The Reliable Replacement Warhead Program

A Slippery Slope to New Nuclear Weapons

A Report from Tri-Valley CAREs

by

Dr. Robert Civiak

January 2006

ON THE COVER: The cover photograph shows molten plutonium metal in a levitated state inside a crucible. The Reliable Replacement Warhead program, if it moves forward as the Department of Energy, National Nuclear Security Administration, and the weapons labs envision, would involve a major expansion of plutonium activities, including the manufacture of new plutonium "pits" (cores) for newly designed nuclear weapons.

Photo credit: Joe Riedel, Los Alamos National Laboratory

Tri-Valley CAREs was founded in 1983 in Livermore, California to increase public knowledge of the relationship between peace, social justice and the environment. The organization is a 501(c)(3) nonprofit group that monitors activities in the U.S. nuclear weapons complex, with a focus on the Lawrence Livermore National Laboratory.

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About the Author

Bob Civiak has been doing research and analysis in nuclear weapons policy and related areas for more than 25 years. He received a Ph.D. in physics from the University of Pittsburgh in 1974. From 1978 through 1988 he was a Specialist in Energy Technology and Section Head in the Science Policy Research Division of the Congressional Research Service (CRS) at the Library of Congress. During the spring and summer of 1988 he was a Visiting Scientist at Lawrence Livermore National Laboratory. From November 1988 through August 1999 he was a Program and Budget Examiner with the Office of Management and Budget (OMB) in the Executive Office of the President. At OMB his primary responsibilities included oversight of the national security activities of the Department of Energy, including the Stockpile Stewardship Program. He currently resides in Lebanon, New Hampshire, where he continues to do research and policy analysis on nuclear weapons and arms control issues as an independent consultant. This is his fourth report for Tri-Valley CAREs on major issues in nuclear weapons policy.

Acknowledgments

The publication and distribution of this report is part of Tri-Valley CAREs' project to expose U.S. nuclear weapons research and development activities. This work is supported by the Ploughshares Fund, Town Creek Foundation, Public Welfare Foundation, Colombe Foundation, the Richard and Rhoda Goldman Fund, New-Land Foundation, Ben and Jerry's Foundation, Tin Man Fund, the Victor and Lorraine Honig Foundation, and individual donors.

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Executive Summary

The United States is poised to embark on a major program that could launch the nation on a "slippery slope" toward developing new nuclear weapons. Promoted by the U.S. Department of Energy and its nuclear weapon design laboratories with an innocuous sounding title, the "Reliable Replacement Warhead" program would actually damage national security. It would also cost billions of taxpayer dollars and could result in the production of new warheads less safe and reliable than those in the current arsenal.

Late in 2004, Congress established the Reliable Replacement Warhead (RRW) program to "improve the reliability, longevity, and certifiability of existing weapons and their components"[1] Exactly what changes Congress envisions for nuclear weapons under the RRW program remains vague. However, in each of the past two years, Congress has rejected Bush Administration proposals to design new nuclear weapons in favor of improving existing weapons in the stockpile. In contrast, the nuclear weapons laboratories[2] want to build new warheads. They see the RRW program as an opportunity to expand their mission "from a program of warhead refurbishment to one of warhead replacement."[3] One recent report calls for the labs to develop a new Reliable Replacement Warhead every five years. [4] Thus, while Congress may see the RRW program as a limited effort to improve existing nuclear weapons, to others it is the holy grail of the weapons labs—a guarantee of jobs designing new nuclear weapons in perpetuity.

A broad RRW program would significantly harm our national security, primarily because U.S. pursuit of an RRW would disrupt international cooperation in non-proliferation.

Thus far, funding for the RRW program has been rather modest—$9 million in 2005 and $25 million in 2006. If left unchecked, however, the weapons labs would grow the RRW program into a multi-billion-dollar effort to redesign the entire stockpile. Nuclear weapon designers would alter the military characteristics of existing weapons and would add new weapons with new capabilities and new missions. Expensive new facilities would also be needed to build the replacement warheads.

A broad RRW program would significantly harm our national security, primarily because U.S. pursuit of an RRW would disrupt international cooperation in non-proliferation. That would diminish pressure on Iran and North Korea to forego their nuclear weapons programs and would disrupt efforts to eliminate clandestine trafficking in nuclear materials and equipment. In addition, the Department of Defense (DoD) would likely demand that any new warhead, which the RRW program might create, undergo full nuclear explosive tests before DoD accepts it into the stockpile. If the U.S. were to conduct even a single nuclear weapons test, other nations would surely follow suit, which could lead to a new nuclear weapons arms race. The damage this would impart to the broad non-proliferation regime would far exceed any conceivable advantage the U.S. could gain from new nuclear weapons.

The weaponeers claim the RRW is needed to improve the reliability, safety, and security of the nuclear weapons stockpile and to reduce the cost of maintaining it. However, a close look at the stockpile reveals that it needs no "improvements." U.S.

nuclear weapons are highly capable, extremely safe and secure, and very reliable. With proper maintenance the reliability, safety, and certifiability of existing weapons can be maintained indefinitely. There is no reason to make any changes to the well-tested, dependable nuclear weapons in the current stockpile. As components age, they can be replaced with identical or nearly identical copies of the original. Only in rare instances, when a component cannot be replaced with an identical copy of the original design because necessary parts or materials are no longer available, should any modifications be considered. This approach to maintaining the stockpile, called the Curatorship approach, would cost far less than what the National Nuclear Security Administration (NNSA)[5] currently spends under its Stockpile Stewardship approach. In addition, by strictly limiting any changes to nuclear weapons, NNSA can avoid potential degradation in its confidence in the stockpile that might arise from accumulating small changes to well-tested warhead designs.

The RRW is merely the latest proposal to fulfill the top priority of the weapons labs—preservation of funding and jobs.

The RRW is merely the latest proposal to fulfill the top priority of the weapons labs—preservation of funding and jobs. The end of the Cold War has led to fewer nuclear weapons and less development of new weapons. Nevertheless, spending on nuclear weapons work has increased dramatically. In 2006, the NNSA plans to spend $6.4 billion on nuclear weapons. Even after adjusting for inflation, that is one and one-half times the average annual spending on nuclear weapons during the Cold War. The weaponeers have achieved this impressive growth by continually inventing new rationales for increased funding. Over the past twenty years, the rationale has shifted from the Cold War competition against the Soviet Union, to the need for expensive underground weapons tests to maintain the stockpile, to a massive aboveground testing and simulation program called Stockpile Stewardship, and now to the Reliable Replacement Warhead program.

Since U.S. nuclear weapons need no improvements and a broad RRW program would damage U.S. security, it would be dangerous to create a new program to pursue even the modest goals for which Congress established the RRW program. We, therefore, believe that Congress should eliminate all funding for the RRW and cancel the program. If Congress is not prepared to cancel the RRW, it should at least give close scrutiny to NNSA plans for the program to head off attempts to design new nuclear weapons. To do so, Congress must get a detailed 5-year plan for the RRW program from the Bush Administration before it acts on spending for 2007. We also recommend that Congress unequivocally prohibit, in law, the use of any NNSA funds to develop new or significantly modified nuclear weapons. In addition, we recommend that Congress strictly limit NNSA's authority to make *any* changes to existing nuclear warheads without prior congressional approval. Finally, Congress should appoint an independent commission to examine less costly options for maintaining the U.S. nuclear weapons stockpile, including the Curatorship option.

What is the RRW Program?

It is difficult to pin down what the RRW program really is. It was born from a single phrase in the Conference Report on the 2005 Appropriations Act. There, Congress provided $9 million "for the Reliable Replacement Warhead program to improve the reliability, longevity, and certifiability of existing weapons and their components."[6] Even with a near tripling of funds to $25 million in 2006, the program is still modest. However, the nuclear weaponeers are trying to seize the opportunity and make the RRW into a grandiose program to design and build new nuclear weapons.

Administration and Laboratory Views

NNSA Administrator, Ambassador Linton Brooks, gave his vision for the program in testimony before the Senate Armed Services Committee.[7] He believes there is a need to transform the nuclear weapons stockpile to meet new requirements. According to Brooks, NNSA is designing the RRW program "to understand whether, if we relaxed warhead design constraints…we could provide replacements for existing stockpile weapons that could be more easily manufactured with more readily available and more environmentally benign materials, and whose safety and reliability could be assured with highest confidence, without nuclear testing, for as long as the United States requires nuclear forces."

The key issue here is whether the RRW is to improve aspects of existing weapons, as the implementing legislation says, or is to replace existing stockpile weapons, as Brooks would have it. Ambassador Brooks' boss, Secretary of Energy Samuel Bodman, appears to want it both ways. In February 2005, he told the Senate Budget Committee the RRW is, "…a matter of maintaining what we have. I think some have suggested it's creating something new. It's maintaining what we have."[8] However, Bodman later told Senator Dianne Feinstein (D-California), "Certain concepts identified in the RRW program could be applied in the development of warheads to meet [these] new requirements."[9] In the latter view, the development of new warheads may not be the purpose of the RRW program, but would be a likely result.

The nuclear weapons labs have their own vision. A paper referred to as the "tri-lab paper" states, "This vision of sustainable warheads with a sustainable enterprise can best be achieved by shifting from a program of warhead refurbishment to one of warhead replacement."[10] The labs hasten to note, "This will require careful reprioritization of existing resources or additional near-term resources, in order to begin the process of transformation." In other words, send us more money!

