

U.S. Nuclear Weapons Capability

Assessing the state of U.S. nuclear weapons capabilities presents several challenges.

First, instead of taking advantage of technological developments to field new warheads that could be designed to be safer and more secure and could give the United States improved options for guaranteeing a credible deterrent, the U.S. has elected to maintain nuclear warheads—based on designs from the 1960s and 1970s—that were in the stockpile when the Cold War ended.

Second, the lack of detailed publicly available data about the readiness of nuclear forces, their capabilities, and weapon reliability makes analysis difficult.

Third, the U.S. nuclear enterprise has many components, some of which are also involved in supporting conventional missions. For example, dual-capable bombers do not fly airborne alert with nuclear weapons today, although they did so routinely during the 1960s (and are capable of doing so again if the decision should ever be made to resume this practice). Additionally, the national security laboratories do not focus solely on the nuclear weapons mission; they also perform a variety of functions related to nuclear nonproliferation, medical research, threat reduction, and countering nuclear terrorism, including nuclear detection. The National Command and Control System performs nuclear command and control in addition to supporting ongoing conventional operations.

Thus, assessing the extent to which any one piece of the nuclear enterprise is sufficiently funded, focused, and effective with regard to the nuclear mission is problematic.

In today's rapidly changing world, the U.S. nuclear weapons enterprise must be flexible and resilient to underpin the U.S. nuclear deterrent. If the U.S. detects a game-changing nuclear weapons development in another country, the U.S. nuclear weapons complex must be able to provide a timely response.

The U.S. maintains an inactive stockpile that includes near-term hedge warheads that can be put back into operational status within six to 24 months; extended hedge warheads are said to be ready within 24 to 60 months.¹ The U.S. preserves significant upload capability on its strategic delivery vehicles, which means that the nation can increase the number of nuclear warheads on each type of its delivery vehicles if contingencies warrant. For example, the U.S. Minuteman III intercontinental ballistic missile (ICBM) can carry up to three nuclear warheads, although it is currently deployed with only one.²

Presidential Decision Directive-15 (PDD-15) requires the U.S. to maintain the ability to conduct a nuclear test within 24 to 36 months of a presidential decision to do so.³ However, successive governmental reports have noted the continued deterioration of technical and diagnostics equipment and the inability to fill technical positions supporting nuclear testing readiness.⁴ A lack of congressional support for improving technical readiness further undermines efforts by the National Nuclear Security Administration (NNSA) to comply with the directive.

The weapons labs face demographic challenges of their own. Most scientists and engineers with practical nuclear weapon design and testing experience are retired. This means

that for the first time since the dawn of the nuclear age, the U.S. will have to rely on the scientific judgment of people who were not directly involved in nuclear tests of weapons that they designed, developed, and are certifying.

Not all of the existing inactive stockpile will go through the life-extension program. Hence, our ability to respond to contingencies by uploading weapons kept in an inactive status could decline with the passage of time.

The shift of focus away from the nuclear mission after the end of the Cold War caused the NNSA laboratories to lose their sense of purpose and to feel compelled to reorient and broaden their mission focus. According to a number of studies, their relationship with the government also evolved in ways that reduce output and increase costs. The NNSA was supposed to address these problems but has largely failed in this task, partly because “the relationship with the NNSA and the National security labs appears to be broken.”⁵

In 1999, the Commission on Maintaining U.S. Nuclear Weapons Expertise concluded that 34 percent of the employees supplying critical skills to the weapons program were more than 50 years old. The number increased to 40 percent in 2009.⁶ On average, the U.S. high-technology industry has a more balanced employee age distribution.⁷

Both the lack of resources and the lack of sound, consistent policy guidance have undermined workforce morale. The Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise recommended fundamental changes in the nuclear weapons enterprise’s culture, business practices, project management, and organization. Others proposed moving the NNSA to the Department of Defense.⁸

Another important indication of the health of the overall force is the readiness of forces that operate U.S. nuclear systems. In 2006, the Air Force mistakenly shipped non-nuclear warhead components to Taiwan.⁹ A year later, it transported nuclear-armed cruise missiles across the U.S. without authorization (or apparently even awareness that it was doing so,

mistaking them for conventional cruise missiles).¹⁰ These serious incidents led to the establishment of a Task Force on DoD Nuclear Weapons Management, which found that “there has been an unambiguous, dramatic, and unacceptable decline in the Air Force’s commitment to perform the nuclear mission and, until very recently, little has been done to reverse it” and that “the readiness of forces assigned the nuclear mission has seriously eroded.”¹¹

Following these incidents, the Air Force instituted broad changes to improve oversight and management of the nuclear mission and the inventory of nuclear weapons, including creating the Air Force Global Strike Command to organize, train, and equip intercontinental-range ballistic missile and nuclear-capable bomber crews as well as other personnel to fulfill a nuclear mission and implement a stringent inspection regime.

