

The Long-Range Standoff Weapon and the 2017 Nuclear Posture Review

President Trump signed a national security presidential memorandum 27 January 2017, calling for secretary of defense Gen James Mattis to “initiate a new Nuclear Posture Review (NPR) to ensure that the United States nuclear deterrent is modern, robust, flexible, resilient, ready, and appropriately tailored to deter 21st-century threats and reassure allies.”¹ Many advocates of nuclear modernization were optimistic that the new president would take a very different approach to nuclear strategy than his predecessor. Some proponents of modernization saw a new NPR as an opportunity to make the case for new delivery vehicles and warheads and reexamine some of the fundamental assumptions and strategic concepts laid out in the 2010 NPR. With an expected completion date in late 2017, this NPR will significantly affect the administration’s modernization spending priorities for the remainder of President Trump’s time in office.

Perhaps the most underappreciated and maligned weapon system in the current modernization program is the long-range standoff weapon (LRSO). While each modernization program has faced some criticism from arms control and disarmament advocates, none has been as disparaged as the LRSO. Former secretary of defense William Perry, who played a major role in the development of the current AGM-86 air launched cruise missile (ALCM), went so far as to take to the pages of the *Washington Post* to call for the cancellation of the program and the retirement of nuclear-armed cruise missiles.²

On the contrary, a modern nuclear-armed cruise missile is essential to US deterrence. The challenge for the US Air Force, which seeks to replace the ALCM with the LRSO, is to effectively explain the role a nuclear-armed cruise missile plays in American nuclear strategy. In doing so, the Air Force will aid drafters of the NPR as they seek to fully understand not only the capabilities and shortfalls present in the current arsenal but also how modernization programs—including the LRSO—will reverse decades of decay in US nuclear capability. It is equally important to provide Congress with compelling justification for funding the initiatives laid out in a new NPR.

This article focuses on the role of nuclear-armed cruise missiles in nuclear strategy, with a particular focus on the LRSO. It presents brief background information then examines the arguments of detractors and makes the positive case for the weapon system—explaining the unique role it plays in creating a credible deterrent force. The article concludes with general and specific recommendations for the 2017 Nuclear Posture Review.

Background

The AGM-86 air launched cruise missile was designed in the mid-1970s and first fielded in 1982. At the time it entered service, the B-52 was facing increasingly potent Soviet integrated air defense systems (IADS) that the venerable bomber was unable to penetrate. Thus, a nuclear-armed cruise missile was designed for the primary purpose of penetrating these networks and providing a standoff strike capability deep into Soviet territory.³ With a planned service life of 10 years, the AGM-86 was to be replaced in the early 1990s. As early as 1982 the Air Force understood that the AGM-86 would have problems penetrating future Soviet IADS as they grew increasingly sophisticated. This led to the ultimate design and fielding of the AGM-129A advanced cruise missile (ACM), a low observable nuclear-armed cruise missile, first delivered to the Air Force in 1987. With the collapse of the Soviet Union on Christmas Day 1991, President George H. W. Bush began large-scale reductions in the United States' nuclear arsenal and cancelled many of the modernization programs then under way.⁴ One of these, the ACM, ultimately proved to be a cost-ineffective weapon and was retired from service in 2012.⁵

This left the Air Force in need of a nuclear-armed cruise missile capable of penetrating Russian IADS that have continued to grow increasingly sophisticated and are proliferating outside Russia. The S-300/400/500 air defense systems that Russia currently fields are the most sophisticated in the world—and a far cry from the SA-6 the Air Force faced in conflicts over the past four decades.⁶ China, too, possesses not only the most dense radar network in the world but also increasingly capable IADS that make standoff attack a necessity.

It is in this challenging air defense environment that the Air Force sought to replace the AGM-86 with a new stealth nuclear-armed cruise missile capable of either destroying these defenses or penetrating them. A growing need has also developed over the past several decades as

adversaries specifically design and site facilities that are immune to attack from US ballistic missiles. The LRSO is required to hold these targets at risk.