Last July, a task force of the Secretary of Energy's Advisory Board (SEAB) presented the most extreme version of the RRW program. The Task Force on the Nuclear Weapons Complex Infrastructure recommended, "immediate initiation of the modernization of the stockpile through the design of the RRW. This should lead to a family of modern nuclear weapons, designed with greater margin to meet military

requirements while incorporating state-of-the-art surety requirements." The Task Force further recommended that a new version of the RRW, "incorporating new design concepts and surety features, be initiated on planned five-year cycles."[11] During an October 14, 2005 meeting to review the report, several SEAB members, including Nobel Prize winners Leon Lederman and Burt Richter, noted that the task force exceeded its mandate by making recommendations regarding the RRW. The Secretary of Energy had requested that they examine the infrastructure requirements of the nuclear weapons complex to support the existing stockpile. The recommendations regarding the RRW go beyond that. Richter, Lederman, and other SEAB members found the RRW recommendations troubling, because the task force had not examined the international effects of an RRW program; particularly its effects on the non-proliferation regime. Rather than recommending the report to the Secretary of Energy, the SEAB voted to "approve the thrust of the report" for the Secretary's consideration and noted that a number of members believed that the issue of a Reliable Replacement Warhead will need further study by the Department of Energy and the Administration. Nevertheless, SEAB forwarded the task force's report to the Secretary unchanged.

SEAB members found the RRW recommendations troubling, because the task force had not examined the international effects of an RRW program; particularly its effects on the non-proliferation regime.

Congressional Views

More than a year after establishing the program, Congress still has a diversity of views regarding what it should be. They range from a belief that the RRW should be, at most, a program to maintain existing weapons with minor upgrades, to sharing Linton Brooks' vision of the need to transform the nuclear weapons stockpile with new warheads to meet new requirements. Reflecting the diversity of views, the language in congressional reports authorizing the program and appropriating funds for it is vague or ambiguous.

The House Subcommittee on Energy and Water Appropriations crafted the language that initiated the RRW program last year. Since then, Subcommittee Chair David Hobson (R-Ohio) has stated that the program might someday lead to "refurbishing" weapons to make them "more robust," but "without developing a new weapon that would require underground testing to verify the design"[12] That apparently leaves room for developing new weapons, as long as they do not require underground testing (if that is possible). The House Appropriations Committee Report for 2006 stated:

> The Committee's qualified endorsement of the RRW initiative is based on the assumption that a replacement weapon will be designed only as a re-engineered and remanufactured warhead for an existing weapon system in the stockpile. The Committee does not endorse the RRW concept as the beginning of a new production program intended to produce new warhead designs for any military mission beyond the current deterrent requirements. The Committee's support of the RRW concept is contingent on the intent of the program being solely to meet the current military characteristics and requirements of the existing stockpile.[13]

The Senate Appropriations Committee Report for 2006 was even more ambiguous. Mirroring last year's language, the Committee:

> …recommends $25,351,000 for RRW to accelerate the planning, development, and design for a comprehensive RRW strategy that improves the reliability, longevity, and certifiability of existing weapons and their components.[14]

That Committee appears to eschew new warhead designs and distance itself from the SEAB Task Force by stating, "the RRW program is not a new weapon, and this fact should be clear to the study panel members." Elsewhere, however, the Senate Committee Report provided $4 million to study the Robust Nuclear Earth Penetrator (RNEP)—a new warhead that could burrow underground to attack hardened bunkers.

As finally enacted into law, the 2006 Energy and Water Appropriations Act provided $25 million for the RRW program and no funding for the RNEP. The Conference Committee report stated:

> …any weapons design work under the RRW program must stay within the military requirements of the existing deployed stockpile and any new weapon design must stay within the design parameters validated by past nuclear tests.[15]

That language is subject to a wide range of interpretations. Under existing procedures, a new military requirement must be issued before any new warhead is designed. The requirements put limits on dozens of performance parameters. A strict interpretation of the above language would prohibit any variation from the detailed military requirements of an existing weapon and would indeed limit the options for new RRW designs. Similarly, under a strict interpretation, any new weapon design would, by necessity, have design parameters that have not been validated by past nuclear tests. On the other hand, since the military requirements and the details of past nuclear tests are all classified and highly technical, it will most likely be left to the labs themselves to interpret the above language. The labs can be counted on to interpret the language as loosely as possible. Thus, for example, the labs might determine that a new low-yield warhead for a ballistic missile would be within the military requirements of the existing stockpile as long as its yield is above that of the lowest yield option on tactical warheads that remain in the stockpile. The labs can also be counted on to use a broad interpretataion of design parameters that have been validated by nuclear tests. The bottom line is that the above language will not significantly restrict what can be developed under the RRW program if the labs are the performers, the judge, and the jury. Over time, NNSA and the weapons labs will undoubtedly skirt such restrictions and add new and improved capabilities to nuclear weapons.

The bottom line is that the above language will not significantly restrict what can be developed under the RRW program if the labs are the performers, the judge, and the jury.

The House version of the 2006 Defense Authorization Act supports the RRW program and proposes a number of objectives for it, including "to increase the reliability, safety, and security of the United States nuclear weapons stockpile" and "to develop reliable replacement components to fulfill current mission requirements of the existing stockpile.[16] It is unclear to what extent the House Armed Services Committee would support new weapon designs. That Committee's report states:

> The Committee expects that the budgeting and reporting of the Reliable Replacement Warhead program will be consistent with the traditional nuclear weapons acquisition process of designating work related to new weapons or weapon modification development and production.[17]

The House Armed Services Committee apparently plans to review the program more closely next year.

Many of the Democrats on the House Armed Services Committee are skeptical of the RRW program. A statement of additional views, signed by 23 of the 28 Democratic Members of that Committee, notes that the RRW should "not be used to produce warheads for new nuclear missions." The Democrats further state:

> Given the current satisfactory performance margins of the enduring stockpile and the lack of an immediate need for a new RRW warhead, Democrats strongly believe that the NNSA should exercise rigorous self-discipline and utilize designs and components that are well understood or have been previously proven through testing.…
>
> Democrats are willing to explore the concept of the RRW program, but do not yet embrace it. In our opinion, the RRW program is only worth support if it:
>
> - Truly reduces or eliminates altogether the need for nuclear testing; …
> - Does not introduce new mission or new weapon requirements, particularly for tactical military purposes; …
> - Significantly reduces the cost of maintaining our nuclear weapon complex, to include avoiding the need to build a modern pit facility.[18]

The Senate Armed Services Committee also appears to be in a wait and see mode. That Committee's report supports the goals set forth by Ambassador Brooks for the RRW program, supports a "modest investment in feasibility studies," and requests that NNSA submit a report, by February 6, 2006, on actual and planned spending on RRW for 2005, 2006, and 2007.[19] In principle, the Committee should not have had to request such a report, since the NNSA is already required to submit a 5-year budget plan for all of its programs in February each year with the President's Budget. On the other hand, NNSA has rarely if ever, provided useful information at this level of program detail in its 5-year budget plan.

The Conference Report on the 2006 Defense Authorization Act accepts the objectives for the RRW program, which are included in the House bill, and endorses the RRW-related language in both the House and Senate Committee Reports.

A large portion of the House of Representatives has expressed concern about the RRW. In a letter to the Chairs and Ranking Minority Members of the House Appropriations and Armed Services Committees, Representatives Edward Markey (D-Massachusetts), Ellen Tauscher (D-California), John Spratt (D-South Carolina), and 133 other House Members stated:

Once Congress opens the door to any new warhead development, it will be difficult, if not impossible, to enforce limits on their design.

> We are concerned that shifting funding from the cancelled Advanced Concepts program into the Reliable Replacement Warhead program may result in new nuclear warheads moving forward without any established need or compelling justification. We therefore ask that you eliminate funds for the RNEP program and for any program to study or develop new types of nuclear weapons.[20]

It is not clear, however, whether even these skeptics of the RRW program are opposed to any new nuclear weapon design or just to new types of nuclear weapons.

In sum, while it is still early and positions are not fully determined, it seems that the majority of the Congress currently supports enhancement of existing nuclear weapons, and perhaps would support new warheads, as long as they are for existing missions and do not require full-scale nuclear testing. This limited version of the RRW is a slippery slope and would be difficult to enforce. If the labs are given approval

to design a new warhead to replace existing Submarine Launched Ballistic Missile (SLBM)-warheads, for example, would Congress prevent the labs from modifying the warheads' yield, improving its accuracy, or adding new delivery modes or yield options? Such a new warhead might threaten a host of new targets. Does that give it new missions? If NNSA completes the development of such a warhead and ten years from now DoD says it needs that warhead to replace existing SLBM warheads, which have by then become suspect from neglect, would Congress stand in the way if DoD says it needs one or two confirmatory underground nuclear tests to be sure that this key warhead will function? Once Congress opens the door to any new warhead development, it will be difficult, if not impossible, to enforce limits on their design. Allowing the weapons labs to begin designing warheads for existing missions is particularly risky given Ambassador Brooks' and the weapons labs' stated desire to transform the nuclear weapons stockpile to meet new requirements.

Status of the Program

In March 2005, the Nuclear Weapons Council (NWC) approved the formation of a Project Officers Group (POG) to direct the RRW program. The POG includes representatives from NNSA, the three weapons labs, the Office of the Secretary of Defense, the Navy, Air Force, U.S. Strategic Command (STRATCOM), and other defense agencies and contractors. The NWC tasked the group to conduct an 18-month design competition, beginning May 2005, for an RRW to potentially replace the W-76 Submarine Launched Ballistic Missile. One design team includes Los Alamos and Sandia Labs in New Mexico and the other team features Livermore Lab and Sandia's California site. The Council set out the terms of reference for the designs in a classified memo.

