

LETTERS

US Can Begin Cutting Its Tritium Needs and Nuclear Arsenal without STARTing

On 22 December 1998, as reported in your February 1999 story entitled "DOE Decides TVA Is Cheapest, Most Flexible Option to Produce Tritium for Nuclear Weapons" (page 54), Secretary of Energy Bill Richardson selected the Tennessee Valley Authority's Watts Bar and Sequoyah nuclear reactors as preferred tritium production facilities for US nuclear weapons. While we commend Richardson for choosing the least expensive method, the US could reap even greater cost savings by reducing its nuclear arsenal in parallel with Russia's retirement of obsolete and decrepit systems in its nuclear arsenal.

The US has not produced tritium since 1988, when it shut down the Savannah River Site's tritium production reactors for safety reasons. Given that tritium decays with a half-life of about 12 years, the US will have about half as much tritium in 2000 as it did in 1988, one-quarter as much in 2012, one-eighth as much in 2024, and so on. Since 1988, dismantled nuclear weapons have supplied tritium for weapons being kept in the US arsenal. Although the Department of Energy (DOE) has classified the amount of tritium available for US weapons, one can still estimate the effects of additional arms reductions on the need for new tritium.

The current START I arsenal contains about 8400 strategic and tactical warheads in an operational stockpile and about 2300 warheads in a reserve stockpile.¹ Although it is known that the operational warheads are all filled with tritium, it is not known—in the open literature—how many reserve warheads actually have tritium allocated to them.

We estimate the number of tritium-allotted warheads by beginning with the year 2016, when, according to DOE, the stockpiled tritium will dip below the requirements of the currently planned START II and tactical

arsenals. Those arsenals are scheduled to consist of 3500 deployed strategic, 1000 tactical, 500 spare, and 2500 upload "hedge" warheads, for a grand total of 7500 warheads.² Using the radioactive decay equation and working backward to 2010, when, according to DOE, insufficient tritium will be available for the START I and tactical arsenals, we find that the current tritium requirements are to support about 10 500 warheads.

The current obstacle to agreed-upon reductions to START II levels is the Russian Duma's reluctance to ratify that treaty, which was signed in 1993. The US government insists that the Duma must ratify START II before negotiations on deeper cuts can be launched. Regardless of ratification, however, most knowledgeable Russian analysts project that Russia's rapidly decaying strategic arsenal will drop below START II levels within a few years of the treaty's final implementation deadline at the end of 2007 and fall much further.

Nonetheless, for two reasons the Pentagon insists on an upload "hedge" consisting of thousands of extra warheads filled with tritium. First, the US can redeploy these warheads if it feels that its "supreme national interests" require it to reverse the reductions process. Second, the US can use the upload "hedge" as a bargaining chip to compel Russia to negotiate reductions in its tactical arsenal during START III negotiations. It seems likely, however, that most of Russia's tactical warheads will also have to be scrapped within a decade. In all probability, Russia will be able to replace only a few hundred of those warheads.

We also question DOE's requirement to maintain a five-year reserve supply of tritium, which will force DOE to begin producing tritium in 2005 and 2011 for the START I and II arsenals, respectively. The five-year reserve is an anachronism resulting from the time needed to restart the Savannah River Site's reactors. This lead time could be significantly shortened with DOE's new policy, which calls for using already operating power reactors as a tritium source.

Adhering to START II's agreed-upon number of 3500 deployed strategic warheads, the US could keep a total of 4500 warheads filled with

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tritium, including 1000 tactical warheads. DOE could delay tritium production until 2025.

Under START III, the total US arsenal could fall below 3500 warheads, thus delaying tritium production until 2029.

We believe that under longer-term reduction agreements, involving Russia, China, France, and the UK, the US arsenal could shrink to only about 200 warheads—still more than enough explosive power to destroy any nation. Such a drastic reduction could make possible a delay in the resumption of tritium production until 2080.