According to information released by the Department of Defense, the long-range standoff weapon will cost an estimated \$15–20 billion for approximately 1,000 weapons. From the limited information available, the LRSO will be a stealthy, subsonic, nuclear-armed cruise missile with a likely range of 2,500–3,000 kilometers. It will carry a modernized version of the W80-4 warhead with improved safety, security, and reliability features.⁷ The LRSO will have defensive systems not present on the AGM-86. The weapon will also have improved accuracy. Beyond these basic features, specific program requirements and capabilities are highly classified. However, it is reasonable to expect that with four decades of technological advancement since the AGM-86 was originally designed, the LRSO will incorporate a number of features that were nonexistent when the ALCM was designed.

The Opposition

The points made by opponents of the LRSO can be grouped into three main arguments. First, they argue that nuclear-armed cruise missiles are destabilizing.⁸ Second, they argue that the LRSO is a redundant capability. Third, they argue that the nation cannot afford the weapon. Each of these objections requires more detail.

Perhaps the most widely stated reason for opposition to the LRSO is the belief that nuclear-armed cruise missiles are destabilizing. According to William Perry, “Because they can be launched without warning and come in both nuclear and conventional variants, cruise missiles are a uniquely destabilizing type of weapon.”⁹ In a letter to then-president Barack Obama, Senator Edward Markey (D-MA) and seven other senators agreed with this proposition and added, “This could result in dramatic escalation and potential devastating miscalculations in a conflict with a nuclear-armed state.”¹⁰

Opponents also argue that the LRSO is a redundant capability for two reasons. First, they argue that because the B-2 and B-21 are stealth bombers and will soon carry the B61-12 gravity bomb, they will be able to penetrate advanced IADS to deliver weapons.¹¹ Second, they argue that the conventional joint air-to-surface standoff missile (JASSM) and

its extended-range variant (JASSM-ER) can effectively target an adversary's advanced IADS, making the LRSO unnecessary.

Finally, opponents suggest that the \$15–\$20 billion price tag is unaffordable.¹² The arms control and disarmament community argues that the current plan to spend \$30–\$35 billion per year on the nuclear enterprise is excessive. Consistent with this larger argument, they also declare that the LRSO is unaffordable and suggest that eliminating the LRSO is one of the ways to lower the cost of nuclear modernization.¹³

Together, the three arguments presented here represent the main thrust of opposition to the LRSO. Others have also offered critiques of the system, but the arguments offered have largely fallen within these parameters.

The Advocates

Supporters of the LRSO advance a number of justifications readily grouped into four main areas: war fighting, strategy, deterrence, and force structure.¹⁴ These four categories also require some detail.

War Fighting

The need to penetrate advanced IADS has not changed since it first led to the development of the AGM-86 in the mid-1970s. In fact, today's Russian systems are thought to be the best in the world and purportedly are able to strike both incoming cruise and ballistic missiles.¹⁵ If unconfirmed reports are correct, the accuracy of S-400/500 batteries may leave the United States no option but to either use large numbers of missiles to attrite surface-to-air missile batteries or use nuclear weapons, specifically the LRSO, to punch holes in Russian, or Chinese, networks.

Bombers armed with the LRSO will greatly complicate Russian and Chinese efforts to defend possible targets. This is because bomber attack vectors can change dramatically and are difficult for an adversary to predict, unlike ballistic missiles, which have a predictable flight path. Russia and China can observe these trajectories with high fidelity because they know the launch points of US intercontinental ballistic missiles (ICBM) and they have some sense of the launch boxes of American ballistic missile submarines. Both countries have watched American test launches of ICBMs and submarine-launched ballistic missiles (SLBM),

which gives them significant knowledge of flight physics, enabling them to develop strategies for countering these weapons.¹⁶

Although opponents of the LRSO argue that the B61 provides the United States with a low-yield option, delivering the B61 to a given target is far more challenging than many understand. Stealth bombers are not invisible. Rather, they rely on specific knowledge of adversary IADS to develop a flight path that minimizes the aircraft's radar cross-section (RCS). Thus, mobile defenses in unknown places can significantly complicate stealth's advantage. With a much smaller RCS than a bomber, the LRSO has the greatest chance of penetrating the dense IADS Russia and China are fielding, particularly near their most valuable targets.