According to the Nuclear Weapons Council's procedural guideline for the phases of nuclear weapons development,[21] the RRW competition appears to be a "Feasibility Study and Option Down-Select" (phase 6.2). In a phase 6.2 study, design options are developed and the feasibility of a particular nuclear weapon is studied. Normally, at the end of a design competition, the Project Officers Group reviews the designs and transmits a recommendation to the Nuclear Weapons Council. If the NWC approves a design and Congress provides funding, the next phase would be a detailed "Design Definition and Cost Study" (phase 6.2A), which would take about a year. During phase 6.2A, the labs continue to refine the design and develop cost estimates for the project leading to a decision to enter phase 6.3, which is "Development Engineering." If development activities continue, the first production unit of a new warhead might roll off the assembly line as soon as 2012.

The RRW Program is Counter to U.S. National Security

The pursuit of an RRW threatens to disrupt international cooperation in non-proliferation and, thus, is counter to U.S. national security. Any damage to international cooperation in non-proliferation would diminish pressure on North Korea, Iran, and other nations to forego their nuclear weapons programs and would limit efforts to eliminate clandestine trafficking in nuclear materials and equipment. The DoD would likely demand that any new warhead undergo full nuclear explosive tests before they accept it into the stockpile. If the U.S. were to conduct even a single nuclear weapons test, other nations would surely follow suit, which could lead to a dangerous new nuclear weapons arms race. Furthermore, a new low-yield RRW, or any other nuclear weapon for a new mission, would reduce the threshold for use of nuclear weapons making all nations less secure.

The RRW Program Would Undermine the International Non-Proliferation Regime

Under the nuclear Non-Proliferation Treaty (NPT), more than 185 nations have foresworn development of nuclear weapons in return for a promise by the United States and the other recognized nuclear powers to "pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament." That pledge was strengthened during the NPT Review Conference at the United Nations in April and May of 2000. All the nations participating, including the United States, agreed to a 13-point action plan that included, "An unequivocal undertaking by the nuclear weapons States to accomplish the total elimination of their nuclear arsenals leading to nuclear disarmament to which all States parties are committed under Article VI." The Bush Administration has backed away from the commitment the United States made in 2000 and refused to use it as the starting point for discussions during the 2005 NPT Review Conference.

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The RRW program would move the United States further from its NPT commitments. The U.S. would open itself to heightened criticism from nations dissatisfied with the slow pace of nuclear weapons reductions. Many would see the RRW program as provocative and antithetical to cessation of the nuclear arms race. The 2005 NPT Review Conference ended without the participants agreeing on a final statement or a plan of action to strengthen the Treaty. The main sticking point was a rift between those nations, including the United States, whose highest priority was to strengthen non-proliferation aspects of the Treaty, and other nations, whose highest priority was to move the weapons states more rapidly toward disarmament. The U.S. refused to reaffirm its disarmament commitment or discuss any additional movement toward disarmament. That refusal undermined efforts to address the nuclear weapons development activities of North Korea, Iran, and others during the Conference. It

also undermined efforts to address the continuing problem of trafficking in nuclear materials and technology. As former Deputy Secretary of Defense and Undersecretary of Energy, John Deutch, has noted:

> . . . the United States relies on the cooperation of many nations to achieve its non-proliferation objectives, and in this regard the U.S. nuclear posture has important consequences. An effective non-proliferation effort requires restricting the transfer of nuclear materials and technology, encouraging effective inspection by the International Atomic Energy Agency, and strengthening standards for the protection of nuclear materials and facilities. Cooperation is also essential for establishing an international norm that forbids the nuclear ambitions of non-nuclear states.[22]

Pursuit of an RRW program by the United States would further disrupt international cooperation in non-proliferation and could break the back of the NPT.

The RRW Program Could Lead to a Return to Nuclear Weapons Testing

Linton Brooks maintains that the initial goal of the RRW program is to investigate whether the laboratories can develop and certify an RRW, with the qualities they desire, without full-scale nuclear testing. Experts at the weapons labs apparently believe they can. Nevertheless, once an RRW is developed, it is likely that military planners in the DoD will require a nuclear test before they accept it into the stockpile. The NNSA Director of Policy and Planning, John Harvey, acknowledges that possibility. Harvey notes, ''Our goal is to carry out this program without the need for nuclear testing . . . But there's no guarantees in this business, and I can't prove to you that I can do that right now."[23] Even more telling, former Deputy Secretary of Defense, John Hamre, who believes that new nuclear warheads will eventually be needed, has stated, "I do believe we should test the new weapons to demonstrate to the world that they are credible."[24]

A Machiavellian might say that lab experts, who claim they can develop an RRW without testing, are attempting a bait and switch trick. In this view, the labs know they will likely have to test an RRW before it enters the stockpile, but they are claiming the program's goal is to develop new weapons, without testing, as the bait before the switch. The labs have already been guilty of bait and switch with the Stockpile Stewardship program. Throughout the 1990s, the labs claimed Stockpile Stewardship was needed to maintain the stockpile, but could not be used to enhance or build new nuclear weapons. Since then, NNSA has enhanced the B-61 nuclear bomb to allow it to penetrate into the earth before detonating and now routinely enhances weapons capabilities under the Life Extension Program. The labs either stretched the truth when they said that Stockpile Stewardship would never allow them to design new warheads without nuclear testing or they are stretching the truth now when they say they can.

If testing is resumed, the damage to the broader non-proliferation regime, and thus to U.S. security interests, would far exceed any conceivable advantage the U.S. could gain from new nuclear weapons.

If the U.S. were to conduct even a single nuclear weapons test, it would surely lead other nations to resume nuclear testing and could lead to resumption of a full-scale nuclear weapons arms race. If testing is resumed, the damage to the broader non-proliferation regime, and thus to U.S. security interests, would far exceed any conceivable advantage the U.S. could gain from new nuclear weapons.

The RRW Program Might Reduce the Threshold for Use of Nuclear Weapons

In its 2001 Nuclear Posture Review, the Bush Administration expanded the role of nuclear weapons from deterrence only to include pre-empting development or use of chemical or biological weapons by other nations and other war-fighting missions. This Administration, or future Administrations, might use the RRW program to further this plan by adding a new low-yield, earth-penetrating warhead to the arsenal. Development of such a warhead would appear to violate limits that *this* Congress has placed on the RRW program. However, the labs might interpret the congressional language in ways to circumvent those limits or may lobby a future Congress to modify the limits once the RRW program begins to produce results. As discussed below, it is unlikely that NNSA could design a low-yield, earth-penetrating warhead that could defeat buried targets with little collateral damage. Nevertheless, even if it marginally reduced collateral damage, military commanders might more readily use a low-yield, earth-penetrating warhead than higher yield warheads. Our nation would be more secure without such a capability. A new low-yield, earth-penetrating warhead would be highly provocative and would provide further rationale for rogue nations to develop their own nuclear weapons. Furthermore, it would reduce the threshold for use of nuclear weapons and, thus, increase the chances of a broad nuclear exchange, which might kill millions of people.

The RRW program is simply not needed to maintain an effective U.S. nuclear weapons stockpile.

Congress has twice rejected Administration proposals to examine the feasibility of a Robust Nuclear Earth-Penetrating bomb. Congress also appears to oppose use of the RRW program to develop warheads for new missions. However, if Congress gives the labs an opportunity to design new warheads, supposedly for existing missions, they will be on a slippery slope toward enhancing performance and adding new capabilities. It is impossible for this Congress to prevent future Administrations from assigning those new warheads to new missions. Reopening the Pandora's box of nuclear weapons design will almost certainly lead to new nuclear weapons with new missions in the future. NNSA Administrator Brooks wants the RRW program, because he believes the current stockpile is the wrong stockpile from a military perspective. His vision of the right stockpile would increase the likelihood that nuclear weapons will be used.

There is No Need for an RRW Program

The existing nuclear stockpile is highly capable. U.S. nuclear weapons are extremely safe, secure, and reliable. With proper surveillance, and repair or replacement of damaged or aged components that are in danger of failure, they can be maintained that way indefinitely. Whether the U.S. *should* keep nuclear weapons indefinitely is beyond the scope of this report. However one answers that question, the RRW program is simply not needed to maintain an effective nuclear weapons stockpile for as long as the U.S. chooses to do so.

U.S. Nuclear Weapons are Highly Capable

The United States has been designing and building nuclear weapons for 60 years. About 90 different designs have been developed into prototypes and 65 of those have entered the stockpile. Each of those was tested extensively. The United States has conducted over 1,000 nuclear explosive tests in the atmosphere and underground. More than 70,000 nuclear weapons have been built and deployed in the United States. The U.S. nuclear weapons stockpile peaked at 32,000 warheads in 1966 and stands at about 10,000 today. According to the 2002 Treaty of Moscow, the U.S. is supposed to cut back to 1,700–2,200 operationally deployed strategic warheads by the end of 2012. Including non-strategic warheads and spares, however, the United States plans to retain a 6,000-warhead stockpile of seven basic designs through at least 2012.

There is a tremendous variety of capabilities and substantial redundancy in the stockpile. Including variants to the basic designs, the enduring stockpile will contain twelve different models of nuclear weapons. The total includes at least two models that are optimized for each of four delivery vehicles—land-based ballistic missiles, submarine-based ballistic missiles, aircraft, and cruise missiles. The explosive yields for at least seven of the twelve warhead models can be selected in the field before delivery from among four or more different levels varying from 0.3 kilotons to 1,200 kilotons. The atomic bomb dropped on Hiroshima had a yield of about 15 kilotons.

There is little room for improvement in key performance characteristics of nuclear weapons. U.S. weapons are near the theoretical maximum in their yield to weight ratio. Ballistic missiles can deliver nuclear weapons to within tens of meters of their targets after traveling for thousands of miles. Cruise missiles can deliver their payloads even more accurately.

U.S. nuclear warheads can be set to explode at various heights above the ground, on impact with the ground, or with a delay after ground impact. In addition, the B61-11 bomb can penetrate a few meters into the ground before exploding. Thus, planners have a vast number of yield and delivery options from which to choose. The

seven different enduring designs also gives planners a range of options for mating to new delivery vehicles in the future. Furthermore, the Bush Administration plans to keep the disassembled plutonium primaries and high-yield fission/fusion secondaries from several additional decommissioned warhead designs in storage indefinitely.

