Atoms for Peace: Vision, Reality and Legacy – A nuclear practitioner's perspective

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In early afternoon of 8 December 1953, Dwight D. Eisenhower asked the pilot of the president's plane bringing him back from a summit in Bermuda to circle above New York City numerous times so he could put the finishing touches on his speech at the United Nations.[1] With one of the most memorable and consequential presidential speeches during my lifetime, President Eisenhower dramatically changed the nuclear landscape by launching the Atoms for Peace initiative.

The Atoms for Peace Vision

Eisenhower wrote in his diary two days after the speech that he was inspired by "the clear conviction that the world was racing toward catastrophe," and that he had to act. As much as the speech was aimed at controlling the arms race with the Soviet Union and preventing potential proliferation of nuclear weapons to other countries, it was his desire to address the dual nature of the atom that opened the way for the peaceful uses of the atom for generating electricity, as well as for medicine, agriculture and industry. He wanted the initiative to offer the world hope and underscore the United States' sincere desire to find a just peace.[2]

Several phrases from his speech have continued to resonate in my head: "To hasten the day when fear of the atom will begin to disappear from the minds of the people and the governments of the East and West…" And his conclusion that to the making of these fateful decisions, "the United States pledges before you, and therefore before the world, its determination to help solve the fearful atomic dilemma—to devote its entire heart and mind to

[1] Susan Eisenhower, *How Ike Led: The Principles Behind Eisenhower's Biggest Decisions* (New York: Thomas Dunne Books, 2020), 177.
[2] Eisenhower, *How Ike Led,* 176.

finding the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life."[3]

These ideas have guided much of my work in the nuclear world since I first set foot in the Los Alamos Scientific Laboratory (as it was called then) as a summer student in 1965. I came to Los Alamos because it was one of the greatest scientific laboratories in the world. I hadn't thought much about its nuclear weapons mission. Norris Bradbury, Robert Oppenheimer successor as director of the laboratory, welcomed the new employees and summer interns in the main auditorium with the message, "At Los Alamos, we don't build nuclear weapons to kill people, but to buy time for our leaders to find other ways of settling our differences." I believe that today, as seventy years ago, we must strive to derive the benefits of the enormous energy liberated when splitting or fusing nuclei while managing the risks of doing so.

The vision of Atoms for Peace was largely Eisenhower's own. The speech reflected how thoroughly he believed in the dual nature of the atom and that it was crucial to have international collaboration to solve the "fearful atomic dilemma." He proposed that "the governments principally involved … should begin now and continue to make joint contributions from their stockpiles of normal uranium and fissionable materials to an international atomic energy agency. We would expect that such an agency would be set up under the aegis of the United Nations." Eisenhower put his personal imprint on the speech reflecting his vision with last-minute edits as he was circling above New York City. His edits are shown in pencil in the declassified version of the typed speech available in the Eisenhower Library.[4]

Eisenhower's speech presented a vision, not a blueprint.[5] Eisenhower had kept the ideas close hold to a few of his key advisors before the speech. It presented aspirations with little consideration to its practical outcomes and had not yet put any policy in place.[6] It would take on many different forms as it was implemented by the various branches of the U.S. government and

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[3] "Address by Mr. Dwight D. Eisenhower, President of the United States of America, to the 470th Plenary Meeting of the United Nations General Assembly," accessed March 9, 2025, https://www.iaea.org/about/history/atoms-for-peace-speech.

[4] "Draft of the Presidential Speech Before the General Assembly of the United Nations: Draft #5, November 28, 1953," Dwight D. Eisenhower Presidential Library, Museum & Boyhood Home, https://www.eisenhowerlibrary.gov/sites/default/files/research/online-documents/atoms-for-peace/atoms-for-peace-draft.pdf.

[5] Susan Eisenhower, personal communications, 2024.

[6] Mara Drogan, "The Nuclear Imperative: Atoms for Peace and the Development of U.S. Policy on Exporting Nuclear Power, 1953-1955." *Diplomatic History* 40, no. 5 (November 2016): 948–74, https://doi.org/10.1093/dh/dhv049.

promoted globally. Consequentially, it would lead to the establishment of the International Atomic Energy Agency (IAEA) in 1957. It also prepared the way for the Nuclear Nonproliferation Treaty (NPT) in 1968, which entered into force in 1970. As I assess the reality and legacy of the Atoms for Peace speech it is in the spirit of how it altered the nuclear landscape to promote the benefits of atomic energy while controlling the risks.

The Reality

From my perspective based on nearly sixty years in the nuclear world, the Atoms for Peace initiative has been remarkably successful. Eisenhower's aspirations have fundamentally shaped the nuclear world we live in today. The programs it created and the international cooperation it fostered led to the establishment of a Global Nuclear Order. The reality today, more than 70 years after Eisenhower's speech and eight decades after Hiroshima and Nagasaki, is that no nuclear weapons have been used in war; fewer than 10 states possess nuclear weapons; there has not been a single incident of nuclear terrorism; and the world has benefited from clean nuclear electricity, nuclear medicine, nuclear technologies in agriculture, industry, and nuclear batteries for space exploration.

