

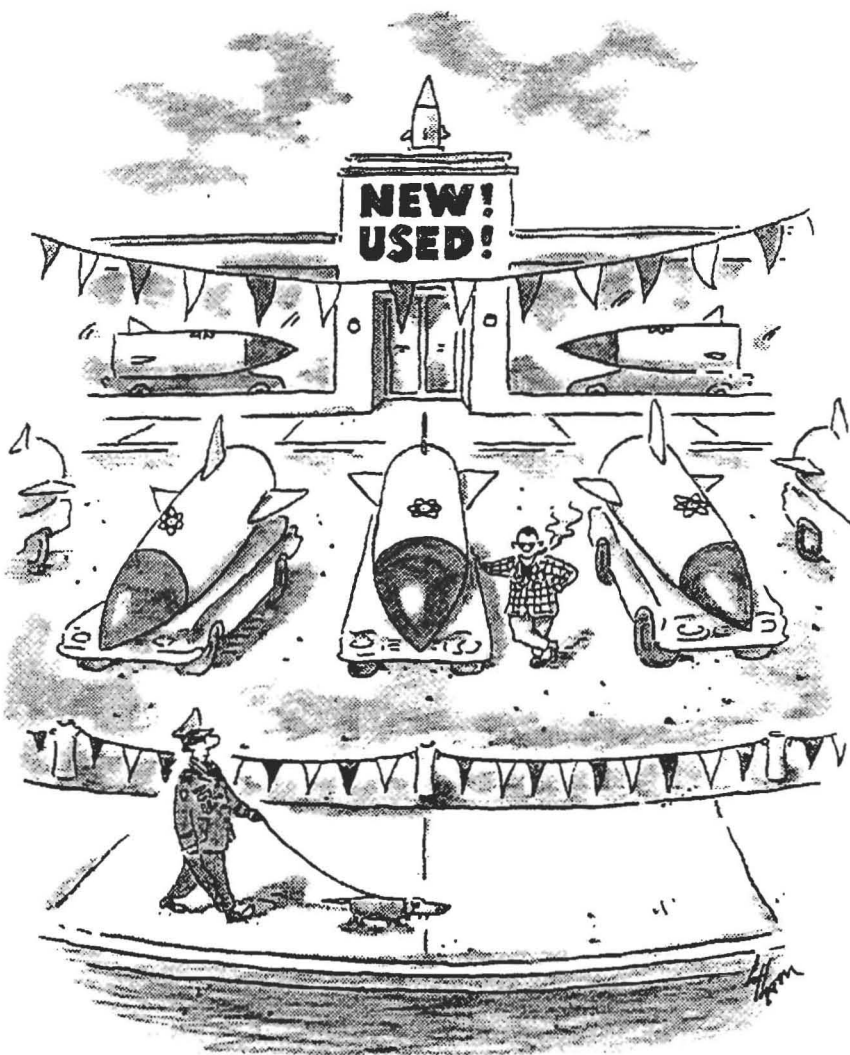
That old designing fever

By Greg Mello

**Building new nukes
was always
part of the plan at the
weapons labs.**

TEN YEARS AFTER THE END OF THE Cold War, the U.S. nuclear weapons labs are having no trouble staying busy. Inflation-corrected budgets are much higher than Cold War averages, and a variety of weapons projects—some for upgraded components, some for modified or entirely new weapons—have hummed along in the 1990s. One high-priority project that went all the way to deployment in 1996, for instance, was the modification of an existing bomb to create the B61-11 variable-yield

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earth penetrator—what the Pentagon calls “a better weapon.”¹

The labs and bomb bureaucrats are at it again—this time devising upgrade options for the navy’s arsenal of submarine-launched ballistic missile warheads (SLBMs). Three complementary programs are under development in the benign-sounding “Submarine Warhead Protection Program” or SWPP.