The existing stockpile has a vast variety of high performance options and considerable flexibility for responding to new security demands should they arise.

In sum, the existing stockpile has a vast variety of high performance options and considerable flexibility for responding to new security demands should they arise. Nevertheless, RRW supporters speak of capability shortfalls in the current stockpile. According to Linton Brooks,

> The Cold War legacy stockpile may be the wrong stockpile from a military perspective .... the NPR [Nuclear Posture Review] suggested that current explosive yields are too high, that our systems are not capable against hard and deeply buried targets, that they do not lend themselves to reduced collateral damage and they are unsuited for defeat of biological and chemical munitions. The designs of the past do not make full use of new precision guidance technologies,... nor are they geared for small-scale strikes or flexibility in command, control, and delivery.[25]

Let's look at Brooks' concerns in turn.

"current explosive yields are too high"—In fact, military commanders have a variety of low-yield options available. They can select yields as low as 5 kilotons from warheads on cruise missiles and as low as 0.3 kilotons from some bombs. That is considerably less than the 15 kilotons of the bomb dropped on Hiroshima. Furthermore, any warhead in the stockpile can easily be modified to prevent its secondary from producing yield. That would give commanders options for yields of 15–30 kilotons from existing ballistic missile warheads.

"our systems are not capable against hard and deeply buried targets"—Here Brooks is referring to a capability to burrow into the earth before exploding to deliver more explosive force against hard and deeply buried targets. In 1997, NNSA modified 35 B61 bombs to provide a capability to burrow 10-20 feet into the earth before detonating to attack hard and deeply buried targets. This capability was sufficient to allow the new B61-11 bomb, with a maximum yield of about 400 kilotons, to replace the 9-megaton B53 bomb, which DoD previously retained in the stockpile specifically for that mission. The Bush Administration would like to design a new improved earth-penetrating warhead called the Robust Nuclear Earth Penetrator (RNEP). Proponents of the RNEP claim it could burrow deeper than the B61-11 and defeat harder and more deeply buried targets, with a lower yield and less collateral damage. However, independent studies have shown there would be substantial collateral damage from any earth-penetrating warhead with a capability to attack buried targets.[26] Furthermore, to the extent that a new earth-penetrating warhead could attack more deeply buried targets, potential adversaries could bury their valued assets even deeper or place them inside of mountains. Thus, there is nothing to be gained by making systems more capable against hard and deeply buried targets and no need for an RNEP. For the past two years, Congress has rejected Administration proposals to examine the feasibility of an RNEP warhead.

"they do not lend themselves to reduced collateral damage"—As discussed above, military planners have numerous low-yield options at their disposal and the goal of designing a new warhead that could attack buried targets with reduced collateral damage

appears unachievable. Even if possible, it is a dubious goal. A new reduced collateral damage warhead would be provocative and would reduce the threshold for using nuclear weapons.

"they are unsuited for defeat of biological and chemical munitions"—Here Brooks is again referring to a low-yield, earth-penetrating warhead, which proponents claim could burrow into a buried biological or chemical facility and detoxify the munitions with intense heat and low collateral damage. However, in addition to producing radioactive fallout, an attack against such munitions would release biological or chemical toxins to the environment, without detoxifying them, unless the warhead penetrates completely into the buried facility.[27] Furthermore, the suggestion that the United States would use nuclear weapons against biological or chemical munitions is a dangerous expansion of the role for nuclear weapons.

"The designs of the past do not make full use of new precision guidance technologies"—Nuclear weapons in the current stockpile are highly accurate. ICBMs are designed to deliver their warheads to within 50 yards of their targets and cruise missiles can deliver nuclear warheads to within a few meters of a target. Precision guidance systems have greatly improved the effectiveness of conventional explosives, allowing them to attack targets that may previously have been vulnerable only to nuclear weapons. There are few missions imaginable in which nuclear weapons would need to "make full use of new precision guidance technologies." Brooks appears, yet again, to be referring to his perceived need for a low-yield RNEP.

In sum, a low-yield, earth-penetrating warhead is the only potential new capability that Ambassador Brooks, or anyone else, has identified for U.S. nuclear weapons. Congress has already rejected that idea twice.

"nor are they geared for small-scale strikes"—That is a good thing. Improving the capability to use nuclear weapons for small-scale strikes would be a dangerous lowering of the threshold for the use of nuclear weapons. In any event, the stockpile already includes bombs with yields as low at 0.3 kilotons, which is 1/50 the size of the Hiroshima bomb.

"nor are they geared for…flexibility in command, control, and delivery"—It is not clear what Brooks is referring to here. U.S. nuclear weapons are highly flexible. As discussed above, they can be delivered by land-based and submarine-based ballistic missiles, by several different aircraft, and by cruise missiles launched from aircraft or naval vessels. They have numerous available yields and targeting and fuzing options. Brooks may be referring to the ability to destroy a warhead after launch, which some designers have proposed. However, it is better to rely on stringent systems of launch control than to count on destroying a warhead after it has been sent.

In sum, a low-yield, earth-penetrating warhead is the only potential new capability that Ambassador Brooks, or anyone else, has identified for U.S. nuclear weapons. Congress has already rejected that idea twice.

U.S. Nuclear Weapons are Extremely Safe and Secure

For the past nine years, the Secretaries of Energy and Defense have been required to jointly certify to the President whether U.S. nuclear weapons are safe and reliable. In each of those certifications, the Secretaries have declared they are confident that the existing stockpile is safe. Safe in this context means there is a very small chance of accidental nuclear detonation or dispersal of hazardous material in the event of an accident. Of course, nuclear weapons are anything but safe in the conventional meaning of the word.

NNSA and lab officials often question whether they will be able to assure the safety and reliability of the stockpile *in the future.* However, we could find no concerns that any warhead in the stockpile may be unsafe today. For example, Ambassador Linton Brooks, the Administrator of the NNSA, recently told the Senate Armed Services Committee, "concerns raised about our ability to assure the safety, security, and reliability of the legacy stockpile over the very long term . . . drive the need to transform the stockpile." Nevertheless, he assured them "we are confident that the stockpile is safe and reliable, and there is no requirement at this time for nuclear tests."[28]

An accidental nuclear explosion of a U.S. weapon is virtually impossible. To initiate a nuclear explosion, the chemical high explosive, which surrounds the weapon's plutonium pit, must first explode and compact the pit in a highly symmetrical manner. This requires the explosive to detonate in at least two specific places simultaneously. All U.S. nuclear weapons are certified "one-point safe." One-point safe means that if the chemical explosive is accidentally detonated, at the worst possible place, there would be no nuclear yield greater than the equivalent of two kilograms of high explosive. Designers conducted numerous underground tests of one-point safety in which they detonated weapons at their most sensitive points under a variety of conditions. Over the past decade, the weapons labs have repeatedly checked and verified the one-point safety of U.S. warheads using the modeling and simulation methods developed in the Stockpile Stewardship program. Even if a projectile is shot into a nuclear weapon or some other shock to the system initiates a chemical explosion, it is exceedingly unlikely that there would be any nuclear explosion.

The chemical explosive in most U.S. nuclear weapons is so-called "Insensitive High Explosive (IHE)." IHE can withstand severe shocks without exploding, which lowers the risk that a chemical explosion might disperse plutonium and other hazardous materials over a wide area. The only U.S. nuclear warheads without IHE are the W-76 and W-88 warheads on submarine-launched ballistic missiles. Little, if anything, would be gained by redesigning those warheads to function with IHE, since the SLBMs use a very energetic propellant, which is relatively easy to detonate. Any accident that causes the missile propellant to detonate would likely break the warhead apart and scatter plutonium, regardless of whether the warhead contains IHE.

RRW proponents have claimed that over time, as nuclear warheads age, their safety and reliability might degrade. However, safety can only improve with age. Extensive tests have shown that the chemical high explosive becomes more stable and predictable as it ages, further reducing the risk of accidental explosions. Similarly,

degradation or failure of any other component could only reduce the chance of chemical or nuclear detonation, thereby improving the safety of the warhead.

To prevent accidental or unauthorized initiation of a weapon's normal firing systems, U.S. nuclear weapons have so-called enhanced nuclear detonation safety (ENDS) systems. The ENDS system typically includes at least one "weak link" and two "strong links." All of them must be closed in order to arm and fire the warhead. The weak link is normally closed, but is designed to fail (open), like a circuit breaker, and prevent power from reaching the detonators in an abnormal environment, such as lightening, fire, or physical shock. The strong links generally isolate the systems that arm the warhead and fire the detonators from their power sources using devices such as motorized switches or mechanisms that physically interfere with the implosion until the proper arming sequence is followed. One strong link, called a Permissive Action Link (PAL) requires that the weapon receive properly coded electronic signals. Two different codes must be received simultaneously. This is the "two man rule," which ensures that any individual acting alone cannot arm a nuclear weapon.[29] The other strong link can be closed only by one or more particular environmental events or sequences of events that would occur during the normal delivery of the warhead. Such events may be a deceleration force, a temperature, or a pressure that would normally occur only during delivery. Thus, if terrorists were to somehow obtain a U.S. nuclear warhead, they could not detonate it, without first making complex internal adjustments. In the unlikely event that the terrorists were capable of making the necessary adjustments, the time required would provide a substantial opportunity for the U.S. to recover or destroy the weapon.

