Nuclear Weapons Research and Development

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Recommendations of the WMD Commission

The reduction and elimination of WMD must be pursued through measures at all stages of the life cycle of WMD—from their creation and deployment to their disposal and destruction. (*Weapons of Terror*, 28)

Retiring obsolete weapons while developing replacements cannot be seen as a fulfilment of a commitment to disarm. (*Weapons of Terror*, 44)

The possibility of developing new types of nuclear weapons has been explored in the United States . . . . US advocates of new so-called low-yield weapons (often called mini-nukes) claim that such weapons would serve to deter other countries from seeking or using WMD. The Commission believes that developing such weapons, especially those with a lower threshold for use, would provide more of an inducement to other countries to do the same than a deterrent to proliferation. They would also be inconsistent with commitments made to strive for disarmament. (*Weapons of Terror*, 98)

The NPT nuclear-weapon states have an obligation vis-à-vis all states that have voluntarily forsworn nuclear weapons not to develop nuclear weapons with new military capabilities or for new missions. Of particular concern would be the adoption of doctrines and weapon systems that blur the distinction between nuclear and conventional weapons, or lower the nuclear threshold. Such modifications could over time have a domino effect and give rise to a renewed demand to resume nuclear testing. *If research on nuclear weapons is continued, modifications should only be for purposes of safety and security—and demonstrably so*. (*Weapons of Terror*, 99; emphasis supplied)

Recommendation 23: Any state contemplating replacement or modernization of its nuclear-weapon systems must consider

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such action in the light of all relevant treaty obligations and its duty to contribute to the nuclear disarmament process. As a minimum, it must refrain from developing nuclear weapons with new military capabilities or for new missions. It must not adopt systems or doctrines that blur the distinction between nuclear and conventional weapons or lower the nuclear threshold.

Test explosions are a key step in the design, development and refinement of nuclear weapons. They have also been widely regarded as a political message: a signal to the outside world that a country has mastered the technology of nuclear weapons. (*Weapons of Terror*, 105)

The adherence of all states to the Comprehensive Nuclear-Test-Ban Treaty would serve several vital objectives. First of all, it would prevent or inhibit qualitative improvements in existing weapons. Second, all non-nuclear weapon states parties to the NPT would become participants in the global verification system of the treaty and would be formal stakeholders in the treaty. Third, universal support of the CTBT, bringing the treaty into force and operation, would send a strong signal that all the states of the world are once again on the path to disarmament. (*Weapons of Terror*, 106)

Recommendation 28: All states that have not already done so should sign and ratify the Comprehensive Nuclear-Test-Ban Treaty unconditionally and without delay. The United States, which has not ratified the treaty, should reconsider its position and proceed to ratify the treaty, recognizing that its ratification would trigger other required ratifications and be a step towards the treaty's entry into force. Pending entry into force, all states with nuclear weapons should continue to refrain from nuclear testing....

Recommendation 29: All signatories should provide financial, political and technical support for the continued development and operation of the verification regime, including the International Monitoring System, the International Data Centre and the secretariat, so that the CTBTO is ready to monitor and verify compliance with the treaty when it enters into force. They should pledge to maintain their respective stations and continue to transmit data on a national basis under all circumstances.

One of the most important contributions made by the WMD Commission is its emphatic linkage of nuclear non-proliferation and disarmament, and its clear recognition of the dangers posed by *vertical* proliferation:

> *The question of how to reduce the threat and the number of existing nuclear weapons must be addressed with no less vigour than the question of the threat from additional weapons, whether in the hands of existing nuclear-weapon states, proliferating states or terrorists*.[1]

In his preface, Hans Blix rightly declares, "*The weapons that exist today are bad enough*."[2] And he states his belief that bringing the Comprehensive Test Ban Treaty (CTBT) into force, "would significantly impede the development of new nuclear weapons."[3] With respect to both the CTBT and a fissile material cut-off, Blix unequivocally states, "*the US has the decisive leverage. If it takes the lead the world is likely to follow. If it does not take the lead, there could be more nuclear tests and new nuclear arms races*."[4]

Indeed, the Commission places supreme importance on the CTBT, concluding, "The single most hopeful step to revitalize non-proliferation and disarmament today would be ratification of the CTBT by all states that have nuclear weapons."[5]

The Commission recognizes the risks arising from vertical proliferation, which it describes as "the expansion or refinement of existing nuclear-weapon capabilities."[6] It expresses concern that, "an endless competition to produce improved weapons fosters new suspicions over military intentions and capabilities. In such a climate, what one state might claim is a prudent safety improvement, another state might view in a more sinister light."[7] And it observes, "great controversies have arisen in recent years over demands in the United States to develop mini-nukes and bunker busters—initiatives that would be likely to lower the threshold for using nuclear weapons."[8] As the Commission briefly acknowledges, "domestic political pressures or advocacy from within government bureaucracies or *specialized weapons labs*," could be a factor in states' pursuit of WMD.[9] However, the Commission fails to examine how the United States' approach to negotiation and ratification of the CTBT, under the powerful political influence of its nuclear weapons laboratories, decisively repudiated the treaty's historic disarmament objective, and laid the groundwork for a revitalized nuclear weapons research and development infrastructure, not dependent on full-scale nuclear explosive tests. Nor does the Commission provide any critical assessment of the central role of a constantly reinforced infrastructure in making possible, and even in driving, new arms races.

In an essay written after the round of Indian and Pakistani nuclear tests in 1998, Dr. Amulya Reddy, an eminent Indian scientist, described how his visit in September 1999 to the former Nazi concentration camps in Poland intensified his opposition to the nuclear tests:

> The most powerful impression that persisted was of detailed engineering resulting in "the immense technological complex created for the purpose of killing human beings." The meticulous organization and rigorous management were characteristic of mega-industries. The camps were "gigantic and horrific factories of death." The main gate of Auschwitz displayed the inscription "Arbeit macht frei" (Work brings freedom). Perhaps "Technology completely decoupled from values" would have been more appropriate….
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> Walking through the scene of genocide in Auschwitz, one begins to think of historical parallels. In particular, one wonders whether there is a difference between the Nazi concentration camps and the development of the atom bombs at Los Alamos, the test at Alamagordo, and the bombing of Hiroshima and Nagasaki (which resulted in the virtually instantaneous annihilation of hundreds of thousands of people). Of course, the Allies in World War II were not driven by the racism of the Nazis, and they were not pursuing the final solution of extermination of any particular religious group. But with regard to the scale of the killing, the recruitment of capable minds, the harnessing of science and technology, the extent of organization, the resort to efficient project management methods, and the choice of targets to maximize annihilation of Japanese civilians—*the Manhattan project and its follow-up were like the concentration camps, in fact, even more horrendous in their impact*.[10]