Because of the relatively flat reentry angle of both ICBMs and SLBMs, adversaries have become adept at locating their highest value assets in facilities protected by terrain, hardening, and burying. This leaves the LRSO as the best option for some high-priority targets. Although it is not publicly known if there will be a "penetrating" version of the LRSO, its ability to collapse tunnel openings and strike terrain-protected targets is a required capability. Nuclear conflict is not like horseshoes or hand grenades; close is not good enough. The nation's ballistic missiles simply cannot destroy some critical targets.

Strategy

At the level of operational strategy, nuclear-armed cruise missiles and a future LRSO are an important part of the United States' nuclear arsenal for a number of reasons. For the B-52, which is expected to remain in service for at least three more decades, long-range standoff is the primary role the venerable bomber can play as it continues to contribute to the nuclear mission.¹⁷ This contribution should not be undervalued.

With its six decades of service in conflicts around the globe, the B-52 is respected by allies and adversaries alike and well known as a dual-capable (conventional and nuclear) bomber.¹⁸ This gives the B-52 the ability to effectively signal adversaries in a way that a stealth bomber cannot. By enabling a bomber to launch at multiple targets, the LRSO allows the president to use bombers as an effective signal of US resolve.¹⁹ For example, when President Truman sent nuclear-capable B-29 bombers to the United Kingdom during the Berlin Blockade, he was signaling Joseph Stalin that the United States was willing to use nuclear weapons if the Soviet Union attacked American forces in Berlin. Absent the required

bomber capability, Stalin may not have been effectively deterred.²⁰ Signaling intent and the ability to use bombers as an escalation/de-escalation tool play important roles in US nuclear strategy. And, maintaining a nuclear-capable B-52 is central to that capability.

Perhaps one of the least-understood aspects of American nuclear strategy is the way in which bombers are employed in executing the nuclear mission. The LRSO will allow each bomber to strike more than a dozen targets on a single mission without the risk of engagement. But, if a B-2 were armed with nothing but the B61, it would be required to employ through dense IADS to release on every individual target—greatly reducing survivability. Furthermore, contrary to popular belief, in the event a bomber executes a nuclear strike, the bomber is not on a “one-way mission.” Current mission planning expects the majority of bombers to survive a given mission and return to a reconstitution point, rearm, and execute a new mission. The United States simply does not have sufficient numbers of bombers—nuclear capable or conventional—to accept a high loss rate. Nuclear-armed cruise missiles enable both stealth and non-stealth bombers to attack targets from safer stand-off distances, which improves the survivability of each aircraft.

Deterrence

At the highest strategic level, the United States may soon find itself in a position where it lacks the range of capabilities needed to credibly hold key targets at risk. As a result, adversaries may no longer believe the United States is willing to fight and win a nuclear conflict, which is central to the credibility of American deterrence. Contrary to the view of one congressman who said, “There is no such thing as a limited nuclear war,” history would suggest otherwise. The single case in which nuclear weapons were used was purposefully limited in effect (striking distant military targets) and outcomes (capitulation rather than destruction).²¹ Should the United States lack the required capability to fight a limited nuclear conflict in the future, it could be self-deterred in certain circumstances where, for example, Russia uses low-yield theater nuclear weapons to de-escalate a conventional conflict in which it is performing poorly.²²

As former deputy assistant secretary of defense Elaine Bunn said, “The regional deterrence challenge may be the ‘least unlikely’ of the nuclear scenarios for which the United States must prepare.”²³ If crisis stability