In his April 4, 2005 testimony, Ambassador Brooks claimed, "Today's stockpile is the wrong stockpile from a physical security standpoint." The rise in terrorism "has driven our security posture from one of containment and recovery of stolen warheads to one of denial of any access to warheads." He went on to claim that new use control technologies would permit NNSA to reduce the cost of gates, guns, and guards.[30] This claim is patently false. It is true that DOE recently required NNSA to upgrade its security. However, the impetus for the upgrade was to protect nuclear materials, not assembled nuclear weapons. In April 2004, DOE required "that all sites with weapons quantities of SNM [Special Nuclear Material, i.e. plutonium and highly enriched uranium] increase their defensive posture to a "denial" strategy because of the Improvised Nuclear Device (IND) vulnerability. In other words, they must be able to prevent terrorists from even entering the facility because the terrorists could create a nuclear detonation within minutes."[31] NNSA has many more sites at which it has significant quantities of nuclear materials than it has assembled warheads. It is ridiculous to suggest that DOE would require a lower level of security for NNSA's assembled warheads than for its nuclear materials, no matter what use control technology the weapons employ. The RRW program would actually increase NNSA's need for security, since development and fabrication of new nuclear weapons would increase the amount of nuclear material in use at NNSA facilities.

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Even though nuclear weapons are extremely safe and secure, it is possible to do even better. The NNSA and the Department of Defense can and should make operational improvements in how nuclear weapons are handled and protected that would im-

prove their safety and security. One significant measure would be to reduce the hair-trigger alert status under which the military maintains many nuclear weapons. And obviously, the fewer nuclear weapons there are the less chance there is of an accidental or unauthorized use. RRW proponents claim that a new warhead could be made safer and more secure that existing weapons. The relevant question to ask, however, is whether the marginal improvements to safety and security, which NNSA may make through design changes, are worth the substantial negative effects the RRW program would have on our national security.

It is also worth noting that new warheads resulting from the RRW program may well wind up being less safe than existing warheads.

It is also worth noting that new warheads resulting from the RRW program may well wind up being less safe than existing warheads. As designers attempt to make warheads more reliable, they are likely to add plutonium (and a concomitant amount of chemical explosive) to weapons' primaries. Adding plutonium can improve designers' confidence that a primary will meet its minimum yield requirement. However, adding plutonium could also increase the potential for significant nuclear yield if there is an accidental detonation of the high explosive. Since RRW proponents claim the new warheads will not have to undergo full-scale nuclear tests, there will be no guarantee that new warheads will meet the stringent one-point safety requirements of existing warheads. More generally, there is a tradeoff in reliability vs. safety. Many of the changes that might increase a warhead's reliability might also increase the chances of accidental detonation. Since existing warheads are both reliable and safe, why take the chance the new designs might sacrifice one for the other?

U.S. Nuclear Weapons are Very Reliable

Along with certifying the safety of U.S. nuclear weapons, the Secretaries of Energy and Defense have also certified in each of the past nine years that the warheads in the existing stockpile are reliable. Those assessments were all based on the collective judgments of the three Directors of the National Weapons Laboratories and the Commander of the U.S. Strategic Command (STRATCOM).

It is relatively straightforward to determine the reliability of the non-nuclear components of a nuclear weapon. The non-nuclear components can be tested as many times as necessary, both individually and as complete systems, to estimate their reliability to any desired level of statistical accuracy. The weapons laboratories and factories conducted such testing during the initial development and fabrication of each warhead in the stockpile. To certify warhead reliability, the labs had to demonstrated at least a 98 percent probability that all of the non-nuclear components of a warhead would function as intended.[32] There is no need to improve upon that reliability level. NNSA need only assure that the reliability of the non-nuclear components does not degrade as they age. (see below)

The nuclear components are also highly reliable. In fact, in all formal reliability reports, through at least the year 2000, evaluators have judged the nuclear components of U.S. weapons to be 100 percent reliable.[33] Since there is a substantial degree of judgment in those assessments, the real question is, how confident are the experts in the reliability of nuclear components. Even when full-scale nuclear weapons tests were allowed, it was too impractical and expensive to test sufficient numbers

of production line weapons to assess their reliability to a high degree of statistical accuracy. Thus, the ultimate performance of nuclear weapons has always included a degree of judgment. The best aid to that judgment is a weapon's performance in actual full-scale nuclear tests. Each nuclear weapon design in the current stockpile underwent several tests during development and production. The testing programs included tests of degraded warheads and tests under a variety of adverse conditions, such as extremes of temperature. Designers used highly sophisticated computer models and the results of those tests to predict the performance of the warheads under additional off-normal circumstances, including imperfections that may have been introduced during production. No warhead entered the stockpile until the designers had a high degree of confidence that it would function as intended and they were able to convince an independent team of experts to join in their assessment.

"It takes an extraordinary flight of imagination to postulate a modern new arsenal composed of [untested] designs that would be more reliable, safe, and effective than the current U.S. arsenal based on more than 1,000 tests since 1945."

Scores of experts at the weapons laboratories have repeatedly retested and reconfirmed those initial judgments. Over slightly more than a decade, the NNSA has spent $60 billion on the Stockpile Stewardship program. Under Stockpile Stewardship, NNSA uses sophisticated equipment to test simulated nuclear weapons. NNSA has vastly improved its computer codes to analyze the results of those tests and to predict the performance of existing nuclear weapons under every conceivable circumstance. The result, as noted above, has been recertification each year that every design in the nuclear weapons stockpile is safe and reliable.

RRW proponents point to the small performance margins of existing weapons, which were designed to minimize their size and weight and to maximize their explosive yield. Performance margins may be small, but that does not negate the numerous tests and years of analysis that has resulted in a high confidence in the reliability of the existing stockpile. As Hoover Institution Fellow Dr. Sidney Drell and Ambassador James Goodby have stated, "It takes an extraordinary flight of imagination to postulate a modern new arsenal composed of [untested] designs that would be more reliable, safe, and effective than the current U.S. arsenal based on more than 1,000 tests since 1945."[34]

How potential adversaries view the likely performance of U.S. nuclear weapons is even more important than their actual physical reliability. Deterrence is based on an adversary's belief that if he takes certain hostile actions, the U.S. response will be certain and effective. It is conceivable that an adversary could question how the United States might react to certain provocations, but it is ludicrous to suggest that any adversary could be emboldened by the belief that U.S. nuclear weapons would not work if employed against them.

Today's Reliability and Safety Can be Maintained Indefinitely with Proper Curatorship

The NNSA can maintain the high level of reliability and safety in today's stockpile indefinitely. Over time, some components might cease to function properly as they age. Several components, such as power sources, neutron generators, and tritium supplies, have well known limited-lifetimes. NNSA always anticipated it would replace those components on a regular schedule and it now does so. NNSA guards against the failure of other components by conducting extensive surveillance programs to

identify potential problems, before they develop. The NNSA takes apart eleven warheads of each design every year and examines and tests their components to determine how they are working. There is a high probability that NNSA's surveillance programs will anticipate any potential problem and fix it well before a failure threatens the reliability of any warhead.

As the stockpile has aged, NNSA has chosen to replace numerous components with modified versions. The vast majority of changes that NNSA made were to enhance warhead performance rather than to maintain safety or reliability.

RRW proponents profess concern that over time an accumulation of small changes in warheads will lead to uncertainty. As the stockpile has aged, NNSA has *chosen* to replace numerous components with modified versions. The vast majority of changes that NNSA made were to enhance warhead performance rather than to maintain safety or reliability. Many of the changes have been made under the so-called Life Extension Program (LEP). Life Extension Program is an insidious misnomer for nearly complete rebuild and upgrade of a warhead system that is nowhere near the end of its life. As part of an LEP, NNSA, with assistance from the Department of Defense, reexamines the performance features for a weapon (called military requirements) and reevaluates the design of every component in the weapon against the revised military requirements. Typically, NNSA replaces dozens of components with newly designed versions. Few, if any, of the replacements are required to extend the life of aging components. Rather, NNSA has chosen to make weapons lighter, more rugged, more tamper proof, and more resistant to radiation. In addition, NNSA installed new components that improved design margins, added arming and fuzing options, improved targeting flexibility and effectiveness, and it has put in advanced tritium delivery systems.

Thus, the labs themselves are responsible for most changes to nuclear weapons. If the NNSA is concerned about changes to weapons, it should stop making them. NNSA should adopt a "Curatorship" approach to maintaining the nuclear weapons stockpile. Under the Curatorship approach, NNSA would expand its surveillance activities to be even more certain it can identify problems with components before they cease to function properly. NNSA would then replace any suspect components with identical or nearly identical components that could be thoroughly tested and certified. In rare instances, a vital material or part that must be replaced may no longer be available or able to be fabricated by the laboratories. Only in those rare instances, or in even rarer instances where the surveillance program identifies a significant flaw in a components design, should NNSA replace the component with a modified design. The vast majority of such components can be thoroughly tested and proven to work, before being installed. Only a small fraction of components—those that might affect the nuclear performance of the warhead—cannot be thoroughly tested. Those components should not be altered.

As warheads age and their nuclear materials undergo radioactive decay, the properties of those materials could ultimately change sufficiently to degrade the warheads' performance. The major isotope of concern is plutonium-239, the key Pu isotope used in nuclear weapons. Its half-life is about 25,000 years. This means that about one in 50,000 Pu-239 atoms will undergo radioactive decay each year. NNSA has spent hundreds of millions of dollars examining this issue. Thus far, the labs have observed only minor age-induced changes in the physical properties of the oldest plutonium available and there is no direct evidence that these affect pit performance

or reliability.[35] Some lab experts believe there is a theoretical basis for assuming that changes could develop rapidly after an unknown threshold period. In such a worst case analysis, assuming the threshold is just beyond the 42 years of the oldest plutonium studied through 2003, NNSA determined the minimum lifetime of plutonium pits to be 45 years. There is, however, no basis for assuming that the threshold is just beyond existing experience. Using less pessimistic, but still conservative extrapolations from the data available through 2003, NNSA determined that pits could remain reliable for *at least 60 years*. NNSA has not yet identified any upper bound for pit lifetimes. Research continues. It is possible that as NNSA gains more data from aged plutonium, it will extend its conservative estimates of pit lifetimes to 100 or even 200 years. Whether existing pits will have to be replaced in two decades or two centuries, they too could be replaced with nearly exact duplicates of the original designs.

