has been replaced by a new line item, the Reliable Replacement Warhead (RRW). Although the specifics are not clear, RRW is intended to research the design modification of existing warheads to determine whether they can be made more reliable. However, there are suspicions that new warhead designs may be introduced in the process, potentially leading to testing.

The funds involved in these requests are small but they have significant policy ramifications and could lead to major spending if implemented over time, requiring increased requests in future Fiscal Years. The repeal of the Spratt-Furse Law does not necessarily 'open the door' to the RNEP. Spratt-Furse applied just to weapons with explosive yields of less than 5 kt. As described below, RNEP would probably be a modification of existing weapons, the B61 bomb or the B83 bomb, both of which are available in a number of explosive yields, with the maximum yield being much greater than 5 kt. Both of these weapons have been in the US stockpile for a long time. The Spratt-Furse ban applied only to nuclear weapons that entered production after 30th November 1993.

The Administration proposal for new nuclear weapons developments arose from arguments of some politicians, military officers, defence bureaucrats and senior scientists in America's nuclear weapon laboratories that the US should develop and deploy a new generation of low-yield nuclear weapons that can be delivered with great precision on hardened and deeply-buried targets. These 'mini-nukes', with less than a 5 kiloton yield, would be designed for use in conflicts with Third World countries, or for attacks on terrorist groups, particularly ones armed with chemical or biological weapons, rather than for deterring warfare with another nuclear power.

There could be a number of types of mini-nukes, enhancing blast or heat or radiation effects. This would allow a nuclear weapon with appropriate characteristics to be chosen for an attack on a specific target. A nuclear weapon with enhanced radiation effects would be similar to the enhanced-radiation weapon (neutron bomb) developed in the 1980s. As described below, the US Congress has not yet authorised any funds for the *production* of any low-yield (less than 5kt) nuclear weapons. Funds have been authorised only for work on the design of low-yield nuclear weapons but not for any more advanced work, such as development engineering.

Because low-yield nuclear weapons blur the distinction between modern precision-guided conventional weapons and nuclear ones, critics have argued that the deployment of these 'mini-nukes' would increase the probability that nuclear weapons would be used. For this reason, the US Congress in 1994 passed the Spratt-Furse Law. Nevertheless, the US Energy and Defense Departments have still been required to undertake a study of earth-penetrating low-yield nuclear weapons that could "threaten hard and deeply buried targets."

Another stimulus for the Administration's enthusiasm for a new generation of nuclear weapons was the 2001 US Nuclear Policy Review (NPR) that suggested that so-called 'advanced concepts', such as low-yield and earth-penetrating weapons, should be explored to provide "important advantages for enhancing the nation's deterrence posture" stimulated the discussion about low-yield nuclear weapons. A member of the National Security Agency testified that a RNEP would be the first element of the advanced concepts programme. In support of the programme to develop the new weapons the NPR calls on the US Department of Energy to revitalise the entire nuclear production and testing infrastructure and accelerate plans to build a Modern Pit Facility to produce cores for up to 900 nuclear weapons a year.

What research and development on low-yield nuclear weapons is authorised in the Fiscal Year 2004 Defense Authorisation Bill?

The development of new nuclear weapons and the modification of existing nuclear weapons proceed through a number of defined stages or 'phases'. These were defined in an agreement on 21st March 1953 between the US Department of Defense and the Atomic Energy Commission (now the Department of Energy). Seven phases are involved. Phase 1 is the Weapons Concept Definition Study; phase 2 is the Feasibility Study or programme study; phase 2a is the Design Definition and Cost Study; phase 3 is Development Engineering; phase 4 is Production Engineering; phase 5 is First Production; phase 6 is Quantity Production and Stockpile; and phase 7 is Retirement (6).

A clear distinction can be drawn between early stages of research and development work on low-yield nuclear weapons and the later stages of development in which a conceptual design is turned into an engineered weapon ready for production. Phase 1 and phase 2, which involves paper and computer studies and some proto-type testing, are not directed towards production. But when the work progresses to phase 2a and 3, development becomes directed to creating an actual design for production.