“aims at developing incentives for using the lowest level of military force possible—all while seeking to prevent escalation,” a low-yield nuclear option is likely the best choice to deter or limit escalation in some regional scenarios.²⁴

This leaves the LRSO as the most credible stealthy and low-yield option available to the president. While some arms control advocates argue that deterrence, not war fighting, is the sole purpose of nuclear weapons, possessing the capability and will to fight and win a nuclear conflict—limited or unlimited—contributes to the credibility of American nuclear deterrence. As nuclear strategist Matt Kroenig has demonstrated, in a nuclear crisis, the country with the superior nuclear balance of power is likely to emerge victorious.²⁵ The implications of Kroenig’s findings would also suggest that the United States would be unwise to cancel the LRSO because it would diminish the nuclear superiority the United States maintains over its adversaries, which would likely reduce the probability of American success in a nuclear crisis.

Those who suggest the LRSO is a destabilizing capability are incorrect for two primary reasons. First, as former deputy secretary of defense John Hamre noted in Senate testimony, “Airborne nuclear assets are the least provocative and the least destabilizing weapons in our inventory.” He further added, “There is no known instance in history that our use of conventional cruise missiles was misinterpreted as a nuclear attack by Russia or China or any other country for that matter.”²⁶

As noted above, opponents of the LRSO suggest that an adversary cannot tell the difference between conventional and nuclear-armed cruise missiles, which makes nuclear-armed cruise missiles destabilizing. However, logic would dictate that nuclear gravity bombs would also be equally destabilizing since an adversary would have no certainty whether an American bomber were armed with B61 nuclear weapons or conventional joint direct-attack munitions (JDAM). Surprisingly, LRSO opponents argue that the B61 is the right nuclear weapon for the B-2 and B-21.²⁷ This is inconsistent with the strategic logic advanced by opponents.

Perhaps Russian nuclear scholar Pavel Podvig best explained the instability argument when he wrote, “The arbitrary nature of the assumptions that underlie the idea of strategic stability makes this concept extremely malleable and politically charged.”²⁸ The reality of conflict is that it has a context in which combatants operate. This context sets

expectations of all parties involved and indicates what behaviors are acceptable or expected. Prior to a dramatic alteration of this context—the introduction of nuclear weapons—one or more clear signals will likely precede any change. In short, the stability of deterrence depends not upon nuclear-armed cruise missiles but upon the unwritten rules and norms of conflict, which nations and their leaders understand and are rarely willing to violate.

Force-Structure Costs

In the larger nuclear modernization debate, many arms control and disarmament advocates suggest that the estimated \$1 trillion in operations and modernization expenditures the Departments of Defense and Energy are likely to spend over the next three decades is both excessive and unaffordable.²⁹ The problem with these assertions is that they rarely place the cost of nuclear operations and modernization in a larger context of defense and federal spending. The same is true of any discussion of LRSO costs. Some context for overall operations and modernization expenditures and LRSO-specific expenditures is instructive.

According to nuclear weapons scholar Stephen Schwartz, the United States spent an estimated \$5.5 trillion on the nuclear enterprise between 1940 and 1996.³⁰ Over the next three decades, the United States is expected to spend an estimated \$1 trillion to modernize the existing stockpile, operate the nation's nuclear forces, and maintain the nuclear enterprise. This equates to an average of \$33 billion per year, which is an increase from the \$25 billion the United States has averaged over the past decade.³¹ To design, field, operate, and maintain the LRSO over this three-decade period, as mentioned previously, the cost is an estimated \$20 billion—an average of less than \$750 million per year over the next three decades.

As a percentage of federal spending, the nuclear enterprise currently accounts for 0.44 percent of the federal budget and will rise to approximately 0.75 percent of the federal budget.³² In the context of the defense budget, nuclear operations currently account for 3.5 percent of the defense budget and at the height of the modernization effort will peak at approximately 6.7 percent. During the Cold War, spending on the nuclear arsenal averaged above 20 percent per year and peaked above 50 percent of defense spending during the early 1960s.³³ In the decades ahead, the nuclear arsenal is likely to be as important a part of the

military's force structure as it was during the Cold War—yet at approximately one-fifth the cost.