When talking about nuclear weapons we are not dealing with just a particularly destructive type of weapon, but rather with what President Dwight Eisenhower originally wanted to call the *congressional*-military-industrial complex,[11] to which we would add the category, "academic." In a well-known line from the movie, *Field of Dreams*, the protagonist declares, "If you build it, they will come." He was talking about a baseball field and the sports fans it would attract. In the same way, as we're now seeing all too clearly*, if you build a new nuclear weapons infrastructure, it will produce new nuclear weapons*.[12]

The Manhattan Project in the 21st Century

In its current Strategic Plan, the Department of Energy (DOE) proudly traces its lineage "back to the Manhattan project and the race to develop an atomic bomb during World War II."[13] The DOE's Lawrence Livermore National Laboratory (LLNL) in California was founded in 1952 to compete with its Los Alamos National Laboratory (LANL) in New Mexico—the original home of the Manhattan Project—to develop a hydrogen bomb, orders of magnitude more powerful than the U.S. atomic bombs that destroyed Hiroshima and Nagasaki in 1945. Today, the Livermore and Los Alamos National Laboratories—*the direct descendants of the Manhattan Project*—are

engaged in a new arms race with each other to develop a new generation of hydrogen bombs, euphemistically called "Reliable Replacement Warheads" (RRWs).

After a protracted design competition, the DOE's National Nuclear Security Administration (NNSA)[14] has given the green light to the Livermore Lab to proceed with development of a replacement for the 100-kiloton W76 warhead[15] (some 1,600 of which are currently deployed on U.S. Trident II D-5 submarine-launched ballistic missiles). The Nuclear Weapons Council, a joint Department of Defense (DOD)-DOE agency, has directed the NNSA to begin another design competition for a second RRW. The first RRW is due for production in 2012; the production goal for the second warhead is 2014.[16] A DOD "Stockpile Transformation" table, outlining the future of the nuclear stockpile, forecasts that the U.S. will "develop warheads for next-generation delivery systems" between 2010 and 2020. The "long term vision" includes "possible new DoD platforms and delivery systems" along with "2-4 types of RRWs."[17]

During the Cold War years, a weapons designer at the Livermore Lab reportedly posted a sign that read, "*Remember: the Soviets are the competition*. *Los Alamos is the enemy*." The internal U.S. nuclear arms race continues today. In April 2006 testimony to Congress, Thomas D'Agostino, Deputy Director for Defense Programs at NNSA bragged:

> Progress on RRW has been remarkable. Last year, the DoD and DOE jointly initiated an RRW competition in which two independent design teams from our nuclear weapons laboratories—LLNL and LANL both in partnership with Sandia and the production complex—are exploring RRW options. A competition of this sort has not taken place in over 20 years, and *the process is providing a unique opportunity to train the next generation of nuclear weapons designers and engineers*. Both teams are confident that their designs will meet established requirements and be certifiable and producible without nuclear testing.[18]

This testimony was proffered in support of the NNSA's "Complex 2030" plan for the future of the nuclear weapons complex. Under this proposal, rolled out in April 2006, "NNSA's future path is to establish a smaller, more efficient Nuclear Weapons Complex that is able to respond to changing national and global security challenges."[19] The RRW Program is identified as a principal element of Complex 2030, "to ensure the long-term reliability and safety of the nuclear weapons stockpile and enable a more responsive supporting infrastructure while reducing the possibility that the United States would ever need to return to underground testing."[20] While claiming that "RRW is not a new weapon providing new or different military capabilities and/or missions," NNSA indicates that this possibility has certainly not been ruled out. "Once it is demonstrated that replacement warheads can be

produced on a timescale in which geopolitical threats could emerge, or the nuclear weapons complex can respond in a timely way to technical problems in the stockpile, further reductions can be made in non-deployed warheads."[21] *This approach also renders meaningless the disarmament objective implicit in further reductions*.

NNSA chief Linton Brooks was very clear:

> In 2030, our Responsive Infrastructure can also produce weapons with different or modified military requirements as required. *The weapons design community that was revitalized by the RRW program can adapt an existing weapon within 18 months and design, develop and begin production of the new design within 3-4 years of a decision to enter engineering development* ... goals that were established in 2004. Thus, if Congress and the President direct, we can respond quickly to changing military requirements.[22]

Brooks spelled out the purpose of the responsive infrastructure:

> The current nuclear weapons complex was built in the 1950s and 60s for the Cold War. Unless this infrastructure is improved, we will not be suited for 21st century challenges. As outlined in the 2001 *Nuclear Posture Review*, we are moving towards a nuclear deterrent that is smaller, more capable and better able to respond to changing needs. Our *Complex 2030* plan ... puts NNSA on a path to achieve this necessary national security goal.... *In short, I see a future world where a smaller, safer, more secure and more reliable stockpile is backed up by a robust industrial and design capability to better respond to changing technical, geopolitical or military needs*.[23]

This work is already in progress. Under the existing Stockpile Stewardship program, "Life Extension Programs" to render the U.S. nuclear arsenal reliable for decades to come are underway for the B61 bomb and the W76 SLBM (Sea Launched Ballistic Missile).[24] Although the Robust Nuclear Earth Penetrator no longer appears in the NNSA's unclassified budget, upgrades to the B61-11, a "bunker buster" already in the U.S. stockpile, are continuing.[25] The NNSA budget's official policy guidance is the once-secret 2001 Nuclear Posture Review, widely dismissed by arms control analysts as a mere "wish list" when it was leaked to the press in January 2002. (*See box*.)

DOE spending on nuclear weapons has climbed steadily from $4.1 billion in FY 1998 to $6.5 billion requested for FY 2008.[26] Accounting for inflation, this is more than one-third higher than the average annual spending on nuclear weapons during the Cold War.[27] The NNSA's "Future-Years Nuclear Security Program" projects continuing annual increases that will raise the nuclear weapons budget to $7.4 billion by 2012.[28] This does not

include tens of billions of dollars more for delivery systems and command and control technology provided for in the DOD budget. Nor does include the classified "black" budget.

