Low-Yield and Earth-Penetrating Nuclear Weapons
aka
"Mini-nukes" and "Bunker Busters"

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December 2003

Those who believed that the nuclear arms race would ease with the Cold War are increasingly disturbed by the arguments of some officials in the Bush administration that the U.S. should develop and deploy a new generation of low-yield "mini-nukes" as well as higher-yield "bunker busters" that can be delivered with great precision on hardened and deeply-buried targets. These mini-nukes, with less than a 5 kiloton (kt) yield, and the bunker busters (or Robust Nuclear Earth Penetrator) with unspecified higher yields, 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 and operating out of underground facilities.

Because low-yield nuclear weapons blur the distinction between modern precision-guided conventional weapons and nuclear ones, critics have argued that the deployment of mini-nukes would increase the probability that nuclear weapons might be used. For this reason, Congress passed a law in 1994 prohibiting the nuclear-weapon laboratories from undertaking research and development that could lead to a new nuclear weapon with a yield of less than 5 kilotons. This restriction was repealed by the 2004 Defense Authorization Act and the same bill provided funds for research on a new, higher yield nuclear bunker buster.

The 2001 Nuclear Posture Review (NPR) 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." In support of the program to develop the new weapons the NPR called upon the Department of Energy to revitalize 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 per year (money for this project was also included in the 2004 defense budget).

Advocates of mini-nukes and bunker busters suggest that they would significantly reduce collateral damage when used to attack hardened, deeply buried targets. This presumably makes their use easier to contemplate compared to the use of a higher yield nuclear weapon exploded on the surface. But critics point out that no earth-penetrating nuclear weapon could burrow deep enough into the earth to contain its blast and would ventilate, injecting a cloud of radioactive material into the atmosphere. Nuclear-weapon scientists at the Nevada Test Site have determined that a nuclear weapon with a yield of as little as that equivalent to 100 tons of TNT (0.1 kt or 0.8 percent of the yield of the nuclear weapon that destroyed Hiroshima) would have to penetrate to a depth of about 57 meters to contain its blast effects and not release significant amounts of radiation into the atmosphere. Other experts put the depth at 70 meters. This does not take into account that, as it 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 that would shoot out like a fountain and seriously contaminate a large area surrounding ground zero. About 50 percent of the total radioactivity

produced in the explosion would be spread far and wide and as local fallout would cause substantial collateral damage to civilians. The remainder would be confined to the highly radioactive crater.[i]

The properties of a warhead that determine the depth to which it can 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 original weapon could be varied between 0.3 and 300kt, although the 2001 U.S. Nuclear Posture Review describes the B61-11 as a "single-yield, non-precision weapon." Designed to penetrate and explode at a depth of 15 meters, tests showed that, dropped from an altitude of 12 kilometers, it could penetrate only between 2 and 3 meters of frozen tundra or 6 meters of dry soil.

Critics have argued that the U.S. military does not need nuclear weapons to attack underground targets – and to be fair, the military itself has been consistently cool to the idea of nuclear weapons for any but deterrent use. There are already in the arsenal a number of conventional weapons capable of destroying hardened targets buried within about 15 meters of the surface. 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. Nevertheless, the U.S. decided to produce the B61-11 by taking the nuclear explosive component from an existing weapon and packaging it in a new hardened casing with a newly designed nose cone to give it the capability to penetrate the ground. Since official U.S. policy at the time was not to develop new types of nuclear weapons, the Department of Energy and the nuclear-weapon laboratories have argued, not incorrectly, 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 to less than about 3 kilometers per second if the casing is made from the very hardest steels. The maximum penetration depth is roughly ten times the length of the warhead – about 30 meters for a 3-4 meter-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 not possible for a warhead relying on kinetic energy to penetrate deeply enough into the earth to contain a nuclear explosion and prevent serious radioactive contamination of the surrounding area.

Among the most vocal proponents of the development of new types of low-yield and bunker buster weapons have been the nuclear weapons laboratories, Los Alamos and Lawrence Livermore. The staffs at the laboratories have been chafing under the last decade's restrictions on their nuclear-weapon activities, and have been keen to generate a new mission, and the associated funding, to keep them in operation for the foreseeable future.

The labs feel particularly threatened by the Comprehensive Nuclear Test Ban Treaty (CTBT) that essentially limits them to maintaining the safety and reliability of the significant stockpile of weapons already in the U.S. 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 program. In fact, very little research and development work would be needed to produce a new low-yield or bunker buster nuclear weapon. Such a wide range of physics packages already exists that it would be possible to choose one and produce a nuclear weapon suitable for virtually any practicable purpose.

The laboratories nonetheless argue that the development of a new earth-penetrating 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 shortly after suffering an intense shock deceleration and produce a reliable yield. 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. And there must be great confidence that the actual nuclear yield is not significantly less than predicted – a bow in the direction of those who claim that the new weapons will be capable of destroying deeply buried, hardened facilities. Very low yield weapons are sensitive to exacting design tolerances. All these factors, according to weapons laboratories, require that any new bunker buster be tested.

The defense hawks in the Administration support the development of these new weapons because they believe a credible nuclear deterrent – one which blurs the line between conventional and nuclear weapons and that the U.S. can reasonably threaten will be used – will keep rogues and terrorists at bay. This "deterrent" argument for mini-nukes and bunker busters against rogues and terrorists is, of course, extremely doubtful: New nuclear weapons in the U.S. arsenal are just as likely to have no impact at all on these threats or, perversely, to further stimulate rogues and terrorists to acquire their own new weapons of mass destruction. Moreover, the fact that the President would face very strong practical, political, legal and moral barriers against using nuclear weapons against non-nuclear weapon states is simply not part of the analysis.

The purveyors of the "credible nuclear deterrent" argument are also strongly opposed to multilateral treaties, like the CTBT, that constrain America's ability to pursue its own nuclear options. For some, simply to ensure that these treaties never come into force is sufficient reason to support mini-nukes and the Robust Nuclear Earth Penetrator.

One final, but critical observation: Resumed testing by the U.S. would threaten the integrity of the Nuclear Non-Proliferation Treaty (NPT), and probably accelerate its disintegration. When the NPT was indefinitely and unconditionally extended in 1995, an outcome the U.S. strongly supported, many non-nuclear weapon states were skeptical about the commitment of the nuclear weapons states to diminishing 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 a Fissile Material Cut-off Treaty, and systematic and progressive efforts to eliminate nuclear weapons. At the 2000 NPT Review Conference, similar promises were confirmed and/or reinforced, including the intention to attach a declining importance to the role of nuclear weapons. None of these three undertakings has been fulfilled, in large part (but not entirely) because of the policies of the five nuclear weapons states.

If the U.S., or any other nuclear weapons state, were to resume testing in order to develop new weapons or refine older ones, it would be clear that the promises of both 1995 and 2000 have not been kept and that the NPT had been extended under false premises. For many non-nuclear weapons states party to the NPT, this would be a clear indication that the nuclear weapons states did not intend to honor their commitments and that the NPT was in the process of unraveling.

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[i] Robert W. Nelson, in a report done for the Federation of American Scientists, writes that "[i]n order to be fully contained, nuclear explosions at the Nevada Test Site must be buried at a depth of 650 feet for a 5-kiloton explosion – 1300 feet for a 100-kiloton explosion. Even then, there are many documented cases where carefully sealed shafts ruptured and released radioactivity to the local environment."