The first—the “default option”—is an upgrade of the arming, firing, and fuzing components of the most numerous warhead in the U.S. arsenal, the 100-kiloton W76. This upgrade would give these 3,200 air-burst warheads a near-ground-burst capability, making them extremely lethal against hardened targets. Unless another upgrade is chosen or the program delayed, the new fuze is slated to begin entering the stockpile in late fiscal 2004.²

Beyond the arming, firing, and fuzing (AF&F) project, the Energy Department is attempting to provide the navy with two certifiable new warhead options to augment its stock of high-yield W88s. One would involve a “mature design,” which could go into production by fiscal 2004.³ It would use a recycled—and thus “pretested”—plutonium pit and possibly a recycled thermonuclear secondary.

The other would utilize an entirely untested design, which is supposed to be certifiable soon enough to achieve a “first production” date of fiscal 2007.⁴ According to the Energy Department, both are “new” nuclear designs—that is, designs that have not been deployed before, either in this specific configuration (the first option) or ever (the second).

Certification of either would require a combination of past nuclear test data, underground subcritical tests, above-ground hydrodynamic and subcritical tests, computer simulations, and flight tests.

At least one of these two designs—or possibly yet another warhead—is slated to eventually replace what the navy called in 1995 the “exiting” W76 and W88 warheads.⁵

But these new warhead options are

not the Energy Department’s only plans to change the nuclear explosives in the stockpile. Under Energy’s current policy, eventually *all* the nuclear weapons in the stockpile are to be replaced with either modified versions or with entirely new weapons.⁶

Whether new or heavily modified “physics packages” can be fully certi-

get counterforce weapons.

This conversion would occur in the face of steep declines that are expected in the numbers of Russian strategic nuclear weapons, a process that is occurring independently of START II ratification.⁷

In turn, deploying significant numbers of additional hard-target weapons

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fied for the long run without nuclear explosive tests is a matter of internal debate at the labs. But one thing is clear: if the Energy Department is allowed to introduce changes and new nuclear designs into the stockpile, the objective link between stockpile reliability and the nuclear testing record will be greatly weakened, making stockpile “confidence” more and more the subjective technical and institutional property of the nuclear laboratories themselves.

During the Cold War, such a monopoly was a principal source of the laboratories’ political power. It has always translated directly into funding and could, in the present deteriorating arms control climate, result in a resumption of nuclear testing—either through a change in U.S. policy or as a response to one or more foreign nuclear tests.

Euphemisms

Even if just the “baseline” project—the new ground-burst fuze—is deployed on W76 weapons, there will be several adverse effects. First, arms control diplomacy will have to take into account the fact that the United States is converting 3,200 air-burst weapons into highly accurate, hard-tar-

would increase the “launch on warning” incentive for Russian commanders, decreasing crisis stability and increasing the dangers from any problems that might arise in Russian nuclear command-and-control systems.

Further, all three upgrade programs fly in the face of the binding obligation to successfully negotiate nuclear disarmament and the “cessation of the nuclear arms race” found in Article VI of the Nuclear Non-Proliferation Treaty. They also contradict the explicit purpose of the Comprehensive Test Ban Treaty, which was recently rejected by the U.S. Senate. According to the treaty’s preamble, its purpose is to promote nuclear disarmament.

Finally, the upgrade projects set the stage for abandoning the Pentagon’s official “no new nuclear weapons production” pledge that was part of the 1994 Nuclear Policy Review, a policy that was proposed by the Pentagon and signed by the president.

Internal documents show that Energy Department managers have been sensitive to the hypocrisy in this program, and they have sought to hide it under euphemisms such as “surety.” Energy Department honchos have even suggested that, given the political environment, “the use of the word ‘warhead’ may not be acceptable.”

In the Bush administration, a warhead was a warhead. Is the Clinton-era Energy Department working on new weapons? That depends on what your definition of "new" is.

Ten cents on the dollar

The navy deploys two kinds of warheads on its 18 Ohio-class submarines: the 100-kiloton W76, carried within the Mk4 reentry body, and the 475-kiloton W88 warhead, carried within the larger Mk5. In comparison, the bomb that destroyed Hiroshima was about 15 kilotons.

