A Need for New WARHEADS?

The U.S. government's proposal to build the first new nuclear warhead in two decades raises a host of questions

By David Biello

JARGON BUSTER

RRW1, W76
Reliable Replacement Warhead, proposed as a successor for W76 nuclear weapons at the end of their planned 30-year service life. The "1" presumes a series of such replacements that would match the capabilities of their precursors.

NNSA
National Nuclear Security Agency, a branch of the Department of Energy that oversees U.S. nuclear weapons. It has offered a variety of rationales for building RRW1s.

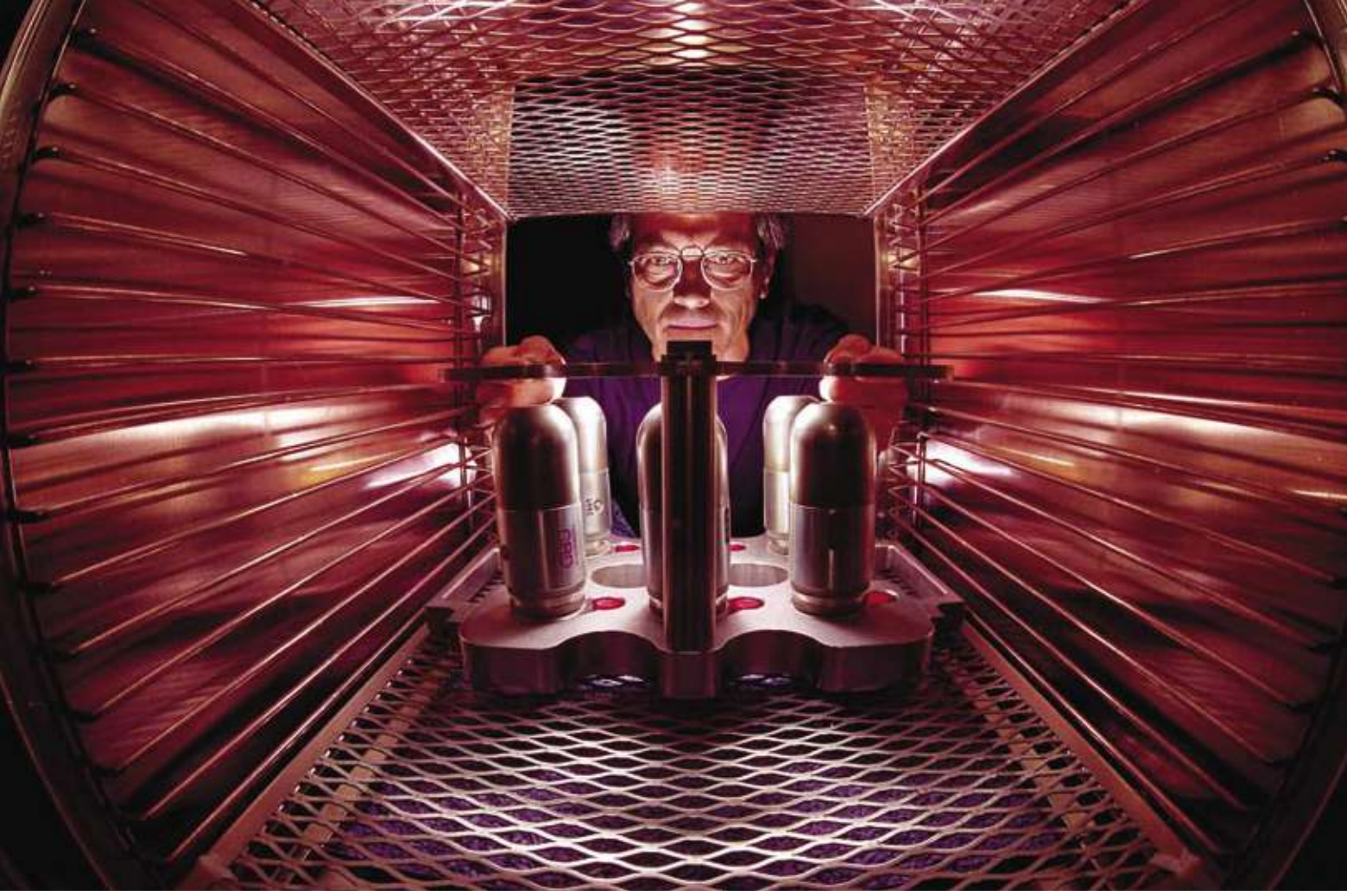
PRIMARY, SECONDARY
RRW1 would use a previously tested primary—a fissile nuclear pit that detonates first, to flood the secondary bomb with radiation to yield a thermonuclear explosion. Proponents say that using a tested primary ensures reliability without the need for confirmation by blowing up the entire warhead.