The reality, of course, depends on the observer. I am fully aware that others have different views of the reality of Atoms for Peace over seventy years. Countless articles and numerous books have been written about the initiative to praise its accomplishments or point out its failings. It certainly had some of each. Some saw it as a sinister move by Americans to control the nuclear world. For example, critics say the U.S. Information Agency (USIA) mounted an intense propaganda campaign, "aimed to strike a blow against the Soviet Union in the contest for world supremacy, to cement the United States' role as the global leader in nuclear technology, and to reinforce or create alliances with other nations that would support the United States in the Cold War."[7] The views across the globe vary widely. Some in the developing countries of the world first rejoiced and later were dismayed with what they viewed as limited benefits. Several of the bilateral initiatives the United States mounted, such as the early ones in the Philippines

[7] Mara Drogan, "The Atoms for Peace Program and the Third World," *Cahiers du Monde Russe* 60, no 2/3 (2019): 441 -60, , https://doi.org/10.4000/monderusse.11249.

and Brazil, were unsuccessful.[8] However, today 32 countries have nuclear power plants that generate about 10 percent of the world's electricity. Over 50 countries utilize nuclear energy in about 220 research reactors. In addition to research, these reactors are used to produce medical and industrial isotopes.[9] Most of these countries were assisted by the United States or the Soviet Union and later, Russia.

The Soviet Union was at first skeptical, but not dismissive of the initiative.[10] Soviet diplomats engaged their American counterparts in Geneva to help shape it. One of the most important outcomes was an agreement to hold a series of international Atoms for Peace conferences under the aegis of the United Nations in Geneva, the first in 1955 and the second in 1958. These conferences allowed Soviet and American scientists, as well as scientists from around the world, to share their work on nuclear energy and nuclear technologies. To do so, the United States and the Soviet Union opened huge files of nuclear science and technology that had previously been classified.

I learned many years later from one of my Los Alamos scientist colleagues, Harry Dreicer, about his experience participating in the second conference in Geneva. He had joined the Los Alamos lab after completing a PhD in physics at the Massachusetts Institute of Technology (MIT) to work on the civilian nuclear fusion program. In April 1956, at the Atomic Energy Research Establishment in Harwell in the United Kingdom, Soviet scientist Igor Kurchatov dazzled the world with news of a new magnetic fusion concept, the tokamak, pioneered in the Soviet Union.[11] The young Dreicer and colleagues were told by the Los Alamos leadership to prepare an exhibit for the 1958 Geneva conference of U.S. fusion research to demonstrate that we had not lagged behind the Soviets. He told me about the excitement of being in Geneva at a conference with thousands of scientists from nearly seventy countries for a two-week event. At the conference, the main scientific proponents of fusion in the Soviet Union and the United States, Lev Artsimovich and Edward Teller, stressed the importance of international

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[8] Mara Drogan, "The Nuclear Imperative," op cit

[9] "Nuclear Power in the World Today," World Nuclear Association, January 6, 2025, https://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.

[10] David J. Holloway, *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939-1956.* New Haven, CT: Yale University Press, 1996), chapt. 16.

[11] Robert Arnoux, "60 Years Ago: The Speech that Changed Everything." ITER, April 25, 2016, https://www.iter.org/fr/newsline/-/2440.

cooperation to tackle the immense challenges of harnessing peaceful fusion energy.[12] The Geneva conferences showed that Soviet nuclear science had arrived to be on par with the West. The Soviet government overcame its skepticism of Atoms for Peace and launched its own "Peaceful Atom" program.

Many years later, Russia and the United States joined 33 other international partners in Cadarache, France to build the world's largest tokamak, a magnetic fusion device that was designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy and is hoped to be the first prototype of a magnetic fusion reactor. The Atoms for Peace conferences helped to set the stage for scientific internationalism.

As much as I believe the Atoms for Peace vision led to a Global Nuclear Order, that order was fragile. There were perilous times and many frightening moments during the Cold War as the two nuclear colossi were, as Robert Oppenheimer said, like "two scorpions in a bottle, each capable of killing the other, but only at the risk of his own life."[13] Let's look at how the nuclear landscape evolved during the Cold War. Eisenhower sounded the warning bells in his speech. He said he had to speak in the new language of atomic warfare. The United States, he said, had conducted 42 nuclear test explosion since August 1945. He did not disclose the size of the nuclear arsenal but said that it exceeded by many times the "equivalent of the total of all bombs and all shells that came from every plane and every gun in every theatre of war in all the years of the Second World War."[14] The U.S. nuclear arsenal is believed to have been roughly 2,000 nuclear weapons by the end of 1953. Great strides were made in dramatically reducing the size and mass of nuclear warheads by this time. American scientists first demonstrated a hydrogen bomb with the Ivy Mike test in the Pacific on Nov. 1, 1952. Soviet scientists were not far behind.