The eight Pacific-based submarines are equipped with the older Trident I C4 missiles, which carry only the W76/Mk4. Both types of warheads can be deployed on the newer Trident II D5 missiles, although warhead types are not mixed on a single missile. As currently configured, both types of missiles carry eight reentry bodies on a "bus" that releases the individually targeted warheads.

Each Trident submarine carries 24 missiles. If all the missiles were fully loaded, there would be 192 warheads per submarine. Currently, 384 W88/Mk5 and 3,072 W76/Mk4 warheads are deployed.⁹ The D5 missile has a longer range than the C4, a heavier throw-weight and, above all, greater accuracy. To take advantage of the D5's accuracy, the high-yield W88/Mk5 warhead was given a radar fuze that enables it to explode, if desired, very close to the ground, at most a few meters above.⁹ The resulting cratering and shock makes the W88, according to Rear Adm. George P. Nanos, director of the navy's Strategic Systems Programs, a "hard target killer." The W76 is not yet such a weapon.¹⁰

If the hard targets are missile silos or launch centers, the sooner the U.S. warheads are launched, the more likely they are to arrive before the target missiles have been launched. The target country knows this. At a time of great tension and high strategic alert, the target country could conceivably

elect to launch sooner and more massively rather than later or not at all. The more "hard-target killers" there are in the U.S. stockpile, the more threatening its strategic posture will appear.

Toward the end of the Bush administration, the navy prepared to downsize its fleet to 10 Trident II subs.¹¹ President Clinton's 1994 Nuclear Posture Review reversed ground, choosing to retain a total of 14. Conversion of four of the older subs to carry the larger D5 missiles will take place between 2000 and 2005.¹²

But without an upgrade to the warheads themselves, only about 11 percent of the Navy's warheads would "be all they can be"—namely, "hard target killers." Again, Admiral Nanos:

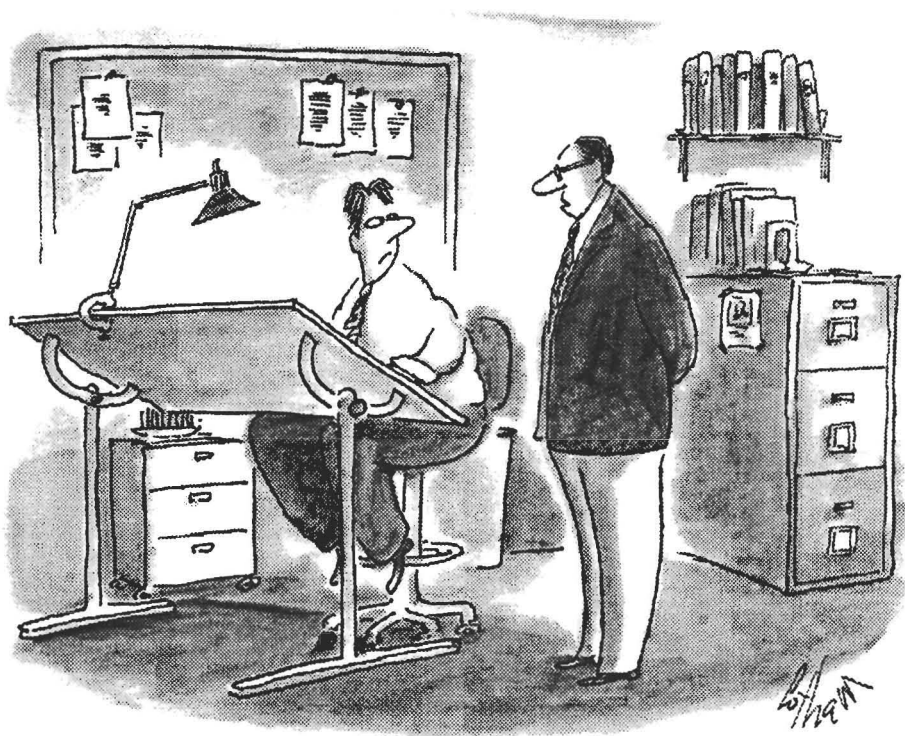
"Our capability for [the] Mk4, however, is not very impressive by today's standards, largely because the Mk4 was never given a fuze that made it capable of placing the burst at the right height to hold other than urban industrial targets at risk.

