By Frank N. von Hippel

The Decision to End U.S. Nuclear Testing

Today, for the first time since the beginning of the nuclear age, none of the world's nuclear-armed states is conducting nuclear test explosions. After more than 2,000 detonations, the world's nuclear test sites are dormant. The journey that brought us to this point has been long, and there have been some key turning points and some particularly important decision-makers who have steered us away from nuclear testing and the arms racing and environmental contamination it produces.

When U.S. President Bill Clinton took office in January 1993, one of the first issues he confronted was the future of U.S. nuclear testing. At the time, Congress was firmly in Democratic control, and the Democrats had been pressing the resistant Reagan and Bush administrations to agree to end U.S. nuclear testing if other countries, especially Russia, did as well.

Soviet leader Mikhail Gorbachev had declared a nuclear test moratorium starting on August 6, 1985.[1] Despite a lack of reciprocation from the Reagan administration, the Soviet moratorium had a substantial impact on Western public opinion, and Gorbachev extended it through 1986 before pressure from the Soviet military forced him to allow resumed testing.

Public pressure against nuclear testing in Kazakhtan, however, where the Soviets conducted the majority of their nuclear tests, was growing. After an underground test vented at the Semipalitinsk test site in Kazakhstan in February 1989, public outrage grew further, forcing the shutdown of the site.[2] Soviet nuclear testing shifted to the Arctic site on the island of Novaya Zemlya, but in the face of international protests, only one more test, on October 24, 1990, was conducted there.

A year later, in October 1991, just before the disintegration of the Soviet Union, Gorbachev announced another year-long testing moratorium.[3] His successor, President Boris Yeltsin, confirmed the extension of the moratorium and called again for the United States to reciprocate.[4]

In response, Democratic and Republican members of Congress introduced legislation to halt U.S. nuclear testing for one year, which gained momentum and, with some modifications, was approved in October 1992 and very reluctantly signed into law by President George H.W. Bush.

The Hatfield-Exon-Mitchell Amendment

The test moratorium law resulted from the Hatfield-Exon-Mitchell amendment to the fiscal year 1993 energy appropriations bill. The amendment was sponsored by Senator Mark Hatfield (R-Ore.), a liberal

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The "Icecap" test of a UK nuclear warhead was readied at the Nevada Test Site in the spring of 1993, but never conducted.
(Photo: National Nuclear Security Administration Nevada Site Office Photo Library)

who had, as a Navy lieutenant, visited Hiroshima a month after the nuclear bombing on August 6, 1945; Senator James Exon (D-Neb.), a moderate serving on the Senate Armed Services Committee; and Senate Majority Leader George Mitchell (D-Maine).

The law suspended U.S. nuclear testing for nine months and required a complete halt of U.S. nuclear testing by September 30, 1996, if other countries had stopped testing by then. Clinton adopted that as a goal, and after more than two years of intensive multilateral negotiations at the Conference on Disarmament (CD) in Geneva, the Comprehensive Test Ban Treaty (CTBT) was opened for signature on September 24, 1996, with Clinton and 65 other national leaders signing on the first day.[5] Since that time, only three nations have tested: India and Pakistan in May 1998 and North Korea (six tests between 2006 and 2017).

The road to the signing ceremony was a bumpy one. One of the most important issues in the U.S. internal policymaking process was how the safety and reliability of U.S. nuclear warheads would be maintained in the absence of testing.

The Hatfield-Exon-Mitchell amendment recognized that problem and allowed up to 15 tests before September 30, 1996, for fixes of specific safety and reliability problems. It also allowed up to three of these tests to be conducted with the United Kingdom, which had no test site of its own, if the UK had a problem with an existing warhead type that needed fixing.[6]

The "physics packages" of all U.S. nuclear warheads have been designed by two Department of Energy laboratories, the Los Alamos and Lawrence Livermore national laboratories, located in New Mexico and California, respectively. The associated electronic controls for the warheads are designed and procured by the Sandia National Laboratories, which has sites near both of the weapons physics labs. These three weapons laboratories therefore had to recommend whether any tests were required before the United States ended testing and, if so, bring them for approval to the secretary of energy.

O'Leary and Her Own Review

In the spring of 1993, Hazel O'Leary, Clinton's newly confirmed energy secretary, was asked to sign off on 15 nuclear tests, the maximum allowed by the law: six for Livermore, six for Los Alamos, and three for the United Kingdom.[7] Much to the astonishment of her staff, however, O'Leary did not agree immediately. She said she needed to learn more about the issues involved.