At this very moment, hundreds of U.S. nuclear warheads and bombs are poised to strike targets in Russia and elsewhere. Despite the demise of the Soviet Union in 1991—and thus the end of the cold war policy of mutually assured destruction—the U.S. maintains a stockpile of roughly 10,000 nuclear weapons. Russia, China, France, India, Israel, Pakistan and the U.K. are now all U.S. allies or, at worst, nonbelligerent competitors. All but Russia possess only limited nuclear arsenals. North Korea and Iran, whose relations with the U.S. are more strained, do not yet have the capability to inflict massive nuclear harm on this nation. Indeed, the most pressing nuclear hazard appears to be a "dirty bomb"—a conventional bomb packed with radioactive material—or a small nuclear explosive. A massive nuclear arsenal may provide little deterrent against the use of such weapons by terrorists or nonstate entities.

As part of its obligations under the Moscow Treaty on Strategic Offensive Reductions, the U.S. plans to reduce its total number of active nuclear weapons to between 1,700 and 2,200 warheads and bombs. At the same time, the U.S. Department of Energy and the Department of Defense, worried that aging warheads may not operate optimally after years of storage, want to replace some of them. First on the list is the W76, which makes up a third of the available warheads; the oldest W76s will reach the end of their 30-year life span in 2008. An individual W76 nuclear explosive generates 100 kilotons of force when detonated, equal to 100,000 tons of TNT; it is designed to obliterate "soft targets," such as ports, garrisons and factories.

Three years ago the DOE and DOD launched the Reliable Replacement Warhead (RRW) program. In March, Lawrence Livermore National Laboratory won the RRW program's initial competition to design the nation's first nuclear warhead in 20 years. As a replacement designed to match the explosive-yield capabilities of the W76, the weapon, called the RRW1, would not fulfill a new strategic role in a post–cold war world, and many observers question the need for it. The W76 is currently undergoing a life-extension program that will refurbish as many as 2,000 of the warheads, and concerns about the reliability of aging plutonium components in this warhead and others have proved unfounded [*see box on page 83*].

Yet the National Nuclear Security Adminis-



TECHNICIAN TESTS neutron pulse tubes at Sandia National Laboratories for the W76 nuclear warheads, as part of the life-extension program for the 30-year-old weapons.

tration (NNSA)—the branch of the DOE in charge of the nation's nuclear weapons—has offered a variety of other rationales, including reducing the risk of a return to nuclear testing and creating a weapon that cuts the use of toxic materials. Although funding of the RRW effort has not been approved, and parts of the program have already been cut or questioned by members of Congress, a cost estimate and production plan will be completed by the end of this year. As the stockpile continues to age, the questions facing the government remain: What is the purpose of the U.S. nuclear arsenal, what should it be composed of and how many weapons are necessary?

Same Old, Same Old?

One government defense of the new weapon is that it would not require testing; President Bill Clinton codified a 1992 moratorium on nuclear testing. NNSA officials emphasize that the RRW1 is based on a previously tested weapon, although it adds a host of new components. "It's new in the sense that we've never done this before, but it's not new in the traditional arms-control sense," says John Harvey, director of policy planning staff at the NNSA. "It will have the same form and function as the current weapon."

In fact, the Livermore design triumphed because it is based on a former design, one detonated during the more than 1,000 nuclear tests conducted before the U.S. moratorium. The weapon's key component—the plutonium pit—"was nuclear-tested four times," notes Bruce Goodwin, Livermore's associate director for defense and nuclear technologies. "It's the exquisite test pedigree of the baseline for this design that gives very high confidence that it will work as expected."