"With the accuracy of D5 and Mk4, just by changing the fuze in the Mk4 reentry body, you get a significant improvement. The Mk4, with a modified fuze and Trident II accuracy, can meet the original D5 hard-target requirement.

"Why is this important? Because in the START II regime, of course, the ICBM hard-target killers are going out of the inventory and that cuts back our ability to hold hard targets at risk. The air force has some plans for how to upgrade their ICBM force to restore that capability. We can do that with the Mk4 reentry body for 10 cents on the dollar in terms of investment because of the accuracy of our system, and we have made this option available to the strategic CINC [commander in chief]."¹³

New product lines

The admiral's hopes are being realized at Sandia National Laboratory. According to the March 1999 version of Energy's stockpile stewardship master



"Just cross out the word 'warhead.'"

plan, the new modular fuzing system will allow the “incorporation of Mk5 fuzing functionality (including radar-updated path length fuzing, and radar-proximity fuzing) as an option for a replacement of the much smaller Mk4 AF&F.”¹⁴

The plan claims that the current arming, firing, and fuzing system of the W76/Mk4 is approaching the end of its design life, and that the occurrence of age-related defects is “unpredictable.” But the fuze modification will enable the W76 to “take advantage of the higher accuracy of D5 missile.”

The new arming, firing, and fuzing system is on a fast track. Production is expected to begin as early as 2003, in plenty of time for installation during refurbishment of the W76, now scheduled to begin in fiscal 2005.¹⁵ Further, the new arming, firing, and fuzing system is to be modular and compatible with W88 warheads as well as with new warheads now under development for the navy.¹⁶

Another upgrade project is the “near-term” design and preliminary certification of a new warhead for the Mk5 reentry body that would use recycled plutonium pits and an existing thermonuclear secondary design, possibly one already “in stock.”

This warhead is to be designed so that it could be assembled “rapidly” in large numbers without new pit production.¹⁷ The warhead would be “derivative” of the one that was explosively tested in Nevada as a pit-reuse option for use in the W89 Short-Range Attack Missile II.¹⁸ Energy characterizes this effort as a:

“Relatively mature design that utilizes available retired pits in a *new* insensitive high explosive primary with fire resistant features included.”¹⁹ (Emphasis added.)

Meanwhile, design of the thermonuclear secondary for the weapon is not regarded as a significant issue: “There are adequate data in the nuclear test history of the secondary to establish its nuclear performance.”²⁰

Livermore is taking the lead on this recycling project. According to the En-

ergy/Defense interagency stewardship plan, the March 1999 “Green Book,” its peer-reviewed final design “decision package,” is supposed to be delivered early in fiscal 2001, along with the flight-tested arming, firing, and fuzing system being developed at Sandia. At that point, the pit-reuse option will either be shelved or enter full-scale engineering development, with a view toward full-scale production in early fiscal 2004.²¹

Livermore managers seem enthusiastic about the economic potential of this warhead for their laboratory: “For the last two decades,” writes James

scale engineering development decision at the end of fiscal 2003, with production to begin in fiscal 2007, if desired.

“Damn the test ban; full speed ahead”

The arming, firing, and fuzing project at Sandia—together with Livermore’s pit reuse warhead and Los Alamos’s “high margin” warhead—are collectively known within the Energy Department as the “Submarine Warhead Protection Program” (SWPP).

The Livermore and Los Alamos por-

“I believe that the SLBM system and the strategic navy will be as solid a market as there is in the nuclear weapons field, and I believe we should pursue that line.”

Tyler, the original SWPP manager at Livermore, “LLNL has largely been shut out of the SLBM warhead arena, which we invented and once dominated. . . . In any future scenario of nuclear deterrence for the United States, we can expect the SLBM systems to play a central role, and I believe that it is essential for LLNL to take this opportunity to once again be a major player. . . .”

