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Congressional Testimony

Future Defense Spending: Nuclear Modernization

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Nuclear weapons appear to help deter nuclear aggression and prevent large-scale conventional conflict in a small number of high-consequence contingencies. Ensuring the efficacy of nuclear deterrence, therefore, is in the national security interests of the United States and its allies—so too are cooperative efforts to reduce the risks of escalation and arms racing and to create the political and security conditions under which nuclear weapons could be safely eliminated. For appropriators, the most salient nuclear policy questions are those with financial implications—in particular, how should the United States maintain and modernize its nuclear forces and their supporting infrastructure?

The coming wave

Today, the United States deploys a triad of strategic delivery systems ("strategic" is a Cold War term that refers to weapons with sufficient range to reach Russia from their deployment locations):

- Ohio-class ballistic missile submarines (SSBNs) armed with Trident II sea-launched ballistic missiles (SLBMs). These missiles can accommodate three different warheads (the W88, W76-1, and the lower-yield W76-2).
- Silo-based Minuteman III intercontinental ballistic missiles (ICBMs), which can be armed with two different warheads (the W78 and W87).
- Two nuclear-capable bombers: B-2 aircraft, which can carry three different types of gravity bombs (the B61-7, B61-11 and B-83), and B-52H aircraft, which can carry the Air-Launched Cruise Missile armed with the W80-1 warhead.

The United States also retains two types of nonstrategic gravity bombs (the B61-3 and B61-4), which can be delivered by F-15E and F-16 aircraft. An extensive command-and-control system—the vital importance of which is often overlooked—enables nuclear operations. A large number of facilities (including some of the U.S. national laboratories) support the production, maintenance, and disassembly of warheads.

Over time, these submarines, aircraft, missiles, warheads, and enabling capabilities will, like all military systems, age and require some form of modernization—whether life extension or replacement. From a budgetary perspective, it would be best if a few modernization programs were underway at any given time so that total expenditure on U.S. nuclear forces remained roughly constant. In practice, the United States has taken a very different path. Today's nuclear forces were, for the most part, designed and built during one of two previous modernization "waves:" one in the late 1950s and early 1960s, and another in the late 1970s and early 1980s.

The United States is now facing a third major modernization wave. Almost every U.S. nuclear delivery system, missile, and warhead will require some kind of modernization over the next 10 to 20 years. Key elements of the nuclear command-and-control system and nuclear warhead infrastructure will too. (Exceptions, such as W76 warheads, are primarily systems for which life extension programs have recently been completed.) In addition, the administration of President Trump decided to begin work on the development of a new high-yield SLBM warhead, the W93, and a new nuclear-armed sea-launched cruise missile (SLCM) with a low-yield option. It also sought to significantly expand the production of plutonium pits for nuclear weapons at two sites.

If this entire set of programs is pursued, the result will be significant increases in expenditure on nuclear forces. In its most recent ten-year analysis, the Congressional Budget Office (CBO) estimated that annual spending on U.S. nuclear forces (which includes operations and maintenance as well as modernization) would rise from $33.6 billion in 2019 (the year of publication) to about $63 billion in 2028—or from about 5% to 7% of the defense budget.[1] Total expenditure during this period is expected to reach almost $500 billion—about two-thirds of which will be borne by the Department of Defense (and the remainder by the Department of Energy).

Peak expenditure on nuclear weapons, however, is not expected until later. In its most recent 30-year assessment, from 2017, CBO estimated that spending on nuclear forces would peak at about $50 billion in the mid-2030s and that total spending over 30 years would amount to $1.2

[1] Congressional Budget Office, "Projected Costs of U.S. Nuclear Forces, 2019 to 2028," January 2019, 4, https://www.cbo.gov/system/files/2019-01/54914-NuclearForces.pdf

trillion.[2] Because of cost growth and additional programs created in the four years since this estimate was published, actual expenditure is likely to be significantly higher—though peak spending will still occur at roughly the same time.

This "bow wave" of expenditure—or "spending cliff" in appropriations-speak—should prompt Congress to ask three questions:

- First, is every proposed modernization program necessary to ensure the security of the United States and its allies?
- Second, can necessary spending be spread over a longer time period, once again in ways that do not compromise the security of the United States and its allies?
- Third, is spending on nuclear weapons—of whatever amount—being allocated in the most effective way?

If some programs will fail to reach fruition—as I believe is likely—then it is cheaper to abandon or alter them now.

To this end, I argue that Congress should deny funding for a new nuclear-armed SLCM and pause the Ground-Based Strategic Deterrent program (which aims to develop a new ICBM) pending a comprehensive review. Conversely, even after modernization, the U.S. nuclear command-and-control system may lack resiliency. I suggest, therefore, that Congress *increase* funding for command-and-control modernization efforts.