When compared to other forms of insurance, nuclear weapons are well worth the cost. For example, the average American spends about \$8,700 on health insurance premiums per year.³⁴ He or she also spends about \$1,300 on auto insurance per year.³⁵ By contrast, the average American taxpayer spends about \$225 annually on the nation's sovereignty insurance—nuclear weapons.³⁶ Over the next three decades the LRSO will account for about 3 percent of that cost. Perhaps the most underappreciated characteristic of the nuclear arsenal is the fact that it enables the United States to spend less on defense by reducing the overall requirement for personnel and materiel to fight conventional wars and more on other national priorities. It is important to remember that the last great power war fought by the United States consumed an average of 36 percent of the nation's GDP each year of World War II.³⁷ Using nuclear weapons and the security they provide to offset conventional defense spending is not a new idea. President Eisenhower's "New Look" policy was specifically designed to do just that.³⁸ Even today, nuclear weapons guarantee the nation's sovereignty while allowing it to allocate more resources to other priorities.

Additional context for the cost of the LRSO and the nation's nuclear arsenal is instructive. If, for example, the average American adult were to purchase one less cup of coffee per week, the United States could pay for the cost of nuclear deterrence with that savings alone.³⁹ Interestingly, Americans spend about as much on Coca-Cola products as they spend on nuclear deterrence each year.⁴⁰ Finally, according to the Centers for Medicare and Medicaid Services, the federal government could pay for the nuclear arsenal and modernization if it could reduce Medicare and Medicaid waste, fraud, and abuse by half.⁴¹ Whether Americans give up a cup of coffee each week or the government reduces waste, fraud, and abuse in Medicaid and Medicare, the LRSO will cost just 3 percent of the money spent on nuclear deterrence. Suggesting that either the nuclear arsenal or the LRSO is unaffordable is simply inaccurate.

Recommendations

While this article has focused on a discussion of the long-range standoff cruise missile and a defense of the weapon system, the LRSO is but a part of a larger nuclear deterrent that is in desperate need of modernization.

As the Trump administration develops the 2017 Nuclear Posture Review, it is important to keep in mind that the NPR is largely a political document that discusses the American view of nuclear deterrence and the role of nuclear weapons in the United States' larger national security and military strategy. With this in mind the following five recommendations are provided.

First, the Nuclear Posture Review should, at a minimum, have an unclassified version. Given that the NPR is first and foremost a political document, the fidelity lost by authoring a highly classified document is outweighed by the benefits provided by clearly laying out an administration's view of nuclear deterrence and the role of nuclear weapons in national security for the American people, allies, and adversaries. The greatest benefit the NPR can provide is in serving as a messaging tool to domestic and foreign audiences.

Second, the next NPR should discuss the threats facing the United States and the modernization efforts under way in adversary countries. Too few Americans understand the threat facing the country and assume the United States no longer faces an existential nuclear threat. They also assume the US military maintains the same level of superiority over adversaries in the nuclear realm as the country maintains in the conventional realm. They do not understand that the US arsenal has atrophied over the past 25 years. Clearly describing the threat may induce greater support for the modernization effort that is required.

Third, it is time to challenge the "no new weapons and no new capabilities" mantra that was established in the years immediately following the Soviet Union's collapse. While this idea is not enshrined in law, some within the military, Congress, and the policy community believe it is law that prevents the United States from developing and fielding new nuclear warheads and new capabilities. Allowing this thinking to persist prevents the United States from fielding the capabilities required to most effectively deter adversaries who do not hold a similar view and who are looking for a distinct advantage over the United States.

Fourth, it is time the administration vigorously challenges the narrative that nuclear modernization is unaffordable. Although a tentative congressional consensus supports existing nuclear modernization programs, there is little appetite for expanding current modernization. This is in part because the case for new capabilities has not been effectively made. It is also because of inadequate efforts to counter the narrative suggesting

nuclear modernization is unaffordable. Offering a compelling story for the role and affordability of nuclear modernization has the potential of reshaping the debate and increasing opportunities for modernization.