The success of these changes has been limited. In January 2014, the Air Force discovered widespread cheating on nuclear proficiency exams and charged over 100 officers with misconduct. The Navy had a similar problem, albeit on a smaller scale.¹² The Department of Defense conducted two nuclear enterprise reviews, one internal and one external. Both reviews identified a lack of leadership attention, a lack of resources to modernize the atrophied infrastructure, and unduly burdensome implementation of the personnel reliability program as some of the core challenges preventing a sole focus on accomplishing the nuclear mission.¹³

The ICBM Force Improvement Program was initiated and mostly implemented throughout 2014 and into 2015, and the Air Force shifted over \$160 million to address problems, modernize certain facilities, and generally improve morale. The Air Force has also seen an increase in badly needed manpower—but not nearly enough to alleviate manpower concerns. If changes in the nuclear enterprise are to be effective, leaders across the executive and legislative branches will have to continue to provide sufficient resources to mitigate readiness and morale issues within the force.

Fiscal uncertainty and a steady decline in resources for the nuclear weapons enterprise (trends that have begun to reverse in recent years) have negatively affected the nuclear deterrence mission. General John E. Hyten, Commander, U.S. Strategic Command (STRATCOM), testified in April 2017 that:

For decades now, we have held a military advantage over our adversaries, both from a nuclear and conventional standpoint. That is starting to change. As our nation rightly focuses on combating violent extremist organizations and the states that support them, other adversaries have taken the opportunity to develop advanced nuclear and conventional weaponry that rival many of our systems.¹⁴

The Trump Administration has inherited a comprehensive modernization program for nuclear forces—warheads, delivery systems, and command and control. The Obama Administration included this program in its budget requests, and Congress to a significant extent has funded it. Because such modernization activities require long-term funding commitments, it is important that this commitment continue. At the same time, the Trump Administration has an opportunity to reassess the U.S. nuclear force posture, including some of its more misguided elements like discounting Russia's aggressive policies toward the United States and U.S. allies in Europe.

Implications for U.S. National Security

U.S. nuclear forces are not designed to shield the nation from all types of attacks from all adversaries. They are designed to deter large-scale conventional and nuclear attacks that threaten America's sovereignty, forward-deployed troops, and allies.

U.S. nuclear forces play an important role in the global nonproliferation regime by providing U.S. assurances to NATO, Japan, and South Korea that lead these allies either to keep the number of their nuclear weapons lower than otherwise would be the case (France and the United Kingdom) or to forgo their development and deployment altogether. North Korea

has proven that a country with very limited intellectual and financial resources can develop a nuclear weapon if it decides to do so. Iran continues on the path to obtaining a nuclear weapon, and the Joint Comprehensive Plan of Action might make reaching this goal easier by providing Iran with money and access to advanced technologies.

This makes U.S. nuclear assurances to allies and partners ever more important. Should the credibility of American nuclear forces continue to degrade, countries like South Korea could pursue an independent nuclear option, which would raise several thorny issues including possible additional instability across the region.

Certain negative trends could undermine U.S. nuclear deterrence if problems are not addressed. There is no shortage of challenges on the horizon, from an aging nuclear weapons infrastructure and workforce to the need to recapitalize all three legs (land, air, and sea) of the nuclear triad, and from the need to conduct life-extension programs while maintaining a self-imposed nuclear weapons test moratorium to limiting the spread of nuclear know-how and the means to deliver nuclear weapons. Additionally, the United States must take account of adversaries that are modernizing their nuclear forces, particularly Russia and China.

Since 2010, when the most recent Nuclear Posture Review (NPR) was concluded, the global strategic security environment has become increasingly dangerous. Russia is now engaged in an aggressive nuclear buildup, having added new modern nuclear systems to its arsenal since 2010. Concurrently, Russia is using its capabilities to threaten the sovereignty of U.S. allies in Eastern Europe and the Baltics. China is engaging in a similar nuclear buildup as it projects power into the South China Sea. North Korea and Iran have taken an aggressive posture toward the West as they attempt to shift from nuclear proliferators to nuclear-armed states.

