Los Alamos National Laboratory December 2014

NATIONAL SECURITY SCIENCE

Back into the COLD?

In this issue

Rethinking the Unthinkable

Debunking Nuclear Weapons Myths

Welcome to this issue of

NATIONAL SECURITY SCIENCE

In this issue's cover story, "Rethinking the Unthinkable," *Houston T. Hawkins, a retired Air Force colonel and a Laboratory senior fellow, points out that since Vladimir Putin returned to power in Russia, relations with the United States and its NATO allies have cooled down like a thermometer in December. The biting off of Crimea from the Ukraine, the callous shooting down of a Malaysian passenger jet, and the frank words and deeds demonstrating Putin's intention to consume more of the Ukraine and "other lands where people speak Russian" have raised concerns that, after two decades of hibernation, the Bear is awake—aggressive and very hungry. The relations have taken on a tone reminiscent of the Cold War.*

Whereas these bellicose actions and others—such as Russia's tests of a new nuclear-capable intermediate-range cruise missile in violation of nuclear arms control treaties—are widely known, others are less so. Col. Hawkins presents a long list of what Russia is doing to modernize and build up its nuclear capabilities. In comparison, what is the United States doing to stay on par with or ahead of its rivals in nuclear science, technology, and deterrence?

Many of us doing national security science encounter rational thinkers who hold beliefs and opinions about nuclear weapons that are contrary to fact. Examples include "maintaining the U.S. nuclear deterrent is just too expensive," or "the United States can maintain an effective nuclear deterrent by relying solely on its nuclear submarines" or "the world is made safer every time the U.S. nuclear stockpile is reduced."

The article "Debunking Six Big Myths about Nuclear Weapons" *provides readers with facts to use in responding logically to these and other misconceptions commonly held by a thoughtful but often not-well-informed public.*

If it is to meet its mission—to solve national security challenges using the world's best science—the Laboratory requires the support of a well-informed public. I hope this issue helps shed some much needed light on what some of the national security challenges are and on what Los Alamos and the other U.S. national security laboratories need if we are to help meet those challenges. The safety and security of the nation, and its allies, are at stake.

Craig Leasure
Principal Associate Director, Weapons Program (acting)

INSIDE THIS ISSUE

The Laboratory dedicates this issue of National Security Science *to*

Bret Knapp
1958–2014

Bret dedicated his career to ensuring a safer and more secure United States.

About the Cover

Russia is flexing its military muscle once again. In addition, it is rebuilding and modernizing its nuclear forces and turning a cold shoulder to the West. How icy will East-West relationships become?

Managing Editor | Clay Dillingham

Writers/Editors | Eileen Patterson, Lisa Inkret

Science Writer/Editor | Necia Grant Cooper

Designers/Illustrators | Kelly Parker, Barbara Maes, Leslie Sandoval

Photographers | Ethan Frogget

Editorial Advisor | Jonathan Ventura

Laboratory Historian | Alan Carr

Printing Coordinator | David Van Etten

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Kidde
Kokoon
FALLOUT SHELTER
CANNED WATER

During the Cold War, in the 1950s and '60s, the fear of nuclear war drove thousands of U.S. families to provide themselves with costly bomb shelters (also called fallout shelters), either converting their basements or installing prefabricated shelters several feet underground in their backyards. The shelters were stocked with essential supplies, and even some amenities, against the possibility of the families' having to shelter for many days or weeks. (Photo: Open Source)

RETHINKING THE UNTHINKABLE

The Cold War began in 1945 with the use of nuclear weapons to end World War II and officially ended in December 1989 with a joint declaration in Malta by Presidents George H. W. Bush and Mikhail Gorbachev. In retrospect, excepting the regional wars in places like Korea and Vietnam, this 44-year period was remarkably stable. While many factors contributed to this stability, the contribution of nuclear weapons is undeniable.

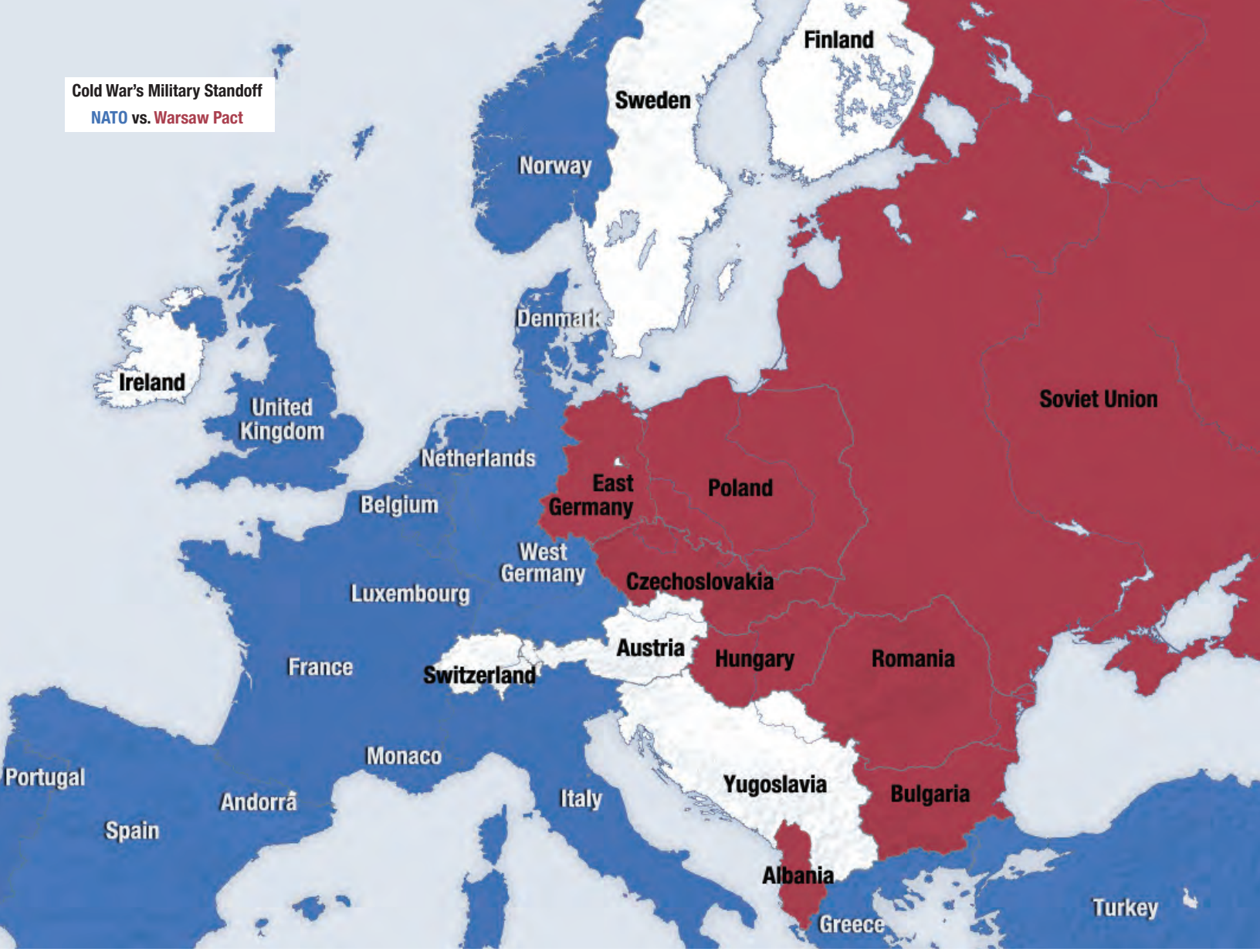
Nowhere is this stability more obvious than in Europe. During the 3.5 centuries before 1945, a major war had erupted in Europe every 11.9 years, and each lasted an average of 6.6 years. As the weapons for conventional war improved, each new war was more vicious and cost more in human lives than the previous one.

Yet for over 40 years following World War II, opposing U.S. and Soviet forces were poised for war in Europe but remained fixed in place. Why? Amassing adequate conventional forces in Western Europe to counter Soviet forces had been politically, economically, and geographically impossible. The peak size of the U.S. Army during the Cold War was 18 divisions. The Soviets had approximately 200 divisions. Western Europe could not have been protected from Soviet aggression without the balance of power brought by the omnipresent American nuclear weapons.

The prospect that any untoward movement to the east or to the west would precipitate the nuclear annihilation of nations, on both sides of the Iron Curtain, resulted in the stalemate created by nuclear weapons. The certainty of "mutually assured destruction" (MAD) reversed that centuries-old pattern of major European warfare and carnage. Europe has not had a major war for 69 years. So while a national security strategy based on MAD might not be Nirvana, history shows that as a deterrent, it worked.

How Deterrence Worked

During the Cold War, much was written on specific factors necessary to achieve deterrence. These requisite factors always included the following: (1) maintaining an acceptable degree of strategic parity between the states involved, (2) having confidence that weapons involved in deterrence would function as designed if called upon to do so, (3) avoiding significant surprises regarding advancements in the nuclear capabilities of foreign nations, and (4) ensuring that intelligence for the U.S. decision makers would be of the highest caliber possible. Prompt and accurate detection of foreign launch preparations and/or actual launches was an important aspect of this latter paradigm. Distinguishing Soviet exercises from actual preparations for a preemptive attack was equally important. Let us examine each of these in turn.



Nuclear weapons work without being detonated. They kept the Warsaw Pact's armies at bay for almost 50 years.

Maintaining Parity

Maintaining the evolving strategic parity with the Soviet Union resulted in the nuclear arms race. Ultimately, parity was arguably a non sequitur in that both the United States and the Soviet Union had more than sufficient numbers and varieties of nuclear warheads and delivery systems to destroy the other, even if a substantial fraction of these nuclear weapons had been destroyed in a preemptive attack.

Confidence That Your Weapons Will Work

Confidence on both sides that their respective nuclear weapons would function properly was achieved through well-funded nuclear weapons physics and engineering laboratories—staffed with scientists and engineers of the highest caliber—and through well-planned nuclear weapons testing programs. These tests were originally in the atmosphere and later underground. Ironically, radioactive debris from the atmospheric tests provided the other party with significant insights into the testing party's technology. This fact, and not concern over introducing radioisotopes into the environment, may well have constituted the most compelling impetus for underground testing.

In any case, when the 1963 Limited Test Ban Treaty moved all nuclear weapons testing underground, its ratification by the U.S. Senate was accompanied by robust safeguards that required the following: the maintenance of modern nuclear weapons laboratories and associated research; the establishment of the National Nuclear Test Readiness Program to enable a return to atmospheric testing if necessary for "supreme national interests;"[1] an active program to improve methods to detect, characterize, and monitor foreign nuclear

[1] A proviso of the 1963 Limited Test Ban Treaty authorized a resumption of U.S. atmospheric nuclear testing if the safety or reliability of the nuclear weapons stockpile could not be assured, with high confidence, without testing. The proviso grew out of the 1961 surprise Soviet withdrawal from the U.S.–Soviet mutual testing moratorium. From September through December, the Soviets conducted 56 tests, including the October test of the world's largest-ever (more than 50 megatons) nuclear weapon, "Tsar Bomba." They conducted more than 70 additional tests in 1962. The United States rushed to reestablish its own tests, but took until April 1962 to conduct its first one. The treaty's proviso is meant to ensure that the United States retains its nuclear testing capability even during test moratoriums like the current one.

detonations; and a robust nuclear weapons intelligence program. In the United States, similar safeguards were again appended to both the 1974 Threshold Test Ban Treaty and the 1996 Comprehensive Test Ban Treaty (CTBT). (The provisions of the CTBT are de facto in effect. The treaty was rejected by the U.S. Senate in 1999 by a vote of 51 to 48.)

No Big Surprises, Please!

During the Cold War, avoiding being surprised by some advancement in the nuclear capability of a foreign nation was considered essential, and this fact drove the development and use of many highly advanced technologies to gather information of the highest quality. This strategy gave rise to many critical innovations, including the Atomic Energy Detection System, which looked for nuclear weapon detonations; worldwide signal intelligence, including communications intelligence and electronic intelligence; reconnaissance systems, including the U-2 spy planes and Corona photographic satellites; and missile-launch detection systems. Of course, human-gathered intelligence was critical too, and much of what are viewed as "classical" espionage activities focused on gathering intelligence on nuclear capabilities.