Despite the fact that the production and maintenance of nuclear weapons and the environmental cleanup of past plutonium production for weapons accounted for two-thirds of the Energy Department's budget, O'Leary, like most of her predecessors, had no nuclear weapons background. She had a law degree and had been a prosecutor and an assistant attorney general in New Jersey. She moved to Washington and joined the Carter administration, ending up as administrator of the Economic Regulatory Administration within the Energy Department. During the Reagan administration, she served as executive vice president of Northern States Power, a public utility in Minnesota that operated a two-unit nuclear power plant. O'Leary is a black woman, and it was widely believed that one of the reasons that Clinton selected her as his energy

secretary was because she increased the diversity of his cabinet.

O'Leary also turned out to be a strong-willed activist. Among her achievements as energy secretary was the Openness Initiative, which reversed the culture of secrecy that the department had inherited from the Atomic Energy Commission.[8] She also launched the Lab-to-Lab Initiative under which the U.S. national nuclear laboratories helped their Russian counterparts strengthen the security of nuclear materials in their newly open country.

After the Republicans took control of Congress in the 1994 midterm elections, however, they demonized O'Leary so effectively for her costly overseas travel that *Time* magazine included her in its list of 10 worst cabinet members ever.[9] Clinton chose a new energy secretary for his second term.

Before she was nominated to become energy secretary, I had met O'Leary once at a dinner. Either because of that dinner or because I had written an anti-testing memo that Dan Ellsberg, then a nuclear arms control activist living in Washington, had distributed to incoming members of the Clinton administration, or perhaps both, in the spring of 1993, I was invited to a meeting that had been organized to inform O'Leary about the issues that she would have to weigh in her decision on whether to approve the tests proposed by the weapons laboratories.

The associate directors responsible for nuclear weapons at Los Alamos and Livermore presented the proposed tests.[10] They were accompanied by their laboratory directors.[11] Al Narath, the Sandia director, was there, as was Victor Reis, the Pentagon's director of defense research and engineering, who would soon transfer to the Energy Department as assistant director for defense programs, i.e., for nuclear weapons.

Three other outsiders also had been invited: James Schlesinger, who had been assistant director of the Bureau of the Budget, chairman of the Atomic Energy Commission, CIA director, and secretary of defense under President Richard Nixon and later served as the first energy secretary for President Jimmy Carter; Sidney Drell, a Stanford physicist who had been for decades a high-level government advisor on nuclear weapons issues and had chaired a 1990 congressionally commissioned panel on nuclear warhead safety;[12] and Ray Kidder, a retired Livermore nuclear weapons expert who had written reports on warhead safety and reliability for test ban supporters in Congress, rebutting the arguments being made by the nuclear weapons laboratories against a nuclear test ban.[13] Very conscious of the limitations of my own expertise with regard to nuclear weapons design, I had suggested that Kidder be invited. (I had not had a clearance until the Energy Department gave me one for the O'Leary meeting.)

One of the associate lab directors who presented the proposed tests recalled them as being for "IHE [insensitive high explosive] warheads that were suitable for the Navy systems…a Stockpile Confidence test for each system currently in the stockpile, and for tests that optimized warhead performance margins and manufacturability (that was the idea behind RRW [Reliable Replacement Warhead]), tests to elucidate holes in our basic physics understanding and some tests having to do with shortfalls in our understanding of potential proliferant devices."[14]

Reliable Replacement Warheads. One of the arguments the labs had made was that, despite the fact that a test ban had been a high-priority U.S. objective since the Eisenhower administration, U.S. warheads were so highly refined to have the highest possible yield-to-weight ratio that they could not be kept operational without testing. They argued that, in contrast, Russian warheads, with their lower yield-to-weight ratios, would fare better under a test ban. They therefore wanted to design Reliable Replacement Warheads whose designs would have larger "margins" between success and failure. This idea was pursued until 2008[15] by which time, most in the U.S. nuclear weapons establishment had concluded that the existing tested designs were well enough understood that confidence in their reliability could be maintained indefinitely without testing. Also, the performance margins of the fission "primaries," the part of the warhead whose reliability is of the greatest concern, have been made larger