Deterrence is an intricate interaction between U.S. conventional and nuclear forces and the psychology of both allies and adversaries

that the U.S. would use these forces to defend the interests of the U.S. and its allies. Nuclear deterrence must reflect the mindset of the adversary the U.S. seeks to deter. If an adversary believes that he can fight and win a limited nuclear war, the task for U.S. leaders is to convince that adversary otherwise even if U.S. leaders think it is not possible to control escalation. The U.S. nuclear portfolio must be structured in terms of capacity, capability, variety, flexibility, and readiness to achieve this objective. In addition, military requirements and specifications for nuclear weapons will be different depending on who is being deterred, what he values, and what the U.S. seeks to deter him from doing.

Due to the complex interplay among strategy, policy, actions that states take in international relations, and other actors' perceptions of the world around them, one might never know precisely if and when a nuclear

or conventional deterrent provided by U.S. forces loses credibility. Nuclear weapons capabilities take years or decades to develop, as does the infrastructure supporting them—an infrastructure that the U.S. has neglected for decades. We can be reasonably certain that a robust, well-resourced, focused, and reliable nuclear enterprise is more likely to sustain its deterrent value than is an outdated and questionable one.

The U.S. is capable of incredible mobilization when danger materializes. The nuclear threat environment is dynamic and proliferating, with old and new actors developing advanced capabilities while the U.S. enterprise is relatively static, potentially leaving the United States at a technological disadvantage. This is worrisome because of its implications both for the security of the United States and for the security of its allies and the free world.

Scoring U.S. Nuclear Weapons Capabilities

The U.S. nuclear weapons enterprise is composed of several key elements that include warheads; delivery systems; nuclear command and control; intelligence, surveillance, and reconnaissance; aerial refueling; and the physical infrastructure that designs, manufactures, and maintains U.S. nuclear weapons. The complex also includes the talent of people from physicists to engineers, maintainers, and operators, without which the continuous maintenance of the nuclear infrastructure would not be possible.

The factors selected below are the most important elements of the nuclear weapons complex. They are judged on a five-grade scale, where “very strong” means that a sustainable, viable, and funded plan is in place and “very weak” means that the U.S. is not meeting its security requirements and has no program in place to redress the shortfall, which has the potential to damage vital national interests if the situation is not corrected.

Current U.S. Nuclear Stockpile Score: Strong

U.S. warheads must be safe, secure, effective, and reliable. The Department of Energy (DOE) defines reliability as “the ability of the weapon to perform its intended function at the intended time under environments considered to be normal” and as “the probability of achieving the specified yield, at the target, across the Stockpile-to-Target Sequence of environments, throughout the weapon’s lifetime, assuming proper inputs.”¹⁵ Since 1993, reliability has been determined through an intensive warhead surveillance program; non-nuclear experiments (that is, without the use of experiments producing nuclear yield); sophisticated calculations using high-performance computing; and related evaluations.

The reliability of nuclear warheads and delivery systems becomes more important as the number and diversity of nuclear weapons in the stockpile decrease, because fewer types of nuclear weapons mean a smaller margin of

U.S. Military Power: Five-Grade Scale

VERY WEAK

WEAK

MARGINAL

STRONG

VERY STRONG

error should one type be affected by a technical problem that requires the repair or decommissioning of a weapon type or its delivery system. Americans and allies must be confident that U.S. nuclear warheads will perform as expected.¹⁶

As warheads age, they become less able to perform their mission as expected, and this can complicate military planning significantly. Despite creating impressive amounts of knowledge about nuclear weapons physics and materials chemistry, the U.S. may not be completely certain about the long-term effects of aging components that comprise a nuclear weapon. According to former NNSA spokesman Bryan Wilkes, for example, “We know that plutonium pits have a limited lifetime.”¹⁷ A plutonium pit is a crucial component of a nuclear weapon,¹⁸ and with life-extension programs introducing new components to warheads whose radiological effects are not fully known, the level of uncertainty has increased.

The United States has the world’s safest and most secure stockpile, but security of long-term storage sites (including overseas sites), potential problems introduced by improper handling, or unanticipated effects stemming from long-term handling could compromise the integrity of U.S. warheads. The nuclear warheads themselves contain security measures that are designed to make it difficult, if not impossible, to detonate a weapon absent a proper authorization.

Grade: The Department of Energy and Department of Defense are required to assess the reliability of the nuclear stockpile annually. This assessment does not include delivery systems, although the U.S. Strategic Command does assess overall weapons system reliability, which includes both the warhead and delivery platforms.