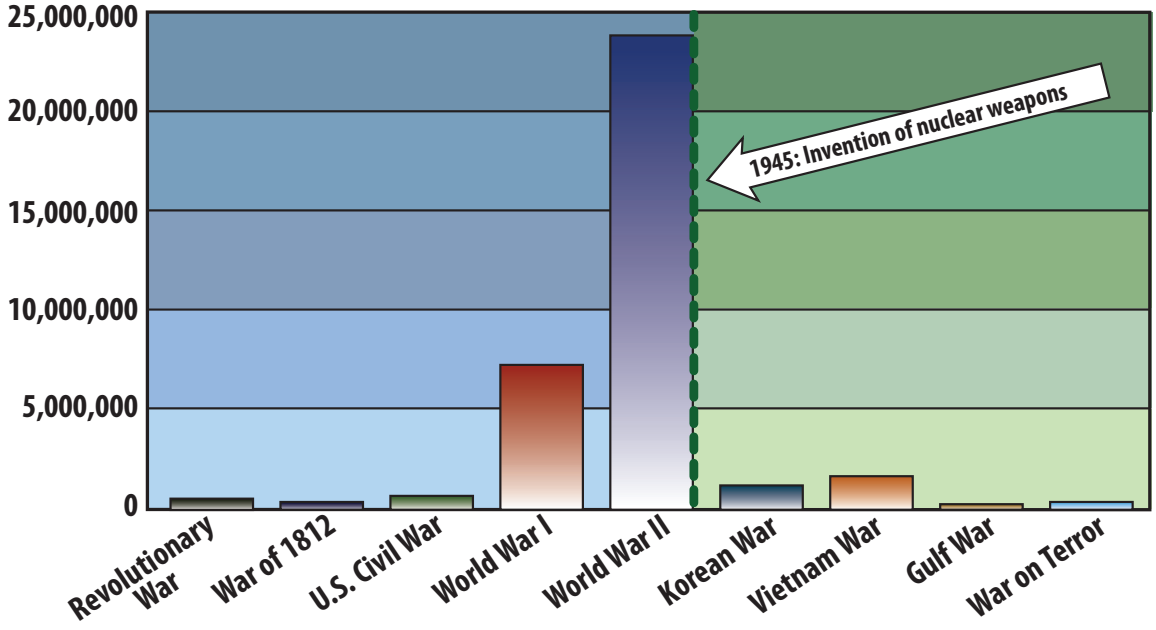
Intelligence Analyses for Making Decisions

Capabilities dedicated to analyzing this type of information for the government's decision makers were well-funded and diversified and included using nuclear scientists, particularly those at the nuclear weapons laboratories, as analysts. The value of using U.S. experts in nuclear weapons to review the data on foreign nuclear weapons activities is obvious.

The Central Intelligence Agency (CIA) established a Field Intelligence Element (FIE) at Lawrence Livermore National Laboratory, and the Defense Intelligence Agency formed FIEs at both Los Alamos and Sandia National Laboratories. In 1976 George H. W. Bush Sr., then the director of the CIA, exempted the Department of Energy's (DOE) FIEs from "contractor" status, an action that provided these civilian FIEs with exceptional access to intelligence information.

How Deterrence Is Working Today: Cold War Lessons Forgotten in a Hot, New World

With the end of the Cold War, the world political landscape has become much more convoluted and unpredictable and dangerous. Nowhere is this change more obvious than in the growing animus toward the United States as the world's chief superpower and its major cultural bully. A concomitant surge has also arisen in reemerging historical conflicts, regional "warlordism," lethal violence by nonstate actors, and international competition for resources, especially energy. Against this new backdrop, terrorists with the declared goal of acquiring nuclear weapons are being supported directly by nations actively pursuing such capabilities themselves in direct violation of international agreements, for example, Hezbollah receiving support from Iran. Other jihadist terrorists, some of them emboldened by "fatwas," are looking for opportunities to acquire nuclear weapon materials directly through theft or diversion.

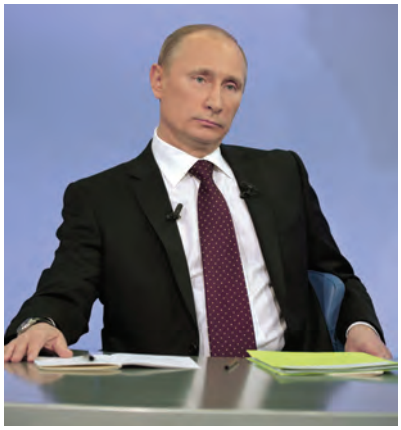


Estimated military deaths from wars before and after MAD. In addition, there were up to 55 million civilian deaths during World War II. Europe has not had a major war for 69 years.

There is a reemergence of confrontational strategies by Russia towards the United States. For example, during major strategic exercises in 2013, the Russians flew two Tu-160 Blackjack strategic bombers to Venezuela. In the Tu-160 shown here, Putin is the pilot launching the cruise missile. The Tu-160, which entered service in 1987, remains the largest supersonic aircraft in the world. The Tu-160 is designed to destroy strategic targets with nuclear or conventional weapons. Some of the Tu-160s are being modernized, but they will be replaced by a new-generation strategic bomber known as PAK-DA. (Photos: Open Source)

Tough Talk from the Bear . . .

Russia's recent actions to demonstrate its independence, military prowess, and new economic power are troubling. These actions include probes by Russian strategic bombers of U.S. naval operations and air defenses around Alaska, Canada, Greenland, and Great Britain; large joint exercises involving Russian and Chinese armed forces; Russia's continued support of Iran's nuclear ambitions; explicit nuclear threats against Poland for accepting a missile defense base on Polish territory; the military incursions into the Republic of Georgia; and more recently, the illegal seizure of Crimea from the Ukraine.



In March 2014, during the crisis in Crimea, Russian spokesman Dmitry Kiselyov starkly reminded the United States that, "Russia is the only country in the world that is realistically capable of turning the United States into radioactive ash." In December 2013 President Putin had named Kiselyov to head a new state news agency charged with portraying Russia in the "most positive light."

Russian Chief of Staff General Yuri Baluyevsky bluntly stated Russia's policy on the use of nuclear weapons: "We do not intend to attack anyone, but we consider it necessary for all our partners in the world community to clearly understand . . . that to defend the sovereignty and territorial integrity of Russia and its allies, military forces will be used preventively, *including the use of nuclear weapons.*"[2] [Emphasis added.]

> **"Russia is the only country in the world that is realistically capable of turning the United States into radioactive ash."**
>
> **~Russian spokesman**

Immediately, many Western policy analysts concluded that Baluyevsky's remarks did not really constitute a shift in Russian policy. However, even a casual observer must consider the policy in the context of the significant modernization now on-going in Russian tactical and strategic nuclear forces and the disturbing increases in Russian probing of Western defenses and resolve.

. . . While the Eagle Is Napping?

While the Russian military holds a positive view of nuclear weapons, these weapons have lost support within elements of U.S. armed forces assigned residual responsibility for them. For example, in August 2007, six nuclear weapons were accidentally loaded on a B-52 strategic bomber at Minot Air Force Base (AFB), North Dakota, and flown to Barksdale AFB, Louisiana, where they sat on the tarmac unnoticed

Continued on p. 8 ▶

[2]General Baluyevsky made this statement in January 2008 at a military conference that was broadcast on Russia's state-run cable Vest-24.

The Bear Comes Out of Hibernation

Nicknamed the "Bear," Russian Tu-95 nuclear capable bombers are again practicing attacks against the United States. (Photo: Open Source)

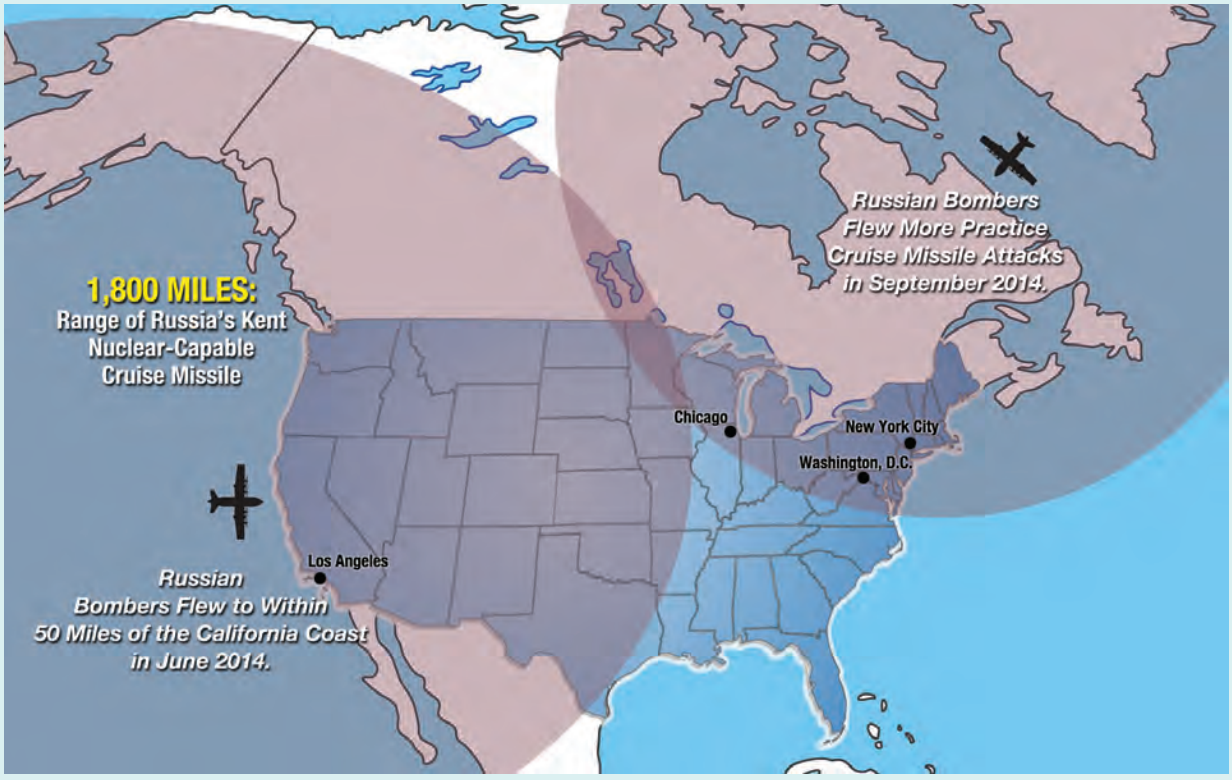
On August 17, 2007, Russian President Vladimir Putin announced that Russian heavy bombers were resuming regular air patrols outside Russian territory: "I have decided that flights of Russian strategic aircraft on a permanent basis should be resumed . . . ." Putin was reversing U.S.-Russia parallel and unilateral post–Cold War decisions to stop nuclear-capable bomber combat patrols into each other's air defense identification zones.

Since then there have been more than 50 instances of Russia's ignoring the post–Cold War practice. On June 13, 2014, Russian Tu-95 bombers, which can carry nuclear weapons such as the Russian AS-15 Kent cruise missile, with a range of 1,800 miles, flew to within only 50 miles of the California coast, close enough to threaten large U.S. cities in states as far east as Minnesota, Iowa, and Missouri. It was the closest a Russian aircraft had come to California since July 2012.

Then in September 2014, Russian bombers flew a similarly aggressive mission off the northeast coast of Canada. They came close enough that their cruise missiles could have reached Chicago, New York City, and Washington, D.C.

It is not known if the Tu-95s were armed with nuclear weapons on either of these occasions.

The Tu-95s can legally come inside the U.S. air defense identification zone, which extends 200 miles from the coastline and is part of international airspace. Foreign aircraft are required to identify themselves inside the zone. U.S. sovereign airspace, which foreign military aircraft may not enter without permission, extends 12 miles beyond the coast.



In 2009 Russian resumed its Cold War–era nuclear submarine patrols off U.S. coastlines. Pictured here is a Russian Delta IV nuclear missile submarine. The Delta-class submarines are being replaced with the modern Borei-class submarines, armed with newly designed ballistic missiles carrying new nuclear warheads. Russia has increased its military spending by 100 percent since 2004. (Photo: Open Source)

◀ *Continued from p. 6*

for *36 hours.* The Defense Science Board, charged with investigating the incident, concluded that commingling nuclear forces with nonnuclear organizations has led to "markedly reduced levels of leadership whose daily focus is the nuclear enterprise and a general devaluation of the nuclear mission and those who perform the mission."

Obviously, the mishaps of a few should not be used to denigrate the commitment of whole commands. However, nuclear weapons, which were designed to prevent war, arguably have never been popular with the majority of military officers, whose careers are often defined by their execution of war and not their maintenance of peace. Clearly, sitting in a silo watching over a 30-something-year-old nuclear-tipped missile under an aged banner declaring "Peace Is Our Profession" is not as exciting and ribbon-garnering as flying a new F-22 Raptor air-superiority fighter into combat. On the positive side, General Norton Schwartz, at that time the U.S. Air Force Chief of Staff, declared the reinvigoration of the Air Force's nuclear enterprise his "number one priority."

Unfortunately, several recent widely publicized events, such as one at Malmstrom AFB in Montana, suggest that this "reinvigoration" has not been realized. In January of this year, more than 90 Malmstrom missileers, officers in charge of nuclear-armed ballistic missiles, were suspended for cheating or condoning cheating on monthly proficiency exams. The cheating was revealed during an investigation of illegal drug use and involved nearly half of the base's missile launch crew.

Are Smaller Stockpiles Really Better?

If Russian and U.S. deployed stockpiles are reduced below several thousand to several hundred weapons, the relative influence that other, smaller nuclear weapons arsenals could have on international security and stability would increase significantly. The possibility of producing enough weapons to reach parity would certainly be attractive to China and within its reach.

As with Russia, China has embarked on a major initiative to improve and modernize its nuclear weapons complex, beginning under Deng Xiaoping's 1978 economic reforms. More recently, this continuing initiative has greatly benefitted from the industrial modernization that is occurring in China, particularly from improvements in high-performance computing, precision manufacturing, and quality assurance.