The fiscal 1999 Defense Authorization Act bars the US government from spending any money on tritium production. This one-year hiatus provides policymakers and other concerned parties with a period for serious study of tritium requirements under different scenarios, including START I, II, and III, as well as reciprocal unilateral arms reductions.

However, aside from reducing the five-year reserve, DOE cannot implement any new production plans unless the administration and Congress break their stalemate. Specifically, although the Pentagon is interested in cost-saving reductions of US strategic forces even if START II remains stalled, Congress has enacted a law mandating that US nuclear forces will remain at START I levels as long as START II remains unratified. The president cannot enforce any Pentagon-proposed reductions without Congress acting first.

References

1. W. M. Arkin, R. S. Norris, J. Handler, *Taking Stock: Worldwide Nuclear Deployments 1998*, Natural Resources Defense Council, Washington, DC (1998), p. 1.
2. Arkin, Norris, Handler, p. 11.

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V. Bush as Computer Visionary: Was Role Key or Only Memex?

Jessica Wang's review of G. Pascal Zachary's *Endless Frontier: Vannevar Bush, Engineer of the American Century* in your December 1998 issue (page 49) provides an excellent summary of Zachary's book but greatly underestimates Bush's contributions to computer and computational R&D.

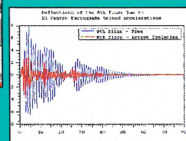
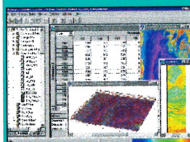
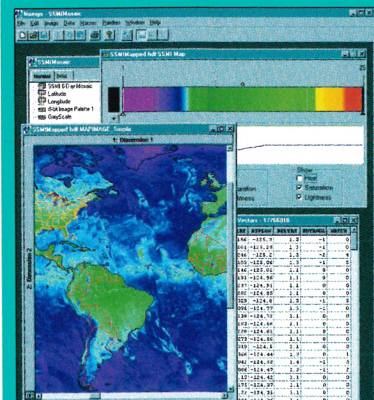
The reviewer concludes that, in the years after World War II, Bush "held steadfast to his beloved analog machines" and "proved incapable of embracing the digital age."

Although he did not return to the computer R&D he had directed at MIT before the war, Bush had a remarkably broad vision of the possibilities of personal, computer-like machines. In his 1945 *Atlantic Monthly* article, "As We May Think," Bush anticipated information-storage and retrieval technologies and ways of establishing personal and collaborative associative memory paths through vast realms of data.¹ In a book published two decades later,² he assessed what technological progress had been made toward realizing his earlier vision. In chapter 5, entitled "Memex Revisited" ("memex" is what he called the computing machine he had conceptualized), he noted the advent and potential of digital computers, and foresaw how high-speed electric circuits, data compression, and other technologies would continue to lead us toward the era of personal information-storage and retrieval machines. He also saw the distance that then lay ahead in achieving an era of low-cost personal computing. In 1945, and again in 1967, Bush did not have all the specific technologies rightly imagined, but he did correctly speculate that personal machines would become available and their costs would drop.

Bush noted that it was not only the scientist and engineer who would benefit from these advances. In 1967, he discussed others: "The lawyer will have at his touch the associated opinions and decisions of his whole experience, and the associated opinions and decisions of his friends and authorities. The patent attorney will call on the millions of issued patents, with familiar trails to every point of his client's interest. The physician, puzzled by a patient's reactions, will study the trail established in studying an earlier similar case, running rapidly through analogous case histories. . . . The historian, . . . with his vast chronological account of a people, can parallel this with a skip-trail which stops only on the salient items."³

Moreover, Bush also envisioned what would become the Internet and the World Wide Web. As he wrote in 1967, "There will be a new profession of trailblazers, those who find delight in the task of establishing useful trails through the enormous mass of the common record. . . . [E]ach generation will receive from its predecessor, not a conglomerate mass of discrete facts and theories, but an interconnected web of all that the race

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