Absent nuclear weapons testing, the assessment of weapons reliability becomes more

subjective, albeit based on experience and non-nuclear tests. While certainly an educated opinion, it is not a substitute for the type of objective data obtained through nuclear testing. Testing was used to diagnose potential problems and to certify the effectiveness of fixes to those problems. Given that modern simulation is based on nuclear tests that were conducted primarily in the 1950s and 1960s, using testing equipment of that era, there is a great deal that modern testing equipment and computer capability could teach us about nuclear physics.

“[I]n the past,” according to the late Major General Robert Smolen, some of the nuclear weapon problems that the U.S. now faces “would have [been] resolved with nuclear tests.”¹⁹ By 2005, a consensus emerged in the NNSA, informed by the nuclear weapons labs, that it would “be increasingly difficult and risky to attempt to replicate exactly existing warheads without nuclear testing and that creating a reliable replacement warhead should be explored.”²⁰ When the U.S. did conduct nuclear tests, it frequently found that small changes in a weapon’s tested configuration had a dramatic impact on weapons performance. In fact, the 1958–1961 testing moratorium resulted in weapons with serious problems being introduced into the U.S. stockpile.²¹

In fiscal year (FY) 2017, the NNSA assessed that the stockpile is safe, secure, reliable, and effective.²²

The lack of nuclear weapons testing creates some uncertainty concerning the adequacy of fixes to the stockpile when problems are found. This includes updates made in order to correct problems that were found in the weapons or changes in the weapons resulting from life-extension programs. It is simply impossible to duplicate exactly weapons that were designed and built many decades ago. According to former Defense Threat Reduction Agency Director Dr. Stephen Younger, we have had to

fix “a number of problems that were never anticipated” by using “similar but not quite identical parts.”²³ The high costs of having to certify weapons without nuclear testing are resulting in fewer types of weapons and, consequently, a greater impact across the inventory if there is an error in the certification process.

“To be blunt,” warned Secretary of Defense Robert Gates in October 2008, “there is absolutely no way we can maintain a credible deterrent and reduce the number of weapons in our stockpile without either resorting to testing our stockpile or pursuing a modernization program.”²⁴ The U.S. is pursuing warhead life-extension programs that replace aging components before they can cause reliability problems. However, the national commitment to this modernization program, including the necessary long-term funding, continues to be uncertain.

In light of our overall assessment, we grade the U.S. stockpile as “strong.”

Reliability of U.S. Delivery Platforms Score: Strong

Reliability encompasses not only the warhead, but strategic delivery vehicles as well. In addition to a successful missile launch, this includes the separation of missile boost stages, performance of the missile guidance system, separation of the multiple re-entry vehicle warheads from the missile post-boost vehicle, and accuracy of the final re-entry vehicle in reaching its target.²⁵

The U.S. conducts flight tests of ICBMs and submarine-launched ballistic missiles (SLBMs) every year to ensure the reliability of its systems. Anything from electrical wiring to faulty booster separations could degrade the efficiency and safety of the U.S. strategic deterrent if it were to malfunction. U.S. strategic, long-range bombers regularly conduct intercontinental training and receive upgrades in order to sustain a high level of combat readiness, but potential challenges are on the horizon.

Grade: U.S. ICBMs and SLBMs are flight tested annually, and these tests were successful

in 2016. To the extent that data from these tests are publicly available, they provide objective evidence of the delivery systems’ reliability and send a message to U.S. adversaries that the system works. The aged systems, however, occasionally have reliability problems.²⁶ Overall, this factor earns a grade of “strong.”

Nuclear Warhead Modernization Score: Weak

During the Cold War, the United States maintained a strong focus on designing and developing new nuclear warhead designs in order to counter Soviet advances and modernization efforts and to leverage advances in understanding the physics, chemistry, and design of nuclear weapons. Today, the United States is focused on sustaining the existing stockpile, not on developing new warheads, even though all of its nuclear-armed adversaries are developing new nuclear warheads and capabilities and accruing new knowledge in which the U.S. used to lead. Since the collapse of the Soviet Union, nuclear weapons and delivery vehicles have not been replaced despite being well beyond their designed service lives. This could increase the risk of failure due to aging components and signal to adversaries that the United States is less committed to nuclear deterrence.

New weapon designs could allow American engineers and scientists to improve previous designs and devise more effective means to address existing military requirements (for example, the need to destroy deeply buried and hardened targets) that have emerged in recent years. New warheads could also enhance the safety and security of American weapons.