“I believe we should view this as a major corporate marketing decision. What product lines will we pursue? I believe that the SLBM system and the strategic navy will be as solid a market as there is in the nuclear weapons field, and I believe we should pursue that line.”²²

The second—and competitive—warhead project is based at Los Alamos. It is described by the Energy Department and the labs as a “new design that will not have UCTs [underground tests] for certification,” using a “conservative/high margin design” for the Mk5 reentry body.²³ The Energy Department expects to reach a full-

tions of the Submarine Warhead Protection Program are at odds with recommendations by the JASONS, the Energy Department’s most senior scientific advisers. In November 1994, 17 JASONS strongly counseled the Energy Department to avoid designing or building new nuclear explosives in a test ban regime:

“The primary—if not the sole—nuclear weapons manufacturing capacity that must be provided for in an era of no nuclear testing is the remanufacture of copies of existing (tested) stockpile weapons. The ultimate goal should be to retain the capability of remanufacturing SNM [special nuclear material] components that are as identical as possible to those of the original manufacturing process and not to ‘improve’ those components. This is especially important for pits.”²⁴

The following August (1995), 14 JASONS, including some of the most senior nuclear weapons designers from the Los Alamos, Lawrence Livermore, and Sandia laboratories, made a de-

tailed technical review of the design and performance of all the nuclear weapons in the U.S. arsenal, with an eye to maintaining these weapons under a zero-yield test ban. Their "Conclusion 3" repeats the previous year's warning even more strongly:

"The individual weapon types in the enduring stockpile have a range of performance margins, all of which we judge to be adequate at this time. In each case we have identified opportunities for further enhancing their performance margins by means that are straightforward and can be incorporated with deliberate speed during scheduled maintenance or remanufacturing activities. However greatest care in the form of self-discipline will be required to avoid system modifications, even if aimed at 'improvements,' which may compromise reliability."²⁵

It seems, however, that the Energy and Defense Departments, as well as the labs, had long planned another approach to stockpile stewardship. In February 1995—in the interval between the two JASON reports—the draft "Green Book" noted that two new weapon "Phase 2" feasibility studies had been completed. One was for the air force. The other was for the navy; it became the Submarine Warhead Protection Program later that year.²⁶

During the week of May 29, 1995, laboratory weaponeers briefed the military at a secret "Stockpile Confidence Symposium" in Omaha. The topics included new "warhead candidates." It was precisely these candidate warheads that became the basis of the Submarine Warhead Protection Program.²⁷

At the first Submarine Warhead Protection Program meeting in June 1995, laboratory representatives apparently described the "yield certification process," "expanded test and analysis techniques to eliminate need for UGTs [underground nuclear tests]," the candidate warheads themselves, and the schedule and process to bring the warhead candidates to the "decision point."²⁸

The Submarine Warhead Protection Program, even from this early date,

was not merely a "concept development" study ("Phase 1," in Energy's system) or a "feasibility and cost study" ("Phase 2"). That early work had taken place between 1990, when Livermore first proposed a pit reuse option for the Mk5 reentry body, and 1994, when a Phase 2 study was peer reviewed by the three labs.²⁹

In fact, the Submarine Warhead Protection Program is designed to produce prototype, flight-tested, nuclear-certified hardware. By November 15, 1995, the Submarine Warhead Protection Program plans and schedules had been approved by the Nuclear Weapons Council Standing and Safety Committee.³⁰ As Energy Department minutes of a subsequent senior-level Submarine Warhead Protection Program meeting make clear, certification was a primary goal:

"All parties view this program as a forcing function for the DOE to define certification for a new weapon and apply it to the products of the SWPP as a trial run."³¹

The labs' Submarine Warhead Protection Program work is not only to be directed toward practical, certifiable weapons, but from the beginning it was integrated with military targeting considerations—specifically near-ground-burst capability. At the first project meeting, Strategic Command's homework, due at the next meeting, was to "Determine user sensitivity to Mk4 and Mk5 yield and accuracy with overall mission effectiveness," and to "Compare systems effectiveness of

prox [proximity fuzing] and RUPL [radar-updated path length fuzing] options for Mk4 application."