U.S. Energy Secretary Hazel O'Leary (center) visits Oak Ridge National Laboratory in 1994 with laboratory director Alvin Trivelpiece (left) and Representative Marilyn Lloyd (D-Tenn., right). After reviewing arguments from a range of experts in 1993, O'Leary concluded that explosive nuclear testing was not needed to ensure the safety and reliability of U.S. nuclear weapons. (Photo: Energy Department)

by increasing the amount of tritium-deuterium fusion "boost" gas injected into the hollow plutonium pit just before implosion.[16]

Insensitive high explosive. Designs with IHE have become a persistent part of the debate over the current U.S. nuclear stockpile. The concern is not about the possibility of a nuclear explosion as a result of the chemical explosive around the plutonium pit being detonated in a crash or by a terrorist's bullet. U.S. nuclear weapons are designed to be "one-point safe." If a detonation starts in only one point in the chemical explosive, the pit will not be imploded symmetrically enough to become supercritical. In fact, the high explosives in U.S. nuclear bombs have gone off in a number of crashes with no nuclear yield.[17]

Some accidents, however, have dispersed plutonium, which is highly carcinogenic if inhaled. The most famous such accident occurred over Spain in 1966, when a B-52 bomber carrying four multimegaton bombs collided with its refueling tanker. The chemical explosives in two of the bombs detonated on impact with the ground and dispersed plutonium over fields near the village of Palomares. Sixteen hundred young U.S. military men were brought in for a cleanup operation that took almost three months amid worldwide attention.[18]

To reduce the chances for such accidents, all U.S. nuclear bombs and cruise missile warheads now have IHE. Three of the four ballistic missile warheads in the U.S. "enduring" stockpile do not: the W-78, the older of the two warhead types on Minuteman intercontinental ballistic missiles (ICBMs), and the W-76 and W-88, the warhead types on the Trident II submarine-launched ballistic missiles (SLBMs). In 2018, the Nuclear Weapons Council, a joint organization of the Defense and Energy departments, decided to replace the ICBM warhead, the W-78, with a variant of the more modern ICBM warhead, the W87, which contains IHE.[19]

The Navy, which has not had a plutonium-dispersal accident, has been resistant to IHE because it could result in an increase in the weight and size of its warheads, decreasing the range of its missiles[20] and requiring new reentry vehicles.[21] The National Nuclear Security Administration (NNSA), the agency within the Energy Department that is responsible for nuclear weapons, expects to complete a refurbishment life extension program (LEP) of the W-76 warhead in 2019 and is expected to begin an LEP of the W-88 in 2020, both with conventional high explosive.[22] The NNSA states, however, that the W87-1 with IHE that it is developing to replace the W78 ICBM warhead may be adapted as well to be used on the Trident II inside the Mk-5 reentry body, which currently holds the W88.[23]

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The Hatfield-Exon-Mitchell amendment set quite stringent standards of justification for nuclear test explosions designed to improve warhead safety and reliability. For safety tests, it required that the test be of the addition of a specific safety feature to an existing warhead. The only new safety feature that the labs were proposing was IHE in the SLBM warheads, but the Navy had vetoed those changes. For a reliability test, the law required that "the President certifies to Congress that it is vital to the national security interests of the United States to test the reliability of such a nuclear weapon." It did not appear that the labs had specific concerns about the reliability of any of their weapons.

At the spring 1993 meeting convened by O'Leary, Kidder and I therefore expressed skepticism about the technical justifications for the different tests that were being proposed.

Political concerns. Drell and Schlesinger focused on more political concerns that cut in the other direction. Drell believed that it was politically necessary to carry out the tests to get the support of the lab directors for the ratification of a CTBT, which was a high priority for the Clinton administration. Negotiations in the CD began the following year, 1994, and were completed in 1996.