An ability to work on new weapon designs would also help American experts to remain engaged and knowledgeable, would help to attract the best talent to the nuclear enterprise, and could help the nation to gain additional insights into foreign nations’ nuclear weapon programs. As the Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile noted, “Only through work on advanced designs will it be possible to train

the next generation of weapon designers and producers. Such efforts are also needed to exercise the DoD/NNSA weapon development interface.”²⁷ Other nations maintain their levels of proficiency by having their scientists work on new nuclear warheads and possibly by conducting very low-yield nuclear weapons tests.

Grade: The lack of plans to modernize nuclear weapons—life-extension programs are not modernization—and restrictions on thinking about new designs that might accomplish the deterrence mission in the 21st century more effectively earn nuclear warhead modernization a grade of “weak.”

Nuclear Delivery Systems Modernization Score: Strong

Today, the United States fields a triad of nuclear forces with delivery systems that are safe and reliable, but as these systems age, there is increased risk of significantly negative impact on operational capabilities. The older weapons are, the more at risk they are that faulty components, malfunctioning equipment, or technological developments will limit their reliability in the operating environment. Age can degrade reliability by increasing the potential for systems to break down or fail to respond correctly. Corrupted systems, defective electronics, or performance degradation due to long-term storage defects (including for nuclear warheads) can have serious implications for American deterrence and assurance. If it cannot be assumed that a strategic delivery vehicle will operate reliably at all times, that vehicle’s deterrence and assurance value is significantly reduced.

The U.S. Air Force and Navy plan to modernize or replace each leg of the nuclear triad in the next several decades, but fiscal constraints are likely to make such efforts difficult. The Navy is fully funding its programs to replace the *Ohio*-class submarine with the *Columbia*-class submarine and to extend the life of and eventually replace the Trident SLBM, but existing ICBMs and SLBMs are expected to remain in service until 2032 and

2042, respectively, and new bombers are not planned to enter into service until 2023 at the earliest. Budgetary shortfalls are leading to uncertainty as to whether the nation will be able to modernize all three legs of the nuclear triad, but the U.S. Strategic Command says that a triad is a “requirement.”²⁸ This requirement, validated by all U.S. NPRs since the end of the Cold War, gives U.S. leadership credibility and flexibility, attributes that are necessary for any future deterrence scenarios.

Maintenance issues caused by the aging of American SSBNs and long-range bombers could make it difficult to deploy units overseas for long periods or remain stealthy in enemy hot spots. At present, the United States can send only a limited number of bombers on missions at any one time. As Bradley Thayer and Thomas Skypek have noted, “Using 2009 as a baseline, the ages of the current systems of the nuclear triad are 39 years for the *Minuteman III*, 19 years for the *Trident II D-5* SLBM, 48 years for the B-52H, 12 years for the B-2, and 28 years for the *Ohio* Class SSBNs.”²⁹ Remanufacturing some weapon parts is difficult and expensive either because some of the manufacturers are no longer in business or because the materials that constituted the original weapons are no longer available (for example, due to environmental restrictions). The ability of the U.S. to produce solid-fuel rocket engines and possible U.S. dependence on Russia as a source of such engines are other long-range concerns.³⁰

Grade: U.S. nuclear platforms are in dire need of recapitalization. The U.S. has plans for nuclear triad modernization in place, and funding for these programs has been sustained by Congress and by the services, notwithstanding difficulties caused by sequestration. This demonstration of commitment to nuclear weapons modernization earns this indicator a grade of “strong.”

Nuclear Weapons Complex Score: Weak

Maintaining a reliable and effective nuclear stockpile depends in large part on the facilities where U.S. devices and components are developed, tested, and produced. These facilities

constitute the foundation of our strategic arsenal and include the:

- Los Alamos National Laboratories,
- Lawrence Livermore National Laboratories,
- Sandia National Laboratory,
- Nevada National Security Site,
- Pantex Plant,
- Kansas City Plant,
- Savannah River Site, and
- Y-12 National Security Complex.

In addition to these government sites, the defense industrial base supports the development and maintenance of American delivery platforms.

These complexes design, develop, test, and produce the weapons in the U.S. nuclear arsenal, and their maintenance is of critical importance. As the 2010 NPR stated:

In order to remain safe, secure, and effective, the U.S. nuclear stockpile must be supported by a modern physical infrastructure—comprised of the national security laboratories and a complex of supporting facilities—and a highly capable workforce with the specialized skills needed to sustain the nuclear deterrent.³¹

A flexible and resilient infrastructure is an essential hedge in the event that components fail or the U.S. is surprised by the nuclear weapon capabilities of potential adversaries.³² U.S. research and development efforts and the industrial base that supports modernization of delivery systems are important parts of this indicator.