Fifth, the administration has the opportunity to use the NPR to make the case for the long-range standoff cruise missile by discussing the unique threats it is designed to defeat and how it contributes to the success of deterrence. As Keith Payne has noted, the number of published articles challenging the need for modernization and the utility of the systems that are part of the modernization program outweigh the number of articles in support of modernization by about six to one.⁴² While some argue that challenges from the arms control and disarmament community carry little weight, it is also possible they may be underestimating the impact of constant objections, making it important to offer a compelling alternative narrative.

As the Trump administration reimagines the nation's approach to nuclear deterrence in a strategic environment far different from that of the 2010 Nuclear Posture Review, it is time to make a full-throated defense of nuclear modernization and the long-range standoff cruise missile. The opportunity to author a Nuclear Posture Review comes once during an administration. Making the case for the programs and strategies that will ensure the credibility of American deterrence for decades to come is an opportunity that should not be lost. **SSQ**

Adam B. Lowther

*Director, School of Advanced Nuclear
Deterrence Studies (SANDS)*

Notes

1. Donald Trump, National Security Presidential Memorandum 1, "Rebuilding the U.S. Armed Forces," 27 January 2017, *Federal Register* 82, no. 20 (1 February 2017): 8983–84, <https://www.gpo.gov/fdsys/pkg/FR-2017-02-01/pdf/2017-02282.pdf>.

2. William J. Perry and Andy Weber, "Mr. President, Kill the New Cruise Missile," *Washington Post*, 15 October 2015, https://www.washingtonpost.com/opinions/mr-president-kill-the-new-cruise-missile/2015/10/15/e3e2807c-6ecd-11e5-9bfe-e59f5e244f92_story.html?utm_term=.19620a337fd2.