The Appropriations Committee should also address the rapid projected cost growth in the activities of the National Nuclear Security Administration, which is responsible for nuclear warheads and their production infrastructure. Indeed, on March 3, 2020, VADM Wolfe, director of the Navy's Strategic Systems Programs, warned the House Armed Services Committee about "the pervasive and overwhelming risk carried within the nuclear enterprise as refurbishment programs face capacity, funding, and schedule challenges."[3] To address help this problem, I believe that Congress should cease funding for the W93 warhead and scale back plans for the

[2] Congressional Budget Office, "Approaches for Managing the Costs of U.S. Nuclear Forces, 2017 to 2046," October 2017, 3, https://www.cbo.gov/system/files/115th-congress-2017-2018/reports/53211-nuclearforces.pdf.
[3] Johnny Wolfe, Testimony before the House Armed Services Committee, Subcommittee on Strategic Forces, March 3, 2020, 7, https://www.congress.gov/116/meeting/house/110593/witnesses/HHRG-116-AS29-Wstate-WolfeJ-20200303.pdf.

production of plutonium pits. Since these activities are largely appropriated through the Energy and Water Subcommittee, I won't discuss them further here except to note that the Defense Subcommittee is responsible for funding the W93 aeroshell and, more importantly, that delays in warhead programs will impact the costs of delivery system programs.

Ground-Based Strategic Deterrent

The United States currently deploys 400 silo-based Minuteman III ICBMs, each of which is loaded with one nuclear warhead. The requirements for the Ground-Based Strategic Deterrent (GBSD) program include the acquisition a new ICBM that will remain in service until at least 2075 and the deployment of 400 of them by 2036. The Air Force and the Office of Cost Assessment and Program Evaluation jointly estimate the total cost of procuring the new missiles to be between $93.1 billion and $95.8 billion (including the impact of inflation).[4] This program appears to be the single most expensive nuclear delivery-system modernization program other than the building of Columbia-class SSBNs, the importance of which I do not question.[5]

The Department of Defense has explained the need for ICBMs primarily in terms of the "intractable targeting problem" that they present to U.S. adversaries (which really means Russia, the only state with sufficient nuclear forces to even consider trying to eliminate the United States' ICBM force).[6] Three characteristics of ICBMs are argued to be relevant here. First, because U.S. ICBMs are currently loaded with one warhead and Russia would probably attack each silo with two, Russian strikes would likely consume more warheads than they destroyed. Second, in the event of a Russian attack, U.S. ICBMs could be launched very rapidly, potentially before any incoming warheads detonated. Third, the death and destruction that would be caused by 800 high-yield Russian nuclear warheads detonating over 400 U.S. silos spread over five states is

[4] Anthony Capaccio, "U.S. ICBM to Replace 1970s Minuteman May Cost $111 Billion," October 1, 2020, https://www.bloomberg.com/news/articles/2020-10-01/pentagon-s-next-generation-icbm-program-may-cost-111-billion. These figures include the costs of upgrades to silos and command-and-control equipment but not warheads.
[5] The cost of the B-21 program is similar to GBSD, but that aircraft will be used for nonnuclear missions too.
[6] Charles A. Richard, Testimony before the Senate Armed Services Committee, February 13, 2020, 9, https://www.armed-services.senate.gov/imo/media/doc/Richard_02-13-20.pdf.

viewed as a feature—not a bug—because Russian leaders would have to assume that their strike would induce the United States to retaliate on a massive scale.

I take issue with some of these arguments (in particular, I believe the United States should seek to build a sufficiently resilient nuclear command-and-control system that it could abandon the perceived need to retain the option of launching ICBMs under attack). Overall, however, for reasons of strategy and domestic and international politics, it would be unwise to scrap the ICBM force at the current time without reciprocal reductions by Russia. Perhaps most importantly, ICBMs provide a degree of redundancy should technological developments threaten the survivability of SSBNs.

Given the Department of Defense's justification for retaining ICBMs, however, the feasibility of extending the service life of the Minuteman III force should be re-examined. Even if one postulates that Minuteman III missiles would perform somewhat less effectively than their prospective replacements at conducting offensive strikes, there is no reason why they would be any less effective as a so-called warhead sponge." GBSD and Minuteman III would present Russian leaders with an identical "intractable target problem."