The new warhead would work much the same way as any other fusion bomb. The fissile nuclear pit, or primary, explodes and floods surrounding chemical compounds, known as the secondary, with radiation. This radiation triggers a fusion reaction between the tritium and deuterium isotopes of hydrogen produced by the irradiated compound. A thermonuclear explosion follows.

Only a few types of primaries have been tested. "It's the SKUA9 design," Goodwin says. The SKUA9 was one of a series of primaries that Livermore created during the most recent nuclear testing program in the 1980s, solely to examine the viability of options for secondaries; it

OHIO-CLASS ballistic missile submarines carry W76 nuclear warheads.

RANDY MONTOYA (*top*); CHRIS OTSEN *U.S. Navy/Zuma Press/Newscom* (*bottom*)

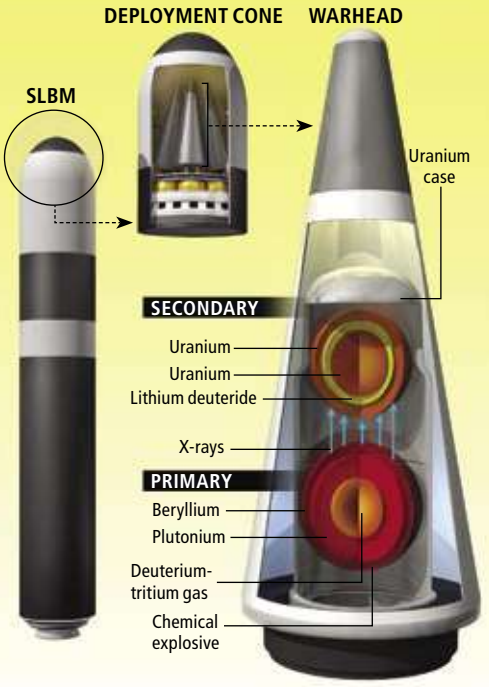
[HOW IT WORKS]

A ONE-TWO PUNCH

Modern nuclear warheads are fusion bombs—essentially fission bombs wrapped in specific elements that can undergo fusion when the conditions are right.

First, shaped explosives surrounding the primary, a fissile nuclear pit, detonate, compressing plutonium that is under neutron bombardment from a special trigger. The plutonium splits apart into smaller elements, releasing energy.

This energy, in the form of radiation, floods the secondary, a device containing elements primed to fuse. The radiation, helped along in some designs by another fission reaction it sets off, initiates fusion between tritium and deuterium isotopes of hydrogen in the lithium-deuteride fuel. This fusion feeds on itself, and a thermonuclear fireball follows.



was never produced in a weapon. As a result of this prior testing and computer modeling, the RRW1 would require no further detonations, according to the NNSA and Livermore.

The RRW1's design improvements will also provide increased confidence in the weapon's margin over the W76, says J. Stephen Rottler, vice president for weapons engineering and product realization at Sandia National Laboratories, which will be responsible for integrating the RRW1 into weapons systems such as missiles. ("Margin" describes a weapon's ability to avoid nuclear explosions of diminished yield; those with sufficient margin, for instance, should remain as powerful in late age as they are when they are first built.)

The new warhead will be bigger, thicker and heavier—and therefore less likely to fail, Rottler and Goodwin say. But critics note that margin could also be improved in existing weapons by changing the composition or mechanism of the so-called boost gas, gaseous tritium and deuterium around the pit that enhances its explosive potential. They also note that no nuclear weapon in the current U.S. arsenal has ever been manufactured without being detonated to confirm its operability. "Is there a military commander out there who will ever rely on something that has not been fully tested? So far that has not been the case," says Hans Kristensen, director of the nuclear information project at the Federation of American Scientists (FAS), which the creators of the original nuclear weapons founded in 1945.

Adds physicist Frank von Hippel of Princeton University: "You never know if you've made a mistake until you've tested the thing. The existing weapons have the merit of having been tested."

Building a Better Bomb

In addition to ensuring sufficient margin in the RRW1s, improvements by weapons designers are addressing another kind of reliability issue: that the bombs will not go off accidentally. The RRW1s will add new, heavier features, such as insensitive high explosives and advanced security technology. During the cold war, the military emphasized packing many warheads into one weapon to generate maximum explosive yield, while also minimizing its overall weight to enable maximum range. Today such considerations are no longer as crucial, designers say.