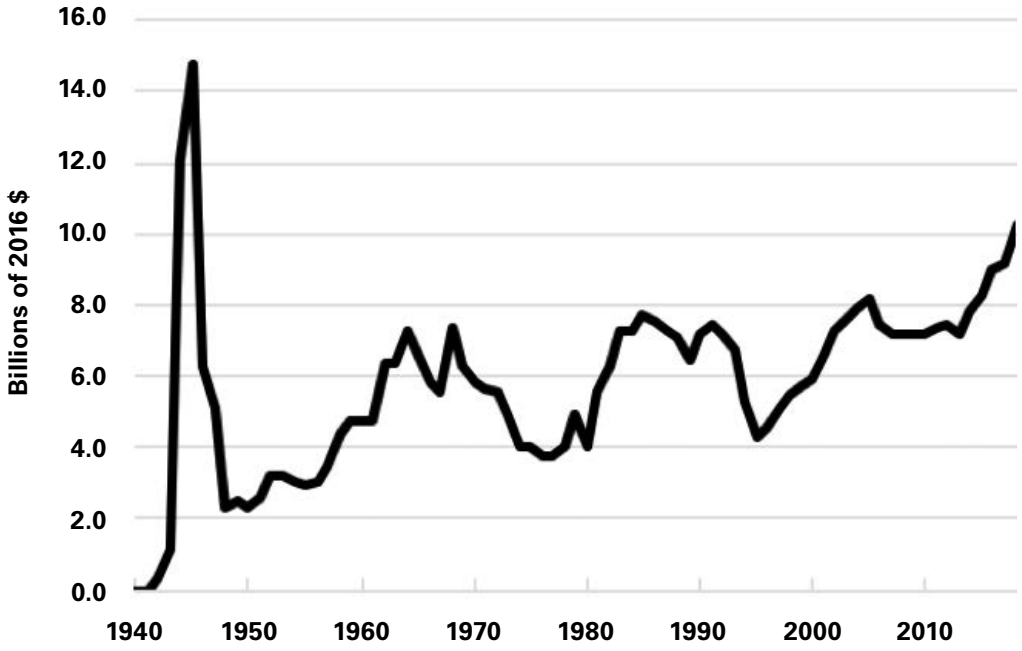
Ratification of a treaty requires that two-thirds of the Senate vote in favor. When the Senate finally held its ratification vote in 1999, however, the Clinton administration failed to obtain even a majority vote for the CTBT. Control of both houses of Congress had shifted to the Republican Party, and 50 of the 54 Republicans and one independent senator voted against it.

Uncertainty about the ability of the labs to keep U.S. warheads safe and reliable without testing was only one of the issues raised by the treaty opponents. They were also skeptical about the verifiability of the treaty and about claims that it would strengthen the nonproliferation regime.

Republican hard-liners led by Senator Jon Kyl (Ariz.) felt that the United States would comply with the treaty while other countries would not and that U.S. national security would be reduced as a result. Kyl mounted a secret campaign to get his fellow Republican senators to commit in advance to vote against the treaty, and Senate Majority Leader Trent Lott (R-Miss.) limited the time for hearings and debate to a period too short for CTBT supporters to mobilize public opinion.[24]

Subsequently, the National Academy of Sciences reviewed the technical issues that had been raised and concluded that the benefits of a CTBT in constraining further developments of nuclear weapons far outweighed any advances that might be achieved by very low-yield clandestine tests.[25]

Figure 1. Annual U.S. expenditures on nuclear weapons.



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Schlesinger had a different political concern in 1993. He wanted to allow the UK to test. He argued that, in that case, the United States should test as well. "Might as well be hung for a sheep as a lamb," he said. He did not explain why he felt so strongly about the UK being able to test. Possibly it had to do with the fact that preparations had been made for a joint Los Alamos/UK test of the single UK warhead type scheduled for that spring. The test, called Icecap, involved cooling down a ballistic missile warhead with dry ice to see whether the cooling that would occur during its transit in space would affect its performance. A hole eight feet in diameter and 1,600 feet deep had been drilled, and a rack loaded with instruments was in place hanging in the tower above the hole, ready to be lowered as soon as the warhead was hung from its bottom. The tower, rack, and hole are still there, now a tourist attraction.[26]

After the presentation of the proposed tests, it must have been clear that O'Leary was not convinced. The lab directors could have tried to go over her head to the National Security Council (NSC) or to Congress to get their tests, but given that Clinton was pro-CTBT, as were the large Democratic majorities in both houses of Congress, they would have had an uphill battle.

At that point, my recollection is that Narath said to O'Leary, in effect, "[I]f you give us as much funding for not testing as you have been giving us for testing, we could see it your way."

Science-Based Stockpile Stewardship

This was the origin of the science-based Stockpile Stewardship Program (SSP), which Reis developed in partnership with the labs' leaderships. I have been told that it was not smooth sailing when O'Leary presented to the NSC her conclusion that there was no need for safety or reliability tests. The defense secretary, chairman of the Joint Chiefs of Staff, and secretary of state all lined up on the other side of the issue, but the president sided with O'Leary.