There is an important dividing line between phases 2a and 3. In phase 2a, the nuclear-weapon laboratories, Los Alamos and Lawrence Livermore, would each produce one or more designs for the nuclear explosive components for the weapon and the Sandia National Laboratory would produce designs for the non-nuclear components. At the end of phase 2a, one design and one laboratory would be chosen. The design chosen at phase 2a is turned into a detailed design for production in phases 3 and 4 using computer simulation, non-nuclear and nuclear testing, and so on. Normally, it is at phase 3 that the US Congress is requested to appropriate large funds for the engineering and testing activities needed to begin production of a warhead for the arsenal.

When existing nuclear weapons are modified, the corresponding phases are numbered 6.1, concept assessment; 6.2, feasibility study; 6.2a, design definition and cost study; 6.3, development engineering; 6.4, production engineering; 6.5, first production; and 6.6, full-scale production.

The Fiscal Year 2004 Defense Authorisation Bill clearly draws the line separating permitted activity and activity requiring the explicit authorisation of the US Congress between phase 2a or 6.2a and phase 3 or 6.3. Explicit authorisation is required when large funds are needed, for phases 3 or 6.3 or beyond.

RNEPs

Advocates of RNEPs suggest that they would significantly reduce collateral damage when used to attack hardened, deeply buried targets, compared to the use of a higher yield nuclear weapon exploded on the surface. This presumably makes their use easier to contemplate. But critics point out that no earth-penetrating weapon could penetrate deep enough into the earth to contain its blast and would ventilate, injecting into the atmosphere a cloud of radioactive material. Nuclear-weapon scientists at the Nevada Test Site have discovered that a nuclear weapon with a yield of as little as that equivalent to 100 tonnes of TNT (0.1 kt or 0.8 per cent of the yield of the nuclear weapon that destroyed Hiroshima) would have to penetrate to a depth of about 57 metres to be confident that its blast effects would be contained and would not release into the atmosphere significant amounts of radiation.

Other experts put the depth at 70 metres. This does not take into account that, as the weapon penetrated the earth, the weapon would bore out and leave behind a chimney though which radioactive fallout and debris would escape into the atmosphere. The result would inevitably be a large crater and a cloud of radioactive fallout would shoot out like a fountain and seriously contaminate the region around the point on the surface above the centre of the explosion with deadly radioactivity. About 50 percent of the total radioactivity produced in the explosion would be spread far and wide as local fallout that would cause substantial collateral damage to civilians. The remainder would be confined to the highly radioactive crater.

The properties of a warhead that determine the depth to which it could penetrate include its shape, the hardness of its casing, its momentum on striking the surface, the type of ground (soft or hard) above the buried target, and its explosive yield. The earth-penetrating nuclear weapon in the current American arsenal is the B-61 modification 11 (B61-11), first deployed in 1997. The yield of the weapon can be varied between 0.3 and 300kt, although the 2001 US Nuclear Posture Review describes the B61-11 as a “single-yield, non-precision weapon”. Designed to penetrate to explode at a depth of 15 metres, tests showed that, dropped from an altitude of 12 kilometres, it could penetrate only between 2 and 3 metres of frozen tundra or 6 metres of dry soil (7).

The US military does not need nuclear weapons to attack underground targets. It already has in its arsenal a number of conventional weapons capable of destroying hardened targets buried within about 15 metres of the surface and protected by concrete and hardened steel. In fact, the conventional GBU-37 guided bomb is probably capable of disabling a silo based ICBM (Intercontinental ballistic missile) – a target formerly considered vulnerable only to nuclear attack.[1] Nevertheless, the US decided to produce the B61-11 by taking the nuclear explosive component from an earlier nuclear-weapon design into a new hardened bomb casing with a newly designed nose cone design to give the weapon a capability to penetrate the ground. Official US policy at the time was not to develop new types of nuclear weapons.

However, the Department of Energy and the nuclear-weapon laboratories have argued that the B61-11 is merely a ‘modification’ of an existing delivery system, using an existing ‘physics package’ or nuclear explosive core.