Another way to improve safety—that of handling these weapons in storage—is to add explosives, such as triaminotrinitrobenzene (TATB), that resist detonation from impact or heat except when properly triggered. "We have taken insensitive high explosives and slammed them into reinforced concrete blocks at Mach 4. They will not detonate," Livermore's Goodwin says. It is so secure, "you can put a gasoline fire out with it. If you put a blowtorch to it, you can get it to molder."

But clients in the armed forces have previously decided that such safety precautions are unnecessary. For example, the U.S. Navy declined to replace the conventional explosives in some of its Trident warheads in the early 1990s. "They decided it wasn't worth it," von Hippel says. "They were confident they could handle the warhead safely."

An additional safety upgrade in the RRW1, not available in the W76, is permissive action link (PAL), a computerized system that requires authorization to fire the weapon. "Under refurbishment, if we wanted to improve security interior to the warheads, we would have had to retrofit that into the warheads, which is difficult to do without nuclear testing," Harvey says.

Whether the armaments require costly additions such as PAL is an open question, however. Because the W76 is carried onboard submarines or stored in heavily secured stockpiles, it

NUCLEAR NUMBERS

15 kilotons

Equivalent to 15,000 tons of TNT. Amount of explosive force produced by the bomb dropped on Hiroshima, Japan, in 1945.

50 megatons

Record yield, equivalent to 50 million tons of TNT, produced by the Soviet Tsar Bomba in a 1961 test.

1 to 475 kilotons

Range of yields for active weapons in the U.S. arsenal. "Boosts" can increase yields.

DON FOLEY

has little need for such features, critics note. And the life-extension program for other nuclear weapons, such as the B61 gravity bomb, has added security measures, such as increased encryption, without having to start a new design from scratch, Kristensen argues. "Here was a weapon that was designed back in the 1960s and 1970s, and when it was first deployed it did not have safety features," he says. "They refit it all on the weapon itself without having to rebuild it. This suggests that you can achieve extraordinarily high levels of safety in current designs without going to a new design."

The U.S. also spent millions of dollars upgrading the security of nuclear weapon storage sites after the September 11 terrorist attacks, leaving open the question of who is capable of improperly triggering such weapons. "I don't know anyone who believes that the physical security of U.S. nuclear weapons is in doubt," says Ivan Oelrich, FAS's vice president for strategic security programs. A panel of experts convened to evaluate the RRW program—the Nuclear Weapons Complex Assessment Committee of the American Association for the Advancement of Science (AAAS)—agrees. In its April assessment report the committee found no reason to believe that features such as PAL would "substantially reduce the current reliance on guns, guards and gates."

The NNSA says the new features are necessary for the small amount of time such weapons spend being trucked from site to site, to eliminate the threat of hijacking. "It gives us an extra measure that we think is prudent, particularly in transportation scenarios," Harvey says.

COSTS

$6.5 billion
Fiscal year 2008 cost for stockpile stewardship
—NNSA FY08 Budget Request

$21 billion
Cost to replace the present weapons complex
—George Allen, Director, Office of Transformation, NNSA

$5.8 trillion
Estimated cost of U.S. nuclear weapons program
—Stephen Schwartz, The Brookings Institution

The "Green" Nuclear Warhead

The RRW1 also would eliminate the need for some of the toxic substances often used in weapons, such as beryllium, a brittle, carcinogenic metal that reflects the neutrons released in a nuclear explosion and redirects them back to start a thermonuclear chain reaction. "Because of the release of the weight requirement, we are able to use materials that are heavier but more environmentally benign," Goodwin says. "We will be able to eliminate an entire [manufacturing] process that produces 96 percent radiological toxic waste that has to be buried and replace it with nontoxic waste that is 100 percent recyclable."

"You replace [beryllium] with something that quite honestly you could eat and be healthy," he adds. "It is in prosthetic body implants. It's about as biologically benign as any material can be." Because the exact specifications remain classified, however, Goodwin cannot reveal what the substance is or its exact role in the new weapon. And any nuclear weapon would still rely on plutonium, which can kill in hours if handled improperly.