The U.S. military was developing every conceivable method of delivering nuclear weapons, from artillery shells to depth bombs, landmines and backpack nukes.[15] The military had plans to use thousands of nuclear arms in combat if necessary. Later in the 1950s and 1960s

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[12] Sabina Griffiths, "Two Weeks in September 1958: Atoms for Peace Conference in Geneva," ITER, September 1, 2008, https://www.iter.org/newsline/47/680.
[13] J. Robert Oppenheimer, "Atomic Weapons and American Policy," *Foreign Affairs*. (July 1963), 529, https://www.jstor.org/stable/20030987.
[14] "Address by Mr. Dwight D. Eisenhower, President of the United States of America, to the 470th Plenary Meeting of the United Nations General Assembly."
[15] One of the smallest nuclear weapons ever fielded was the Davy Crockett, a recoilless rifle system operated by a crew of three. Matthew Seelinger, "The M28/M29 Davy Crockett Nuclear Weapon System," Army Historical Foundation, accessed March 9, 2025, https://armyhistory.org/the-m28m29-davy-crockett-nuclear-weapon-system/.

the United States moved to the current concept of the triad: land, sea and air delivery. These were the Wild West days of the nuclear arms race with the Soviets—or what Harvard scholar Steven Miller called "unmanaged competition" in an unregulated environment.[16]

Nuclear testing became rampant. Atmospheric explosions by the Americans, Soviets and British sent huge radioactive clouds around the globe. Public opposition, both around the world and in the United States, led President Eisenhower, Soviet leader Nikita Khrushchev, and British Prime Minister Harold Macmillan to agree to a nuclear test moratorium. It halted all nuclear testing from 1958 to 1961 until the Soviets broke out in October 1961 with the biggest hydrogen bomb explosion in history, at roughly 50 megatons.[17] The Americans were ready to respond and did—with a staggering 98 nuclear tests in 1962. The Soviets were not to be left behind and tested nearly 80 of their own. France decided to join the nuclear club with a test in 1960 in French Algeria. The Cold War ground on, leading to the world's most dangerous nuclear moments during the Cuban Missile Crisis in October 1962. The testing spree galvanized public opposition and led to the United States, the Soviet Union, and the United Kingdom signing the Limited (or Partial) Nuclear Test Ban Treaty in November 1963 that banned all nuclear tests except those underground.

Even after the tenth anniversary of Atoms for Peace in December 1963, the U.S. nuclear arsenal continued to expand to its eventual peak of some 31,000 nuclear weapons in 1967. The sophistication of the weapons and their means of delivery continued to improve unabated. The Soviets were accelerating weapon production to catch up with the United States, which they eventually did in the late 1970s. The Cuban Missile crisis, however, seemed to frighten U.S. and Soviet leaders into a recognition that any use of nuclear weapons would bring devastating consequences and must be prevented. These were also the heydays for deterrence strategists with the likes of Thomas Schelling and the creation of the concept of mutually assured destruction.

Schelling and Halperin made the case for arms control stating that "our military relation with potential enemies is not one of pure conflict and opposition." Arms control, they stated, reduces likelihood of war, reduces the destruction if war occurs, and reduces the burden in

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[16] Miller, S.E. (2021). The Rise and Decline of the Global Nuclear Order? in Steven E. Miller and Alexey Arbatov, Nuclear Perils in a New Era Bringing Perspective to the Nuclear Choices Facing Russia and the United States. American Academy of Arts and Sciences.

[17] The device was designed by Andrei Sakharov and colleagues for an explosion yield of 100 megatons. Sakharov tried to convince Soviet Premier Khrushchev not to test at all. Having failed to do so, Sakharov got Khrushchev's approval to test it at half the design yield to reduce the radioactive fallout.

peacetime being ready for war.[18] Several important arms control treaties, such as the Strategic Arms Limitation Treaty and Anti-Ballistic Missile Treaty were negotiated in the late 1960s and signed in the 1970s. Steven Miller called it managed rivalry in which the rivals built an architecture of restraint. Nevertheless, tensions between the superpowers continued to rise peaking in the early years of the Reagan administration during which Reagan warned of "the aggressive impulses of an evil empire"[19]

Early on, several countries, including unlikely ones such as Sweden and Switzerland, explored the nuclear weapons option. China was the last of what are now called the Permanent Five (P-5 of the UN Security Council) to test a nuclear device in 1964. It followed in very short order with demonstration of a hydrogen bomb in 1967. The Chinese nuclear turn accelerated discussions in the United Nations to seek a treaty to prevent the spread of nuclear weapons. Ireland had introduced such a notion in 1958. The Eighteen Nation Committee on Disarmament, a United Nations-sponsored organization, negotiated the Treaty on the Non-Proliferation of Nuclear Weapons or NPT between 1965 and 1968. It opened for signature in 1968 and entered into force in 1970. The treaty defined nuclear-weapon states as those that had built and tested a nuclear explosive device before 1 January 1967—namely the United States (1945), Soviet Union (1949), United Kingdom (1952), France (1960), and China (1964). The treaty was to be reviewed every five years. It was initially limited to a duration of 25 years, but it was extended indefinitely at the 1995 Review Conference.