The NNSA's FY 2008 budget request "maintains current commitments to the nuclear deterrence policies of the administration's Nuclear Posture Review."[29] It also identifies "[t]ransforming the nuclear weapons stockpile and infrastructure while meeting Department of Defense requirements, through the Reliable Replacement Warhead and other Complex 2030 initiatives," as a "key investment."[30]

The Nuclear Posture Review

The classified Nuclear Posture Review (NPR) presented to Congress by the Department of Defense on December 31, 2001, and subsequently leaked to the media, underlines the fundamental policy and technological underpinnings for the Bush administration's aggressive "preventive war" doctrine, and has served as the administration's primary justification for all subsequent budget requests for nuclear weapons research, development, and testing activities.

The NPR expanded the role of nuclear weapons in U.S. national security policy, including the possible use of nuclear weapons in "immediate, potential, or unexpected contingencies" against a number of named countries including Iraq, Iran, and North Korea, called for indefinite retention of a large, modern, and diverse nuclear force, and rejected ratification of the Comprehensive Test Ban Treaty (CTBT). Significantly, the NPR also elevated the weapons research and development infrastructure—*including the nuclear weapons laboratories*—to one leg of a "New Strategic Triad," intended to support both "offensive" and "defensive" integrated nuclear and non-nuclear high-tech weapons systems that will enable the U.S. to project overwhelming global military force. The NPR specified: "*the need is clear for a revitalized nuclear weapons complex that will... be able, if directed, to design, develop, manufacture, and certify new warheads in response to new national requirements; and maintain readiness to resume underground nuclear testing if required*." To accomplish this, the NPR called for the "transfer of warhead design knowledge from the current generation of designers to the next generation" through an "Advanced Concepts Initiative."[1] The Advanced Concepts Initiative has been superceded by the Reliable Replacement Warhead (RRW) Program.

Viewed as part of a continuum, these NPR requirements closely

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track testimony to Congress by one of the most powerful and influential nuclear weapons scientists, then-Sandia National Laboratory Director C. Paul Robinson. In March 1996—six months before President Clinton signed the CTBT—Robinson argued the need to maintain laboratory nuclear weapons competencies to Congress:

> New designs for components and subsystems will be a continuing requirement which will require all the original core competencies we needed to make new weapon designs, as well as contemporary capabilities in advancing technology.... *The engineers and scientists who will do that work are probably entering kindergarten this year*... They have to design whole systems with real deliverables to fully develop their capabilities... *It is my belief that nuclear weapons will remain important for a long time to come*.[2]

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1 "Nuclear Posture Review [Excerpts], Submitted to Congress on 31 December 2001," January 8, 2002 (emphasis supplied). Online at http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm. For a more detailed analysis of the Nuclear Posture Review and current U.S. nuclear weapons policies and their relationship to other high-tech weapons programs, see Andrew Lichterman and Jacqueline Cabasso, "The Shape of Things to Come: The Nuclear Posture Reivew, Missile Defense, and the Dangers of a New Arms Race," Western States Legal Foundation, April 2002. Online at http://www.wslfweb.org/docs/shape.pdf. For additional information about the NPR from a variety of sources, see the WSLF NPR information page, online at http://www.wslfweb.org/nukes/npr.htm.

2 C. Paul Robinson, "Statement of the Director Sandia National Laboratories," Statement to the United States House of Representatives Committee on National Security, Joint Hearing of the Subcommittee on Military Procurement and Subcommittee on Research and Development, March 12, 1996 (emphasis supplied).

The FY 2008 budget request of $89 million for the RRW program—a 220 percent increase over FY 2007—reflects the NNSA's expectation that Congress will approve the transition from warhead design to the next phase of implementation. This figure does not include the DOD's requested share of the RRW program, $30 million for FY 2008.[31] Under the RRW program, virtually every warhead component will be redesigned, including the physics packages—which include the spherical plutonium cores commonly referred

to as "pits." The new warheads aren't supposed to require full-scale explosive testing, but just in case, the Nevada Test Site is being maintained in a state of 24-month readiness. The FY 2007 budget provided for demonstrating the ability to produce tritium—radioactive hydrogen used to "boost" the yield of nuclear weapons—by 2007. Sure enough, on December 4, 2006, NNSA announced that its new Tritium Extraction Facility at the Savannah River Site in South Carolina "has begun operations and tritium can now be extracted from target rods, ensuring a sustainable supply of tritium for the nation's nuclear weapons stockpile."[32] Tritium production in the U.S. was halted in 1988, and plutonium pit production in 1989, due to environmental and public health hazards.

In April 2003, the Los Alamos Lab announced that it had successfully manufactured the first plutonium pit in 14 years that meets specifications for the U.S. stockpile. The newly made pit was for the 475-kiloton W88 warhead, carried on the Trident II D5 Submarine-Launched Ballistic Missile, and described in the Los Alamos press release as "a cornerstone of the U.S. nuclear deterrent."[33] The NNSA is asking for $43.6 million for pit manufacturing and certification in FY 2008, an 18.4 percent increase over the FY 2007 level. According to the budget documents, this program, which has focused on the manufacturing and certification of W88 pits, is "working to establish the capability to manufacture replacement pits other than the W88 pit."[34] The NNSA hopes to begin manufacturing pits at LANL in FY 2008. Approximately 40 W88 pits would be produced over the first 3 years. After the W88 production run, pre-production activities for the first RRW pit would begin. If the program is approved, the RRW is expected to enter production at LANL in FY 2012.[35] Meanwhile, more than 12,000 pits from dismantled weapons languish at the Pantex nuclear weapons assembly/disassembly plant in Texas, available for reuse, if desired by the weaponeers.[36]

The Los Alamos Lab is one of five sites under consideration in the Complex 2030 proposal for a consolidated plutonium center for long-term research and development, surveillance, and pit manufacturing operations, with a baseline capacity of 125 "qualified" pits per year.[37] Initial funding for this program is included in the FY 2008 budget request.[38] Other actions proposed by the NNSA to "transform to a more modern, cost-effective nuclear weapons complex," under the Complex 2030 moniker, include consolidating duplicative facilities and programs in order to improve operating efficiencies for tritium research and development, high-explosives testing, and nuclear materials storage.[39] Complex 2030 plans also anticipate identifying sites for joint flight testing operations in which "NNSA and DOD hardware is tested to assure compatibility between NNSA and DOD hardware interfaces for current and *future* ... weapons,"[40] along with accelerated dismantlement activities. In other words, *fewer but newer nukes forever*.