The Long-Range Standoff Weapon and the 2017 Nuclear Posture Review

3. Bill Yenne, *B-52 Stratofortress: The Complete History of the World's Longest Serving and Best Known Bomber* (Hudson, WI: MBI Publishing, 2012), 113–15.
4. Richard Dean Burns and Joseph M. Siracusa, *A Global History of the Nuclear Arms Race: Weapons, Strategy, and Politics* (Santa Barbara, CA: Praeger, 2013), 450–65.
5. Bill Orndorff, “Last Cruise Missiles Crushed at Hill AFB,” *Hilltop Times*, 19 April 2012, <http://www.hilltoptimes.com/content/last-cruise-missiles-crushed-hill-afb>.
6. Stephen Lendman, “Russia’s Superior Air Defense Systems,” Center for Research on Globalization, 27 February 2017, <http://www.globalresearch.ca/russias-superior-air-defense-systems/5577032>.
7. Hans Kristensen, *LRSO: The Nuclear Cruise Missile Mission* (Washington, DC: Federation of American Scientists, 2016).
8. Kingston Reif, “Cruise Control: Why the United States Should Not Buy a New Nuclear Air-Launched Cruise Missile,” *War on the Rocks*, 16 March 2016, <https://warontherocks.com/2016/03/cruise-control-why-the-u-s-should-not-buy-a-new-nuclear-air-launched-cruise-missile/>.
9. Perry and Weber, “Mr. President, Kill the New Cruise Missile.”
10. Edward Markey, Dianne Feinstein, Jeff Merkley, Bernard Sanders, Patrick Leahy, Al Franken, Ron Wyden, and Barbara Boxer, to President Barack Obama, letter, 15 December 2015, <https://www.markey.senate.gov/imo/media/doc/2015-12-15-Letter-New-Nuclear-Missile.pdf>.
11. Steven Pifer, “Who Needs a New Air Launched Cruise Missile Anyway?” *Order from Chaos* (blog), 10 December 2015, <https://www.brookings.edu/blog/order-from-chaos/2015/12/10/who-needs-a-new-nuclear-air-launched-cruise-missile-anyway/>.
12. “Cruise Control,” *The Economist*, 23 January 2016, <http://www.economist.com/news/united-states/21688862-barack-obamas-administration-which-began-vision-get-rid-nuclear-weapons-has>.
13. See Jon Wolfsthal, Jeffrey Lewis, and Mark Quint, *The Trillion Dollar Nuclear Triad* (Monterey, CA: James N. Martin Center for Nonproliferation Studies, 2014).
14. See Kristensen, *LRSO: The Nuclear Cruise Missile Mission*.
15. Loic Burton, “Bubble Trouble: Russia’s A2/AD Capabilities,” *Foreign Policy Blogs* (blog), 25 October 2016, <https://foreignpolicyblogs.com/2016/10/25/bubble-trouble-russia-a2-ad/>; and Tyson Wetzal, “Russian S-400 in Syria: What Does it Mean for US Air Assets?” *Medium*, 27 November 2015, <https://medium.com/@GetterWetzal/russian-s-400-in-syria-what-does-it-mean-for-us-air-assets-6bd31605cedd>.
16. While Russia and China cannot predict the exact launch point of SLBMs, they do understand the flight dynamics of these weapons and can predict reentry angles and attack vectors from a number of hypothetical points in the Pacific Ocean (Russia and China) or the Atlantic Ocean (Russia).
17. Bill Sweetman, “The B-52 Just Keeps on Flying,” *Air and Space Magazine*, March 2015, <http://www.airspacemag.com/flight-today/b-52-just-keeps-flying-180953933/>; and Kyle Mizokami, “The B-52 Is Getting Out of the Nuke-Dropping Business,” *Popular Mechanics*, 25 May 2017, <http://www.popularmechanics.com/military/aviation/a26651/b-52-nuclear-weapons/>. B-52s will continue to deploy miniature air-launched decoy-jammer missiles, conduct electronic attack, and deploy joint air-to-surface standoff missiles in support of defeating integrated air defense systems.
18. Adam Lowther and Chris Winklepleck, “Why Bombers Are Key to Nuke Modernization; Think Russia, North Korea, China,” *Breaking Defense*, 9 March 2016, <http://breakingdefense.com/2016/03/why-bombers-are-key-to-nuke-modernization-think-russia-north-korea-china/>.