The NPT was constructed around three pillars. First, nonproliferation: The NPT non-nuclear-weapon states agree never to acquire nuclear weapons and the NPT nuclear-weapon states commit not to assist other states to acquire or develop nuclear weapons. Second, right to nuclear energy: The nuclear-weapons states agreed to share the benefits of peaceful nuclear technology. Third, disarmament: The nuclear-weapons states commit to pursue nuclear disarmament aimed at the ultimate elimination of their nuclear arsenals.[20] These pillars clearly resonated with Eisenhower's Atoms for Peace vision. The NPT provided the legal basis for constraints on nuclear and related technologies as well as for mandatory inspections of suspected

[18] Thomas C. Schelling and Morton H. Halperin, Strategy and Arms Control (New York: Twentieth Century Fund, 1961), p. 2.
[19] "Ronald Reagan, 'Evil Empire' Speech (8 March 1983)," Voices of Democracy: The U.S. Oratory Project, accessed March 5, 2025, https://voicesofdemocracy.umd.edu/reagan-evil-empire-speech-text/.
[20] Treaty on the Non-Proliferation of Nuclear Weapons (NPT). https://disarmament.unoda.org/wmd/nuclear/npt/.

facilities in possible pursuit of nuclear weapons. Nevertheless, the nuclear-weapons states and the rest continue to have contested views of how much and what kind of nuclear assistance should be afforded compared to how strict a system of safeguards should be constructed.

Suspicions that Israel was developing nuclear weapons in the 1960s and India's test of what it called a "peaceful" nuclear device in 1974 resulted in additional international measures to prevent proliferation. In the 1970s, the Zangger Committee, the Nuclear Suppliers Group, the Wassenaar Arrangement, and a Missile Technology Control Regime were established.[21] The discovery of a nuclear weapon program in Iraq in 1990 led the IAEA to establish an Additional Protocol that required states to provide additional information and allow additional inspections about suspected nuclear programs.

In 1998, India and Pakistan conducted a series of nuclear tests and declared themselves to be nuclear weapons powers. Iran put in place the necessary requisites for nuclear weapons but stayed a stroke away. North Korea did the same in the 1980s and 1990s and after failed diplomacy with the United States, tested a nuclear device in 2006.[22] In contrast, many non-nuclear states decided it was best to live in a non-nuclear weapon neighborhood and established regional Nuclear Weapons-Free Zones. There are five such zones in the world today.[23]

Critics claim that Atoms for Peace and the NPT helped countries develop nuclear weapons without much positive impact on nuclear electricity, leading to proliferation rather than the opposite. It is, of course, no surprise that there are linkages between civilian and military nuclear programs. Oppenheimer warned early on that much of the science and technology for civilian and military programs are interrelated and interchangeable.[24] Civilian nuclear programs can be used to disguise a military hedge during the development of a weapons program or provide a hedge during alleged reversals of such programs.

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[21] Isabelle Anstey, "Negotiating Nuclear Control: The Zangger Committee and the Nuclear Suppliers' Group in the 1970s" in *The Making of the Global Nuclear Order in the 1970s,* edited by David Holloway and Leopoldo Nuti, (New York: Taylor and Francis, 2021): "Wassenaar Arrangement: On Export Controls for Conventional Arms and Dual-Use Goods and Technologies," https://www.wassenar.org/; and "Missile Technology Control Regime (MTCR): Frequently Asked Questions," U.S. Department of State, accessed March 3, 2025, https://www.state.gove/remarks-and-releases-bureau-of-international-security-and-nonproliferation/missile-technology-control-regime-mtcr-frequently-asked-questions/.

[22] Siegfried S. Hecker, S.S. and Elliot A. Serbin (2022). *Hinge Points: An Inside Look at North Korea's Nuclear Program* (Stanford CA, Stanford University Press, 2022).

[23] "Overview of Nuclear-Weapon-Free Zones," United Nations Platform for Nuclear-Weapon-Free Zones, 2024, https://www.un.org/nwfz/content/overview-nuclear-weapon-free-zones.

[24] *A Report on the International Control of Atomic Energy* (Acheson-Lilienthal Report), March 16, 1946, International Panel on Fissile Materials, https://fissilematerials. org/library/ach46.pdf.

Eight states have tested nuclear weapons and declared they have nuclear arsenals: the P-5, India, Pakistan, and North Korea. The P-5 developed nuclear weapons first; nuclear power came later. For the other three, civilian nuclear programs preceded the military programs. These were used as a hedge for the eventual turn to military programs. South Africa did the same on the way to developing a small stockpile of nuclear devices before it decided to disarm in 1989. Iran used the civilian program as a hedge to develop the military option during the Shah's time, and the ayatollahs did the same after the revolution. Today, Iran sits only a few weeks away from being able to build a bomb. Iraq and Libya also flirted with a nuclear weapons capability under the cover of a civilian program but neither came close. If Israel has a nuclear weapon program, the linkage to civilian nuclear programs would also exist, but Israel has no commercial nuclear power program.[25] There are numerous other countries that can be considered as latent nuclear weapons capable—foremost among them is Japan, which has amassed tens of tons of plutonium from its civilian nuclear power program. Latency is only one side of the proliferation coin—it deals with the supply side. However, the demand side—that is, do countries actually want or need nuclear weapons is an equally important factor.