Maintaining a safe, secure, effective, and reliable nuclear stockpile requires modern facilities, technical expertise, and tools both to repair any malfunctions quickly, safely, and

securely and to produce new nuclear weapons if required. The existing nuclear weapons complex, however, is not fully functional. The U.S. cannot produce more than a few new warheads per year, there are limits on the ability to conduct life-extension programs, and Dr. John Foster has reported that the U.S. no longer can “serially produce many crucial components of our nuclear weapons.”³³

If the facilities are not properly funded, the U.S. will gradually lose the ability to conduct high-quality experiments. In addition to demoralizing the workforce and hampering further recruitment, obsolete facilities and poor working environments make maintaining a safe, secure, reliable, and militarily effective nuclear stockpile exceedingly difficult. The NNSA’s facilities are old: Upwards of 50 percent are more than 40 years old, nearly 30 percent date to the Manhattan Project of the 1940s, and 12 percent are considered excess or no longer needed.³⁴ As a consequence, the NNSA had about \$3.7 billion in deferred maintenance at the end of FY 2015.

Since 1993, the DOE has not had a facility dedicated to production of plutonium pits, one of the main components of America’s nuclear warheads. The U.S. currently keeps about 5,000 plutonium pits in strategic reserve. There are significant disagreements as to the effect of aging on pits and whether the U.S. will be able to maintain them indefinitely without nuclear weapons testing. Currently, the U.S. can produce no more than about 10 plutonium pits a year at the Los Alamos PF-4 facility. Infrastructure modernization plans for PF-4, if funded, will boost that number to about 20 by the middle of the next decade and to between 50 and 80 by the end of the following decade. Russia can produce around 2,000 pits a year.³⁵

Manufacturing non-nuclear components can be extremely challenging either because some materials may no longer exist or because manufacturing processes have been forgotten and must be retrieved. There is a certain element of art to building a nuclear weapon, and such a skill can be acquired and maintained only through hands-on experience.

Grade: On one hand, the U.S. maintains some of the world's most advanced nuclear facilities. On the other, some parts of the complex—most importantly, parts of the plutonium and highly enriched uranium component manufacturing infrastructure—have not been modernized since the 1950s, and plans for long-term infrastructure recapitalization remain uncertain. The infrastructure therefore receives a grade of “weak.”

Quality of People Working in the National Nuclear Laboratories Score: Marginal

Combined with nuclear facilities, U.S. nuclear weapons scientists and engineers are critical to the health of the complex and the stockpile. The 2010 NPR emphasizes that:

[A] highly skilled workforce [is] needed to ensure the long-term safety, security, and effectiveness of our nuclear arsenal and to support the full range of nuclear security work to include non-proliferation, nuclear forensics, nuclear, counter-terrorism, emergency management, intelligence analysis and treaty verification.³⁶

The ability to maintain and attract a high-quality workforce is critical to assuring the future of the American nuclear deterrent. Today's weapons designers and engineers are first-rate, but they also are aging and retiring, and their knowledge must be passed on to the next generation that will take on this mission. This means that young designers need challenging warhead design and development programs to hone their skills, but no such challenging programs are in place today. The NNSA and its weapons labs understand this problem and, with the support of Congress and despite significant challenges, are taking steps to mentor the next generation.

The U.S. currently relies on non-yield-producing laboratory experiments, flight tests, and the judgment of experienced nuclear scientists and engineers to ensure continued confidence in the safety, security, effectiveness, and reliability of its nuclear deterrent. Without their experience, the nuclear weapons

complex could not function. A basic problem is that few scientists or engineers at the NNSA weapons labs have had the experience of taking a warhead from initial concept to a “clean sheet” design, engineering development, and production. The complex must attract and retain the best and brightest. The average age of the NNSA's workforce remained 48.1 years as of April 2017.³⁷

Grade: In addition to employing world-class experts, the NNSA labs have had recent success in attracting and retaining talent. However, because many scientists and engineers with practical nuclear weapon design and testing experience are retired, nuclear warhead certifications will rely largely on the judgments of people who have never tested or designed a nuclear weapon. Management challenges and a lack of focus on the nuclear weapon mission contribute to the lowering of morale in the NNSA complex. In light of these issues, which have to do more with policy than with the quality of people, the complex earns a score of “marginal.”