While there is value to retaining ICBMs as a hedge in case SSBNs becomes vulnerable, it is significantly more likely that technological developments will undermine the survivability of silo-based ICBMs. In particular, it seems possible—probable perhaps—that, over the next few decades, China and Russia will develop and deploy large forces of *non*nuclear missiles capable of destroying U.S. silos.[7] This development would significantly devalue silo-based ICBMs and cause future Congresses, as well as the American people, to look back with incomprehension at the decision to pursue GBSD.

Various Department of Defense officials have stated that further extending the life of the Minuteman III force is either uneconomic or impossible.[8] They typically point to the results of the

[7] In theory, the United States could threaten to launch ICBMs on warning of an incoming nonnuclear attack. In practice, such a threat would lack credibility because launching up to 400 high-yield ICBMs in response to precise nonnuclear attacks that could cause very few casualties would be utterly disproportionate.

[8] For a detailed critique of this argument, see George Perkovich and Pranay Vaddi, *Proportionate Deterrence: A Model Nuclear Posture Review* (Washington, DC: Carnegie Endowment for International Peace, 2021), Appendix A, https://carnegieendowment.org/files/Perkovich_Vaddi_NPR_full1.pdf.

Department of Defense's analysis of alternatives, which concluded in 2015. This study was reportedly framed around a requirement for the United States to maintain 450 deployed ICBMs until 2075.[9] Moreover, it considered only three options in depth: life extension of Minuteman III until 2075 and two different kinds of near-term replacements. Procurement of its preferred option—now known as GBSD—was projected to cost $62.3 billion.

The estimated cost of this program has risen by almost 50% in less than six years, even as the requirement for deployed ICBMs has dropped from 450 to 400. This fact alone should raise questions about the validity of the 2015 study's conclusions. Moreover, that study's assumptions were problematic. For one, it failed to examine the option of procuring a new ICBM for deployment in, say, 2055, after a medium-term life extension of Minuteman III. It also failed to consider the option of fielding fewer ICBMs. Reducing the size of the Minuteman III force could enable it to remain viable for longer, not least by making additional missiles available for testing.[10] (If needed, a larger number of warheads could be deployed on submarines to compensate). Indeed, a 2014 RAND study commissioned by the Air Force endorsed this approach in concluding that extending the service lives of Minuteman III missiles was feasible.[11]

Ultimately, I believe that it is high time for this question to be settled by an independent commission of authoritative technical experts who hold the appropriate security clearances. This approach would provide Congress and the executive branch with a credible basis for deciding between GBSD and a Minuteman III life extension program.

Moreover, if life extension is feasible and cost effective, it would, as George Perkovich and Pranay Vaddi have argued, buy time for negotiations with Russia over reciprocal reductions in—or perhaps even the elimination of—silo-based ICBMs entirely.[12] If such negotiations were successful, the cost of a new ICBM program could be reduced significantly or perhaps totally

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[9] Kingston Reif, "Air Force Drafts Plan for Follow-On ICBM," *Arms Control Today*, July 8, 2015, https://www.armscontrol.org/act/2015-07/news/air-force-drafts-plan-follow-icbm.
[10] Steve Fetter and Kingston Reif, "A Cheaper Nuclear Sponge," *War on the Rocks*, October 18, 2019, https://warontherocks.com/2019/10/a-cheaper-nuclear-sponge/.
[11] Lauren Caston et al., *The Future of the U.S. Intercontinental Ballistic Missile Force* (Santa Monica, CA: RAND Corporation, 2014), https://www.rand.org/content/dam/rand/pubs/monographs/MG1200/MG1210/RAND_MG1210.pdf.
[12] Perkovich and Vaddi, *Proportionate Deterrence*, 68. China is not relevant here. Because U.S. ICBMs would need to overfly Russia to reach targets in China, they are unsuitable for conducting strikes against China.

eliminated. (Indeed, in general, arms control offers a pathway to constrain spending on U.S. nuclear forces in a way that actually enhances U.S. and allied security.)

Congress should pause the GBSD program by reducing FY 2022 funding to the lowest level consistent with preserving the program in its current state, pending a full assessment of the feasibility and costs of extending the service lives of Minuteman III ICBMs beyond 2035. This study, which should be conducted by an independent commission, should examine a broad range of options, including the fielding of a new ICBM in 2045, 2055, 2065, and 2075, and possible reductions in the size of the Minuteman III force in the intervening period.

Lower-yield warheads

The United States should retain some lower-yield nuclear warheads. I prefer the term "lower-yield" to "low-yield" because while an explosive power of, say, 5,000 tons of TNT is small by nuclear standards, it is still enormous by conventional standards. As a point of comparison, the huge August 2020 explosion in Beirut was estimated to have a yield of between 500 and 1,110 tons.[13]

I am far from sanguine about the feasibility of two nuclear-armed states' fighting a limited nuclear war (though, fortunately, it has never been tried). The danger it would escalate into apocalyptic slaughter would be very real. But if a U.S. adversary were to engage in limited nuclear use, the United States should want the option to respond proportionately and preserve at least some chance of avoiding a civilization-ending catastrophe.