A strong nonproliferation regime has developed over the years. The NPT is the centerpiece. It is supported by various political instruments, such as security alliances, diplomacy, arms control and sanctions. It is also supported by a variety of international institutions and agreements with the IAEA being the most prominent. It includes limitations and safeguards on fissile materials, export controls of nuclear materials and sensitive nuclear technologies. It also provides for border and port security, as well as technologies and measures for detection and interdiction.

As much as the NPT is maligned, 191 states have signed the treaty. Only India, Pakistan, and Israel are non-signatories. North Korea had signed but withdrew in 2003. And the reality today is that fewer than ten states have nuclear weapons, so neither Atoms for Peace nor the follow-on programs opened the flood gates to nuclear proliferation. The major powers and the international community have done an effective job of controlling it, an effort that requires constant vigilance.

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[25] Israel has a policy of *amimut* or opacity. It neither confirms nor denies a nuclear weapon program but states it will not be the first to introduce nuclear weapons in the Middle East. The U.S. government positions is that it doesn't know whether Israel has nuclear weapons.

The NPT was extended indefinitely at the 1995 Review Conference. However, significant tensions and disagreements remain between the nuclear-weapon states and the rest, especially about the failure of the nuclear-weapon states to disarm at an early date as stipulated in Article VI. In 2017, the UN General Assembly convened a United Nations conference to negotiate a legally binding instrument to prohibit nuclear weapons, leading towards their total elimination. The Treaty on the Prohibition of Nuclear Weapons was adopted by the Conference in July 2017. It opened for signature in September and entered into force on 22 January 2021.[26] Not surprisingly, the treaty is opposed by the nuclear-weapon states and most of their allies. There is concern whether such a treaty is verifiable, but of greatest concerns is that it appears to have caused an even bigger divide between the states on the two sides of the disarmament argument.

The greatest change for the Global Nuclear Order was the dissolution of the Soviet Union. The ascent of Mikhail Gorbachev to Soviet leader in 1984, with a new agenda of curing a lethargic empire with policies of glasnost and perestroika, was received with open arms by President Reagan. Their summit at Reykjavik in October 1986 led to a series of agreements including the Intermediate Nuclear Forces Treaty (INF Treaty) in 1987 and the ratification and entry into force of the Nuclear Threshold Test Ban Treaty in 1990, followed in 1991 by the Strategic Arms Reduction Treaty (START I). These agreements in a greatly changing political environment led to dramatic reductions in the nuclear arsenals of both countries.

The Soviet Union, along with the entire world, held its collective breath when Soviet hardliners in an attempted putsch put Gorbachev under house arrest at his dacha in the Crimea during late August 1991 and took away the nuclear briefcase with the launch codes for the Soviet nuclear arsenal. Boris Yeltsin, the president of the Russian Republic of the Soviet Union, was able to gain the support of the Russian military to stop the insurrection. Gorbachev returned to Moscow but his days in office were numbered. These events triggered alarm in the U.S. government and community of security experts.[27] President George H.W. Bush had the wisdom to launch the Presidential Nuclear Initiatives,[28] several unilateral arms reduction and threat reduction measures that allowed for a soft landing as the Soviet Union dissolved into 15

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[26] "Treaty on the Prohibition of Nuclear Weapons," United Nations Office for Disarmament Affairs, accessed March 5, 2025, https://disarmament.unoda.org/wmd/nuclear/tpnw/.
[27] Ash Carter, Steven E. Miller, Charles A. Zraket, and Kurt M. Campbell, *Soviet Nuclear Fission: Control of the Nuclear Arsenal in a Disintegrating Soviet Union* (Boston, MA: Harvard University Press, 1991).
[28] Susan J. Koch, The Presidential Nuclear Initiatives of 1991–1992 (Washington, DC: National Defense University Press, 2012), https://ndupress.ndu.edu/portals/68/documents/casestudies/cswmd_casestudy-5.pdf.

independent states on December 25, 1991. The U.S. Congress also rose to the occasion by passing the Nunn-Lugar Cooperative Threat Reduction (CTR) Act in December to pave the way for the safer landing.[29]

The nuclear threat changed dramatically with the breakup of the Soviet Union and the economic devastation that followed in all fifteen former republics. The United States was no longer threatened by the nuclear arsenal in the hands of the Soviet government, but rather the prospects of nuclear weapons, fissile materials, nuclear experts getting out of the hands of the Russian government and the other former Soviet republics. Moreover, the dissolution resulted in Soviet nuclear weapons in the hands of the governments of four states: Russia, Ukraine, Kazakhstan, and Belarus. The Clinton administration, particularly Secretary of Defense William J. Perry, did an admirable job to provide the necessary political incentives and financial support to persuade Ukraine, Belarus, and Kazakhstan to return the Soviet weapons to Russia for disassembly.