Further, the December 1995 "Draft Memorandum of Understanding" between the navy and the Energy Department's Defense Programs (DP) is clear about the role of the program in defining a certification methodology for future weapons:

"The DP will be responsible for . . . providing a warhead certification methodology which does not rely on future Underground Nuclear Testing (UGT) and is consistent with the forecasted capabilities for both above and underground non-nuclear testing and computational techniques of Science Based Stockpile Stewardship (SBSS)."³²

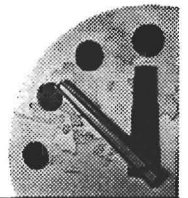
The reason such a certification methodology is so sorely "needed" is that the Energy Department believes that it would be modifying nuclear explosive packages in stockpile weapons indefinitely, as well as adding entirely new weapons to the stockpile.

For example, at the first Submarine Warhead Protection Program inter-agency executive meeting (which included representatives from the Nuclear Weapons Council, the Energy Department, the labs, the Office of the Secretary of Defense, and the uniformed military), Energy presented a briefing slide titled "Notional Stockpile Support Strategy."

The slide shows near-term primary modifications for all types of B61 gravity bombs as well as for the W80 cruise missile warhead. According to this

in the next **Bulletin**

- **Incoherence at the Energy Department**
- **Why National Missile Defense still won't work**



plan, every weapon in the stockpile would have a “renewed” nuclear explosive package in the out years, after a “new infrastructure” was built. The stockpile shown on the slide included a future “B93” bomb and a “W94,” the latter described as a “potential new warhead.”³³ This policy was the same two years later. Energy’s authoritative October 1997 stewardship plan states:

“The requirement to maintain the capability to design and engineer new weapon systems to military requirements [was] stated in the DOD Nuclear Posture Review (NPR). Nuclear weapons in the enduring stockpile will eventually be replaced. (New system

But doubts are beginning to arise about the “high margin” warhead Los Alamos is working on. The Energy Department said in April 1998, “The replacement warhead for the Mk5 may not be certifiable without nuclear testing.”³⁵

Run silent, run deep

The military, the labs, and the Energy Department have not been comfortable discussing these projects. In an April 1996 breakfast meeting with reporters, Harold Smith, chair of the Nuclear Weapons Council Standing and Safety Committee, denied all

ture existing designs. ‘Those are all well-tested designs,’ said Smith of the warheads already fielded. ‘We have the blueprints. We will simply go back, and if necessary remanufacture them from scratch.’³⁶

This interview has often been cited to quell fears that the Energy Department could or would develop new weapons under a test ban. But Smith’s remarks are unfortunately contradicted by the documentary record, some of it bearing his signature.

At a June 6, 1996 Energy Department meeting, damage control was in full swing:

“Karen Lombardo DOE HQ (DP-17) explained for the benefit of the Labs and AL [Albuquerque] the political climate that is evolving in Washington concerning the development of new nuclear weapons. Questions of whether WPP [Warhead Protection Program] constituted a new weapon have been raised. . . . Therefore, it is paramount that the program develops and maintains a direction that emphasizes Stockpile Stewardship and de-emphasizes new warhead development.

“In addition HQ [headquarters] was concerned about the name of the program and the name of ‘High Margin Warhead’ and suggested that we consider changing them. The group raised some concerns over changing the name of the program. LANL stated that they had already considered a name change to ‘Replacement Warhead.’ It was suggested that the use of the word ‘warhead’ may not be acceptable. Because of the confusion over wording, Karen Lombardo had been asked at the Program Review to develop a Program Definition Glossary.”³⁷

With or without the “glossary,” it proved impossible to entirely expurgate the word “warhead” from a program to develop new warheads. A second-best option—couching the program in vague and reassuring language—was chosen. In a May 1997 status report, the current activities in the replacement warhead project included “Warhead Surety Theme being developed.”³⁸

“It is paramount that the program develops and maintains a direction that emphasizes Stockpile Stewardship and de-emphasizes new warhead development.”

development may be needed even to maintain today’s military characteristics). This work is anticipated to begin around 2010.