The need to protect the electronics of the weapon while it burrows into the ground severely limits the impact velocities of the weapon to less than about three kilometres per second if the casing is made from the very hardest steels. The maximum penetration depth is roughly 10 times the length of the warhead – about 30 metres for a 3-4 metre long warhead like the GBU-37. To prevent serious damage to the warhead and its contents the impact velocity must, in practice, be much less than this and the penetration depth would be correspondingly less. Therefore it is simply not possible for a warhead relying on kinetic energy to penetrate deeply enough into the earth to contain a nuclear explosion and to prevent serious radioactive contamination of the surrounding area.

The proponents of the development of a new generation of nuclear weapons

The most vocal proponents of the development of new types of low-yield weapons come from the American nuclear weapons laboratories, Los Alamos and Lawrence Livermore, from defence intellectuals and from hawks in the Bush Administration. The staffs at the laboratories feel threatened by the current restrictions on their nuclear-weapon activities, and are keen to generate a new mission, and the associated funding, to keep them in operation for the foreseeable future. It should, however, be emphasised that further research and development work is not needed to produce any new low-yield nuclear weapons. Such a wide range of physics packages has already been developed that it would be possible to choose one to produce a nuclear weapon suitable for virtually any practicable purpose.

The nuclear weapons laboratories feel particularly threatened by the Comprehensive Nuclear Test Ban Treaty that essentially limits them to maintaining the stockpile of weapons already in the US arsenal. This mundane task is not very attractive to bright young scientists and they are slowly leaving for other jobs. There is, therefore, much pressure to generate a new mission that requires a new weapon-development programme.

The US weapons laboratories argue that the development and deployment of a new warhead capable of destroying a deeply buried and hardened bunker would require full-scale nuclear testing. The missile casing, the physics package and the electronics must all function, it is said, under extreme conditions. The weapon detonates and produces a reliable yield shortly after suffering an intense shock deceleration. And there must be great confidence that the actual nuclear yield is not significantly greater than predicted – a bow in the direction of those who somewhat deceptively claim the new weapons will reduce collateral damage. Very low yield weapons are sensitive to exacting design tolerances. All these factors, according to weapons laboratories, require that the new low-yield bunker buster be tested.

These arguments are supported by defence intellectuals and those in the Bush Administration who believe a credible nuclear deterrent – one which blurs the line between conventional and nuclear weapons and that the US can reasonably threaten will be used – will keep rogue states and terrorists at bay. They are thus strongly opposed to multilateral treaties, like the CTBT, that constrain America's ability to pursue its own nuclear options. For some, simply to destroy these treaties is the real and only reason for the political support for the RNEP. The strong political, legal and moral barriers to actually using nuclear weapons to attack non-nuclear states or the actual need for a new type of nuclear weapon is not part of the argument.

Consequences of a resumption of nuclear testing

Resumed testing by the US would threaten the integrity of another key multi-lateral treaty, the NPT and probably accelerate its disintegration. When the NPT was indefinitely extended in 1995, an outcome all the nuclear-weapons states strongly supported, many non-nuclear weapon states were skeptical about the commitment of the five nuclear weapons states to diminish their arsenals and reliance on nuclear weapons. To seal the extension, the nuclear weapons states agreed to three undertakings: a CTBT by 1996, the early conclusion of an FMCT (Fissile Material Cut-off Treaty), and systematic and progressive efforts globally to eliminate nuclear weapons. None of these three undertakings have been fulfilled, in large part (but not entirely) because of the policies of the five nuclear weapons states. At the 2000 NPT Review Conference, similar promises were confirmed and/or reinforced, including the intention to attach a diminishing importance to the role of nuclear weapons.

If the US or any other nuclear weapons state were to resume testing in order to develop new weapons or refine older ones, it would be much clearer that the promises of both 1995 and 2000 have not been kept. The non-nuclear weapons states would get an unambiguous confirmation that the NPT extension in 1995 had been agreed to under false premises. For many, this would be a definite sign that the treaty was unravelling.

Conclusions

The world's nuclear-weapon powers have removed a large number of nuclear warheads from their operational nuclear arsenals. A grand total of about 128,200 nuclear warheads were produced by the world's nuclear-weapon powers after the end of the Second World War. When the Cold War ended in 1989, there were a total of about 59,000 operational nuclear warheads in the arsenals. Currently, the number of operational nuclear weapons, tactical and strategic, in the world's nuclear arsenals is about 16,000.