The Russian government under President Boris Yeltsin was left with what Senators Nunn and Lugar called an inheritance from hell.[30] At its peak, the Soviet Union possessed 41,000 nuclear weapons, nearly 1.5 million kilograms of fissile materials (highly enriched uranium and plutonium), nearly one million nuclear (military plus civilian) workers, and a vast nuclear empire spanning its 11 time zones—all in a country in political turmoil, its institutions in jeopardy, and its economy in chaos.

In the nuclear world, this resulted in a radical shift from confrontation to cooperation. As director of the Los Alamos National Laboratory at the time, I helped to create the lab-to-lab scientific cooperative program to help mitigate some of the greatest risks in the nuclear weapons complex of Russia and other republics. How that was accomplished together with Russian nuclear scientists and engineers and supported by the governments of the United States and Russia is recounted in *Doomed to Cooperate.*[31] The enormous CTR effort in the Department of

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[29] Fact Sheet: The Nunn-Lugar Cooperative Threat Reduction Program," Center for Arms Control and Non-Proliferation, March 29, 2022, https://armscontrolcenter.org/fact-sheet-the-nunn-lugar-cooperative-threat-reduction-program-2/.

[30] David E. Hoffman, *The Dead Hand: The Untold Story of the Cold War Arms Race and Its Dangerous Legacy* (New York: Doubleday, 2009).

[31] Siegfried S. Hecker, *Doomed to Cooperate: How American and Russian Scientists Joined Forces to Avert Some of the Greatest Post–Cold War Nuclear Dangers* (Los Alamos, NM: Los Alamos Historical Society, Bathtub Row Press, 2016).

Defense is recounted in *With Courage and Persistence.*[32] The U.S. Department of State had numerous CTR efforts. Some of these are described in *Our Own Worst Enemy.*[33]

Hence in the 1990s and into the early 2000s the United States, Russia and the other former Soviet republics worked cooperatively to avoid a nuclear catastrophe. Concerns of a possible nuclear exchange faded into the background. The iconic Doomsday Clock of the Bulletin of the Atomic Scientists was set at 17 minutes to midnight in the early 1990s, the farthest it has been from midnight. In the United States as well as in Russia, the challenge turned to stockpile stewardship—that is, how to keep the decreasing nuclear arsenal safe, reliable and effective without reliance on nuclear testing.

The terrorist attacks on September 11, 2001, once again changed the trajectory of our nuclear concerns. The specter of any one of the planes that hit the World Trade Center or the Pentagon carrying not only a full tank of fuel but a nuclear payload—either a nuclear weapon or radiological materials—focused the attention of the George W. Bush administration on nuclear terrorism. Both President Bush and President Obama were able to marshal the world's leading countries to join the fight against nuclear terrorism. Russia initially was a willing and able partner. Several of the cooperative programs were designed to reduce and safeguard the vast amounts of fissile materials in both countries. Likewise, attention turned to the elimination and safeguarding of radiological materials that might be used by terrorists for dirty bombs.

Yet, these were also the times when Russia and the United States developed very different visions of the future. Whereas Russian President Vladimir Putin chafed at what he called American hyper exceptionalism, President Bush and his advisors saw this time as an opportunity to lead the world to democracy. The United States withdrew from the Anti-Ballistic Missile Treaty in 2002. It invaded Iraq in 2003 and established a significant presence in Afghanistan. President Putin rejected what he called American unilateralism in his February 2007 speech at the Munich Security Conference, which I view as the fork in the road of U.S.-Russian relations. The paths of the two nations continued to diverge leading to a serious break

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[32] Joseph P. Harahan, *With Courage and Persistence: Eliminating and Securing Weapons of Mass Destruction with the Nunn-Lugar Cooperative Threat Reduction Programs* (Washington, DC: Defense Threat Reduction Agency, 2014), https://www.dtra.mil/Portals/125/Documents/History/With_Courage_and_Persistence.pdf.
[33] Sharon K. Weiner, *Our Own Worst Enemy?: Institutional Interests and the Proliferation of Nuclear Weapons Expertise* (Cambridge, MA: The MIT Press, 2011).

with Russia's 2014 annexation of Crimea and occupation of the Donbas region in eastern Ukraine.

Although a few arms control agreements were concluded during this time, such as the Strategic Offensive Arms Treaty (SORT) in 2002 and New START in December 2010, most nuclear and military cooperation had ceased. [34] The Cooperative Threat Reduction program was officially terminated in December 2014. Since then, Russia and the United States have terminated most of their arms control agreements. The extended New START will expire in 2026.

The Legacy and Challenge

The most beneficial legacy of the Atoms for Peace initiative is the Global Nuclear Order. But we must still deal with the problematic legacy of the Cold War arms race, with the backsliding on arms control and nuclear cooperation during the past twenty years, and now with the damage inflicted on the foundation of that order by Russia's invasion of Ukraine on Feb. 24, 2022.