A government study on plutonium aging, released in late 2006, created a flurry of national media attention. The study, conducted by nuclear scientists at the Livermore and Los Alamos Labs and reviewed by an outside panel of

nuclear weapons experts known as the JASONs, concluded that plutonium pits degrade at a much slower rate than was previously believed. The study found that plutonium in the U.S. nuclear arsenal remains viable for as long as 100 years, more than twice as long as had been previously thought. Some critics of the RRW and Complex 2030 seized on the report, claiming it "proved" that a new pit factory and new warheads are "completely unnecessary" because the existing warheads will last for a century.[41] However, Ellen Tauscher, the Democratic Congressional Representative whose district includes the Livermore Lab, welcomed the study, claiming that plutonium aging is a "side matter" that will not influence the RRW decision, which she characterized as "an opportunity to rejuvenate the complex" and attract the "smartest scientists in the world" to the weapons labs.[42] Indeed, the NNSA issued a press release two days later, reaffirming its commitment to the RRW program as the best strategy "for sustaining the nation's nuclear weapons stockpile for the long-term without underground nuclear testing."[43]

In April 2006, around the same time the NNSA announced its proposal for Complex 2030, the U.S. Government Accountability Office (GAO) assessed a Secretary of Energy Advisory Board task force report entitled, "*Recommendations for the Nuclear Weapons Complex of the Future*." The October 2005 report, which had been mandated by Congress, "provided a systematic review of the requirements for the weapons complex for the next 25 years and offered its vision for an agile and responsive weapons complex."[44] According to the GAO, the task force estimated costs ranging from $155 billion to $175 billion for the NNSA to support its current baseline operations and modernize the current weapons complex until 2030. However, the GAO cautioned that the "NNSA has established over 70 plans with associated performance measures to manage the Stockpile Stewardship Program," and concluded, "until NNSA develops a credible, defensible method for estimating life-cycle costs and performs detailed cost analyses … it will not be possible to objectively evaluate the budgetary impact of any path forward."[45] By any estimate, indefinite maintenance of the U.S. nuclear weapons infrastructure, *with or without Complex 2030*, will be an enormously expensive undertaking.

With virtually no national debate about the *purpose* nuclear weapons serve, the advent of the RRW has given rise to an increasingly narrow and distorted public discourse about the *future* of nuclear weapons. For example, Joseph Martz, a leading nuclear weapons designer at Los Alamos and self-proclaimed critic of how U.S. nuclear weapons policy is being discussed in Washington, has proposed a plan, purportedly for the elimination of nuclear weapons. In an interview with the *San Francisco Chronicle*, Martz explained how the numbers of warheads would be slowly reduced over a period of years. During that time older weapons would be replaced by new RRWs as an interim measure. The ultimate goal, he said, would be the elimination of the entire arsenal. But the United States would retain in its place the technology to assemble warheads from stockpiled materials in case of a grave threat to

its national security. Martz explained, "I'm trying to offer solutions that say, 'How can we get the benefits of deterrence without having to put thousands of warheads on hair-trigger alert?'" In his Orwellian version of disarmament, *Martz is suggesting that the United States should build new nuclear weapons in order to eliminate its old ones, decades from now, and to retain a credible "virtual stockpile" indefinitely*. Moreover, Martz admits that the Labs already have the capability to rapidly assemble warheads from stockpiled materials.[46]

In a document entitled, "Complex 2030: An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threats of the 21st Century, 'Getting the Job Done,'" the NNSA set forth its planning assumption: "*Start with the end in mind*."[47] Considering the scenario that follows, that could be interpreted as a reference to the end of the world. Clearly, the meaning of "the end" needs to be unambiguously defined as the verifiable, irreversible reduction and elimination of all nuclear weapons, in compliance with the Nuclear Non-Proliferation Treaty (NPT) disarmament obligation, with measurable milestones along the way.

The Deal for the CTBT

Conclusion of CTBT negotiations by 1996 was the most solid commitment the United States and the other nuclear weapon states made in exchange for the acquiescence of the non-nuclear weapon states to the indefinite extension of the NPT in 1995. Ironically, it was this commitment that the U.S. nuclear weapons establishment exploited to fuel the absurd argument that whatever it took to conclude a CTBT—*even if it meant building a new nuclear weapons complex to buy their support*—would be good for non-proliferation. The NPT, which entered into force in 1970, established a direct link between nuclear non-proliferation and disarmament: those states without nuclear weapons promised not to get them; those states with nuclear weapons promised to give them up. The CTBT was viewed by most of the world as a means to cut off the development and modernization of nuclear weapons, and thus, as a meaningful disarmament measure. The CTBT deal brokered with the nuclear weapons labs flew in the face of the NPT's central bargain.

In August 1995, citing the promise made in connection with indefinite extension of the NPT, President Clinton announced his support for a "zero" yield CTBT by 1996, in order to "reduce the danger posed by nuclear weapons proliferation."[48] He also announced the U.S. intent, "as part of our national security strategy," to "retain strategic nuclear forces..." and in this regard considered "the maintenance of a safe and reliable nuclear stockpile to be a supreme national interest of the United States."[49] Clinton strongly endorsed the nuclear weapons labs' "Science Based Stockpile Stewardship" program as a means of maintaining the U.S. "nuclear deterrent" without nuclear testing, and he appealed to Congress for bipartisan support for the program "*over the next decade and beyond*."[50] Clinton also set forth a set of conditions

for U.S. agreement to a CTBT including, "The conduct of a Science Based Stockpile Stewardship program to insure a high level of confidence in the safety and reliability of nuclear weapons in the active stockpile..." and "The maintenance of modern nuclear laboratory facilities and programs ... which will attract, retain, and ensure" a continuing supply of nuclear weapons scientists. He also directed that the capability to resume underground nuclear testing be maintained.[51] (*See box*.)

This trade-off reprised the deal struck in 1963, when the U.S., Great Britain, and the Soviet Union negotiated the Partial Test Ban Treaty (PTBT), which banned nuclear tests in the atmosphere, in space, and under water. The weapons laboratories are credited with keeping underground tests out of the treaty. Then, as in 1995, there were concerns that the Senate might not ratify the treaty—at that time, because they feared that the U.S. would be unprepared if the Soviet Union broke out of the treaty and resumed testing. Therefore, in 1963 the Joint Chiefs of Staff and their allies in the Senate insisted as a condition for ratification that the U.S. pursue certain initiatives, referred to as the "four safeguards." These included an extensive underground nuclear weapons testing program, maintenance of "modern nuclear weapons laboratories and programs which will attract and retain 'human scientific resources,'" and maintaining the capacity to quickly resume atmospheric testing.[52] In the years immediately following the PTBT, the weapons labs were strengthened, U.S. nuclear testing increased, and the arms race surged ahead. Yet in 1995, with the former Soviet Union splintered both geopolitically and economically, the labs and the military made essentially the same arguments they put forth at the height of the Cold War, and President Clinton duly updated and expanded the 1963 safeguards.