Readiness of Forces Score: Marginal

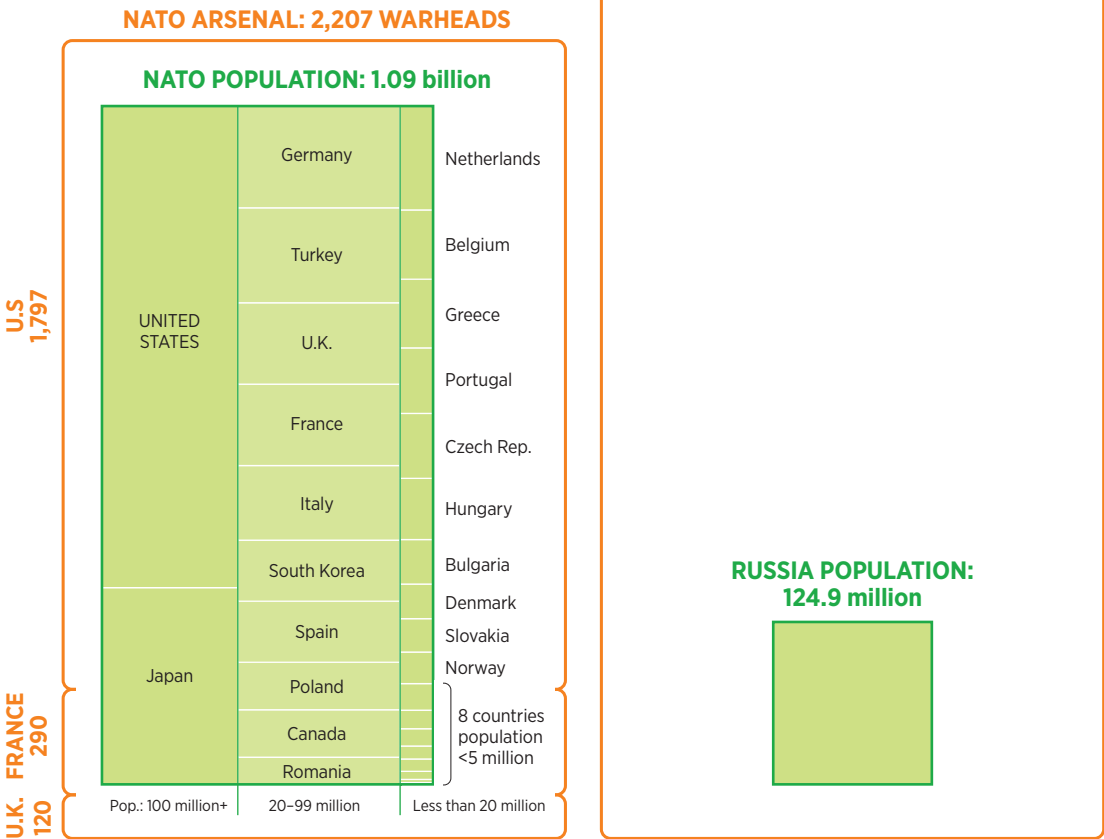
The readiness of forces is a vital component of America's strategic forces. The military personnel operating the three legs of the nuclear triad must be properly trained and equipped. It is also essential that these systems are maintained in a high state of readiness.

During FY 2017, the services have continued to align resources in order to preserve strategic capabilities in the short term, but long-term impacts remain uncertain. Continued decline in U.S. general-purpose forces eventually could affect nuclear forces, especially the bomber leg of the nuclear triad. Changes prompted by the 2014 Navy and Air Force cheating scandals have begun to address some of the morale issues. A sustained attention to the situation in the nuclear enterprise is critical.

Grade: Uncertainty regarding the further potential impacts of budgetary shortfalls, as part of the overall assessment, earns this indicator a grade of “marginal.”

Putting the U.S. Nuclear Arsenal in Context

The U.S. has 1,797 nuclear warheads deployed. Combining those with arsenals from NATO allies France and the U.K. totals 2,207 warheads—1,375 warheads below Russia’s estimated total. Additionally, NATO’s combined arsenal protects 1.09 billion people in 30 countries, while Russia’s arsenal protects only its population of 124.9 million.



NOTES: Figures are from 2015. Warhead totals are estimates.
SOURCES: U.S. Department of State, “New START Treaty Aggregate Numbers of Strategic Offensive Arms,” July 1, 2015, <http://www.state.gov/t/avc/rls/240062.htm> (accessed September 3, 2015); Amy F. Woolf, “Nonstrategic Nuclear Weapons,” Congressional Research Service *Report for Members and Committees of Congress*, February 23, 2015, <https://www.fas.org/sgp/crs/nuke/RL32572.pdf> (accessed September 3, 2015); and Terry Miller and Anthony B. Kim, *2017 Index of Economic Freedom* (Washington: The Heritage Foundation, 2017), <http://www.heritage.org/index>.