The Air-Launched Cruise Missile and various deployed gravity bombs currently have lower-yield options. These capabilities will be retained for the indefinite future in the form of a life-extended gravity bomb, the B61-12, and a new air-launched cruise missile, the Long-Range Standoff Weapon (LRSO) armed with the W80-4 warhead. Additionally, the Trump administration deployed some lower-yield W76-2 warheads on Trident II SLBMs. I find it difficult to conceive of any circumstances in which U.S. interests would be better served by the

[13] S. E. Rigby et al., "Preliminary Yield Estimation of the 2020 Beirut Explosion Using Video Footage from Social Media," *Shock Waves* 30 (2020): 671-675.

use of a W76-2 warhead rather than one of the alternatives—but since the budgetary implications of retaining the W76-2 are insignificant, I won't attempt to proselytize any further here.

The Trump administration also began early work on the development of a new nuclear-armed SLCM with a lower-yield option. CBO estimates that this program will cost about $9 billion between 2019 and 2028 (although it cautions that this estimate is "very uncertain.")[14] The United States made the decision to dismantle its previous nuclear-armed SLCM as part of the 2010 Nuclear Posture Review. Since then, there have been no plans to deploy nuclear weapons of any kind on attack submarines or surface ships. As a result, deployment of a new nuclear-armed SLCM would likely have to be accompanied by additional expenditure on new command-and-control capabilities.

A new nuclear-armed SLCM would be redundant. The United States is expected to spend roughly $100 billion on procuring a new fleet of stealthy B-21 aircraft and upwards of $20 billion on acquiring LRSO and modernized warheads.[15] The combination of these two weapon systems will likely be particularly survivable because the LRSO's range should enable B-21 aircraft to operate from areas where an adversary's air defenses are weak or even nonexistent. As a result, I believe that there is little reason to question the survivability of B-21s carrying LRSOs, at least in the near- to medium-term. (In fact, if the Department of Defense has such concerns, they would call in question the entire B-21 program.)

After launch, LRSO and a SLCM would have essentially identical flight profiles. Indeed, CBO assumes that the latter's design "would draw heavily from the design of the LRSO" in order to reduce costs.[16] As a result, if LRSO were unable to penetrate enemy air defenses, there would be every reason to assume that a nuclear-armed SLCM would be similarly unable to do.

Congress should refuse any funding requests to develop a new nuclear-armed SLCM.

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[14] Congressional Budget Office, "Projected Costs of U.S. Nuclear Forces, 2019 to 2028," 4.
[15] Congressional Budget Office, "Approaches for Managing the Costs of U.S. Nuclear Forces, 2017 to 2046," 53; Kingston Reif, "Air Force Wants 1,000 New Cruise Missiles," *Arms Control Today*, May 2015, https://www.armscontrol.org/act/2015-05/news/air-force-wants-1000-new-cruise-missiles; and U.S. Department of Energy, National Nuclear Security Administration, "Fiscal Year 2021 Stockpile Stewardship and Management Plan—Biennial Plan Summary," Report to Congress, December 2021, 5-32, https://www.energy.gov/sites/prod/files/2020/12/f82/FY2021_SSMP.pdf.
[16] Congressional Budget Office, "Projected Costs of U.S. Nuclear Forces, 2019 to 2028," 4.

Nuclear command and control

Because the United States would be literally unable to conduct nuclear operations without the ability to command and control its nuclear forces, the development of a resilient nuclear command-and-control system should be the single highest priority for nuclear modernization—especially because the threat to command-and-control assets is growing as the result of advances in cyber, anti-space, and other nonnuclear weapons. Not only do budget requests suggest that command-and-control is not the top priority, but some design choices could have the unintentional effect of further undermining resilience.