As Secretary of State Madeline Albright explained:

> We simply do not need to test nuclear weapons to protect our security. On the other hand, would-be proliferators and modernizers must test if they are to develop the kind of advanced nuclear designs that are most threatening. *Thus, the CTBT would go far to lock in a technological status quo that is highly favorable to us.*[53]

When Clinton submitted the CTBT to the Senate for ratification in September 1997, his transmittal letter made clear that his endorsement of the Treaty was conditioned on Senate support for the Stockpile Stewardship program as a central requirement of "*our national security strategy.*" Clinton repeated the conditions he first announced in August 1995, and added a new "certification" procedure that gave the labs even more power.

The link between control over nuclear weapons-relevant information and influence over nuclear weapons policy was formally institutionalized by this procedure, in which the directors of the weapons laboratories "certify" the safety and reliability of the nuclear arsenal once a year. There is no apparent

external check on this process, and the certification is essentially a judgment call by the labs. If it is determined "that a high level of confidence in the safety or reliability of a nuclear weapon type ... critical to our nuclear deterrent could no longer be certified," Safeguard "F" provides that "the President, in consultation with the Congress, would be prepared to withdraw from the CTBT under the standard 'supreme national interests' clause in order to conduct whatever testing might be required."[54] The "safeguards" provide an opportunity for the weapons laboratories to threaten an administration with termination of the CTBT regime if they are not given what they consider adequate resources to "certify" the reliability of the stockpile.

The Livermore Lab Director, Bruce Tartar, indicated how the demand for funding would work, when he warned Congress in 1997:

> *My greatest concern regarding the success of the SSMP [Stockpile Stewardship and Management Program] is the possibility of a lack of timely and sustained support*.... Program support must be timely because we must get on with the task before existing experienced people retire or leave to pursue other endeavors. In addition, the support must be sustained at an adequately funded level because every element of the SSMP is needed for the success of the program as a whole. *The technical risks in SSMP will be significantly greater if we are forced to stretch out activities in time or reduce the scope of planned research activities to meet more constrained budgets*.[55]

Tartar's reference to "technical risks" in the Stockpile Stewardship program was meant as an implied threat that if the labs didn't get everything they wanted, they would find themselves unable to certify the stockpile without conducting full scale nuclear tests.Then-Secretary of Energy Federico Peña emphasized the contingent nature of the CTBT commitment: "[L]et me stress that if I am advised by the nuclear weapons laboratory directors that there is a problem with the stockpile that is critical to our nuclear deterrent and that we are unable to correct without returning to underground testing, I will not hesitate to advise the President of such."[56]

In her book, *The Game of Disarmament*, Alva Myrdal, a Swedish minister of disarmament and 1982 winner of the Nobel Peace Prize, wrote about the "inside story of how progress towards arms limitation was stymied."[57] She described how, during the early 1960s negotiations on the CTBT, a politically favorable climate emerged in the aftermath of the Cuban Missile Crisis and the nonaligned delegates, "encouraged ... by the rhetoric of the great powers," worked out a practical formula to resolve the remaining small differences between the United States and the Soviet Union.[58] But at the last minute the comprehensive test ban was abandoned in favor of a partial ban:

> What happened? Both Moscow and Washington started to exert diplomatic pressure in our capitals, undercutting our work through

> intimations to our own governments that we were jeopardizing important progress towards an agreement by the two superpowers. Such pressure, which has never been exerted *in favor of disarmament*, led to the abandonment of plans for the total test ban on 1963. What was achieved instead was a partial and ineffective test ban.... which actually legitimized the continuation of testing underground.[59] [Emphasis in original.]

By providing for the preservation and expansion of U.S. nuclear weapons capabilities through underground testing, the 1963 safeguards represented a tragic lost opportunity to stem nuclear proliferation and move toward disarmament. Similarly, the substitution of a laboratory-based infrastructure for underground testing in the 1990s recapitulated the profound failure of the PTBT to end the nuclear arms race, and strengthened the nuclear weapons labs, as a driving force.

In February 2007, it was reported that a *new* deal might be in the making, with Democrats in Congress linking support for the RRW program with ratification of the CTBT and reductions in the overall nuclear arsenal. At a Washington, DC conference on Strategic Weapons in the 21st Century, keynote speaker Representative Ellen Tauscher (a Democrat representing Livermore), the new chair of the House Armed Services subcommittee on strategic forces, expressed her strong support for the RRW and the weapons labs that were hosting the conference. Warning that if new warheads can't be fielded without testing, she stated, "I see no alternative but to terminate funding for the program." But, she added, "*if new warheads can be deployed without live explosive testing, then ratifying the CTBT should be the central objective of our nation*."[60]

Stockpile Stewardship
Nuclear Weapons Research and Production for the 21st Century

"*If my modeling and simulation really understands the environment in which that weapon will go to, I can do things with it that allow me to stay within the law which says that I have to leave the current warhead configuration as it is, but that I can take my 1966 Mustang, which is when most of these assets were made available to me, and I could put seatbelts, airbags, antilock brakes, GPS in it. I could do a whole bunch of things that would fundamentally change the characteristic of that stockpile*."[1]

-General Cartwright, U.S. Strategic Command

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A significant part of the "revitalized defense infrastructure" called for by the 2001 Nuclear Posture Review is the complex of DOE/NNSA nuclear weapons research, testing, and production facilities. To sustain this vast complex, the U.S. is spending over six and a half billion dollars a year on the "Stockpile Stewardship" program. Originally called "Science Based Stockpile Stewardship" (SBSS), the term was coined to describe the transition from an engineering-based understanding of how nuclear weapons work to a scientifically-based understanding. Legislation passed by Congress in 1993 called on the Secretary of Energy to "establish a stewardship program to ensure the preservation of the core intellectual and technical competencies of the United States in nuclear weapons." In 1994, the JASON group, a think tank of top physicists and other scientists who advise the Pentagon and the Energy Department on applying science and technology to military problems, issued a report on SBSS at the request of the DOE. "The basic principle of this plan," they wrote, "is to compensate for the termination of the underground testing program by improved diagnostics and computational resources that will strengthen the science-based understanding of the behavior of nuclear weapons, thereby making it possible for the United States to maintain confidence in the *performance* and safety of our nuclear weapons during a test ban."[2]