Allied Assurance Score: Marginal

The number of weapons held by U.S. allies is an important element when speaking about the credibility of America's extended deterrence. Allies that already have nuclear weapons can coordinate action with other powers or act independently. During the Cold War, the U.S. and the U.K. cooperated to the point where joint targeting was included.³⁸ France maintains its own independent nuclear arsenal, partly as a hedge against the uncertainty of American credibility. The U.S. also deploys nuclear gravity bombs in Europe as a visible manifestation of its commitment to its NATO allies.

The U.S., however, must also concern itself with its Asian allies. The United States provides nuclear assurances to Japan and South Korea, both of which are technologically advanced industrial economies facing nuclear-armed adversaries and potential adversaries. If they do not perceive U.S. assurances as credible, they have the capability and know-how to build their own nuclear weapons and to do so quickly. That would be a major setback for U.S. nonproliferation policies.

Grade: At this time, most U.S. allies are not seriously considering developing their own nuclear weapons. European members of NATO continue to express their commitment to and appreciation for NATO as a nuclear alliance. Doubts about the modernization of dual-capable aircraft and even about the weapons themselves, as well as NATO's lack of attention to the nuclear mission and its intellectual underpinning, preclude assigning a score of "very strong." Additionally, the perception among some that America has accepted Iran's nuclear program may encourage other countries in the Middle East region to seek similar capabilities. Thus, allied assurance remains "marginal."

Nuclear Test Readiness Score: Weak

Testing is one of the key elements of a safe, secure, effective, and reliable nuclear deterrent. While the U.S. is currently under a self-imposed nuclear testing moratorium, it

maintains a low level of nuclear test readiness at the Nevada National Security Site (formerly Nevada Test Site). This approach is questionable with regard to its efficacy in assuring that the U.S. has the timely ability to conduct yield-producing experiments should it discover a flaw in one or more types of its nuclear weapons that requires experimentation to correct. The U.S. might need to test to develop a weapon with new characteristics that can be validated only by testing and to verify render-safe procedures. Yield-producing experiments can also play an important role if the U.S. needs to react strongly to other nations' nuclear weapons tests and communicate its resolve or to understand other countries' new nuclear weapons.

Current law requires that the U.S. be prepared to conduct a nuclear weapons test within a maximum of 36 months after a presidential decision to do so. The current state of test readiness is between 24 and 36 months, although both the NNSA and Congress required the NNSA to be ready within 18 months in the past.³⁹ The U.S. could meet the 18-month requirement only if certain domestic regulations, agreements, and laws were waived.⁴⁰ Because the United States is rapidly losing its remaining practical nuclear testing experience, including instrumentation of very sensitive equipment, the process would likely have to be reinvented from scratch.⁴¹

"Test readiness" refers to a single test or a very short series of tests, not a sustained nuclear testing program. Because of a shortage of resources, the NNSA has been unable to achieve this goal. The test readiness program is supported by experimental programs at the Nevada National Security Site, nuclear laboratory experiments, and advanced diagnostics development.⁴²

Grade: As noted, the U.S. can meet the readiness requirement mandated by the law only if certain domestic regulations, agreements, and laws are waived. In addition, the U.S. is not prepared to sustain testing activities beyond a few limited experiments, which certain scenarios might require. Thus, testing readiness earns a grade of "weak."

Overall U.S. Nuclear Weapons
Capability Score: Marginal

Though modernization programs for warheads and delivery systems are uncertain, the infrastructure that supports nuclear programs is aged, and nuclear test readiness has revealed troubling problems within the forces, those weak spots are offset by strong delivery

platform reliability and allies who remain confident in the U.S. nuclear umbrella. The commitment to warhead life-extension programs and modernization of nuclear delivery platforms is a positive trend that should be maintained. Averaging the subscores across the nuclear enterprise therefore results in an overall score of “marginal.”

U.S. Military Power: Nuclear

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Warhead Surety				✓	
Delivery Platform Reliability				✓	
Warhead Modernization		✓			
Delivery Systems Modernization				✓	
Nuclear Weapons Complex		✓			
National Labs Talent			✓		
Force Readiness			✓		
Allied Assurance			✓		
Nuclear Test Readiness		✓			
OVERALL			✓		

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