> **Without very careful planning, disarmament would take us into an even more unstable and dangerous world.**

If the downsizing of Russian and/or American nuclear weapon inventories were to entice China to expand its nuclear weapons arsenal to parity with them, that expansion would not be constrained by a lack of technology or resources or by extant proscriptive treaties. Obviously, bringing China

Like Russia, China has embarked on a major push to improve and modernize its nuclear weapons complex and its military capabilities in general. China has increased its military spending by 170 percent since 2004. Shown here is the Chengdu J-20, a stealth, twin-engine fifth-generation fighter aircraft prototype. The J-20 is expected to be operational in 2017–2019. (Photo: Open Source)

into any nuclear arms reduction negotiations between Russia and the United States would become increasingly important.

> **As with Russia, China has a major initiative to improve and modernize its nuclear weapons complex.**

Smaller U.S. and Russian stockpiles could even encourage the nuclear weapon ambitions of emerging nuclear weapon states such as Iran. The status of Iranian aspirations toward achieving a nuclear weapons capability is somewhat confusing. For example, in 2008 one National Intelligence Estimate (NIE) concluded that Iran had made the decision to stop its nuclear weapons program. Other experts disputed this estimate. Ironically, in another estimate, the NIE concluded with moderate confidence that the earliest possible data Iran would be technically capable of producing enough highly enriched uranium for a weapon was late 2009. Even Director of National Intelligence Admiral Michael McConnell seemed to reconsider the NIE's first estimate when he said, "I think I would change the way that we described [the Iranian] nuclear program."[3]

[3]Admiral McConnell's clarification came in testimony to the Senate Select Committee on Intelligence on February 5, 2008. He added, "We remain concerned about Iran's intentions and assess with moderate-to-high confidence that Tehran at a minimum is keeping open the option to develop nuclear weapons."

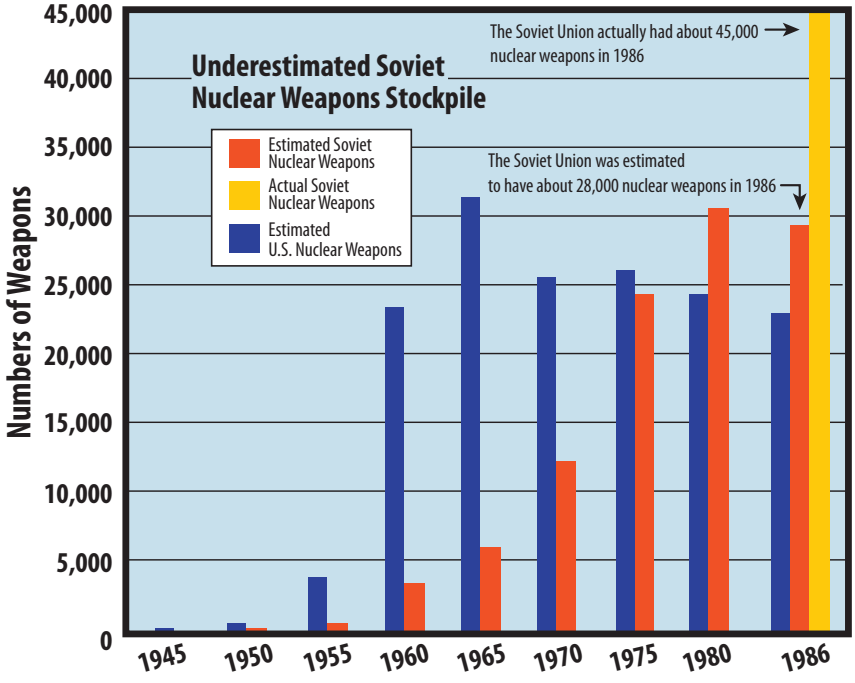
Whatever the actual status of Iranian nuclear weapon ambitions and capabilities, the rhetoric and ambitions expressed by Iran would lead one to conclude that nuclear weapons are an essential element in the reestablishment of Iran's historical dominance within the Fertile Crescent. In that case, negotiated reductions of Russian, American, and possibly Chinese arsenals must consider Iranian ambitions.

Of course, lower U.S. and Russian force levels also could precipitate a switch in their targeting strategies. Specifically, emphasis on "countervalue" targeting (the targeting of cities and civilian populations versus military assets) could supplant strategies based on "counterforce" targeting (military assets). While any strategies involving nuclear weapons would hold large populations at risk, at least indirectly, the change to smaller nuclear arsenals could result in the change to direct targeting of population and industrial centers, thereby giving each nuclear warhead a larger "deterrent value."

In the absence of very careful planning, the march toward disarmament would take us backwards into an even more unstable and dangerous world.

Seeking Balance in a New and Unstable World

In this unstable world, or possibly because of the instability, almost everyone would agree that the nuclear arsenals of the United States and Russia exceed numbers required for nuclear deterrence provided that a requisite balance is also achieved in the other defense elements that contribute to



In 1986 the United States underestimated the Soviets' nuclear arsenal by about 17,000 weapons.

deterrence. From the perspectives of both sides, those other defense elements include the respective confidence in their capabilities to maintain and certify the safety and reliability of their nuclear weapons, their extant abilities to rapidly reconstitute larger and/or different arsenals should these become necessary, and the survivability and reliability of their delivery systems.

For the United States, other essential defense elements include the possibility of resuming nuclear weapons tests under the "supreme national interest" clause of the CTBT. Such tests would be to ensure nuclear weapon readiness and effectiveness and to remediate any major defects that might be discovered via our Stockpile Stewardship Program and that are deemed a threat to U.S. security.

Often overlooked by proponents of disarmament who focus on the relative numbers in active or reserve stockpiles, these other defense elements are essential to the calculus of stability and must be maintained even as nuclear arsenals are reduced toward any bilateral goal of ultimate elimination. Then again, even if the United States and Russia agree to lower levels, what is the basis for establishing the new levels, and can these levels be verified—given our prior record of inaccurately estimating the size and composition of foreign nuclear arsenals?

Maintaining Parity: Problems with the Numbers

Since the end of the Cold War, maintaining parity with Russia has resulted in extensive negotiations to reduce strategic nuclear weapon stockpiles, eliminate specific weapons, enact specific limits or bans on nuclear weapon testing, and enact specific limits on antiballistic systems and capabilities. Thus, the most referenced comparisons between the U.S. and Russian nuclear arsenals are the relative numbers of strategic (but not tactical) weapons in their active and reserve stockpiles.

However, generating an estimate of those numbers of weapons and then verifying the estimates are problematic. Historically, the estimates have not always been accurate. For example, the *error* in the estimated size of the Soviet nuclear stockpile during the Cold War was larger than the *entire stockpile Russia is estimated to have today*. In 1993 the Russians revealed that the Soviet's nuclear stockpile peaked in 1986 at 45,000 weapons. This number was 17,000 warheads above estimates from the U.S. intelligence community (IC) at the time. Today, estimates are that Russia has about 4,500 strategic weapons in its inventory. But how accurate are these new estimates?

The error in the estimated size of the Soviets' Cold War nuclear stockpile was larger than Russia's entire estimated stockpile today.

The primary driver for why the Cold War assessment was so wrong was a persistent belief on the part of the IC that Soviet production of highly enriched uranium was achieved using gaseous-diffusion technology, which is considered to be a relatively inefficient enrichment technology. As such, the estimated quantities of uranium that could be produced, about 500 metric tons, were incapable of supporting any larger estimate of the Soviet nuclear weapons inventory. This view was defended in spite of contrary information that, by the mid-1980s, the Soviets had developed a large surplus in uranium enrichment capacity as evidenced by the fact they were strenuously trying to market excess enriched uranium to Western Europe. We now know that the Soviet Union had converted its entire enrichment process to the highly efficient gas-centrifuge technology and that the IC estimate of Russia's highly enriched uranium was low by at least 500 metric tons.[4] Therefore, our estimate was off by 100 percent.

[4] An intelligence assessment prepared for the Starbird Study (1980) correctly assessed that Russia had converted its uranium enrichment process to gas centrifuges and estimated Russia's nuclear weapon stockpile at 45,500. This assessment was harangued by arms control advocates as "wild speculation by war mongers" and by the U.S. intelligence community as "misinformed." ("Russian Says Soviet Atom Arsenal Was Larger Than West Estimated," William J. Broad, *The New York Times*, Sept. 26, 1993)

Obviously, stability is best achieved within a framework where estimates can be verified promptly and with an acceptable degree of certainty. Unfortunately, our history in formulating such estimates does not add to our confidence that such estimates will be valid.

Moreover, at lower numbers of strategic weapons, the calculus of stability requires that tactical nuclear weapons must also be taken into account. This imperative arises because such categorizations as "tactical" and "strategic" are policy-driven differences without any significant military distinction. Tactical nuclear weapons are defined as those used on a battlefield whereas strategic weapons are used against cities and a nation's military-industrial complex. But a nuclear warhead is a nuclear warhead, and the "how" and "why" it might be used are nuances of no import to the people targeted.

Thus, a disparity in the number of stockpiled tactical nuclear weapons is as significant as a disparity in strategic weapons. Their numbers should be combined when determining the calculus of stability.

At lower numbers of strategic weapons, the calculus of stability requires that tactical nuclear weapons must also be taken into account.

Without Testing: Confidence That the Weapons Will Work

Arms control agendas must consider the United States' capabilities to maintain and certify the aging weapons in its reduced nuclear arsenals. In the absence of nuclear weapon testing, maintaining and certifying nuclear weapons have defaulted to the Stockpile Stewardship Program, which is based on computer simulations, nonnuclear experiments, and scientific observation of nuclear weapons materials and components.

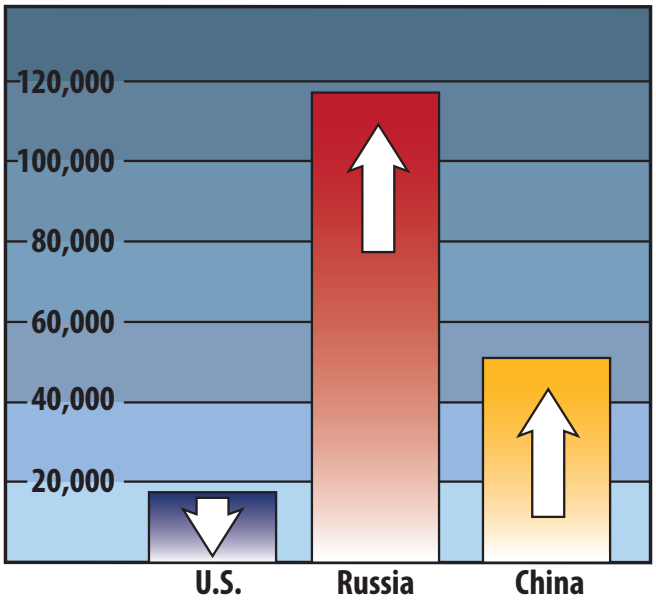
A second part of this program entails fabricating replacement warheads using extant procedures to replicate, as accurately as possible, the legacy warheads being replaced. Both parts of this program require the following: a significant reliance on legacy nuclear weapon designs and testing data; legacy manufacturing techniques that have fabrication problems, including a lack of detailed documentation regarding manufacturing designs and their acceptable tolerances; and access to materials that can adequately replace those no longer available, including some adhesives, lubricants, plastics, and materials (such as asbestos) that are now proscribed in the workplace.

Obviously, the most essential ingredient of any legacy-dependent program is the long-term retention of the requisite knowledge base and the special facilities upon which such a program must rely. But is this retention taking place?

The number of U.S. nuclear facilities that allow research on materials for nuclear weapons has been reduced significantly.

The U.S. nuclear weapons science laboratories were the last bastions within the DOE to be "transformed," that is, converted from nonprofit to for-profit organizations. Obviously, positive changes are always needed in any organization to preserve its vital capabilities. Such changes normally focus on cost savings, efficiencies, responsiveness, improvement in the work environment, and opportunities that will attract "the best and brightest" workforce.

It remains to be seen whether or not the recent transformations at both Los Alamos and Lawrence Livermore National Laboratories are successful. For example, have they retained benefits and hiring incentives sufficient to attract and retain a workforce with the requisite knowledge base capable of maintaining the extant U.S. nuclear weapon stockpile or of manufacturing replacement warheads? In fact, a number of the best mid-career contributors to whom the laboratories'



Estimated staffing of nuclear weapons complexes in 2014. The differences in the staffing are due primarily to the fact that Russia and China are maintaining and expanding their nuclear weapons production capabilities, while the United States has largely dismantled its capabilities.

After only 74 years of experience with the element, how well do we really understand plutonium? We still have problems predicting the stability of steel structures under stress, despite our over 2,000 years experience with steel. Here, cars rest on the collapsed portion of the I-35W Mississippi River bridge in Minneapolis, MN, after the bridge's August 1, 2007, collapse. (Photo: Open Source)

accumulated knowledge might have been transferred have already left or are planning to do so.[5]

For sure, in the absence of replacing these staff or providing other types of succession planning, workforce reductions at Los Alamos and Livermore have resulted in the loss of thousands of person-years of corporate memory covering the period of time in which U.S. nuclear weapons were designed, built, and actually tested. This is memory that is critically important to the national security mission of DOE's National Nuclear Security Administration (NNSA).

> **An essential ingredient of any legacy-dependent strategy is the retention of knowledgeable people and special facilities.**

In addition, the number of Category 1 nuclear facilities, the category that allows research on plutonium, uranium, and other materials for nuclear weapons, has been reduced significantly. For example, at Los Alamos, the number of such facilities has decreased from 12 in the late 1980s to 1 today. It is not obvious, given the situation, how the requisite materials research necessary for maintaining the residual U.S. stockpile and for performing technical assessments of foreign nuclear weapons capabilities will be sustained.