19. Adam Lowther and Allen Agnes, "Long-Range Stand-Off Missile: The Indispensable Weapon," *National Interest*, 10 July 2016, <http://nationalinterest.org/feature/long-range-stand-missile-the-indispensable-weapon-16906>.
20. Office of the Historian, Bureau of Public Affairs, "The Berlin Airlift, 1948–1949," *United States Department of State*, 2016, <https://history.state.gov/milestones/1945-1952/berlin-airlift>.
21. Kingston Reif, "New Cruise Missile Capability Debated," *Arms Control Today* 46, no. 1 (January/February 2016): 43–45, https://www.armscontrol.org/ACT/206_0102/News/New-Cruise-Missile-Capability-Debated.
22. Zachary Keck, "Revealed: Why America Needs New, Super Usable Nuclear Weapons," *National Interest*, 23 June 2015, <http://nationalinterest.org/blog/the-buzz/revealed-why-america-needs-new-super-usable-nuclear-weapons-13168>.
23. Statement of M. Elaine Bunn, deputy assistant secretary of defense for nuclear and missile defense policy, in Senate, *Hearing before the Subcommittee on Strategic Forces of the Committee on Armed Services*, 113th Cong., 2nd sess., 5 March 2014, 4, https://www.armed-services.senate.gov/imo/media/doc/Bunn_03-05-14.pdf.
24. Christine Leah and Adam Lowther, "Conventional Arms and Nuclear Peace," *Strategic Studies Quarterly* 11, no. 1 (Spring 2017): 19, http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-11_Issue-1/Leah.pdf.
25. Matthew Kroenig, "Nuclear Superiority and the Balance of Resolve: Explaining Nuclear Crisis Outcomes," *International Organization* 76, no. 1 (January 2013): 141–71, <http://doi.org/f4k2zb>.
26. Statement of John J. Hamre, former deputy secretary of defense, in "US Nuclear Modernization and the LRSO," in Senate, *Hearing to Review Budget Requirements and Justification for the Nuclear Cruise Missile before the Energy and Water Appropriations Subcommittee*, 114th Cong., 2nd sess., 13 July 2016, <https://www.appropriations.senate.gov/imo/media/doc/071316-Hamre-Testimony.pdf>.
27. Perry and Weber, "Mr. President, Kill the New Cruise Missile."
28. Pavel Podvig, "The Myth of Strategic Stability," *Bulletin of the Atomic Scientist*, 31 October 2012, <http://thebulletin.org/myth-strategic-stability>.
29. Jon Wolfsthal, Jeffrey Lewis, and Mark Quint, *The Trillion Dollar Nuclear Triad* (Monterey, CA: James Martin Center for Nonproliferation Studies, 2014), https://www.nonproliferation.org/wp-content/uploads/2016/04/140107_trillion_dollar_nuclear_triad.pdf.
30. Stephen Schwartz, *Atomic Audit* (Washington, DC: Brookings Institute, 1998), 105.
31. See *Projected Costs of US Nuclear Forces, 2014 to 2023* (Washington, DC: Congressional Budget Office, 2013), <https://www.cbo.gov/publication/44968>.
32. Adam Lowther and Jeffrey Blackrick, "Myths of Global Zero" (lecture, Sandia National Laboratory, Albuquerque, NM, 14 December 2016).
33. Stephen Schwartz, *Atomic Audit* (Washington, DC: Brookings Institution Press, 1998), 100–110.
34. Keith Speights, "Here's What the Average American Pays for Health Insurance: How Do You Compare?" *The Motley Fool*, 4 January 2015, <https://www.fool.com/investing/general/2015/01/04/heres-what-the-average-american-pays-for-health-in.aspx>.
35. Mark Vallett, "Car Insurance Rates by State, 2016 Edition," *Insure.com*, 2 March 2016, <http://www.insure.com/car-insurance/car-insurance-rates.html>.
36. This number is derived by dividing the cost of the nuclear arsenal by the number of federal tax filers.

37. Stephen Daggett, *Cost of Major U.S. Wars* (Washington, DC: Congressional Research Service, 2010), 2, <https://fas.org/sgp/crs/natsec/RS22926.pdf>.

38. See Saki Dockrill, *Eisenhower's New Look National Security Policy, 1953–1961* (New York: St Martin's Press, 1996).

39. This number is derived by taking the number of Americans over the age of 18 (218 million), multiplying that number by 52 (number of weeks in a year), and then multiplying that number by 2.25—the cost of the average cup of coffee.

40. Anjelay Athavaley, "Coca-Cola Sales Miss Estimates on Flat North America Growth," *Reuters*, 22 July 2014, <http://www.reuters.com/article/us-cocacola-results-idUSKBN0FR16420140722>.

41. US Government Accountability Office, *Medicare and Medicaid Fraud, Waste, and Abuse: Effective Implementation of Recent Laws and Agency Actions Could Help Reduce Improper Payments*, GAO-11-409T (Washington, DC: Government Accountability Office, 2011), <http://www.gao.gov/products/GAO-11-409T>.

42. Keith Payne, president, National Institute for Public Policy, Missouri State University (panel discussion, US Strategic Command Strategic Deterrence Symposium, La Vista, NE, 27 July 2016), <https://www.youtube.com/watch?v=s5xiHu7FTeY>.

Disclaimer

The views and opinions expressed or implied in SSQ are those of the authors and are not officially sanctioned by any agency or department of the US government. We encourage you to send comments to: strategicstudiesquarterly@us.af.mil.