Building a new warhead would entail refitting the nation's nuclear weapons–producing factories, such as Amarillo, Tex.–based Pantex, Kansas City Plant in Missouri, and Y-12 in Oak Ridge, Tenn. All are "antiques," as Goodwin calls them, some dating from the 1940s. The Bush administration unveiled plans in April for a complex to build all the components of new nuclear warheads—dubbed Complex 2030 for the year set for its completion.

Even if the Complex 2030 plans were scaled back, upgrades to the current infrastructure would be needed to carry out the RRW program, according to the AAAS panel, including at least a doubling of the current assembling and disassembling work at the Pantex plant as well as a significant increase in the amount of plutonium pits produced at the Los Alamos TA-55 facility, which began producing new primaries for the first time in 18 years in July. "We do have pit production capability but it's one-

[RELIABILITY CONCERNS]

TRUST BUT VERIFY

Concerns about the reliability of aging weapons first prompted the U.S.'s Reliable Replacement Warhead program. Some argued that older plutonium cores would degrade and impede the thermonuclear explosion they were designed to create. But subcritical tests, computer models and other analyses allayed those fears, and a government-commissioned independent review by a panel of scientists known as Jason estimates that the plutonium pits in the current W76 warheads will last a minimum of a century. Jason has therefore recommended that no action be taken other than continuing routine maintenance in the current life-extension program, such as replacing surrounding circuitry and parts as needed.

Some scientists, most prominently Richard Morse, a former group leader of bomb design as well as laser fusion at Los Alamos National Laboratory, argue that the W76 design itself is flawed. The thin uranium shell that surrounds the core would fail to contain the initial explosion long enough to channel its energy into igniting fusion for the secondary hydrogen detonation.

But many scientists and officials refute this so-called Morse effect, pointing to several successful tests of the weapons package in the 1980s. The "W76 is fine. It's gone through its annual assessment," says Hank O'Brien, RRW program leader at Lawrence Livermore National Laboratory.

The life-extension program itself could inadvertently cause reliability issues, however. Replacing aging parts changes the weapon incrementally. "I couldn't provide the fuse that was done in the 1980s if somebody put a gun to my head," notes J. Stephen Rottler, vice president for weapons engineering and product realization at Sandia National Laboratories. "The more you move away, the greater the uncertainties," Rottler continues. "Then you must either retire the weapon or test, and neither is an acceptable outcome." *—D.B.*

sies and twosies," says Martin Schoenbauer, principal assistant deputy administrator for operations at the NNSA. The TA-55 "doesn't have the right capacity."

Aside from doubting the need for a new nuclear warhead, critics worry about the infrastructure investment required to support its construction in addition to the cost of currently scheduled refurbishments of the W76 and other weapons. "If you are going to life-extend weapons, you need to re-create the enterprise, the production complex of the 1970s, which is an enormous investment in infrastructure," Goodwin explains. "Do you want to reinvest in technologies that in many cases are extremely unpleasant? Or do you want to make the smallest possible enterprise to support a very different deterrent stockpile, a much smaller stockpile?"

Further complicating the issue is that no one knows how much the RRW1 or Complex 2030 will cost. A detailed bill for the entire RRW program should be available by the end of this year, after engineers compile their estimates. Until such estimates are available, there is no way to determine whether the RRW program presents a savings or an additional financial burden compared with the $6.5 billion requested to fund stockpile stewardship in 2008.

Production on the W76 replacement could begin by 2012, depending on how much money Congress provides, Sandia's Rottler says. In the bomb makers' preferred scenario, the RRW1 would replace some portion of the W76s that would otherwise be refurbished. This swap would likely take decades, according to AAAS experts, and would require a commitment of "significant new funds."

"In this year's budget, the NNSA requested $88 million for the first design and development stages of RRW1. Where did [the funding] come from? It came out of the life-extension program for the W80," another nuclear weapon, notes Robert Nelson, a senior scientist at the Union of Concerned Scientists, an independent scientific research and advocacy group. "We're worried about the long-term reliability of the stockpile, but to pay for [the RRW program] we are going to cut the very programs that maintain the reliability of the stockpiles." He adds that cutting the funding for the maintenance programs for existing weapons precludes other options: "It makes it impossible to reverse course."