However, the nuclear-weapon powers are all improving the quality of their nuclear warheads by, for example, improving their accuracy of delivery and reliability. These on-going improvements that the P-5 powers are making to their nuclear arsenals are, at least in spirit, violations of their commitments under Article VI of the NPT to pursue negotiations on disarmament.

American plans to develop new or modified nuclear weapons are causing particular concern. The US has not developed a new nuclear weapon since 1988 and has not conducted a test of a nuclear weapon since 1992. Nevertheless, the US defense budget for Fiscal Year 2004 includes funds for research and development of low-yield (less than 5 kt) nuclear weapons, for studying the RNEP, and to reduce the maximum time between a presidential order to conduct a nuclear test and the test itself. These moves could lead to the production of a new generation of nuclear weapons and significant modifications of existing nuclear weapons.

Critics of any move towards the development and production of new mini-nukes argue that they would blur the distinction between modern conventional weapons and nuclear ones. Their deployment would, therefore, significantly increase the probability that nuclear weapons would be used.

Advocates of RNEPs argue that they would reduce collateral damage when used to attack underground targets, compared to the use of a higher yield nuclear weapon exploded on the surface. But critics point out that RNEPs would not penetrate deep enough to contain effectively its blast and radioactivity and would, therefore, contaminate the atmosphere with a cloud of radioactivity.
The development of mini-nukes and RNEPs could lead to resumed nuclear testing by the US. This would threaten the integrity of both the CTBT and the NPT and probably accelerate the disintegration of the NPT. Those anxious to maintain and strengthen the NPT should, therefore, oppose any moves to deploy a new generation of nuclear weapons.

[1] According to Lisbeth Gronlund and David Wright of UCS, "the two largest conventional EPWs (called GBU-28 and GBU-37) use the same body but different guidance systems. The bodies are long tubes, a third of a meter (14.5 inches) in diameter and four meters (12.8 feet) long, that weigh over two tons and contain nearly 300 kilograms (630 pounds) of high explosive. Both are dropped from aircraft, and tests have shown they can penetrate six meters of concrete or 30 meters of earth. The GBU-28 is laser guided and the GBU-37 is guided by the Global Positioning System, which reportedly makes it more accurate than the GBU-28 and allows it to operate under all weather conditions. Very high accuracy increases the ability of these weapons to destroy shallow hardened targets with known locations (such as missile silos) but not deeply buried targets."

References

1. Natural Resources Defense Council, *Archive of Nuclear Data; Index of Nuclear Data, Table of Global Nuclear Weapons Stockpile, 1945-2002*, Natural Resources Defense Council, 2003. http://www.nrdc.org/nuclear/nudb/datab19.asp

2. Stockholm International Peace Research Institute, *Armaments, Disarmament and International Security, SIPRI Yearbook 2003*, Oxford University Press, 2003, pp. 610-627.

3. Robert S. Norris and Hans M. Kristensen, *Russian Nuclear Forces, 2004*, Bulletin of the Atomic Scientists, July/August 2004, pp.72-74.

4. Robert S. Norris and Hans M. Kristensen, *U.S. Nuclear Forces, 2004*, Bulletin of the Atomic Scientists, May/June 2004, pp.68-70.

5. David Wright, *The Spratt-Furse Law on Mini-Nuke Development,* Union of Concerned Scientists, May 11, 2003.
http://www.ucsusa.org/global_security/nuclear_weapons/page.cfm?pageID=1182

6. Jonathan Medalia, *Nuclear Weapon Initiatives: Low-Yield R&D, Advanced Concepts, Earth Penetrators, Test Readiness*, Congressional Research Service, Library of Congress, Washington DC, CRS Report for Congress RL32130, December 11, 2003.

7. Robert W. Nelson, *Nuclear Bunker Busters, Mini-Nukes, and the US Nuclear Stockpile*, Physics Today, American Institute of Physics, 2003.
http://www.physicstoday.com/vol-56/iss-11/p32.html