“In the meantime, future national policies are supported for deterrence by retaining the ability to develop new nuclear options for emergent threats. . . . Miniature, modular building blocks for nuclear weapon systems are being developed . . . proof-of-principle flight tests will demonstrate alternative concepts to address new threats and will provide the technology for new approaches to deterrence, should the nation ever need them, as well as attract and train new nuclear weapon system engineers.”³⁴

Energy’s 1998 and 1999 stewardship plans—the most recent, publicly available redacted “Green Books”—do not mention any doubts about the ability to certify the Submarine Warhead Protection Program pit-reuse option, which it describes as a “mature” design.

knowledge of the Submarine Warhead Protection Program—even though he was the one who formally requested that the Energy Department, along with the Defense Department, flesh out an “alternative warheads” program for the navy in May 1995. Smith’s denial, as reported by Elaine Grossman in *Inside the Pentagon*, was complete:

“There are no new nuclear designs for the SLBM force. None. There are no new warheads. There cannot be,’ said Smith, whose official title is assistant to the secretary of defense for nuclear and chemical and biological defense programs. ‘Because if you cannot test, you cannot develop new warheads. That is almost the eleventh commandment as given to Moses on Mount Sinai,’ Smith said. [Emphasis added.]

“When pressed on whether new designs were being sought, even if they would be shelved for possible emergency production in the future, Smith suggested the navy could remanufac-

A few questions

The Submarine Warhead Protection Program is much more than an effort to maintain weapons. It is designed to increase the military capability of the U.S. arsenal as it downsizes—while pioneering the design and certification of new weapons without nuclear testing.

Despite its potentially adverse effects on crisis stability, stockpile reliability, and arms control and disarmament efforts, there has been no public or congressional debate over upgrading warheads or the gratuitous modification and novel design of nuclear explosives. Rather, there have been denials that such efforts are occurring or *could* occur—even though the public record is replete with references to these developments. A public debate might start with a few basic questions:

■ Is it a good idea to threaten Russia with even more hard-target weapons?

■ Is the Stockpile Stewardship Program, as currently structured, compatible with *any* comprehensive test ban treaty? If untested weapons are allowed to enter the stockpile, who but the labs—whose funding rides on the answer—can credibly say whether those untested designs actually work, now and in the years to come?

■ Looking beyond the Submarine Warhead Protection Program, will continuous weapons development build pressure for the eventual deployment of new weapons?

■ Continuing nuclear weapons programs, including the Submarine Warhead Protection Program and the earlier B61-11 modifications, raise still more fundamental questions: Will the United States comply with its Nuclear Non-Proliferation Treaty commitment to successfully negotiate nuclear disarmament? Or will it pursue a goal of continued—and increasing—military utility for nuclear weapons?

Neither the Clinton administration nor the Congress has yet asked these questions, much less provided answers. Nor has the Energy Department been provided with policy guid-

ance on the question of new weapons and weapons with new military utility.

In the absence of such guidance, the labs and their Energy Department overseers have been making up policy as they go. In the case of bureaucracies whose fundamental purpose has been

to devise new weapons, whatever is not forbidden may well be considered mandatory.

Progress in nuclear arms control, let alone nuclear disarmament, will require disarming the institutions that defend and promote nuclear weapons. ■

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2. Ronald Hartwig, "Overview of Sandia's SWPP Project & Initiatives Aimed at Reducing Defects," briefing slides, Sandia National Laboratory (SNL), January 14, 1997.

3. U.S. Department of Energy (DOE), *Stockpile Stewardship and Management Plan: Second Annual Update*, April 1998, pp. 5-9, 5-16.

4. *Ibid.*, p. 5-16.

5. Adm. George P. Nanos, "SLBM Warhead Protection Program," memo to Harold Smith, NWC-SSC, April 14, 1995.

6. DOE, *Stockpile Stewardship and Management Plan: First Annual Update*, October 1997, p. 7-34.

7. Alexei Arbatov, "Deep Cuts and De-alerting: A Russian Perspective," in *The Nuclear Turning Point: A Blueprint for Deep Cuts and De-alerting of Nuclear Weapons*, Harold Feiveson, ed. (Washington D.C.: Brookings, 1999), 305–24.