LAND, AIR OR SEA: Weapons can be launched from ground silos (*not shown*), submarines (*top*) and aircraft (*bottom*) to ensure retaliation.

PAUL SHAMBROOM

The Ultimate Cost

Billions more will be needed to retool the production infrastructure if Congress decides to authorize the RRW program and Complex 2030, both proponents and opponents say. And members from both sides of the aisle on the House Appropriations Subcommittee on Energy and Water Development have expressed skepticism about the program and the strategy behind it, as laid out in July by the DOD and DOE. "Although a lot of time and energy went into determining the winning design for a new nuclear warhead, there appears to have been little thought given to the question of why the United States needs to build new nuclear warheads at this time," said panel chair Representative Pete Visclosky of Indiana in a written statement. "Without a comprehensive defense

strategy that defines the future mission, the emerging threats and the specific U.S. nuclear stockpile necessary to achieve the strategic goals, it is impossible for Congress to appropriate funding for RRW in a responsible and efficient manner." And Livermore makes no claims that an RRW would last any longer in storage than existing weapons, raising the possibility of an RRW for the RRW in a few decades' time.

The planned replacement of the W76 with the RRW1 is also just the first of such substitutions. "If we're really going to have an impact as to a reduction in the stockpile, we have to address the whole stockpile," said Steve Henry, deputy assistant to the secretary of defense for nuclear matters, at a press conference announcing the design winner. And that will require different laboratory priorities and manufacturing capabilities. "It is a responsive infrastructure that you rely on to mitigate technical surprise and changes in the geopolitical environment. That responsiveness allows you to trade off numbers of weapons," Henry said.

The NNSA has already launched a feasibility study for a second RRW-produced weapon specifically designed for air delivery, according to Harvey. A likely candidate for replacement by an eventual RRW2 would be the W78 warhead that sits atop land-based intercontinental ballistic missiles, Kristensen says. It is nearly as old and also lacking insensitive high explosives and security features. Neither the DOD nor NNSA has any comment on how many RRWs might ultimately be necessary.

A Credible Deterrent

The biggest impact of the replacement weapons program might be on the global nuclear arms situation. The U.K., France, Russia and China have similar modernization efforts under way or planned, but construction of the RRW1 by the U.S. might send an inflammatory signal to the rest of the world. "If the United States, the strongest nation in the world, concludes that it cannot protect its vital interests without relying on new nuclear weapons for new military missions, it would be a clear signal to other nations that nuclear weapons are valuable, if not necessary, for their security purposes, too," said Sidney Drell, an arms-control expert and physicist at the Stanford Linear Accelerator Center, at the American Physical Society Conference in Denver in March.

As a result, former secretaries of state Henry Kissinger and George Shultz, former secretary of defense William Perry and former senator Sam Nunn of Georgia (a former chair of the Senate Committee on Armed Services) have argued for the elimination of such weapons. "We endorse setting the goal of a world free of nuclear weapons and working energetically on the actions required to achieve that goal," they wrote earlier this year in a *Wall Street Journal* editorial.

Ultimately, the RRW program may address a more fundamental concern: ensuring that the U.S. retains the capacity to build and field nuclear weapons well into the future, should they be needed once again. "We want to exercise the scientists and engineers," Harvey says. "The folks who did this back in the cold war are about to retire. We need the next generation to do this and do it now so that they can be mentored by that older generation."

Adds physicist Bob Civiak, former budget and policy analyst at the U.S. Office of Management and Budget: "We have existing warheads that can be maintained mostly by the production sites. That leaves the labs with nothing to do, and that is why we have an RRW program."

The true rationale for the RRW program, then, may be reliable replacement scientists, engineers and technicians—and the maintenance of the capacity to build new nuclear weapons. Whether they, in fact, need replacing is yet another subject of controversy. ■

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PAUL SHAMBROOM

NINE TYPES of active bombs and warheads exist in the U.S. arsenal, including these B83 gravity bombs, and all need routine maintenance.

MORE TO EXPLORE

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