The awesome destructive power of nuclear weapons demonstrated at Hiroshima and Nagasaki followed by the Cold War arms race and concerns of proliferation promulgated a great sense of fear of nuclear technologies.[35] These fears were exacerbated by the environmental and health hazards resulting from the enormous production of fissile materials for bomb fuel and atmospheric nuclear testing by the P-5 powers. The U.S. government responded to the public outcry over its hazardous nuclear sites only as the Cold War drew to a close. Much effort has since been expended to clean up the military nuclear production complexes and the nuclear laboratories. The Department of Energy environmental cleanup budget today exceeds $8 billion annually. Based on the look I got at the Russian nuclear complex during our years of cooperation, I found their problems even more massive and likely not receiving similar levels of remediation attention. There are other sites around the globe that were affected by the nuclear

[34] SORT committed the United States and Russia to reducing their deployed strategic nuclear forces to between 1,700 and 2,200 warheads apiece. The two countries also agreed to keep the 1991 Strategic Arms Reduction Treaty (START I) in force. The New START Treaty entered into force on February 5, 2011. Under the treaty, the United States and the Russian Federation had seven years to meet the treaty's central limits on strategic offensive arms (by February 5, 2018) capped at 1,550 and are then obligated to maintain those limits for as long as the treaty remains in force. See "New START Treaty," U.S. Department of State, accessed March 6, 2025, https://www.state.gov/new-start/.

[35] Spencer R. Weart, Nuclear Fear: A History of Images (Boston, MA: Harvard University Press, 1998).

weapons production and testing of the big powers. These include uranium mining sites in Africa and in American Navajo country, among others. Nuclear contamination also covered the nuclear test sites in Kazakhstan, the Pacific, Algeria, Australia and general nuclear testing fallout around the globe.

The global civilian nuclear industry faced its own challenges with three serious reactor accidents: the first in 1979 at Three Mile Island in the United States, the second in 1986 at the Soviet Chernobyl Nuclear Power Plant in what now is Ukraine, and the third in 2011 at Fukushima Daichi in Japan. These greatly undermined the public's confidence in nuclear power and trust in their governments' ability to regulate and respond. The American civilian nuclear industry was seriously derailed and may only now be able to recover from the Three Mile Island accident and the subsequent concerns about safety and cost. Many safety improvements, both technically and regulatory, have been implemented, but economic competitiveness remains a challenge as well as finding an acceptable process for nuclear waste disposition. The hope today is based on a new class of inherently safe small modular reactors for clean electricity to help mitigate climate change.

The Russians nuclear power industry recovered remarkably well from the Chernobyl accident and became the most successful supplier of fuel-cycle services globally, with a strong base for reactor exports combined with the possibility of spent-fuel return. China was a latecomer in nuclear power, but through collaboration with Westinghouse Corporation it is now in a leading international position. The same can be said for South Korea.

These issues all present significant challenges for the big powers, but none compares to the damage done by Russia's unjustified and brutal invasion of Ukraine and the continued war. It is no exaggeration to say that President Putin blew up the Global Nuclear Order.[36] The no-nuclear-use norm, which Nina Tannenwald called the nuclear taboo,[37] is in jeopardy with Putin's oblique threats to use nuclear weapons in Ukraine when the war was not going well in late 2022. Former president and current Deputy Chairman of the Security Council of the Russian Federation Dmitry Medvedev made similar threats more often and more directly. Russian

[36] John Mecklin, "Siegfried Hecker: Putin Has Destroyed the World Nuclear Order. How Should the Democracies Respond?," Bulletin of the Atomic Scientists, April 21, 2022, https://thebulletin.org/2022/04/siegfried-hecker-putin-has-destroyed-the-world-nuclear-order-how-should-the-democracies-respond/#post-heading.
[37] Nina Tannenwald, "The Nuclear Taboo: The United States and the Normative Basis of Nuclear Non-Use," International Organization 53, no. 3 (Summer 1999), 433–68, https://www.jstor.org/stable/2601286.

intellectuals, such as Sergei Karaganov and Dmitry Trenin,[38] explicitly promoted using nuclear weapons, not directly against Ukraine, but rather in NATO countries to punish them for their support of Ukraine. To make matters worse, they all apparently continue to get strong support from the state news media and the Russian public.

Putin's invasion also tears the intricate fabric of the nonproliferation regime. He violated Russia's negative security assurance given in the 1994 Budapest Memorandum signed by Russian, American and United Kingdom heads of state. The memorandum guaranteed Ukraine's sovereignty and pledged it not to be threatened by nuclear weapons, in return for Ukraine returning to Russia the several thousand Soviet nuclear weapons it inherited at the dissolution of the Soviet Union. Moreover, Russia's cooperation with North Korea and Iran, as well as an agreement for a nuclear power plant construction in the terrorist torn state of Burkina Faso[39] calls into question Russia's support the rest of the nonproliferation regime. Russia's actions may have far-reaching implications around the rest of the world.