Using less pessimistic, but still conservative extrapolations from the data available through 2003, NNSA determined that pits could remain reliable for at least 60 years. NNSA has not yet identified any upper bound for pit lifetimes.

Proponents of the RRW program grossly overstate the overall problem of aging. Modern nuclear weapons are hermetically sealed and filled with inert gases that dramatically reduce, if not eliminate, changes in materials or corrosion over time. Corrosion of some materials was a problem in warheads of the 1940s and 1950s, but problems were identified and solved years ago. In general, the lab's confidence in the reliability of U.S. nuclear weapons has increased as they aged, since lab experts corrected potential problems or otherwise resolved them. After reviewing a classified "Stockpile Life Study" performed by Sandia National Laboratory, one expert concluded:

> The thirty years of experience summarized in this study revealed that there is not known to be any upper limit on weapon life, given appropriate maintenance and renewal of perishable materials and parts (e.g. tritium). No U.S. weapon has ever been retired due primarily to aging problems, even though some weapons have, in the past, been in the active stockpile for more than 30 years before being superseded by new designs. Aggregate data show that the rate of required modifications and repairs of stockpile weapons *decreases* as the years go by, reflecting continually increased reliability as the 'bugs' are gradually worked out of weapons systems.[36]

With proper maintenance, under a Curatorship approach, NNSA can maintain the reliability, safety, longevity, and certifiability of existing weapons indefinitely with greater confidence and for less money than it currently spends under the Stockpile Stewardship approach. It is hard to grasp how the same people who are concerned about certifying the occasional small changes to well-tested nuclear weapons, which may be necessary under the Curatorship approach, are confident they can certify an entirely new and untested RRW design.

The Weapons Labs' Highest Priority is Maintaining Jobs

NNSA Spending on Nuclear Weapons is Exorbitant and Wasteful

Since U.S. nuclear weapons are extremely safe, secure, and reliable, there should be little for the NNSA weapons complex to do, except to examine and maintain the weapons in the current stockpile and to dismantle retired warheads. Nevertheless, NNSA's 2006 appropriation for nuclear weapons work is $6.4 billion. Even after adjusting for inflation, that is 1.5 times the average spending level on nuclear weapons during the Cold War, when the United States was building thousands of warheads a year.

In 2006, NNSA will spend $2.9 billion for research and development (R & D) alone. That figure, which amounts to 44% of NNSA's total budget for nuclear weapons, is a lower bound estimate.[37] In FY 2000, the last year that NNSA specifically identified its R&D spending, NNSA spent 50% of its total budget on R & D.[38] That is a huge percentage of the nuclear weapons budget, especially since the Administration claims it is not designing or developing any new weapons. We could not find a single large American corporation that spent even close to that portion of its operating budget on R & D. For example, Intel and Microsoft, which must stay on the forefront of technology to survive, spent 19% and 22% of their operating funds on R & D in 2004. Even research-intensive biotechnology firms, like Amgen and Genentech, spent only 28% and 27% of their operating funds on R & D. Boeing, Ford, and General Motors each spent only 4% of their operating funds on R & D, even though all of those companies are continually developing new models.[39]

We estimate that NNSA could reduce its R & D spending by $1.2 billion and reduce total spending on nuclear weapons by $2 billion the first year after adopting the Curatorship approach.[40] The savings would be larger in later years.

Weapons Scientists Have Used False Arguments to Maintain Employment

There is no reason to spend such a large portion of the nuclear weapons budget on R & D. The nuclear weapons enterprise is long established, with well-tested and certified products that it does not need to upgrade. The excessive spending results from the nuclear weapons laboratories' excessive influence in all decisions about U.S. nuclear weapons. Congress provides the funding for nuclear weapons, but relies upon those in the nuclear weapons business to determine the funding needs. The foxes are guarding the hen house. The RRW is the latest in a long line of self-serving proposals designed to meet the weapons labs most important mission—preservation of jobs. The labs are extremely good at fulfilling that mission. In 2003, the most recent year for which information is available, Lawrence Livermore National Lab employed more than 4,200 people in nuclear weapons R & D out of a total workforce of about 8,000. That is the highest level of employment in nuclear weapons R & D in the

more than 50-year history of Livermore Lab. Following a temporary slump in the 1990s, Livermore has increased its employment in nuclear weapons R & D by more than 60 percent.[41]

Over the years, the weaponeers' arguments for expanding nuclear weapons work have shifted several times. After its origin with the Manhattan Project, the justification for the huge buildup in the U.S. nuclear weapons program was the need to counter the Soviet Union. One of the chief arguments for the massive buildup was a purported missile gap, which was later proven non-existent. Indeed, the demise of the Soviet Union has laid bare the overall weakness in this adversary, and a corresponding weakness in the justification for massive spending on nuclear weapons during the Cold War.

By the 1980s, as Cold-War tensions waned, long time pleas from arms control advocates for an end to testing of nuclear weapons were beginning to be heard. The potential end of nuclear weapons testing was an overwhelming threat to lab employment. Fighting to maintain their existence, the labs argued that even if the U.S. ceased development of new nuclear weapons, the labs needed to continue nuclear testing to maintain the safety and reliability of the stockpile. A typical example of lab hyperbole on this issue was, "without testing and with the inevitable age-related changes that occur in nuclear weapons, the situation may well arise in which one might believe that no weapons of a given type will work."[42] Nevertheless, in 1992, the United States joined the Soviet Union in declaring a moratorium on the testing of nuclear weapons.[43] Since then, the safety and reliability of the stockpile has not deteriorated as the labs claimed it would. The weaponeers' false claim that they needed to continue nuclear weapons tests was the first instance of a trumped up program justification based on maintaining safety and reliability. Maintaining safety and reliability has remained the labs primary justification for increasing nuclear weapons R & D, but they keep inventing new programs, which they claim they need to do it.

The weaponeers' false claim that they needed to continue nuclear weapons tests was the first instance of a trumped up program justification based on maintaining safety and reliability.

Once it became apparent that Congress and the Clinton Administration would not quickly resume testing, the labs switched gears and began saying they could maintain the safety and reliability of the stockpile, without testing, through an approach called Stockpile Stewardship. The premise behind Stockpile Stewardship was that the labs needed to significantly enhance their understanding of nuclear weapons behavior to maintain the stockpile. This in turn required increased funding for a massive effort to improve the modeling and simulation of exploding nuclear weapons. To replace testing, the labs began building huge, expensive experimental facilities to mimic the conditions in exploding nuclear weapons. New, multi-billion dollar facilities included the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility at Los Alamos National Lab and the National Ignition Facility (NIF) at Lawrence Livermore National Lab. The laboratories also requested, and Congress funded, acquisition of the world's fasted computers. Since 1995, NNSA has spent nearly $6 billion on computer hardware and software and has increased the speed of its fastest computers by a factor of 100,000.

Stockpile Stewardship has been a fraud since its inception. NNSA never needed a massive R&D program if it truly wanted only to maintain the existing stockpile. As already noted, a Curatorship approach would have been a less expensive and more certain way to maintain the stockpile. From a funding and employment perspective,

Stockpile Stewardship has been a huge success for the labs. The first two years after the testing moratorium began, funding for weapons R & D and employment at the labs declined. Both soon recovered and grew rapidly once Stockpile Stewardship became the organizing principal for the U.S. stockpile. It would takes a brave Member of Congress to vote against funds that the lab experts say are needed to maintain a safe and reliable nuclear deterrent.

In addition to falsely claiming that Stockpile Stewardship was necessary to maintain the existing stockpile, the labs also claimed that the advances in nuclear weapons science and technology they sought through Stockpile Stewardship would not be sufficient to develop new nuclear weapons or to significantly modify existing weapons. The labs' assurances that they could not use Stockpile Stewardship to develop new or enhanced nuclear weapons were key to Congress' initial acceptance of the program. That claim was true for only a brief time at best. As the Stockpile Stewardship program progressed, the labs gained confidence in their ability to modify existing nuclear weapons and realized they could enhance employment levels even more if they expanded their work to include weapons modifications. In 2000, NNSA expanded its mission statement from "maintain a safe, secure, and reliable nuclear weapons stockpile"[44] to "maintain **and enhance** [emphasis added] the safety, reliability and performance of the U.S. nuclear weapons stockpile."[45]

In truth, NNSA had been modifying nuclear weapons under the Stockpile Stewardship program for some time. However, in its 2001 budget request, NNSA proposed accelerating enhancements to existing nuclear weapons by expanding the Life Extension Program.[46] NNSA continues to claim that it keeps changes to a minimum under the LEP. However, an independent Weapon Assessment Team, which the Nuclear Weapons Council commissioned in 2000 to review plans for the W76 LEP, determined that the preferred option represented "a viable design that enhanced reliability over the extended lifetime and afforded nuclear safety and significant use control enhancements to the present baseline W76 design."[47] This demonstrates that NNSA is using the LEP not only to extend warhead lifetimes, but also to enhance capabilities.