8. Robert S. Norris and William M. Arkin, "U.S. Strategic Nuclear Forces. End of 1998," *Bulletin*, January/February 1999, pp. 78–80.

9. Sandia National Laboratory, "Product Realization Initiatives: SLBM Warhead Protection Program," briefing slide titled "Radar ringdown design optimization is more efficient," January 14, 1996.

10. Adm. George P. Nanos, "Strategic Systems Update," *Submarine Review*, April 1997, pp. 12–17. This important article was provided by Joshua Handler of Princeton University and Bruce Hall, then of Greenpeace.

11. Walter Pincus, "Questions Raised on Trident Subs?" *Washington Post*, January 3, 1999, p. A22.

12. Robert Aldridge, "Trident Updates Useless: Arguments Against D-5 Backfit and SSCN Conversion," Pacific Life Research Center, PLRC-990610A.

13. Nanos, "Strategic Systems Update."

14. DOE, *Stockpile Stewardship and Management Plan: Third Annual Update*, March 1999, p. 5-14.

15. DOE, "Stockpile Stewardship/Future Stockpile Activities," *FY2000 Congressional Budget Request*.

16. *Ibid.*, pp. 4–12.

17. Lawrence Livermore National Laboratory (LLNL), "SLBM Warhead Protection Program Pit Reuse Project Proposed Tier-0 Project Overview," draft, September 15, 1995. The first part of this document repeats concisely the program requirements given to LLNL: "The technical objective of the project will be a Data Package. It will be a collection of information that defines the SLBM WPP pit reuse warhead design option and its integration into the Mk5 RB and that provides the rationale,

from both experiments and calculations, that this design option would meet requirements and could be fabricated rapidly and entered into the stockpile with high confidence. It will include a summary of the certification study and a Product Realization Plan." These deliverables did not significantly change over the next few years.

18. DOE, *Second Annual Update*, p. 6-39.

19. *Ibid.*, p. 5-9.

20. *Ibid.*, p. 6-40.

21. *Ibid.*, p. 5-16.

22. James Tyler, "The SLBM Warhead Protection Program Has Been Authorized," memo, LLNL, November 20, 1995.

23. SNL, "Replacement Warhead Summary and Status Charts for SWPP Program Review Meeting," May 1997.

24. JASON, "Science Based Stockpile Stewardship," Mitre Corporation, November 1994, p. 81.

25. JASON, "Nuclear Testing," Mitre Corporation, August 4, 1995.

26. DOE DP Interagency Working Group, *Stockpile Stewardship Program Plan for Fiscal Years 1995 through 1997*, draft, February 27, 1995, p. 27.

27. Cliff DeJong of Kaman Sciences, memo, re "SLBM Warhead Protection Program," June 15, 1995.

28. *Ibid.*

29. LANL X-6, "Inrad Implications for Mk5 Reuse Proposals," WTU-91-49 (CRD), January 31, 1991; LANL Nuclear Weapons Technology Program Office, "SLBM Designs Reviewed," *Weapons Insider*, May 1994; also see Tyler, "SLBM Warhead Protection Program."

30. LANL Nuclear Weapons Technology Program Office, *Weapons Insider*, January/February 1996.

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32. DOE and United States Navy, "Draft Memorandum of Understanding between Department of Navy, Strategic Systems Programs, and Department of Energy (Defense Programs) for the SLBM Warhead Protection Program," December 19, 1995. The final memorandum of understanding was not provided with the Freedom of Information Act documents.

33. DeJong, "SLBM Warhead."

34. DOE, "First Annual Update," p. 7-34.

35. DOE, "Second Annual Update," p. 6-42.

36. Elaine Grossman, "Navy, Energy Department Seek Back-Up Warhead Design for Trident Missiles," *Inside the Pentagon*, May 9, 1996, p. 1.

37. Glenn Bell, DOE DP-17, "Meeting minutes, DOE Team Meeting for the SLBM WPP, Germantown, June 6, 1996."

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