The design of the U.S. nuclear command-and-control system has historically been guided by the manifestly important objective of survivability during a nuclear war. Because it is expensive to develop and build systems that can withstand, for example, an intense electromagnetic pulse, the U.S. nuclear command-and-control system consists of a relatively small number of exquisite assets. For example, the Space-Based Infrared System (SBIRS)—a constellation designed to provide warning of an incoming nuclear attack—comprises just six satellites (though it is supplemented by a few legacy satellites that have exceeded their design lives). As the Air Force has acknowledged, this system has a single-point vulnerability—that is, the loss of just one satellite could leave the system unable to fulfil its mission goals.[17]

The problem is that, as the Government Accountability Office notes, most nuclear command-and-control assets are dual-use—that is, they support both nuclear and nonnuclear operations.[18] SBIRS satellites, for example, can cue defenses intended to intercept nonnuclear ballistic missiles. As a result, in a conventional conflict, a U.S. adversary might launch nonnuclear attacks against dual-use command-and-control assets in order to undermine U.S. *non*nuclear operations. Such attacks, however, would have the effect of degrading U.S. nuclear command-

[17] William L. Shelton, "Space and Cyberspace—Foundational Capabilities for the Joint Warfighter and the Nation," speech at the Air Force Association Air Warfare Symposium, Orlando, FL, February 21, 2014, http://web.archive.org/web/20141225171206/http://www.afspc.af.mil/library/speeches/speech.asp?id=747.
[18] Christina Chaplain, "Nuclear Command, Control, and Communications: Update on DOD's Modernization," GAO-15-584R, Government Accountability Office, June 15, 2015, 1, http://www.gao.gov/assets/680/670801.pdf.

and-control capabilities, producing the risk of potentially catastrophic escalation.[19] Indeed, under existing policy, the United States may use nuclear weapons if an adversary launches nonnuclear attacks on nuclear command-and-control assets.[20] The upshot is a growing difficulty of preventing a regional conflict in Europe or East Asia from escalating into a global nuclear war, even if none of the leaders involved sought such escalation.

Some modernization decisions are exacerbating this problem. For example, the replacement for SBIRS, the Next Generation Overhead Persistent Infrared system, will comprise just five satellites—one *fewer* than SBIRS.[21] Even if the new satellites are somewhat more able to evade anti-satellite weapons than their predecessors, reducing redundancy in this way could still leave the constellation less able to withstand nonnuclear attacks in the kind of high-intensity conventional conflict that could precede a nuclear war.

That said, simply building a few more identical satellites may not be the optimal response. Instead, the Department of Defense should consider some fundamentally different architectures, as either a supplement or an alternative to existing programs. For example, the United States could deploy many small early-warning sensors on a large number of satellites that are primarily used for other purposes. There would be trade-offs involved in deploying this kind of dispersed architecture in place of a smaller number of dedicated satellites; in particular, it would probably increase resilience at the expense of performance. Such trade-offs deserve to be properly evaluated by those with access to the relevant classified information.

Congress should redirect at least some funds saved by ceasing the development of a new nuclear-armed SLCM and from pausing (and potentially ceasing) the GBSD program to nuclear command-and-control modernization. It should require the Department of Defense to use some of these funds to study fundamentally different command-and-control architectures.

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[19] James M. Acton, "Escalation Through Entanglement: How the Vulnerability of Command-and-Control Systems Raises the Risks of an Inadvertent Nuclear War," *International Security* 43, no. 1 (Summer 2018): 56–99.
[20] U.S. Department of Defense, "Nuclear Posture Review," February 2018, 21, https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF.
[21] Sandra Erwin, "Air Force Reports Progress in Missile Defense Satellite Programs," *Space News*, June 6, 2019, https://spacenews.com/air-force-reports-progress-in-missile-defense-satellite-programs/.

Ideally, this study would be conducted by an independent commission. Congress could use this study to inform funding in future years.

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Given where the United States currently is in its nuclear modernization cycle, significant increases in expenditure on U.S. nuclear forces are both inevitable and appropriate. That said, in my assessment, this growth is unnecessarily large because not all of the proposed programs are necessary now. The result is opportunities for some targeted cost cutting and for the reallocation of resources to critically important efforts to modernize nuclear command-and-control capabilities.

Moreover, the Defense Subcommittee of the Appropriations Committee is one of the few places within the U.S. government where the trade-offs between nuclear and nonnuclear defense programs can be adjudicated. Responsibly reducing spending on nuclear forces can enable more spending on important nonnuclear programs. Conversely, funding nonnuclear programs adequately can enable reductions in nuclear spending. For example, the United States' continued need for some lower-yield nuclear weapons is driven, in large part, by the concern that Russia might use its conventional superiority in the Baltic region to seize NATO territory, rapidly and relatively bloodlessly, and then threaten to use nuclear weapons to try to deter a NATO counter-intervention. Efforts by United States and other NATO members to redress this conventional imbalance would help bypass the whole challenge of negating Russia's nonstrategic nuclear forces.

These issues will confront this committee for the better part of the next two decades. While I do not envy your challenge in managing them, I respectfully suggest that it is better to confront them sooner rather than later.