More important, the nonprofit university environment at Los Alamos and Livermore, initially provided by the University of California, no longer exists. Ironically, it was that environment, in which every idea and concept was challenged by the "clash of mind with mind,"[6] that gave the United States intrinsically reliable and yet intrinsically safe nuclear weapons.

Finally, although successful testing is the gold standard for having confidence our weapons will work as designed, the safeguards in the National Nuclear Test Readiness Program are now ignored or not maintained. Under those safeguards, the United States should maintain the capabilities needed to resume nuclear testing if needed in the future—but is this being done?

Nuclear Vigor: Russia and China

After the end of the Cold War, the Russian federal nuclear centers VNIIEF and VNIITF and other nuclear weapon research organizations were stabilized by an influx of U.S. support to, for example, prevent the migration of Russian nuclear weapons expertise. Today, in contrast to what is happening at their American counterparts, these Russian institutes are seeing their benefits, compensation,

[5] From the end of the Cold War until 1996, the DOE/NNSA contractor workforce dropped from about 59,000 to less than 30,000. Possibly because of the position taken by NNSA that "science-based stockpile stewardship" was essential to maintaining the stockpile without testing, the Los Alamos and Livermore laboratories were the last two organizations to be downsized and given new contractual configurations. This downsizing of their workforces continues; in 2012, for example, Los Alamos offered incentives to leave the Lab that reduced its staff of about 10,000 by about 800: an 8 percent reduction.

[6] "A university… is a place where inquiry is pushed forward, and discoveries verified and perfected, and rashness rendered innocuous, and error exposed, by the collision of mind with mind, and knowledge with knowledge." (John Henry Cardinal Newman, "The Idea of a University," 1852)

The Soviets discovered a surprisingly easy way to defeat our warheads.
(Photo: Defense Nuclear Agency)

appreciation, working conditions, facilities, and meaningful research significantly improve. Rigorous research—including year-around experimentation at their Novaya Zemlya Test Site, which is leading to the development and deployment of new Russian nuclear weapons for newly designed delivery systems—continues to be their top priority.

The improvements in Russia's nuclear capabilities are leveraged off the increased profits garnered from Russian exports of oil on the one hand and driven by new confrontational trends in foreign policy on the other. The net result is that, at a time when U.S. nuclear weapon budgets are being cut and U.S. nuclear weapon experts are being offered early retirements or terminated, Russia's 2014–2016 defense program is planning a 50 percent spending increase in its nuclear program, designed to fund a significant upgrade in Russian strategic nuclear forces in conjunction with more Russian nuclear weapons research.

China's nuclear weapon program is enjoying a similar economic vigor and is directly benefiting from the rapid infusion of foreign advanced technologies appurtenant to China's economic modernization.

Russia's 2014–2016 defense program is planning a 50 percent spending increase in its nuclear program.

Surprising Ourselves

In the historical flow of science, nuclear weapons physics represents a relatively recent development. While nuclear weapons research has been rigorously pursued for over 70 years, it is naive to maintain that all possible technical discoveries that could lead to an advantage or all failure mechanisms that could lead to a disadvantage have been investigated and defined.

For example, our knowledge of plutonium metallurgy is only 74 years old whereas our knowledge of steel metallurgy exceeds 2,000 years. But as we learned from the collapse of the World Trade Center's Twin Towers in September 2001 and the I-35W bridge in Minneapolis in August 2007, we have problems predicting the stability of steel structures under stress despite our long history of working with steel.

Imagine then the challenges we face in understanding plutonium. Plutonium is much more complex and unstable than iron. Material scientists who work with plutonium know that predicting its behavior has always been a careful balance between empirical knowledge and informed guesswork. In an era when testing is banned, these plutonium ambiguities become even more problematic.

Staying on the right side of the fulcrum today requires rigorous, long-term experimental research programs in plutonium metallurgy, energetic materials, and weapons physics. These programs are supported by supercomputer modeling and simulation in lieu of the validation that testing would provide. Regardless of these efforts, because the properties of plutonium continue to change with age, what we think we know now about the plutonium triggers inside our nuclear weapons could change, and this could surprise us in some very unwelcome ways. The Stockpile Stewardship Program, in its present form, might work for now, but whether it will continue to be the best way to steward the nuclear stockpile should be questioned at some point in the future.

Just as we surprised our adversaries in WWII with our technological advances, our adversaries today can do the same to us.

Surprise! Undetected by the U.S. intelligence community, by the mid-1980s the Soviet Union had converted its gaseous-diffusion technology for making highly enriched uranium to the highly efficient gas-centrifuge technology. The centrifuges (shown here) had doubled Soviet production capacity.
(Photo: Open Source)

Surprised by Our Adversaries

Just as we surprised our adversaries in World War II with technological advances such as the atomic bomb, our adversaries today can do the same to us. One important example of technological surprise from the Soviet nuclear weapons program occurred in the early 1960s. Soviet scientists had for years published numerous technical articles on the effects of x-rays on polymeric materials. Suddenly, they quit publishing. This aroused the interest of attentive U.S. IC experts.

Nuclear detonations produce intense x-rays. The polymeric heat shields used to protect the warheads of U.S. nuclear missiles were made of polymers that were reinforced by asbestos or glass fibers. Subsequently, we conducted underground nuclear tests at the Nevada Test Site and exposed these heat shields to the intense x-rays that the tests produced. Sure enough, the x-rays caused the protective heat shields to fail catastrophically.

This discovery was a real shocker. The Soviets had discovered that if they detonated one of their nuclear weapons in space anywhere near our incoming warheads, the intense x-rays would destroy the warheads' heat shields. Unbeknownst to us, all of our warheads were fatally flawed. This prompted the immediate development of new x-ray-resistant, graphite-reinforced heat shields for U.S. warheads, and these are still in use today.

> **The x-rays caused the warheads' heat shields to fail catastrophically. This discovery was a real shocker.**

Other examples of technological surprise from the Soviets include the rapid development of their first atomic bomb and their design and demonstration of the first thermonuclear bomb (a.k.a. hydrogen bomb). (Whereas the United States tested the first thermonuclear device, the Soviets were the first to make it a deliverable weapon.) They discovered that high-altitude electromagnetic pulses (EMPs) had catastrophically damaging effects on electronics, and they created special alloys for use in their nuclear weapons to counter those effects. The Soviets also were the first to deploy neutron bombs (enhanced-radiation weapons). Without going into details, each of these developments gave the Soviets military advantages. Only because we learned of their work were we able to evaluate and counter it with our own developments, strategies, and/or new technologies.

Given this prior record of important discoveries by our adversaries, any nuclear weapon reduction initiative must consider the possibility that other new-concept weapons or defenses could be developed that would provide strategic and/or tactical advantages.

Secretary of State Colin Powell's February 5, 2003, presentation slide to the United Nations Security Council showed an Iraqi-ordered aluminum tube allegedly meant for use in uranium enrichment.

As a result of a combination of systemic weaknesses, primarily in its nuclear weapons analytic capabilities, the U.S. intelligence community failed to accurately analyze and describe Iraq's nuclear capabilities in 2002. For example, it claimed that Iraq had made repeated attempts to acquire high-strength aluminum tubes for the purpose of enriching uranium to use in nuclear weapons. The intelligence community tested the tubes without inviting DOE experts—the intelligence community's nuclear experts—to participate. DOE, however, after doing its own analysis, concluded that "a [conventional] rocket production application is the more likely end-use for these [aluminum] tubes." DOE's conclusion was eventually accepted as the correct one.

President George W. Bush announces the beginning of Operation Iraqi Freedom from the Oval Office, March 19, 2003. "The people of the United States and our friends and allies will not live at the mercy of an outlaw regime that threatens the peace with weapons of mass murder."

(Photos: Open Source)

It is also possible that while foreign nuclear weapon programs could develop new weapons, these might not meet political definitions of "strategic" or even "nuclear" weapons. The problem then—for nuclear arms control and for deterrence—is that such novel weapons may not be considered as candidates for reduction under the terms of extant negotiated reduction agreements concerning strategic nuclear weapons.

Has Foiling Surprises Been Foiled?

Obviously, determining the existence of any such game-changing weapons or defenses would require the IC to have a robust and effective intelligence program. However, today, while remnants of technology-based intelligence collection systems remain in place, many have been reduced to the point that coverage is inadequate for today's potential threats.

In addition, capabilities dedicated to analyzing this type of information for use by the government's decision makers have also suffered. The most significant example is the unfortunate steady decline—to near extinction—of using nuclear scientists, particularly those at the DOE's national security science laboratories, as analysts.

With better nuclear intelligence, the "aluminum tube" issue certainly would not have been given weight in the debate leading up to the second war with Iraq.

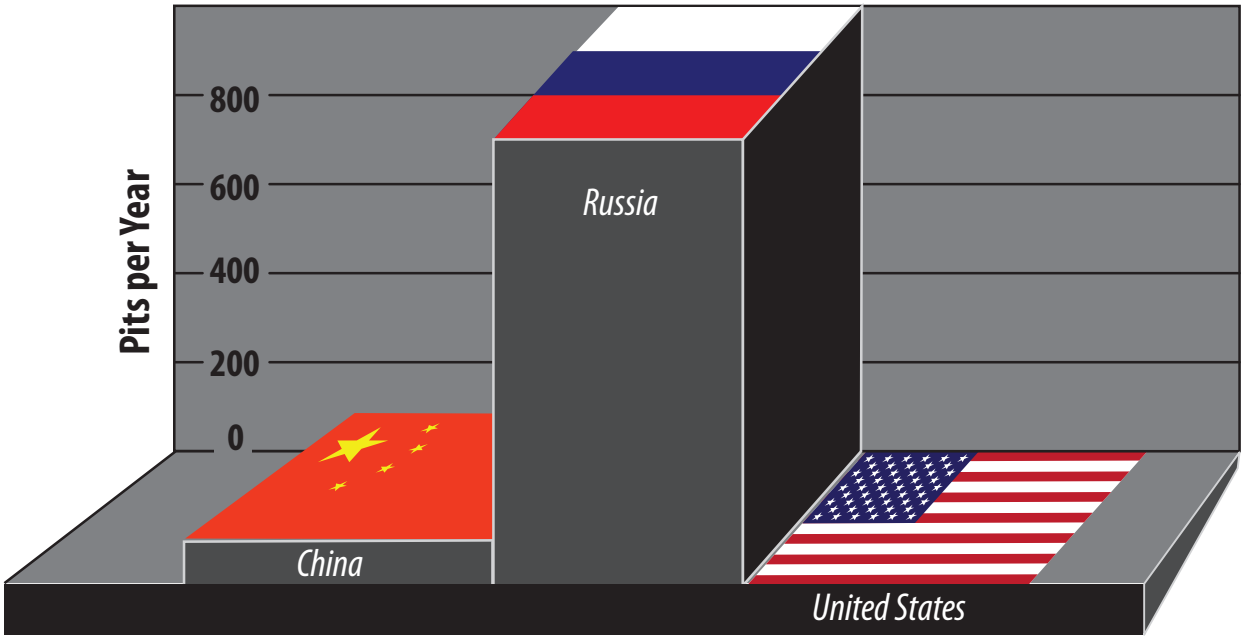
Unfortunately, one of the first causalities of the end of the Cold War was the IC's highly focused and well-funded nuclear intelligence program. For example, the nuclear intelligence divisions in both the CIA and the Defense Intelligence Agency were disestablished, and funding to the FIEs, charged with assessing foreign nuclear weapon developments, plummeted. Similarly, the Nuclear Intelligence Panel that consisted of senior nuclear weapons scientists and provided direct assessments to the director of the CIA was abolished.

Arguably, the intelligence failures evident in the First Gulf War (1991), in which the nuclear program of Iraq was *underestimated*, and the Second Gulf War (2003), in which the nuclear program of Iraq was *overestimated*, were directly related to the aforementioned reductions in the IC nuclear intelligence program. For example, if those reductions had not occurred, the widely publicized "aluminum tube" issue certainly would not have been given the weight it was given in the debate leading up to the second war with Iraq.[7]

Out of Balance: Rapidly Rebuilding Nuclear Stockpiles

As negotiated weapons levels are reduced, the calculus of deterrence becomes progressively more uncertain and

[7] Assessments that Iraq had acquired export-controlled, high-strength, high-specification aluminum tubes for use as centrifuge rotors were in error. They were procured to produce 81-mm rockets. (Aluminum Tube Investigation; Global Security Organization; http://www.globalsecurity.org/wmd/library/report/2004/isg-final-report/isg-final-report_vol2_nuclear-05.htm)



Plutonium pit production estimates for 2014. Russia has the ability today to produce at least 1,000 plutonium pits per year for use in building their new nuclear weapons. The United States, in contrast, has only one plutonium pit facility—an improvised one at Los Alamos—which has produced 29 certified pits since 1989.

By 2021 new nuclear missile systems, composed of new warheads and new delivery systems, will constitute 98 percent of Russia's intercontinental ballistic missile forces. This modernization includes the new RS-24 Yars (which NATO calls the SS-27 Mod 2), shown here, which is a new road-mobile system designed to carry up to six warheads and to counter U.S. antiballistic missile defense technology. (Photo: Open Source)

dangerous, particularly given the large stockpiles of plutonium and highly enriched uranium Russia has available for rapidly rebuilding its weapons inventories.