Russia's intrusion early in the war into Ukraine's Chernobyl contaminated exclusion zone and the pillaging at the site are actions of an irresponsible nuclear state. Its military takeover of the Zaporizhzhia nuclear power plant, Europe's largest, forcing its personnel to operate at gunpoint, along with active shelling of the site is a form of state-sponsored nuclear terrorism. Much had been done post September 11th around the world to strengthen nuclear power plants against possible terrorist attacks. Russia's actions at Chernobyl and Zaporizhzhia now raise concerns about nuclear power plants in a war zone. India and Pakistan concluded an agreement in 1998 not to attack each other's nuclear sites.[40] There was no such guarantee from Russia as it attacked Ukraine's nuclear power sites.

In addition to destroying these three parts of the Global Nuclear Order, Russia also sets back the drive to increase nuclear power around the world. Russia had made great strides in its

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[38] Sergei A. Karaganov, "A Difficult but Necessary Condition," Russia in Global Affairs, June 13, 2023, https://eng.globalaffairs.ru/articles/a-difficult-but-necessary-decision/; and Dmitry V. Trenin, "A Response to Karaganov's 'A Difficult but Necessary Condition,'" Russia in Global Affairs, June 22, 2023, https://eng.globalaffairs.ru/articles/ukraine-and-nuclear-weapons/.

[39] "Burkina Faso and Russia's Rosatom Sign Agreement for Nuclear Power," Reuters, October 13, 2023, planthttps://www.reuters.com/world/africa/burkina-faso-russias-rosatom-sign-agreement-nuclear-power-plant-2023-10-13/.

[40] Government of India & Government of Pakistan. (1988, December 31). Agreement between India and Pakistan on the prohibition of attack against nuclear installations and facilities [Non-attack agreement]. Entered into force January 1, 1991. Nuclear Threat Initiative. https://www.nti.org/wpcontent/uploads/2021/09/india_pakistan_non_attack_agreement.pdf

own nuclear power program after the Chernobyl accident in 1986—a switch to light water reactors, better and more independent regulatory system, and better operator training and discipline. Russia had developed closer cooperation internationally and specifically with the West. By 2020, Russia has signed more foreign orders for construction of nuclear power plants than any other country. Those are now in jeopardy. Agreements like those with Burkina Faso raise warning flags about Russia's international sense of responsibility.

Russia had also become an essential element in the nuclear power supply chain, particularly in the conversion and enrichment of uranium for nuclear reactor fuel. Today, Russia is still the biggest exporter of enriched uranium and enrichment services globally. It accounts for about 44 percent total capacity of global enrichment services.[41] It is estimated that Russia sold $2.7 billion of enriched uranium to the West in 2023—at a time when the West tried to sanction much of Russia's exports to the world because of the war in Ukraine. Russia was also the only country that offered spent-fuel takeback for the reactors it constructs in other countries. It has down-blended some of its enormous stock of highly-enriched uranium into HALEU (high assay low enriched uranium [LEU]) —typically just under the 20 percent U-235 limit for LEU.[42] Such fuel is essential to many of the small modular reactor designs. That is now also in jeopardy.

Russia's participation in international organizations critical to the non-proliferation regime, such as the IAEA and the Comprehensive Test Ban Treaty Organization is now also more problematic. In fact, Russia recently decided to de-ratify its agreement for the Comprehensive Test Ban Treaty.[43] Russian nuclear research facilities had offered unique test facilities useful to Western countries as they develop new reactor concepts and new fuels or prepare for fusion energy. Clearly, no Western country will send its researchers to Russia now. Likewise, many of the other cooperative research ventures, such as neutrino observatories, are now in limbo.

Conclusions

[41] Henry Ridgwell, "West Reliant on Russian Nuclear Fuel Amid Decarbonization," Voice of America News, March 26, 2024, https://www.voanews.com/a/west-reliant-on-russian-nuclear-fuel-amid-decarbonization-push-/7543132.html.

[42] At the end of the Cold War, Russia also agreed to down-blend 500 metric tons of highly enriched uranium into LEU suitable for use in American nuclear power plants. This program, known as Megatons to Megawatts, ended in 2013 and provided much of the nuclear fuel for American nuclear reactors.

[43] It should be added, however, that in 1999 the United States Senate failed to ratify the CTBT and has still not ratified it.

In my view, Eisenhower's vision of Atoms for Peace has provided many of the benefits of nuclear energy while through international cooperation combined with good leadership and some luck has managed to limit the dangers. Putin's invasion of Ukraine has undermined the very foundation of the Global Nuclear Order. It has put Russia on a trajectory of an irresponsible nuclear state with outcomes yet undefined. It now behooves countries of the rest of the world to redouble their efforts to restore that order. We won't be able to count on Russia until it rejoins the nuclear world as a responsible state. It will be crucial for the other two great powers, the United States and China, to find a way to cooperate to restore that order.