Several years ago, the labs began claiming that new capabilities—an Earth-penetrating warhead and more vague "advanced concepts"—were needed to address post Cold-War threats. Congress emphatically rejected those programs by denying Administration funding requests for 2005 for the Robust Nuclear Earth Penetrator (RNEP) and for the Advanced Concepts Initiative and by denying a subsequent 2006 request for RNEP. The House Appropriations Committee recognized those new weapons development efforts as dangerous jobs programs stating:

> The Committee recognizes the dilemma that NNSA's nuclear weapon design laboratories find themselves in after the Cold War. In the absence of a Cold War between nuclear-armed superpowers, the importance of nuclear weapons to the war fighters in the Pentagon has steadily diminished. The pressure on the nuclear weapon design laboratories to maintain the canonical role for their weapons in order to justify increasing budgets becomes very difficult. By contrast, the Committee's priorities are maintaining our Nation's nuclear deterrent in a safe and secure condition and maintaining our Nation's integrity in the international effort to halt the proliferation of weapons of mass destruction. The Department's obsession with launching a new round of nuclear weapons development runs counter to those priorities.[48]

Faced with this defeat, the labs have returned to their trusted and true, but bogus, rationale for more spending -- maintaining the safety and reliability of the existing stockpile. The Reliable Replacement Warhead program is the new horse that the labs hope to ride to greener pastures of increased funding. The laboratories clearly intend to ride the RRW program as far as they can to increase funding and create more jobs.

The RRW Program Will Require More Funding Increases

RRW supporters claim it will be cheaper to design and build new weapons than to maintain existing warheads indefinitely. They correctly note that existing weapons were built with hazardous materials and with complex, difficult to replace components that make remanufacture complex and costly. They go on to claim that RRWs would be simpler and would be specifically designed for ease of maintenance. However, the DOE laboratories have not demonstrated an ability to design and build anything simply and cheaply. Rather, they have a history of enormous cost overruns, which are often the result of too much complexity (see box).

The design costs for an RRW will be enormous, making it extremely unlikely that the initial investment could be recovered through reduced maintenance costs. If the NNSA foregoes underground testing, it will have to conduct numerous costly aboveground tests to develop an RRW. Independent analyses of the design by a second lab as a substitute for proof tests will further increase costs.

Fabricating new warheads will require costly new facilities to process plutonium and uranium and to produce new nuclear components. For the past two years, Congress has rejected Administration funding requests to begin design of a "Modern Pit Facility." A facility to produce 200 or more plutonium pits/yr could cost $3–5 billion to build. If ongoing studies confirm pit lifetimes of 60 years or more, then existing pit production facilities at Los Alamos National Laboratory will be sufficient to systematically replace pits in the enduring stockpile over time. However, an expensive new pit facility would be needed to more quickly replace existing warheads with new RRW versions. Similarly, new facilities for processing uranium components would be needed to support an ambitious RRW program. Storing, recycling, or disposing of existing warheads replaced by RRW versions would add to the cost.

RRW proponents have not released any quantitative cost benefit analysis. For there to be a net savings from the RRW program, the extra cost of designing and building completely new warheads would have to be recovered over time by dramatically reducing maintenance costs. That idea strains credulity.

RRW proponents have not released any quantitative cost benefit analysis. For there to be a net savings from the RRW program, the extra cost of designing and building completely new warheads would have to be recovered over time by dramatically reducing maintenance costs. That idea strains credulity. Any savings from reduced maintenance costs will be a fraction of the increased spending on new capabilities. For example, one of the few concrete measures that RRW proponents claim could produce savings in maintenance costs is to remove certain hazardous materials from warheads. A key hazardous material that RRW proponents would like to remove is beryllium. However, even the RRW proponents of the SEAB Task Force on the Nuclear Weapons Complex note, "the hazardous nature of beryllium and plutonium make handling specifications and restrictions similar."[49] Thus, it is unclear where any cost savings will come from in replacing beryllium with more plutonium in a new RRW. There should be a heavy burden on RRW proponents to demonstrate that the

Can the Labs Design a Simple Weapon?

In principle, the labs could design a nuclear warhead that would likely work, without full-scale nuclear testing. After all, the Manhattan Project designed a plutonium weapon that worked the first time they tried it. It all depends on how simple the design is. However, the weapons design labs have a miserable record in designing anything simple. Their history shows a pattern of preferring complex technical solutions to problems and underestimating the cost and difficulty of implementing them. The existing generation of nuclear weapons, which the labs now say are too costly to maintain and are near the edge in their design margins, are but one example.

In 1997, the Government Accountability Office (GAO), examined the history of 80 DOE projects. GAO found that 31 of those projects were terminated before completion, after expenditures of over $10 billion.[1] Of the 14 projects, which were completed and had adequate cost accounting, nine had cost overruns averaging 99%. Eleven were completed behind schedule, by an average of 31 months. GAO found similar cost overruns for 17 of the 22 ongoing projects for which cost estimates were available. DOE and NNSA have not solved their problem with cost overruns. The National Ignition Facility (NIF), under construction at Livermore Laboratory, was initially scheduled for completion in 2002 at a cost of $1.1 billion. Now, NIF is scheduled to be completed by 2009 at a cost of $3.5–5 billion. Similarly, the Dual-Axis Radiographic Hydrodynamic Test Facility (DARHT), at Los Alamos National Laboratory, was initially scheduled for completion in 1990 at a cost of $30 million. After spending $270 million, NNSA commissioned the facility in 2003. However, key operating parameters missed their design specifications. NNSA now plans to spend an additional $87 million to bring DARHT nearer to its design goals.

There is ample reason to believe that NNSA will not keep the design of the RRW simple. Capabilities that have already been suggested for the RRW include:

- Multiple yield options
- Very low yield options
- Earth-penetrating capability
- Internal self-monitoring capabilities using modern optical technologies
- Additional surety options, including remote self destruct
- Insensitive High Explosive in all warheads
- Enhanced ability to defeat biological or chemical munitions
- Enhanced ability to produce electromagnetic pulse
- Components with ultra-high reliability
- Components that will not have to be replaced
- Improved guidance systems
- Improved warhead symmetry and balance to improve accuracy of delivery
- Ability to fit on existing delivery systems
- Elimination of tritium boosting
- Diverse components to prevent common mode failures across warhead types
- An ability for later modification to respond to potential new military requirements

Scores of additional requirements will likely be layered upon the above, which will increase the cost and complexity of the RRW and make it more difficult to certify without testing.

[1] U.S. General Accounting Office. *Department of Energy: Opportunity to Improve Management of Major System Acquisitions.* Nov. 1996. GAO/RCED-97-17.

program will generate savings before a significant amount of funds are committed to the program.

Some RRW proponents, including House Energy and Water Subcommittee Chair David Hobson, would seek to finance the RRW by reducing near term LEP activities for warheads that would be replaced. At best, that might allow NNSA to fund the first few years of the RRW program within current budget projections, which call for increasing spending on nuclear weapons to $7.3 billion in 2010. It remains to be seen whether DoD would agree to forego near-term enhancements to existing warheads in return for an uncertain RRW development program. The tri-lab report includes the traditional refrain that we must have "additional near-term resources, in order to begin the process of transformation, which will allow for a more efficient and more affordable enterprise."[50] In all likelihood, an RRW would require huge increases in spending that would never be recovered.

Conclusion and Recommendations

U. S. nuclear weapons are highly capable, extremely safe and secure, and very reliable. There is no need to improve any aspect of nuclear weapons.

U. S. nuclear weapons are highly capable, extremely safe and secure, and very reliable. There is no need to improve any aspect of nuclear weapons. With proper maintenance, under a Curatorship approach, the reliability, safety, longevity, and certifiability of existing weapons can be maintained indefinitely with greater confidence and for much less than what NNSA currently spends under the Stockpile Stewardship approach. We see no reason to make any changes to the well-tested nuclear weapons in the current stockpile, except in those rare instances when a component that is about to fail cannot be replaced with an identical copy of the original design because necessary parts or materials are no longer available nor easily fabricated. Since no improvements are needed, we see no need to pursue even the modest goals for which Congress provided the initial funding for the RRW program in 2005—to "improve the reliability, longevity, and certifiability of existing weapons and their components."

NNSA and the weapons labs have something much more grandiose in mind. If left unchecked, there is no question that the labs would grow the RRW program into a comprehensive effort to redesign and rebuild the entire stockpile. The labs would significantly alter the military characteristics of existing weapons and would add new weapons with new capabilities and missions. A broad RRW program would significantly harm our national security. U.S. pursuit of an RRW would diminish pressure on Iran and North Korea to forego their nuclear weapons programs and would disrupt efforts to eliminate clandestine trafficking in nuclear materials and equipment. In addition, a U.S. resumption of nuclear testing, which might well result from the RRW program, would cause other nations to follow suit and could lead to a new nuclear weapons arms race. The damage this would impart to the broad non-proliferation regime would far exceed any conceivable advantage the U.S. could gain from new nuclear weapons.

The Conference Committee on the 2006 Energy and Water Appropriations, which provided $25 million for the RRW program, stated:

> …any weapons design work under the RRW program must stay within the military requirements of the existing deployed stockpile and any new weapon design must stay within the design parameters validated by past nuclear tests.[51]

This limited version of the RRW is a slippery slope and will be difficult to enforce. If the labs are given approval to design a new warhead, *they* will largely be the ones to determine whether specific modifications are within the military requirements of the existing deployed stockpile and within design parameters validated by past nuclear tests. Over time, NNSA and the weapons labs will undoubtedly skirt such restrictions and add new and improved capabilities to nuclear weapons. Congress will not be able to control the RRW program. We, therefore, believe that Congress should eliminate all funding for the RRW and cancel the program.

If Congress is not prepared to cancel the RRW, it should at least give close scrutiny to NNSA plans for the program and seek out any attempt to design new nuclear weapons. Congress should fully review a 5-year funding plan for NNSA's proposed work under the RRW program before it acts on spending for 2007. Congress has required NNSA to provide 5-year funding plans with its annual budget submission for some time, but the Administration's response has been uneven. The Bush Administration should provide Congress with a detailed 5-year plan for the RRW program with, or shortly after, the submission of its 2007 Budget.