In robust, renovated nuclear weapons factories, Russia has the ability today to produce at least 1,000 plutonium pits per year for use in making new nuclear weapons. In an emergency, the production capacity could be much greater.[8]

The United States, in contrast, has only one plutonium pit facility—an improvised one at Los Alamos—which has produced 29 certified, "diamond-stamped"[9] pits since 1989 (when the Rocky Flats plutonium facility was closed).[10] The last diamond-stamped pit was produced in 2009.

While reconstituting new pit production was a significant accomplishment, the fact that the United States unilaterally disarmed itself with respect to being able to produce pits—and therefore produce new nuclear warheads or refurbish its aging warheads with new pits—arguably represents the largest nonnegotiated disarmament in history.

Arguably, this disarmament should have been a product of bilateral negotiations to reduce both U.S. and Russian stockpiles and the capacities and capabilities to reconstitute them, with adequate verification protocols appended to the agreement. If increased stability at lower force levels is the real goal, taking the production factor into consideration is an absolute necessity.

Any *balanced* arms control initiative to reduce nuclear weapons stockpiles must provide a balance in the comparable abilities of the negotiating parties to modernize and/or reconstitute larger stockpiles. In this regard, an imbalance between Russia and the United States probably already exists.

Ironically, if this capacity is not taken into consideration, bilaterally reducing the numbers of nuclear weapons could result in greatly increased dangers to the very world stability that arms control initiatives posit as their goal.

In addition to addressing production capacity, a particular interest of the United States should be to gain verification that closed or converted warhead-dismantlement plants in Russia are not being covertly used to produce new nuclear warheads. There are also obvious but difficult questions to be answered about how the refurbishment or remanufacture of extant weapons could be distinguished from the production of new warheads without classified information being revealed.

[8] During the peak of the Cold War, Russia produced plutonium and/or uranium parts for 2,500 to 4,000 warheads per year. Much of this production capacity has been mothballed but is still available to be put back into production.

[9] "Diamond stamped" signifies that a product has been manufactured to the highest standards required by the NNSA and the DoD. (*National Nuclear Security Administration Newsletter*, July 2007, Washington, D.C.)

[10] In 1989, due to safety and environmental concerns, DOE closed the Rocky Flats pit facility, which was the only facility in the country that could serially produce pits. A replacement pit facility has never been built.

Something Old, Something New

Absent the capability to replace its aging nuclear weapons, the United States will see the average age of its stockpiled weapons progressively increase. In 2005 our newest intercontinental ballistic missile (ICBM), the Peacekeeper, was decommissioned. In 2014 the average age of all nuclear weapons in the U.S. stockpile is about 34 years; the youngest U.S. warheads are about 23 years old. From public statements, it appears that the NNSA is preparing to accept weapons approaching twice that age.[11]

In contrast, Russian production capacity, if our estimates are accurate, will allow Russia to maintain a stockpile of nuclear weapons with a constant average age of approximately 5 years. (The average age of China's nuclear weapons is also about 5 years.) Moreover, with further negotiated reductions expected, the Russians could reduce the average age of their weapons by retiring older systems while maintaining production of new ones.

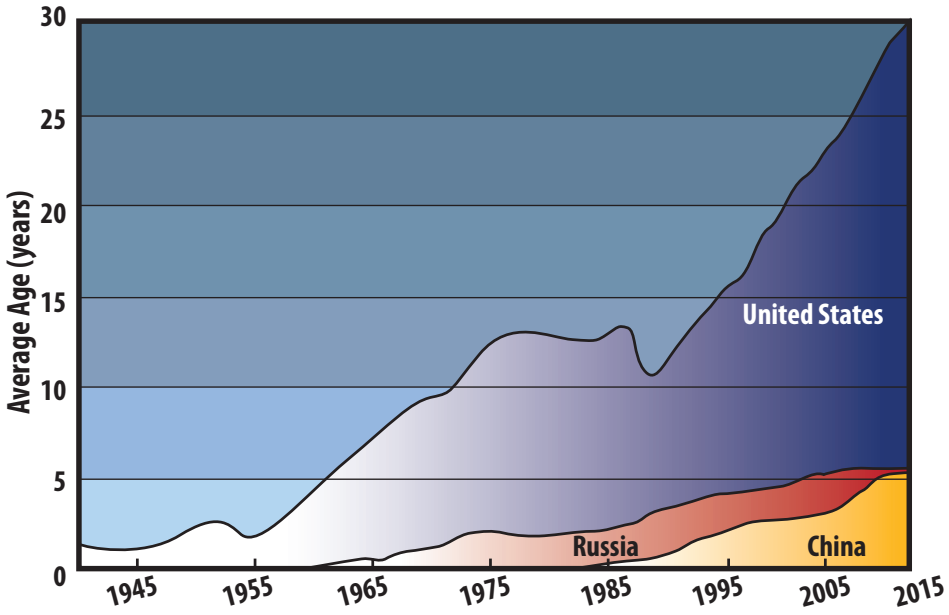
To a lesser extent, the age differential in favor of Russian warheads extends to their delivery systems. The most recent U.S. strategic missile to enter the active inventory was the U.S. Navy Trident II D-5, which was first deployed in 1990 and, under a proposed life-extension program, will remain in service until 2042. Much of the U.S. land-based strategic capability is based on the Minuteman III missiles, which entered service in 1970 and were produced until 1978. A refurbished Minuteman III could remain in service until 2040.

[11] "Right now, our best estimates [for the lifespan of plutonium pit-based weapons] are somewhere between 45 and 60 years, and that sounds like a long time, but remember, the last pit we made was made in the 1980s. After that, the properties [of plutonium pits] have changed to the point where you lack confidence that what you saw when you were testing is what you'd see now." (Linton Brooks, NNSA Administrator, *Global Security Newswire,* March 2, 2006)

The average age of nuclear weapons in the U.S. stockpile is about 34 years, and the youngest U.S. warheads are about 23 years old.

In contrast, Russia is making significant progress in modernizing its strategic and tactical nuclear weapons and their delivery systems. By early 2021 newly designed missile systems—the Topol-M ICBM, which NATO calls the SS-27 "Sickle"—will constitute 98 percent of Russian ICBMs. Russia is also deploying a newer road-mobile RS-24 Yars ballistic missile, probably a variant of the Topal, capable of carrying up to six warheads and designed to counter U.S. antiballistic missile technology. The Russians also have a new rail-mobile ICBM. By 2020 the Russian navy will have eight new Borei-class nuclear submarines. The Borei can carry 16 to 20 new solid-fuel Bulava R-30 submarine-launched ballistic missiles (SLBMs) with a range of over 6,000 miles. Each of these Bulava SLBMs will carry 6 to 10 individually targeted warheads for a total of up to 200 newly designed and newly manufactured warheads per submarine.

On October 31, 2014, the Russian news agency TASS reported that Putin announced, at a meeting with his top-ranking military officers, that 55 percent of Russia's strategic nuclear forces were now modernized. (He also announced Russia had modernized about 35 percent of their air force, over 50 percent of their navy, and close to 70 percent of their army's armored vehicles.)



The average age of U.S., Russian, and Chinese nuclear weapons. Unlike the United States, Russia and China continually replace their aging weapons with newly built weapons.

Rethinking the Unthinkable

The end of the Cold War brought many changes. These changes included the unification of Germany, the expansion of democracy into Eastern Europe, and the integration of Russia into the global economy. It also removed the worry about a nuclear war. "Thinking about the unthinkable," that is, seriously contemplating nuclear war, has all but vanished from the minds of most people.[12]

Another change that occurred was the substitution of informal "hand-shake" agreements for extensively negotiated treaties involving nuclear weapons. Verification protocols or safeguard provisions seldom accompanied these new informal agreements. Even as active stockpiles were reduced, agreements to reduce the capacity to manufacture nuclear weapons were never in vogue for a number of reasons, one of the most significant being mutual concerns over the secrecy inherent in such manufacturing processes.

Russia's warhead production capacity will allow it to maintain a stockpile of nuclear weapons with an average age of approximately 5 years.

While this imbalance should have raised concerns in the United States, it has not. Even Russia's modernization of its strategic nuclear forces and its touting of these forces as the most important element of the Russian military have been little more than passing news items.

Similar apathy is being shown over the revival of incursions of Russian nuclear-capable aircraft to test the defenses and resolve of the United States and its allies. These probes, echoing the Cold War, are disturbing.

Significantly, these military incursions are being conducted at a time when Russian officials have continued to make substantial investments toward modernizing Russian nuclear weapon production and research capacities, while also supporting a robust testing program at Novaya Zemlya, in part to develop new nuclear weapons. (Within the limits of our detection capabilities, no evidence suggests that these tests are generating proscribed nuclear yields.)

Major imbalances have arisen between the nuclear weapon research and production capacities of Russia and the United States.

[12] *Thinking about the Unthinkable* is the title of Herman Kahn's infamous and widely read 1962 book that explores the consequences resulting from a nuclear war. Kahn is one of the founders of the Hudson Institute.

President John F. Kennedy's address to the nation regarding the 1963 Limited Test Ban Treaty ~July 26, 1963~

"I ask you to stop and think for a moment what it would mean to have nuclear weapons in so many hands, in the hands of countries large and small, stable and unstable, responsible and irresponsible, scattered throughout the world. There would be no rest for anyone then, no stability, no real security, and no chance of effective disarmament. There would only be the increased chance of accidental war, and an increased necessity for the great powers to involve themselves in what otherwise would be local conflicts."

Since president Kennedy's speech in 1963, the number of declared nuclear weapons states has doubled to eight.

In stark contrast, the nuclear weapons research, testing, and production infrastructures of the United States have continued their rapid erosion through elimination and restructuring of organizations and reductions of workforces and budgets. This erosion has been accelerated by funds being diverted away from nuclear weapons research, surveillance, and manufacturing to address burgeoning environmental and security requirements. Ironically, the latter, spawned largely by those who inveigh against hypothetical security threats, are leaving the United States less secure internationally.

Former Los Alamos director Sig Hecker, now at Stanford University, argues that this problem is further exacerbated by "a risk-averse federal bureaucracy that has layered so many checks on the folks trying to do the actual nuclear weapons work at Los Alamos and elsewhere that a significant fraction of the work simply doesn't get done." [13]

The undeniable fact is that stability between the United States and Russia is now being maintained by Mutually "Assumed" Destruction.

The author, Houston T. Hawkins, is shown here with a model of a nuclear warhead from an ICBM. The warhead is coated with a graphite-based x-ray–resistant heat shield he helped to develop. *(Photo: Los Alamos)*

Obviously, no one is advocating a return to the Cold War or an abrogation of environment or security regulations. However, the undeniable fact is that stability between the United States and Russia is now being maintained by Mutually "Assumed" Destruction. "Assured" no longer is the operative adjective, given the robustness of the Russian nuclear weapons program and the demise of similar emphasis, capacities, and capabilities in the United States. If the international stability everyone wants is to be maintained, this potentially destabilizing imbalance cannot be allowed to continue.

Our lack of capabilities for rapidly reconstituting large numbers of nuclear weapons and our virtual abandonment of vital nuclear programs must be evaluated in the calculus of defense and of arms reduction diplomacy.

An outcome of the extant situation is that major imbalances have arisen between the nuclear weapons research and production capacities of Russia and the United States.

Given these realities, it is easy to understand Russian President Putin's statement in his 2013 end-of-year address to the Russian Parliament: "In our efforts to upgrade our nuclear arsenal, we are reaching new milestones successfully and on schedule. Some of our partners will have to catch up."

~ Houston T. Hawkins

Hawkins is a retired USAF colonel and a senior fellow of Los Alamos National Laboratory

[13] http://www.nti.org/gsn/articleregulators-squelching-U.S.-nuke-reliability-tests-ex-los-alamos-chief/

The Children's Milk Fund

It was 1986, during the Cold War, and I had finished my session at a large conference focused on topics related to nuclear war. It was lunchtime. I walked into the lunchroom. I noticed that former senator Albert Gore Sr. was sitting by himself in the corner of the room. I walked over and asked Senator Gore if I could join him for lunch. He replied, "Sure, general, sit down."

"Sir, I am a colonel."

"You should be a general, and I hereby promote you to that rank for the term of our lunch. What do you do in your present assignment?"

"Sir, I work in the Office of the Secretary of Defense as the Special Assistant for Air Force Nuclear Matters. That means I deal with issues pertaining to Air Force nuclear weapons."

"I have always loved nuclear weapons. General, do you want to know why?"

"Yes sir, I would!"

"In 1940 I was a young congressman from Tennessee, serving on several committees that arranged funding for public services and works. One of these was the Children's Milk Fund. This fund subsidized milk production and provided excess milk, free, to the nation's public schools. One day, Speaker Sam Rayburn called me into his office. 'Albert,' he said, 'I want you to hide a couple hundred million dollars in the federal budget.'

"No questions asked, I left Speaker Rayburn's office and immediately started putting away two million dollars here and five million dollars there. I could do so because, at that time, there were lots of opportunities. For example, there was a spike in funding for the Children's Milk Fund and for highway programs, and there were more dam construction projects than we had water to fill them. I was able to hide lots of this 'excess' money. I never stopped to ask how this money was going to be used . . .