On July 3, in his weekly radio address, Clinton announced

> After a thorough review, my administration has determined that the nuclear weapons in the United States arsenal are safe and reliable…. Additional nuclear tests could help us prepare for a test ban and provide for some additional improvements in safety and reliability. However, the price we would pay in conducting these tests now by undercutting our own nonproliferation goals and ensuring that other nations would resume testing outweighs these benefits.[27]

He added, "If, however, this moratorium is broken by another nation, I will direct the Department of Energy to prepare to conduct additional tests while seeking approval to so from Congress."

Two months later, I joined the White House Office of Science and Technology Policy as assistant director for national security and found Bob Bell, a former aide to Senator Sam Nunn (D-Ga.), who had joined the Clinton administration NSC, enforcing on the Office of Management and Budget a minimum budget of $3.6 billion per year for the Energy Department's weapons program

with instructions that the labs should have great freedom on how to spend the money. The directors of the three national labs each specified investments in the capabilities of their labs that would be essential to their support of a CTBT.[28]

The most expensive of the resulting lab projects was Livermore's $3.5 billion National Ignition Facility (NIF), which has 192 huge lasers delivering up to two megajoules of energy, about the amount of energy released by a half kilogram of chemical explosive, to implode millimeter-radius spherical pellets of frozen deuterium and tritium.

Although NIF has not achieved its goal of igniting the fuel to produce more energy than the lasers put in,[29] it gave Livermore, which some in the Clinton administration considered redundant in the post-Cold War era, a lifeline for its continued existence.

Other investments were more successful. Notably, Los Alamos and Livermore invested in cutting-edge computers and used massive parallel processing to achieve ever more fine-grained simulations of implosions that could be tested against experiments at NIF and subcritical plutonium implosions.[30] As a result of this stockpile stewardship, it has been possible for a complex, multifaceted review process to continue to certify that each weapon type in the U.S. stockpile is safe and reliable, would perform after being exposed the conditions of delivery, and would be militarily effective and that therefore no tests are required.[31]

Figure 1 shows the Energy Department weapons budget in constant 2016 dollars. It can be seen that the post-Cold War decline ended in 1995 with the launch of the SSP and that today the spending level is well above Cold War levels despite the fact that the number of operational weapons in the U.S. nuclear stockpile has declined by about 80 percent since the end of the Cold War and no new designs have been introduced. It would be unfair to blame all this budget growth on the SSP. It is in part a manifestation of the broader dysfunction of the NNSA and perhaps to some degree that the labs are now run by profit-seeking consortia.

China Tests

Almost immediately after I took up my position in the Clinton administration in September 1993, I learned that U.S. reconnaissance satellites had detected preparations for a test on China's test site. I recalled Clinton's July 3 warning if the moratorium was broken by another nation. I wrote a passionate memo to the president's science advisor urging that this threat not be implemented. If the United States resumed testing, so would Russia and, with our permission, the UK. This would undercut our effort to extend the nuclear Nonproliferation Treaty (NPT) indefinitely in 1995. Through an intermediary, I also sent an email to Hu Side, the head of the China Academy of Engineering Physics, China's nuclear weapons laboratory, urging him not to proceed with the test. I knew him in an earlier incarnation, when he had launched in 1988 the biennial Beijing Seminars on International Security, to which experts from around the world were invited to discuss the dangers from nuclear weapons and how to reduce them.

China's first of eight nuclear tests took place on October 5, 1993, with the last on July 29, 1996, two months before the CTBT opened for signature. France, recognizing that the end of nuclear testing was approaching, also decided to conduct a final test series of six tests in 1995 and 1996. Yet, the United States, Russia, and the UK did not test.

To date, of the 44 states whose ratifications are required to bring the CTBT into force, 36 have ratified. The missing eight ratifications are from China, Egypt, Iran, Israel, and the United States, which have signed but not ratified, and India, North Korea, and Pakistan, which have not signed or ratified. Among nuclear-weapon states recognized under the NPT, France, Russia, and the UK have ratified.[32]

It is likely that the other nonratifying states would ratify if the United States did, but the political conditions for that

A specialist examines the remnants of nuclear test measurement facilities at the Semipalatinsk test site in Kazakhstan in 2011. Kazakh anti-nuclear activists built public pressure to end Soviet testing in the 1980s, enabling U.S. and Soviet leaders to begin negotiating a global ban on tests. (Photo: Vyacheslav Oseledko/AFP/Getty Images)

to happen are clearly not in sight today. Nevertheless, the actions of Kazakhstani anti-testing activists and the decisions made by Russian and U.S. leaders some three decades ago set us on course to end testing and establish a de facto global nuclear test moratorium that has strengthened international peace and security.

ENDNOTES

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