Congress should also strengthen last year's Committee report language with a prohibition, in law, on the use of any NNSA funds to investigate, design, or develop new or significantly modified nuclear weapons. Even with the force of law, the labs are certain to push on the edges of such a prohibition. Therefore, Congress should prohibit NNSA from proceeding beyond development phase 6.2A for any proposed replacement warheads, before it has approved detailed performance specifications and lifecycle cost estimates.

Congress will not be able to control the RRW program. We, therefore, believe that Congress should eliminate all funding for the RRW and cancel the program.

In addition, we recommend that Congress strictly limit NNSA's authority to make *any* changes to existing nuclear warheads without prior congressional approval. Components in existing warheads should be replaced only if there is a significant risk that they may no longer properly perform their intended function before the next scheduled refurbishment cycle for that warhead. When such replacements are necessary, NNSA should make every effort to replace components with exact duplicates of the original design. If NNSA wants to design a new replacement component, the agency should be required to justify to the Congress (in separate classified and non-classified versions, if necessary) why the existing component must be replaced and why it cannot be replaced with a duplicate of the original design. The Administrator of the NNSA should be required to certify that the new component would not contribute to an eventual need for a nuclear test.

Finally, Congress should appoint an independent commission, which includes experts in international arms control and non-proliferation, to examine options for maintaining the U.S. nuclear weapons stockpile to include at a minimum the Stockpile Stewardship, Curatorship, and RRW options.

Endnotes

[1] U.S. Congress. Committee on Appropriations. **Conference Report to Accompany H.R. 4818—Consolidated Appropriations Act, 2005.** Nov. 20, 2004. H. Rept. 108-792. Division C. p. 951.

[2] The nuclear weapons labs are the Los Alamos National Laboratory in Los Alamos, NM; the Lawrence Livermore National Laboratory in Livermore, CA; and the Sandia National Laboratory, with sites in Albuquerque, NM and Livermore, CA.

[3] O'Brien, K.H., et al. **Sustaining the Nuclear Enterprise—A New Approach.** May 20, 2005. UCRL-AR-212442. www.armscontrolwonk.com/Sustaining_the_Enterprise.pdf

[4] U.S. Department of Energy. Secretary of Energy Advisory Board (SEAB). **Recommendations for the Nuclear Weapons Complex of the Future.** Draft Final Report of the Nuclear Weapons Complex Infrastructure Task Force, July 13, 2005. www.seab.energy.gov/publications/NWCITFRept-7-11-05.pdf

[5] The NNSA is a semi-autonomous agency within the Department of Energy, which runs the nuclear weapons research and production complex.

[6] **Conference Report to Accompany H.R. 4818.** op. cit. p. 951.

[7] Statement of Ambassador Linton F. Brooks, Administrator, National Nuclear Security Administration, before the Senate Armed Services Committee, Subcommittee on Strategic Forces. April 4, 2005. p. 5.

[8] Ruppe, David. "Warhead Replacement Program Intends No New Weapons, U.S. Energy Department Head Says." *Global Security Newswire,* February 16, 2005.

[9] Schwartz, Stephen. "Warheads Aren't Forever." *Bulletin of the Atomic Scientists*. September/October 2005. p. 62.

[10] O'Brien, K.H., et al. op. cit. p. 3

[11] **Recommendations for the Nuclear Weapons Complex of the Future.** Draft Final Report, July 13, 2005. p. vii.

[12] Ruppe, David. op. cit.

[13] U.S. Congress. House. Committee on Appropriations. **Energy and Water Development Appropriations Bill, 2006. Report to accompany H.R. 2419.** May 18, 2005. H.Rept. 109–86. p. 130.

[14] U.S. Congress. Senate. Committee on Appropriations. **Energy and Water Appropriations Bill, 2006. Report to accompany H.R. 2419.** June 16, 2005. S.Rept. 109–84.

[15] U.S. Congress. House. **Making Appropriations for the Energy and Water Development for the Fiscal Year Ending September 30, 2006, and for Other Purposes.** Nov. 7, 2005. H.Rept. 109–275. p. 159.

[16] **H.R. 1815. National Defense Authorization Act for Fiscal Year 2006.** Sec. 3111.

[17] U.S. Congress. House. Committee on Armed Services. **National Defense Authorization Act for Fiscal Year 2006. Report to accompany H.R. 1815.** May 20, 2005. H.Rept. 109–89. p. 464.

[18] Ibid. p. 511ff.

[19] U.S. Congress. Senate. Committee on Armed Services. **National Defense Authorization Act for Fiscal Year 2006. Report to accompany S. 1042.** May 17, 2005. S.Rept. 109–69. p. 484.

[20] Letter from Edward J. Markey, et al, to Honorable David Hobson, Chairman, House Appropriations Committee, Subcommittee on Energy and Water Development. May 9, 2005.

[21] Department of Defense and Department of Energy. Nuclear Weapons Council. **Procedural Guideline for the Phase 6.X Process.** April 19, 2000

[22] Deutch, John. "A Nuclear Posture for Today" *Foreign Affairs,* January/February 2005.

[23] Broad, William. "U.S. Redesigning Atomic Weapons." *The New York Times.* Feb. 7, 2005.

[24] "The United States Needs a Credible Plan to Modernize its Nuclear Forces." Statement of John J. Hamre, before the House Subcommittee on Energy and Water Development Appropriations. March 18, 2005.

[25] Statement of Ambassador Linton F. Brooks. op. cit. p. 3.

[26] Nelson, Robert W. "Nuclear Bunker Busters, Mini-Nukes, and the US Nuclear Stockpile." *Physics Today*. November 2003.

[27] National Academy of Sciences. National Research Council. Committee on the Effects of Nuclear Earth-Penetrator and Other Weapons. **Effects of Nuclear Earth-Penetrator and Other Weapons.** Washington, National Academy Press. 2005.

[28] Statement of Ambassador Linton F. Brooks. op. cit.

[29] Warheads on Submarine-Launched Ballistic Missiles do not have PALs incorporated into the warheads themselves, but similar code-based systems prevent unauthorized launch of the missiles.

[30] Statement of Ambassador Linton F. Brooks. op. cit. p. 4.

[31] Statement of Danielle Brian, Executive Director, Project on Government Oversight before the House Subcommittee on National Security, Emerging Threats and International Relations. April 27, 2004.

[32] Memorandum from H. M. Agnew, Los Alamos Scientific Laboratory to J.K. Bratton, U.S. Department of Energy. Subject: Yield Certification Policy. Feb. 13, 1979.

[33] Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile. John S. Foster, Jr., Chairman. **FY 2000 Report to Congress.** February 1, 2001. p. 2.

[34] Drell, Sidney and James Goodby. **What are Nuclear Weapons For? Recommendations for Restructuring U.S. Strategic Nuclear Forces.** Arms Control Association. April 2005 p. 20.

[35] Martz, J. and A. Schwartz. "Plutonium Aging: Implications for Pit Lifetimes." LA-UR-03-0259. Included in Appendix G to **Requirements for a Modern Pit Facility,** NNSA Report to Congress pursuant to P.L. 108-375. January 2005.

[36] Dan Kerlinsky as quoted in: Mello, G. **No Serious Problems: Reliability Issues and Stockpile Management**. Tri-Valley CAREs. February 6, 1995. p. 5.

[37] It includes the 2006 Appropriation for Campaigns ($2,145 million), Research and Development Certification and Safety ($228 million), Research and Development Support ($61 million), the Reliable Replacement Warhead ($25 million), and half of the Appropriation for Safeguards and Security in the Weapons Activities Account ($403 million). This is an underestimate of R&D spending, since it does not include the R&D portion of Directed Stockpile Work, which NNSA does not identify, or the laboratories' cost for readiness and infrastructure improvements. Source: H.Rept. 109–275. op. cit.

[38] U.S. Department of Energy. Congressional Budget Request FY 2001.

[39] These figures are derived from income statements, which can be found on the companies' websites or through numerous financial portals, such as www.finance.yahoo.com.

[40] Civiak, Robert. **America's One-Nation Arms Race.** An Analysis of the Department of Energy's Fiscal Year 2006 Budget Request for Nuclear Weapons Activities for Tri-Valley CAREs. April 2005. www.trivalleycares.org/TVC-Civiak_2006Rpt.pdf

[41] Information contained in Lawrence Livermore Timeline on the web at www.llnl.gov/timeline/home.html. Comparable information could not be obtained for the other two weapons labs.

[42] Barker, Robert. Assistant to the Secretary of Defense for Atomic Energy. Letter to the editor, *Physics Today,* December 1983.

[43] The Soviet Union had ceased testing in 1989.

[44] U.S. Department of Energy. Congressional Budget Request FY 2001. Budget Highlights. p. 68.

[45] U.S. Department of Energy. Congressional Budget Request FY 2002. Budget Highlights. p. 41.

[46] The Nuclear Weapons Council authorized a life extension for the W87 warhead as early as 1994. However, such changes were kept secret and were minimized. The LEP grew in scope significantly in 2000, when the term first appeared in the budget and LEP's were initiated for additional warheads.

[47] Pike, John. "Weapons of Mass Destruction (WMD). W76-0/Mk4 / W76-1/Mk4A". www.globalsecurity.org/wmd/systems/w76.htm.

[48] U.S. Congress. House. Committee on Appropriations. **Energy and Water Development Appropriations Bill, 2005. Report to accompany H.R. 4614.** June 18, 2004. H.Rept. 108–554. p. 115.

[49] Recommendations for the Nuclear Weapons Complex of the Future. op. cit. p. H-1.

[50] O'Brien, K.H., et al. **Sustaining the Nuclear Enterprise—A New Approach.** op. cit. p. 9.

[51] **Making Appropriations for the Energy and Water Development for the Fiscal Year Ending September 30, 2006, and for Other Purposes.** op. cit.