"Then in 1945 I and several other congressmen were on a trip to the Pacific to see how the war was going. Before landing on Tinian Island [where the nuclear bombers that attacked Hiroshima and Nagasaki were based], we had flown over hundreds of warships and troop transports that were stacked up awaiting the imminent invasion of the Japanese mainland. I knew that those ships held thousands of good ol' Tennessee boys, and I knew that many of those boys would never live to see the green hills of Tennessee again. I felt extremely saddened by that prospect. When we got to Tinian, the length of the airstrip was lined with new wooden coffins, stacked 10 high.

"Upon landing we were rushed into a large briefing room. A general briefed us on plans for the invasion. He told us that in defense of their homeland, the Japanese would put up intense resistance. Casualties on both sides were expected to number millions. The general told us that three large hospitals had been built on Tinian to receive the wounded. The largest of these was a 4,000-bed hospital. [The largest U.S. hospital today is New York-Presbyterian/Weill Cornell. It has 2,200 beds.]

"We sat stunned and silent. At this point, General MacArthur strode in—as only he could do. MacArthur dismissed the other general. He looked at us and said, 'Gentlemen, the war will be over before you get back to California.' With that pronouncement, he left as suddenly as he had appeared. We went from stunned to confused. We thought, how can this be? Millions of casualties filling up the Tinian hospitals, and yet the war will be over before we get home?

"We departed from Tinian and island-hopped back to Hawaii. When we landed at Hickam Army Air Base someone handed me a newspaper. The banner headline read, 'Secret Atomic Bomb Destroys Hiroshima.'

"'The Children's Milk Fund!' I shouted, 'The Children's Milk Fund!' My traveling companions were nonplused, to say the least."

The senator went on to say that he (and his colleagues) had eventually hidden over *2 billion dollars*. He subsequently confirmed this was the money used to build and operate Hanford and the Oak Ridge and Los Alamos laboratories. In other words, this was the money that funded the Manhattan Project!

"By the time we left Hawaii," he went on, "Nagasaki had been destroyed by a second atomic bomb. When we landed in San Francisco, the headlines announced that Japan had unconditionally surrendered. The war was over. Those Tennessee boys would live to see the green hills of Tennessee again and possibly even vote for me. That, General, is why I love nuclear weapons."

I said, "Senator, I also love nuclear weapons. My father was on one of those ships that your party overflew before landing at Tinian."

For me, hearing the elder Senator Gore relate this history is one of those precious moments that I'll never forget. Los Alamos was partly funded by the elder Senator Gore's ingenuity and the Children's Milk Fund, an interesting footnote in Los Alamos' 71-year-history.

~ Houston T. Hawkins

Nuclear test "Truckee," conducted June 9, 1962, south of Christmas Island as part of Operation Dominic.
(Photo: Open Source)

DEBUNKING SIX BIG MYTHS

ABOUT NUCLEAR WEAPONS

For over 20 years—beginning in 1991 with the fall of the Soviet Union and the end of the Cold War—the importance of the nation's nuclear deterrent has been fading from the public's mind.

Out of Sight, Out of Mind

Two generations, that is, millions of Americans, have been born and raised and never felt the threat of a nuclear war as did those generations living during the Cold War. They have never pondered the fact that today hundreds of Russian thermonuclear-armed missiles could reach U.S. cities in less time than it takes to have a pizza delivered to their doorstep.

Because they have not felt threatened in decades, many Americans have, understandably, not felt the need for maintaining the U.S. nuclear deterrent, much as healthy people in a waning epidemic might believe there is no longer a need for vaccination. But an epidemic can wax again, and the same is true for nuclear threats from abroad. Letting down one's guard can be a dangerous proposition.

They Got It

Between the end of World War II and the fall of the Soviet Union, the American public understood nuclear deterrence. *They got it.* The Soviet Union was aggressively trying to expand around the world, and back then it had 10s of thousands of nuclear weapons aimed at the United States. So the United States needed to have its own, and better, weapons to keep the Soviets at bay.

It worked. Because of the U.S. nuclear deterrent, the Soviet expansion was stopped at the Iron Curtain.

Nuclear deterrence is also about preventing not just nuclear wars but also major *conventional* wars, in part because a major conventional war is the most likely road to nuclear war. Over the last several centuries—and with ever-increasing frequency—the world's major military powers have waged major conventional wars against each other. But due to nuclear deterrence, that has not happened since 1945.

Taking an Intellectual Holiday

The role nuclear deterrence has played since 1945 in preventing a major war is not widely appreciated, so the importance that nuclear deterrence plays in today's national security is

The Air Force's B-52 Stratofortress has been in active service since 1955. (Photo: Open Source.)

not widely recognized. The public has, as a consequence, lost sight of the continued need for the nuclear enterprise—the weapons; their delivery systems; and the scientific, technological, and manufacturing capabilities, along with the skilled *people* who create and support these. Nor is the public aware that the entire U.S. nuclear enterprise is aging or that there are severe negative consequences that arise from that aging.

Thus, when it comes to the nuclear deterrent, the nation has taken a procurement holiday and, just as important, an intellectual holiday.

It often seems clear that, even within the upper ranks of the military, there are people who don't get it.

Today there are plenty of officers and civilians in the Department of Defense who are well versed in conventional warfare or in counterinsurgency but who have *never* studied the relevance of the U.S. strategic nuclear deterrent. Yet these same people may be helping to formulate national security strategies wherein nuclear deterrence is the *foundation* of national security.

Taking a Procurement Holiday

The "procurement holiday" affecting the nuclear deterrent is a piece of the "peace dividend," the economic shift away from defense spending following the end of the Cold War. But after two decades, isn't it time to begin reinvesting in the deterrent?

For example, the Air Force is in need of a new long-range bomber. Why? The youngest bomber, the B-2 Spirit Stealth, is now over 20 years old. The oldest bomber, the B-52, is over 50 years old. World War I biplanes would have been younger than that if they had been used in World War II.

As the Air Force's Major General Garrett Harencak puts it, "The fact is my son, who's a lieutenant at Minot Air Force Base, flies the same airplane I flew as a young 20-something pilot in 1984. I don't mean the same *type* of airplane. I mean it's the *same* airplane! It's the same B-52 with the same tail number that I flew as a 23-year-old B-52 pilot out of Blytheville Air Force Base in Arkansas. He's flying that *same* airplane."

He goes on, "It doesn't stop there. The way things are going his child—who could graduate from the Air Force Academy in 2036—could also fly that same B-52. Wrap your head around that! So my *grandchild* may someday have to take into combat that very same old airplane that I once flew."

Of course, the general's grandson *will* take it into combat if that is what is required. That is what the nation's warfighters do, every day. They don't say, "Hey, wait a minute, I don't want to fly a B-52 that's over 70 years old!" They don't say, "Wait, I haven't flown enough hours yet due to defense budget sequestration!" No, when asked to defend their country they will go, and go with what they've got.

If the procurement holiday continues, it looks like the nation is going to ask its sons, granddaughters, nephews, nieces, and friends to go into combat with bombers that old.

Here is another example. The B61 thermonuclear bomb was, like the B-52 bomber, first built in the 1960s using radio-tube-era technology. Production of the B61 ended about 1989. The B61 was designed to have a life expectancy of about 10 years. To remain a credible part of our nuclear deterrent, the B61 needs to be brought into the 21st century. It needs its key components rebuilt, refurbished, or replaced. (This refurbishment, undertaken by Los Alamos and Sandia National Laboratories in partnership with the Air Force, is underway.)

In contrast, the Russians and the Chinese are modernizing their nuclear forces by designing and building brand-new weapons and delivery systems. Shouldn't the United States be modernizing and recapitalizing its nuclear deterrent, too?

Granted, doing that is not going to be easy. The nation is in the tough position of needing to upgrade its nuclear weapons systems, and the infrastructure that supports them, in a time of large fiscal difficulties.

How will the nation prioritize funding its needs?

Bombs before Butter?

The Congressional representatives who were around during World War II and the Cold War and who understood the need for nuclear deterrence are mostly gone. They realized Congress would have to set aside funding to maintain the nuclear deterrent for the security of the nation and its allies.

Today, many members of Congress do not support funding our nuclear deterrent. Like the public that elected them, many of them don't get it. They believe that nuclear weapons are now irrelevant to national security. They believe the

China's new H-6K strategic bomber, armed with long-range nuclear cruise missiles, can now attack U.S. military bases in South Korea, the Philippines, Guam (all were previously out of reach), and the Japanese mainland without leaving Chinese airspace. The newly built H-6K bombers are capable of launching CJ-10K cruise missiles with an estimated range of up to 1,200 miles. (Illustration: Open Source.)

A pod of cruise missiles being loaded onto a B-52. The B-52 can carry up to 20 nuclear-armed cruise missiles. (Photo: U.S. Air Force)

deterrent is too expensive. These and other myths about nuclear deterrence have arisen since the end of the Cold War. And unchallenged, myths like these make it hard to critically think about the value of the nation's nuclear deterrent.

So let's debunk six of the biggest myths surrounding the nuclear deterrent.

We don't use nuclear weapons.

A myth similar to this one is, "Nuclear weapons will never be used again."

Actually, we *do* use nuclear weapons. We use them *every single day*. They do not have to be used in combat to be doing their job.

General Harencak, a career bomber pilot who has flown all three of the nation's nuclear bombers (B-52, B-1, and B-2), likes to point out that, "there is *never* a day where there isn't continuous nuclear deterrence in effect. There is never a day when there aren't nuclear-armed submarines at sea and intercontinental ballistic missiles [ICBMs] manned and ready in their silos. Every day there are nuclear-capable bombers and fighters fueled up and ready to fly. Every day these nuclear forces provide the nation and its allies with the nuclear deterrence they need."

When U.S. nuclear weapons are deployed and ready to engage, they make a credible deterrent. Weapons that are not deployed and ready are not credible.

Clearly, there is *never* a day when the nation is not using its nuclear weapons as a credible deterrent. Given the world's current political configuration, nuclear weapons will continue to be of the utmost relevance to U.S. national security into the future. As long as other nations have nuclear weapons, the United States will continue to use its nuclear weapons as a deterrent, every day.

We can't afford nuclear weapons.

This myth *seems* credible—certainly nuclear weapons must be very, very expensive. But costs and benefits are relative things.

Consider this. According to General Harencak, the Air Force's two legs of the nuclear triad, the ICBMs and nuclear-capable aircraft, cost approximately $5 billion a year to

The AGM-86B is an air-launched cruise missile that can be launched from a B-52 Stratofortress and can be armed with a nuclear warhead. The AGM-86B was first built in 1977 with a life-expectancy to 2020 but the Air Force plans to extend its service life to 2030 or later. (Photo: U.S. Air Force)

The U.S. Navy's FA-18 Hornet is designed to be both a fighter plane and a ground attack aircraft. Its versatility allows it to operate from aircraft carriers or land bases. The Hornet is capable of carrying the B61 thermonuclear bomb. The upgraded Super Hornet (shown here), though not designed to carry the B61, is bigger, can carry more munitions, and can fly much farther. (Photo: Open Source)

maintain. Let us put that cost into perspective. Congress has mandated (in the Postal Accountability and Enhancement Act of 2006) that the government put about $5.5 billion a year into the U.S. Postal Service employees' retirement health and pension benefits. That money is meant to ensure the security of the postal retirees' lives. General Harencak points that, for about $5 billion, what amounts to only 5 percent of the Air Force's entire budget, the Air Force can maintain its portion of the U.S. nuclear deterrent, which helps to ensure the security of the entire nation—and its allies. From that perspective, $5 billion is a bargain.

We're stuck in a Cold War mindset.

If by "mindset" one means "military strategies," then nothing could be further from the truth. The primary Cold War strategy was for the United States to build and deploy enough nuclear weapons to ensure the obliteration of the Soviet Union and its Warsaw Pact allies. The Soviets had the same Cold War strategy regarding the United States and its NATO allies.

Thus at the height of the Cold War, the United States and the Soviet Union each had 10s of thousands of weapons. In 1967 the United States reached its peak in the numbers of weapons in its stockpile: over 31,000. The Soviet Union had thousands more than the United States did: at their peak in 1986, the Soviets had over 45,000.

The Soviet Union and the Warsaw Pact are gone. Russia is the only nation left of that cabal that still has nuclear weapons. So the U.S. Cold War–era strategic plans have changed. The plan now is to negotiate ways of staying numerically matched with Russia but at *agreed-upon* lower numbers. Today, the United States has about 2,200 weapons, and it is reducing that number even further.

But considering that there are more nuclear nations today than during the Cold War, a new U.S. strategic plan cannot be to eliminate all its nuclear weapons. The nation cannot safely let its numbers fall too low even while the nation reduces its stockpile in tandem with Russia. In today's post–Cold War geopolitical environment, these new nuclear-armed countries threaten each other, they threaten this nation, and they make the world vastly more complex and dangerous than it was during the Cold War. This new, post–Cold War geopolitical environment is so different that it creates, essentially, a Second Nuclear Age, one that requires a different "mindset" and new strategic plans.

Major General Harencak is the Assistant Chief of Staff for Strategic Deterrence and Nuclear Integration at U. S. Air Force Headquarters. (Photo: U.S. Air Force)

The Cold War "mindset" and the comparatively simple national security strategies it evoked will not work in today's geopolitical environment, so the U.S. military's strategic planners no longer rely upon them.

Nuclear weapons are going away, anyway.