Under the Stockpile Stewardship Program, an array of new nuclear weapons research facilities of unprecedented sophistication—some already completed, some currently under construction, and some still on the drawing board—will allow the continued testing of many aspects of nuclear weapons.[3] These include:

- The multi-billion dollar National Ignition Facility (NIF), newly built at the Lawrence Livermore National Laboratory in California. The NIF is a laser driven fusion machine the size of a football stadium, designed to create very brief, contained thermonuclear explosions. It is slated to be used for a wide range of applications, from training weapons designers in nuclear weapons science to nuclear weapons effects testing. NIF experiments, together with other fusion research being conducted at the nuclear weapons laboratories, could, in the long run, lead to the development of pure fusion weapons, not requiring plutonium or uranium.
- The Dual Axis Radiographic Hydrotest Facility (DARHT). This facility at the Los Alamos National Laboratory in New Mexico,

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will join several already existing facilities where mockups of primaries or "pits," the first stage of a thermonuclear weapon, are imploded while very fast photographic or x-ray images are generated, thus allowing scientists to "see" inside the implosion. DOE already is developing technology for an even more sophisticated "hydrodynamic testing" facility, the Advanced Hydrotest Facility.

- Pulsed power technologies. Further experiments exploring the extreme conditions created in a nuclear weapon explosion are studied using various types of "pulsed power," in which a large amount of energy is stored up and then released very quickly in a small space. The energy source can be chemical high explosives or stored electrical energy. Pulsed power facilities at both DOE and Department of Defense laboratories are used to explore nuclear weapons function and effects and directed energy weapons concepts, and could play a role in the development of a wide range of high technology weapons, including new types of nuclear weapons.

The data streams from these and other experimental facilities, along with that from "subcritical" tests which implode nuclear materials but have no measurable nuclear yield[4] and the archived data from over 1000 past U.S. nuclear tests, will be integrated via the Advanced Simulation and Computing Program. This multi-billion dollar supercomputing program reaches beyond the weapons laboratories, seeking to incorporate the nation's leading universities into an effort to attract and train yet another generation of nuclear weapons designers.

While considering options for a new large-scale factory for warhead components, the U.S. is establishing significant "interim" capacity to make bomb parts at its existing facilities.

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1 General James Cartwright, Commander, U.S. Strategic Command, remarks delivered at the Air Warfare Symposium, Orlando, Florida, February 18, 2005.

2 Dr. Sidney Drell, et al., *Science Based Stockpile Stewardship*, JASON/The Mitre Corporation, November 1994 (emphasis supplied). The JASON "think tank" was founded in response to the Soviet Union's successful Sputnik program in the late 1950's, in order to strengthen the collaboration, begun during the Manhattan Project, between top U.S. physicists and the U.S. military.

3 For a lavishly illustrated description of the Stockpile Stewardship

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program and how the DOE/NNSA views its future development, see, "DOA/NNA-0014: Fiscal Year 2007-2011 Stockpile Stewardship Plan Overview," National Nuclear Security Administration, Washington, D.C., November 13, 2006.

4 Between 1997 and 2006, the U.S. conducted 23 "subcritical" underground nuclear tests at the Nevada Test Site. In these experiments, chemical high explosives and plutonium are exploded underground without creating a self-sustaining nuclear reaction. In 2007 a series of four smaller scale subcritical tests have been conducted. Two subcritical tests have been conducted jointly with the United Kingdom, under the terms of the 1958 Mutual Defense Agreement.

The Role of the Nuclear Weapons Laboratories

In 1946, Congress created the Atomic Energy Commission (AEC) "to take control over the scientific and industrial complex supporting the Manhattan Project and to maintain civilian government control over atomic research and development." The AEC was superseded by the DOE, established in 1977 under legislation that brought together for the first time energy, science and technology programs with "defense responsibilities that included the design, construction, and testing of nuclear weapons."[61] The Los Alamos and Livermore National Laboratories are operated under the auspices of the National Nuclear Security Administration of the DOE. Until recently, both labs were managed under contract, exclusively by the University of California (UC), which provided a fig leaf of academic respectability for their central mission, the research and development of nuclear weapons. Last year, a consortium made up of Bechtel and other corporations, in partnership with UC, took over management of LANL under the name Los Alamos National Security, LLC. The same consortium is expected to bid for the Livermore contract in the near future.[62] The Los Alamos and Livermore Labs are augmented by the Sandia National Laboratories, established in New Mexico in 1949 as an outgrowth of the Manhattan Project. Sandia's original mission was to turn the nuclear physics packages created by LANL and LLNL into deployable weapons. A second Sandia Lab was built in California in 1956, across the street from Livermore's main site. Sandia is a government owned, contractor-operated facility, managed by Lockheed Martin Corporation for the NNSA.[63]

According to the Los Alamos Lab Director, Sig Hecker, in 1997 testimony to the Senate:

> *Our job is to help the U.S. Government ensure that no one in the world doubts that the United States has the capability to project*

> *overwhelming force in the defense of its vital interests... Nuclear weapons are the 'big stick' that defends our homeland and are the ultimate deterrent force against any potential aggressor.*[64]

It is difficult to overestimate the labs' historical influence on the proliferation of nuclear weapons. Since their inception, the U.S. weapons labs have competed with each other to develop ever more sophisticated nuclear weapons systems, "selling" their ideas to presidents, congresses, and the Pentagon, and actively opposing an end to nuclear testing.