The people who believe this myth tend to do so because they also believe the myth that nuclear weapons are useless and obsolete (see myth #1).

In this "nuclear weapons are going away" myth, the believer predicts that in the near future the world's leaders—including the Putins and Kim Jong Uns of this world—will come to their senses, meet together in an atmosphere of mutual admiration and respect, resolve their nations' differences rationally and peacefully, and swear off nuclear weapons (and other weapons of mass destruction) for the good of all people.

Unfortunately, nuclear weapons are not going away any time soon. As long as the world's population continues to grow exponentially, as long as the world's climate continues to change and make less of the planet hospitable, and as long as the world's supplies of water and other natural resources continue to plummet, then nations, tribes, and religions will compete and conflict with each other. Possessing nuclear weapons provides a survival advantage over those nations that do not have them and a measure of competitive equality with those who do have them. Nature's law of natural selection and the survival of the fittest suggests that most nuclear nations in conflict will not put their nuclear genie back into the lamp. The laws of nature predict that the nations who do this will not survive.

Sure enough, instead of reducing their stockpiles, other nuclear nations are busy *increasing* their stockpile numbers *and* designing and building newer, more-modern weapons and weapon delivery systems.

At the same time, some nonnuclear nations, such as Poland, Turkey, and Ukraine are debating whether to become nuclear weapons states and doing so openly. Other nonnuclear nations may be having that debate in secret or may already be secretly rubbing the nuclear genie's lamp.

As long as nuclear weapons exist anywhere in the world, as long as state and nonstate actors have nuclear weapons or seek to acquire them, this nation must retain its nuclear deterrent to counter them. The United States is reducing the numbers in its stockpile, but the president has also committed the nation to maintaining a nuclear deterrent that is safe, secure, and effective for as long as other nations possess nuclear weapons.

How long will that be? As long as they are struggling with one another for survival, nations that possess weapons will continue to have them and will continue to improve their stockpiles, and other nations will seek out their own.

Given these realities, nuclear weapons are not going away.

We can do it all with submarines.

Many people believe the nation can provide itself all the deterrence it needs by relying on its nuclear-armed Trident submarines. With budgets constrained and with the belief that nuclear weapons will eventually go away, this is an attractive myth.

However, as nuclear weapons are not going away consider this: the "nuclear triad," composed of nuclear-capable aircraft, ICBMs, and submarines, is still the most effective way to provide the national security the president promises. The strategic logic behind the nuclear triad is this: having three very different nuclear systems, each with hundreds of weapons, eliminates any likelihood that an adversarial nation could destroy the entire deterrent in a first strike. No first strike could destroy all U.S. ICBMs, nuclear bombers, and submarines. Currently, only the Russians have enough

missiles to hold a large number, but not all, of the nation's nuclear weapons at risk.

The triad guarantees to the nation, its allies, and its adversaries that the United States will have the capability for a substantial retaliatory strike. If an adversarial nation knows the United States can and will strike back with an ample number of nuclear weapons, they are deterred from shooting first.

Each leg of the triad is also important because it has significant strategic advantages over the other two. The missiles—ICBMs and air-launched cruise missiles—are too numerous to be destroyed in a first strike. In addition, the cruise missiles can be widely deployed making them harder to find and destroy.

Submarines are fundamental to the triad because they can carry about half of the active U.S. nuclear stockpile. They are constantly moving beneath the sea, making this half of the nation's nuclear deterrent all but undetectable. If it cannot be found it cannot be destroyed.

Whereas ICBMs, submarine-launched missiles, and cruise missiles are committed once they are launched, nuclear-armed bombers can be retargeted or even recalled if the president deems it necessary. With midair refueling, bombers can fly to anywhere on the planet. This means that, unlike ICBMs or submarine-launched missiles, bombers armed with bombs or cruise missiles can hold at risk any target anywhere in the world.

Bombers can pack a bigger- or smaller-yield nuclear bomb (in addition to carrying conventional munitions), which gives the president important strategic options. Why launch a big, multiwarhead-armed missile if a single small warhead will do the job with less collateral damage?

Bombers are not as vulnerable as some might think. For example, armed with nuclear-tipped cruise missiles, bombers can attack outside an adversary's air defenses.

Unlike submarines and ICBMs, bombers can be *seen*. When nuclear-capable bombers go on alert, the fueling, arming, and crewing activities are obvious to adversaries with spy

The U.S. Navy Trident submarine first entered service in 1981. Currently, the Navy sails 14 Ohio-class Tridents armed with 24 Trident II D5 intercontinental ballistic missiles. Four other Tridents have been converted to carry missiles with conventional warheads. (Photo: U.S. Navy)

satellites, meaning the president can send a powerful message to those adversaries to "stand down."

What about those adversaries without satellites? Following North Korea's nuclear test in 2013, the president ordered a couple of B-2 Stealth bombers to fly all the way from Missouri to South Korea—over 6,500 miles. The world press described these bombers not as "the bat-winged B-2" or as "B-2 Stealth," but as "B-2 *nuclear-capable* Stealth bombers." Making that point matters.

Again, in June 2014, following Russia's occupation of Crimea and the shooting down of a Malaysian passenger jet over the Ukraine, the president ordered B-2 *and* B-52 bombers, again described in the press as "nuclear-capable bombers," to fly to the United Kingdom for training and exercises with NATO forces. These kinds of U.S. nuclear bomber flights have not occurred in over a decade. They were designed to send the following powerful message of support to the NATO allies: the United States is committed to protecting NATO with its nuclear capabilities.

The president could not have made such blatant, in-your-face shows of force by opening up an ICBM silo in a Montana wheat field or surfacing a submarine and opening up a missile tube to show the news media. Nuclear-capable bombers make strategic statements and show U.S. resolve in ways that submarines and ICBMs cannot. Bombers can provide a clear and immediate show of force to adversaries of the United States and its allies. They give the president a quick way to demonstrate overwhelming strength in response to escalating confrontations.

Rather than reduce the triad, the Air Force is hoping to build a modern, long-range-strike bomber that would increase the current bombers' range without the expense and risk of refueling. The new bomber would also have a host of other advanced attributes—like improved payload capabilities and survivability—and would eventually be nuclear capable. All these qualities would give the president more flexibility and more options for avoiding a war, or winning the war should war become necessary.

Are the nation's nuclear submarines ready to become the nation's primary or even sole source of its nuclear deterrence? U. S. Ohio-class submarines are getting old and approaching the end of their life expectancy; they were first commissioned in 1981. To maintain this boat's role as one part of the triad, much less giving it a more prominent role, the nation needs to build a replacement for the Ohio-class submarine.

Each leg of the triad has its own unique strengths. Bombers and ICBMs are not, as some folks believe, irrelevant to deterrence. Submarines do not make them redundant. Having all three systems in a triad provides the balance needed for the president to make a clear show of force and have a variety of military response options. Only the triad provides the kind of variety in weapons and delivery systems that guarantees to the nation, its allies, and its adversaries that there can and will be a second strike.

The North Koreans continue to develop their nuclear weapons program and threaten to use their weapons on South Korea and Japan. If the United States continues to reduce the size of its nuclear deterrent, will South Korea and Japan feel unprotected and begin building their own nuclear weapons programs? Kim Jong Un (center) is shown here visiting a military flight exercise in Pyongyang, North Korea, in March 2014. (Photo: Open Source)

The triad has worked well to help maintain world stability. Together, the legs of the triad ensure the nation has a powerful, survivable nuclear deterrent. And the diversity of the triad becomes all the more strategically important as the nation works toward further lowering the numbers of weapons in the stockpile.

To believe that the nation can count on submarines alone belies the triad's strategic logic. Submarines, in conjunction with the other legs of the triad, help guarantee the nation always has that second-strike capability.

So, no, subs alone cannot do it all.

The fewer nuclear weapons there are, the safer the world becomes.

This is a very important myth to debunk, particularly for those who push for deeper and deeper arms reductions. Because when it comes to making a causal relationship between the numbers of nuclear weapons and world instability, maybe less is not less—maybe less is *more*. In other words, fewer nukes may actually *increase* world instability and the risk of nuclear war.

Counterintuitive? Well, *lowering* the U.S. stockpile numbers makes it attractive for other nuclear nations to build *more* of their own weapons. Parity in the number of nuclear weapons is a strategic goal for nations with fewer weapons when they are in competition with nations possessing more. As nations with bigger stockpiles reduce their stockpile numbers, nations with smaller stockpiles realize that parity may suddenly be within their reach.

For example, if the United States reduces its stockpile to a few hundred weapons, nations like China, India, and Pakistan, who currently possess weapons numbering in the low hundreds but have the capacity to make many more, may be enticed to match the U.S. stockpile number—or even *surpass* it. How would their building more nuclear weapons make the world more stable? How would having an expansionist China being on nuclear par with the United States improve world stability?

Additionally, will lower stockpile numbers affect the nation's ability to reassure its allies that it still has the will *and the means* to protect them? Will lower numbers give them a continued feeling of security? Or will our allies wonder if the United States can still defend them? Maybe U.S. allies will feel the need to start their *own* nuclear weapons programs.

In some cases, this might be very easy for them to do. Some have even tried. For example, when in 1970 the United States planned to withdraw troops from South Korea, the South Koreans, fearing North Korea, began a secret nuclear weapons research program. Once discovered, under U.S. pressure, South Korea ended the program. Then in 2004 the International Atomic Energy Agency revealed that South Korea had had *another* secret nuclear program underway since the 1980s. The South Koreans were forced to stop this program, too.

In a 2013 poll, following North Korea's third nuclear test, two-thirds of surveyed South Koreans supported the idea of South Korea's building its own nuclear weapons. If South Korea's fears of North Korea become compounded by the United States' announcing its intentions to make further, significant reductions in its nuclear stockpiles—thereby, in South Korea's view, shrinking the U.S. nuclear umbrella over South Korea—will even *more* South Koreans support their nation's joining the nuclear-weapons club? Would a nuclear-armed North Korea *and* South Korea make the world more secure?

The causal relationship between the numbers of nuclear weapons and world instability is neither a simple nor an intuitive one. Nor is it a positive correlation. This is why, when it comes to the relationship between the numbers of nuclear weapons and world instability, less is not necessarily less—less may be more.

Congress, College, and the Kiwanis Club

It has been more than 70 years since the world's major powers tangled in a huge, hot war and more than 20 years since the end of the Cold War. The threat of a major conventional war or a nuclear war has slipped from the daily thoughts of U.S. baby boomers. These threats have *never* darkened the hopes or dreams of Generation X or the Millennials. The importance of the nation's nuclear deterrent is, today, far from the public's mind. Ironically, the very success of the U.S. nuclear deterrent largely explains why so many people today give it neither attention nor respect.

Myths arise around things that—like the U.S. nuclear deterrent—are misunderstood, little known, and greatly feared. Myths surrounding the U.S. nuclear deterrent's role in national security, its cost, its content, and its current health are not then unexpected.

For the sake of U.S. national security and world stability, these myths must be debunked in Congress, in colleges, and even in the Kiwanis Club down the street.

~ Clay Dillingham

Charlton Heston *FROM MOUNT SINAI TO LOS ALAMOS*

Though Charlton Heston passed away several years ago, in 2008, the Academy Award–winning actor lives on through his epic and timeless films. He starred in *The Ten Commandments*, *Ben-Hur*, *Planet of the Apes*, and *El Cid* but also played a starring role for Los Alamos National Laboratory later in his career.

Heston was born in Illinois in 1923. As a boy, he moved with his family to Michigan, where he developed interests in hunting, fishing, and acting. While attending Northwestern University on a drama scholarship in 1944, at the height of World War II, Heston joined the Army Air Forces and was deployed to the Pacific to fight against Imperial Japan.

As the end of the war came into sight, Heston, who was a gunner aboard a B-25 bomber, prepared for the seemingly inevitable invasion of the Japanese home islands. The invasion, however, never happened. The atomic bombings of Hiroshima and Nagasaki in August 1945 helped bring World War II to an abrupt—and victorious—conclusion.

After the war, Heston returned home to his wife and gradually started making a name for himself as an actor. In the years that followed, Heston would become a Hollywood legend, accumulating numerous awards and an international following. But he never forgot the role the atomic bombs may have played in saving his life.

Trinitite, a rock containing glassy parts created inside the fireball from the world's first nuclear explosion. The glassy parts were made from melted sand and radioactive bits of the nuclear device. Almost all Trinitite is green, as shown here, but some is either black or red, black if it contains bits of the device's supporting tower, and red if it contains copper from the device or from communications cables at the test site. (Photo: Open Source)

In recalling the potential cost involved in an invasion of Japan, Heston said, "U.S. losses were expected to be one million men. One million men who would not come home. I don't know if I would have been among them or not, of course . . . but I'm glad I didn't have to find out."

When longtime LANL filmmaker Charles Barnett contacted Heston in early 1983 to gauge his interest in narrating documentaries for the Laboratory, Heston enthusiastically accepted. He refused, however, to accept any compensation for his services.

Upon receiving a security clearance, Heston set to work immediately on a series of classified documentaries showcasing several of the Laboratory's national security programs. Early on, Heston provided narration for a short film called *Project Whitehorse*, which served as an introduction to LANL's Strategic Defense Initiative research, and hosted a programmatic overview of the Laboratory called *The Flavius Factor*.

One of Heston's final Los Alamos films, *Trust, But Verify*, documented the U.S.-Soviet collaboration on nuclear testing verification technologies. Though virtually all of Heston's films were originally classified, *Project Whitehorse*, *The Flavius Factor*, and *Trust, But Verify* are now publicly available.

During one of Heston's first visits to Los Alamos, he was presented a very special gift, a piece of Trinitite, a glassy rock made by the heat of the Trinity test of July 16, 1945 (see photo). Interestingly, he chose to give it away. "I took it home and gave it to my son, Fraser, . . . because it occurred to me that it was, in a very real sense, his birthstone," said Heston. "In the summer of 1945, when the blast that coalesced the sands . . . into Trinitite was set off, Fraser was unconceived and his mother was still in school."

Having seen war firsthand, Heston strongly believed nuclear weapons could play an ongoing role in preventing conflicts on a global scale. The pursuit of peace motivated Charlton Heston to work with Los Alamos, just as it continues to motivate the Laboratory's national security scientists today.

~Alan Carr

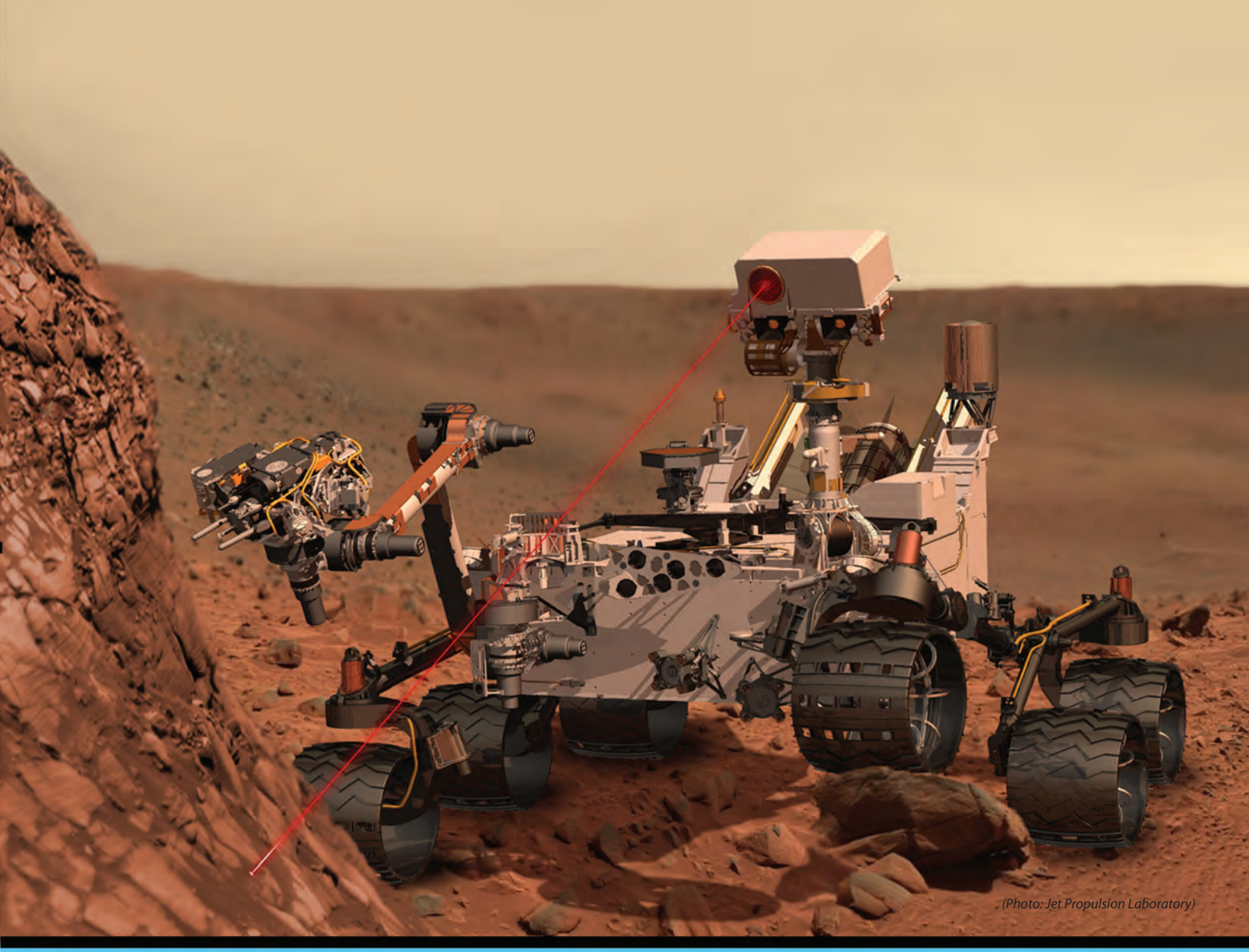
In 1988, while filming Trust, But Verify, *Heston visited the Nevada Test Site. In this photo he poses with his official DOE escort, Sally Kendall, and Los Alamos scientist Dr. Robert A. Jeffries.* (Photo: Courtesy Former LANL Test Director Walt Wolff)

THEN &

Los Alamos photographs celebrating the Laboratory's past and present

Following the world's first nuclear test, Trinity, in 1945, Los Alamos scientists used a Lab-customized Sherman tank to roam the test site and collect radioactive debris and soil samples for analysis.

To protect the scientists, the tank was outfitted with lead shielding and bottles of air for breathing. The scientists gathered samples through a trap door in the bottom of the tank.



(Photo: Jet Propulsion Laboratory)

NOW

NASA's Mars rover Curiosity continues its 23-month mission, begun in August 2012, to gather evidence scientists will use to determine if Mars has or ever had an environment that could support microbial life. Roaming the planet surface, Curiosity analyzes the flashes of light produced as the laser it carries vaporizes bits of rock and soil on the planet's surface. It also collects physical samples for further analysis.

Curiosity's laser and its chemical- and mineral-analysis instruments are products of Los Alamos and its collaborators. In addition, Los Alamos developed the type of plutonium-powered battery that powers Curiosity. This type of long-lasting battery, which has been used by NASA for more than three decades to power space exploration, is a byproduct of the Laboratory's work in plutonium science. The National Nuclear Security Administration proclaims Los Alamos to be the "center of plutonium excellence for the nation."

From 1943 until the end of World War II (WWII) in 1945, Los Alamos was a secret city—officially it did not exist. Even after its existence became public in 1945, access to the town was controlled for security reasons until 1957. Everyone coming into or leaving the town had to show a government-issued pass and undergo careful scrutiny at its main entrance gate (shown here in 1951).

THEN

WWII military-style vehicles were a common sight in Los Alamos for many years. Below, a WWII-era U.S. military-style truck drives through the muddy intersection of Central Avenue and 15th Street in Los Alamos in the winter of 1948. The main streets were not paved until the 1950s.

In 1957 Los Alamos became an open town—official passes were no longer required, and the entrance gates were removed. However, the guard station remained. It was remodeled and eventually became a popular restaurant at the edge of town. The guard station's chimney is still visible today, incorporated into the restaurant's kitchen.

& NOW

In the summer of 2013, a modern truck drives through the same intersection.

After WWII, the Atomic Energy Commission (AEC) was created to administer the nation's nuclear weapons complex. In Los Alamos this meant that in 1947 the AEC began to oversee the Laboratory and the community of Los Alamos, neither of which was open to the public. In the photograph above, taken in the late 1940s, armed AEC guards on horseback are shown patrolling the northern perimeter of the community (on Los Alamos Mesa overlooking Pueblo Canyon).

THEN &

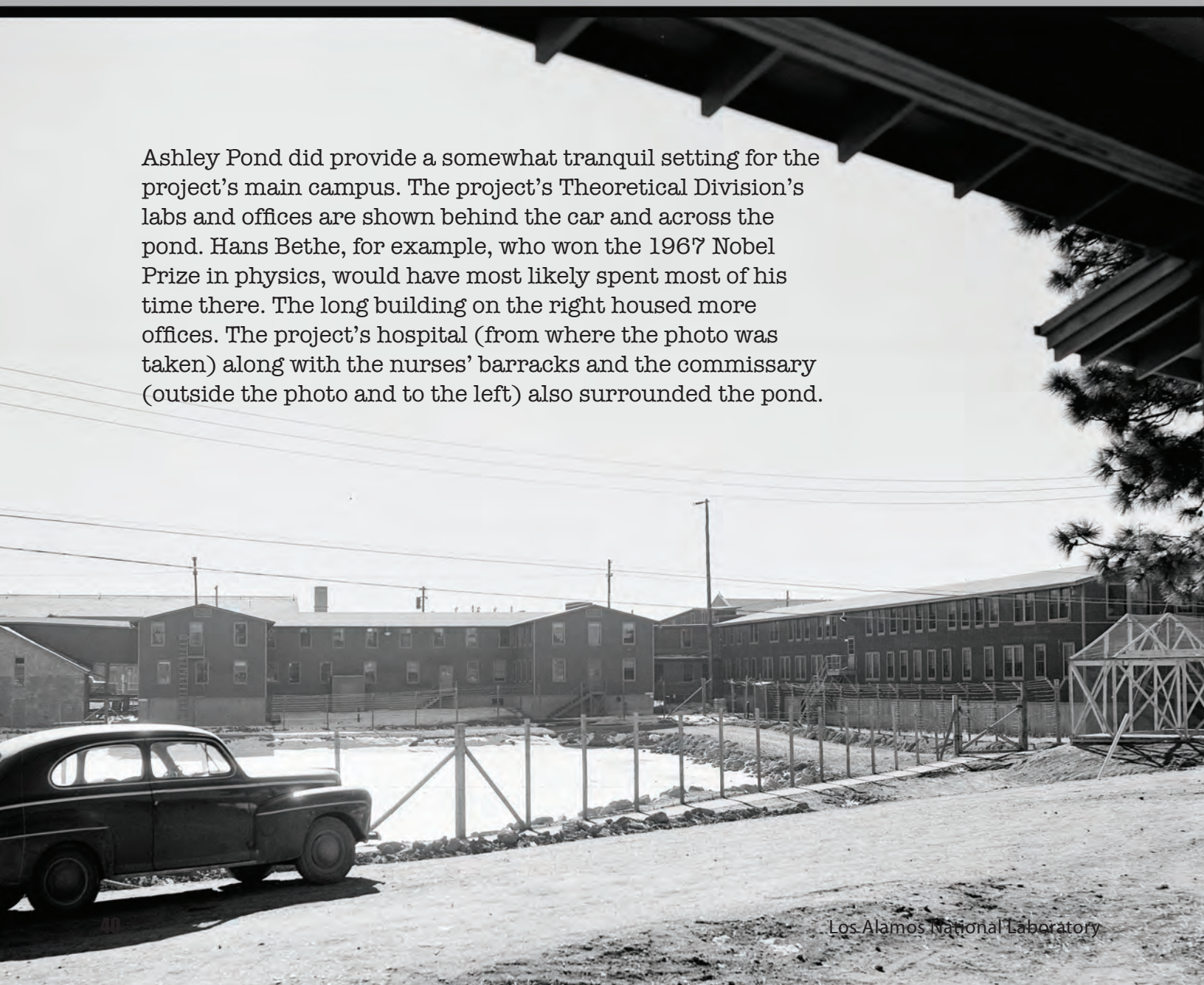
NOW

Los Alamos remained a guarded, secured community until 1957. Many of the trails used by the AEC's horse-mounted patrols are today used for recreation.

THEN &

Ashley Pond, shown here in January 1947, was named after Ashley Pond, the founder of the secluded Los Alamos Boys Ranch School. The pond was part of the school's campus but had no buildings around it. The U.S. government bought the school to use its remote location for the Manhattan Project. It's a natural pond and it served no purpose in making the atomic bombs during the project.

Ashley Pond did provide a somewhat tranquil setting for the project's main campus. The project's Theoretical Division's labs and offices are shown behind the car and across the pond. Hans Bethe, for example, who won the 1967 Nobel Prize in physics, would have most likely spent most of his time there. The long building on the right housed more offices. The project's hospital (from where the photo was taken) along with the nurses' barracks and the commissary (outside the photo and to the left) also surrounded the pond.



Los Alamos National Laboratory

All of the war-era buildings around the pond were removed when the Lab eventually moved to a more isolated location. By 1966, the government had given the pond and the property surrounding it to Los Alamos County.

NOW

Ashley Pond, shown here in July 2014, is now the public center of the town of Los Alamos. Concerts, weddings and celebrations of all kinds, and the counties' various fairs regularly use the grounds around the pond. This photo was taken from approximately the same location as the 1947 photo.

National Security Science
Mail Stop A107
Los Alamos National Laboratory
Los Alamos, NM 87545
Email: NSSPub@lanl.gov
Tel: 505-667-7814
www.lanl.gov/science/NSS

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Down a remote canyon near Los Alamos National Laboratory lies a facility known as the "Tunnel Vault." Buried 300 feet deep underground and built between 1948 and 1949, it was once one of the most secret and secure locations in the United States—the original post-WWII nuclear stockpile storage area. The Tunnel Vault has a formidable security perimeter, a hardened guard tower, complete with gun ports and bulletproof glass, and a series of gates and doors that open into a 230-foot-long concrete tunnel that goes straight back into the canyon wall. About halfway down the tunnel is a side room that was used for early research that led to detection of the neutrino—work that later won a Nobel Prize in physics. *(Photo: Los Alamos)*