The laboratories' successful opposition to a nuclear test ban dates back to the late 1950's when lab representatives talked President Eisenhower out of putting a halt to nuclear tests.[65] Reflecting the labs' hostility toward placing limits on research and development of nuclear weapons, the Livermore Lab deliberately stockpiled plutonium above its authorized limit, in anticipation of the end of the Kennedy-era nuclear testing moratorium in 1961. According to then-Lab Director John Foster:

> The Lab's view was that the test ban was not likely to continue indefinitely. So we chose to be ready to test once the ban was lifted. We decided to staff up and procure materials above the authorized levels. These moves were a little at odds with the administration in Washington…. *I guess it is an example of the value of a relatively independent Laboratory, one that could execute actions at slight variance to the consensus in Washington.*[66]

During the Carter administration, the Los Alamos Lab Director Harold Agnew, and his Livermore counterpart Roger Baetzel, each took pride in claiming that they had personally talked President Carter out of a comprehensive test ban. In September 1992, Robert Barker, Deputy Associate Director at the Livermore Lab, told a group of lab employees, "one of the major jobs this institution has is to help the country realize this legislation [the Nuclear Testing Moratorium Act] was a mistake."[67]

In March 1994, Livermore Lab Director John Nuckolls reinforced the terms of the impending deal for the CTBT in lurid testimony to Congress, advocating massive funding increases over the next decade for defense programs at the weapons labs. Unless funding is provided for "vastly more advanced computational and experimental facilities" for nuclear weapons research, development, and testing, he warned, "the building blocks of modern civilization" will be put at risk by the "incalculable and catastrophic threats" posed by nuclear proliferation and nuclear terrorism.[68]

Even that sector of the nuclear weapons community professing to support the CTBT contributed to its demise and helped lay the groundwork for a resurgent arms race by promoting technical solutions to what are fundamentally political problems. A letter sent to key members of Congress in May 1996 by three of the most prestigious members of the nuclear weapons establishment,

physicists Hans Bethe, Herbert York, and Henry Kendall, urged congressional support for Science Based Stockpile Stewardship (SBSS) in the strongest possible terms, arguing that "the implementation of the [SBSS Program] can help achieve a CTBT" and that "there must be strong and sustained support for the entire [SBSS Program] so that the U.S. and other nuclear weapons states can undertake a true CTBT without sacrificing security, safety and reliability in the remaining weapons." They also declared: "*achieving a CTBT will signal the real end to the nuclear arms race and demonstrate that the nuclear weapons states are fulfilling their obligations under the recently extended [NPT]*." Almost in the same breath, the authors completely contradicted themselves: "*these new elements—advanced computer capabilities and new experimental facilities—do not detract from the core weapons science capabilities, they strengthen and sustain them.*"[69]

It can't be both ways. First, the claim that SBSS was necessary to achieve a CTBT was a baseless assumption, premised on political speculation about how the United States Senate might vote regarding ratification of the CTBT. *It had nothing to do with science or technology*. And indeed, it proved to be wrong. The Clinton administration relied on the Stockpile Stewardship deal it had made with the labs to secure Senate ratification of the treaty. But in the end, the lab directors raised questions about whether Stockpile Stewardship would "work" and on October 13, 1999, the U.S. Senate voted down the CTBT. Thus the weaponeers got everything they wanted—no CTBT *and* a massive infusion of funding and prestige, while the U.S. Senate signaled to the world that the United States has little interest in the elimination of nuclear weapons.

Secondly, laboratory testing and other signs of ongoing reliance on nuclear weapons were matters of great controversy at the NPT Review and Extension Conference in 1995 and the 2000 and 2005 Review Conferences. Non-nuclear countries *rightly* expect the nuclear states to meet their obligations under Article VI of the treaty to negotiate an end to the arms race and nuclear disarmament. More than thirty five years after the NPT went into effect, they *should* be concerned that the United States is spending billions of dollars on a new generation of laboratory facilities in order to replace underground testing and augment an already extensive nuclear weapons research and development infrastructure. What does this demonstrate, other than a "nukes forever" attitude?

However, some in the U.S. weapons establishment have little regard for the NPT. According to the Sandia National Laboratory Director, Paul Robinson:

> In truth, I believe that the NPT was intended more as a confidence-building measure than as a real arms control treaty that we were willing to bet our country's survival on. We would never have negotiated an arms control treaty with the ridiculous verification inspections by the International Atomic Energy Agency prescribed

> in the NPT, which missed the programs in Iraq and Iran and even Israel. Where has the IAEA spent the most money in terms of inspections? In Germany, Canada, and Japan. Why? Because it is a confidence-building measure among friendly countries eager to prove they are not violating it. It was never set up to catch cheaters. *That's why I disagree with people who infer that the NPT is a real arms control treaty. It's not*.[70]

In late 2003, Congress repealed a law that put restrictions on research and development that could lead to the production of new low-yield nuclear weapons. Then-NNSA chief Linton Brooks sent a very revealing memo to the directors of the nuclear weapons labs, thanking them, on behalf of the administration, for their support in getting the ban repealed. In the memo, Brooks declared to the nuclear scientists, "[W]e are now free to explore a range of technical options that could strengthen our ability to deter, or respond to new or emerging threats without any concern that some ideas could inadvertently violate a vague and arbitrary limitation." And he urged:

> Along these lines, I expect your design teams to engage fully with the Department of Defense to examine advanced concepts that could contribute to our nation's security. Potentially important areas of such research include agent defeat and reduced collateral damage.
>
> In addition, we must take advantage of this opportunity to ensure that we close any gaps that may have opened this past decade in our understanding of the possible military applications of atomic energy—no novel nuclear weapons concept developed by any other nation should ever come as a technical surprise to us.[71]

If the world's leading nuclear state continues to insist "do as we say, not as we do," while openly threatening to preemptively attack—*including with nuclear weapons*—any country that even thinks about acquiring nuclear, chemical, or biological weapons in order to defend *its* "national security," can the non-proliferation regime last? And, how is it that the Bush administration can so easily make that threat credible? Because of its overwhelming nuclear capabilities, *unimpeded by the end of the Cold War and augmented by the Stockpile Stewardship deal.*

The Shape of Things to Come

In spring 1996, the year President Clinton signed the CTBT, Sandia Director Paul Robinson forecast the future of nuclear weapons in testimony to Congress:

> New designs for components and subsystems will be a continuing requirement which will require all of the original core competencies

> we needed to make new weapon designs, as well as contemporary capabilities in advancing technology.... *The engineers and scientists who will do that work are probably entering kindergarten this year....*[72]

One of the most troubling aspects of the revitalized nuclear weapons infrastructure is its dependence on and aggressive pursuit of young scientists and engineers, manifested through an increasingly close relationship between the nuclear weapons laboratories and leading universities. Early on, the DOE established the "Academic Strategic Alliance Program" (ASAP) as a "key component" of the Stockpile Stewardship Program. In 1997, DOE awarded $250 million to five major American universities to work collaboratively with the Livermore, Los Alamos, and Sandia National Laboratories "*to help advance high-performance computer simulation capabilities needed to make an historic leap in large-scale computer modeling and simulation.*" The Assistant Secretary of Energy for Defense Programs, Dr. Victor Reis, emphasized the central importance of the Accelerated Strategic Computing Initiative (ASCI) in simulating nuclear weapons tests:

> *ASCI is an enormous challenge and is such a demanding consumer of intellectual resources that the significant capabilities of our national laboratories need to be augmented with expertise in the academic community.* Together with our university and private-sector partners, we are confident we can achieve the kind of dramatic advances in computing and simulation capabilities that will make science-based stockpile stewardship a reality.[73]

That same year, the DOE announced plans to provide $10 million to Washington State University to establish a "Shock Physics" institute "as part of DOE's strategic investment in selected scientific disciplines important to science based stockpile stewardship."[74] And, the DOE's Office of Defense Programs began soliciting proposals from "all segments" of the U.S. private sector—including universities—through the "Inertial Fusion Science in Support of Stockpile Stewardship Financial Assistance Program." This program offered grants of up to $1 million a year to small research projects at universities and other private sector institutions in order to "promote interactions between such investigators and scientists at the Department of Energy weapons laboratories," and assist in training scientists in areas relevant to stockpile stewardship."[75]

Based on the success of this program, in April 2006, the same month it made public its plans for Complex 2030, the NNSA announced a new phase of its Academic Computational Science (ASC) Partnership Program, with an emphasis on "predictive science." According to the NNSA's deputy administrator for defense programs:

> Since the 1992 moratorium on underground nuclear testing, large-scale computational science has provided an essential methodology to the scientific discovery and understanding of physical and engineering phenomena. ASC's academic alliances have played an important role in developing these technologies. *They have also provided valuable training opportunities in graduate students and post doctoral candidates for future employment in laboratory, academic and industrial settings*.[76]

The Predictive Science Academic Alliance Program consists of both very large scale research centers and much smaller research projects tightly integrated with the NNSA Laboratories. Goals of the new program include improving "the relevance of this program to stockpile stewardship and the NNSA Laboratories," and focusing "on discipline areas of critical interest to the stockpile stewardship program and NNSA Laboratories." As the Program Statement notes, "the academic community can provide key research and development expertise in many of the disciplines critical to the Predictive Science." Among other requirements, proposals must specifically include:

> A plan for interacting with the NNSA Laboratories; for example, students supported by the program may be required to spend summers at NNSA Laboratories, and Post Docs and other staff supported by the program may be required to spend some designated period like 2-4 weeks.
>
> A plan for attracting US citizen graduate students and post docs and associating them or involving them with the NNSA Laboratories.[77]

The NNSA is making its recruiting intentions more explicit, noting in its application guidelines that in contrast to the earlier ASAP, "the applications and associated sub-disciplines require a stronger direct connection to NNSA interests."[78]

The Responsibility of Scientists

Ted Taylor was a brilliant young nuclear weapons designer working at Los Alamos in the early 1950s. Although upon hearing news of the Hiroshima bombing he had written to his parents that he would never work on atomic bombs, working side by side with world renowned scientists such as Enrico Fermi, John von Neumann, Hans Bethe, Edward Teller, and Stan Ulam, he quickly became fascinated by all aspects of nuclear weaponry. While others worked on the H-bomb, Taylor focused on increasing the explosive power of fission bombs, while reducing their size and weight. He later wrote:

> Over the months, I learned that I was good at my work; and that gave

> me a sense of personal power over events of global significance. Our work at Los Alamos was strongly encouraged by the president of the United States, the Congress, the entire military establishment, and most of the general public.[79]

In 1964, Taylor became deputy director of the Defense Atomic Support Agency:

> It was during the next two years, working most of the time in the bowels of the Pentagon, that my peacemaking rationalizations collapsed. I became privy to the actual characteristics and deployments of what, by then, were thousands of nuclear weapons. And I discovered willful deception at all levels of government concerning the effects of nuclear weapons on people, on buildings, on military equipment, on everything. The nuclear arms race had a force and a momentum I had never dreamed of. All proposals for major, verifiable disarmament actions had been rejected not only by the Soviet Union, but also by the United States. *I eventually resigned, and I have worked since then to rid the world of nuclear weapons*.[80]

Unfortunately, the Taylors and Rotblats[81] were and are the exceptions to the rule. After several generations of "normalization" of nuclear weapons and the scientific, military, and academic institutions which spawn, modernize, and sustain them, there are almost no inside voices demanding genuine disarmament measures. Instead of questioning the fundamental legitimacy, legality, and morality of these most destructive weapons of all, the scientists and engineers are for the most part devising methods to ensure that nuclear weapons remain "reliable" for the coming decades, or even worse, exploring ways to make nuclear weapons "more useable" in a constantly changing geopolitical context.

While it is not fair to lump all scientists together, there is no basis for believing that the scientists who brought us into the nuclear age have any special qualifications to lead us out of it. To the contrary, it is the scientists who have time and time again imposed *technical* solutions onto the *political* problems of war and peace, often exacerbating those political problems in the process. At the same time, it is undeniable that *technological* problems resulting from the design, testing, production, and deployment of nuclear weapons will require, in part, technological solutions. Only by working *with*, and taking guidance *from*, the people asking the *right* questions, will scientists be able to make a unique and invaluable contribution to a world without nuclear weapons and war.

At an event celebrating the conclusion of CTBT negotiations in 1996, Ted Taylor warned: "*The signing of this treaty must not cause the relaxation or postponement of worldwide actions to rid the world of these terrible weapons that have moved the human capacity for destruction clear off the human scale*."[82]

Recommendations for U.S. Policy

- The United States should terminate nuclear weapons research and development, and limit "Stockpile Stewardship" programs to securing the existing arsenal in a safe condition as it awaits verifiable and irreversible disablement and dismantlement, in compliance with the Nuclear Non-Proliferation Treaty's disarmament obligations.

- The United States and other states possessing nuclear arsenals should halt research, development, testing, and component production while reductions of arsenals are in progress, not afterwards, with production and research facilities subject to an intrusive verification regime at the earliest possible time.[83]

- The United States should accompany ratification of the Comprehensive Test Ban Treaty with commitments to permanently close the Nevada Test Site and warhead component production plants, and to phase out the nuclear weapons laboratories, with specified, measurable milestones.

- Scientists and engineers, and students in those fields, should refuse to participate in the design, development, testing, production, maintenance, targeting, or use of nuclear, biological, or chemical weapons or their means of delivery, or in research or engineering they have reason to believe will be used by others for those purposes.[84]