TAXPAYERS for COMMON SENSE

REPORT

May 2024

Ripe for Rescission: A Cost-Benefit Analysis of U.S. ICBMs

At Northrop Grumman's test facility in Promontory, UT, the Air Force Nuclear Weapons Center conducted its first full-scale test fire of the LGM-35A Sentinel stage-one solid rocket motor on March 2, 2023. The Sentinel ICBM is projected to cost taxpayers roughly $315 billion over the course of its lifecycle. U.S. Air Force photo by R. Nial Bradshaw.

Executive Summary

The U.S. is currently planning to revamp its entire nuclear arsenal, including replacing the Minuteman III (MMIII) Intercontinental Ballistic Missile (ICBM) with a new ICBM known as the Sentinel. In January 2024, the Air Force informed Congress of a 37 percent increase in the Sentinel's projected acquisition costs, triggering a critical breach of the Nunn-McCurdy Act, which mandates that the Pentagon reevaluate programs experiencing significant cost overruns. Accounting for this recent cost growth, the development, procurement, operation, and sustainment of the Sentinel and its nuclear warheads is projected to cost taxpayers up to $315 billion through 2075. Weighing the purported benefits of the Sentinel against this immense cost, this report finds that the Sentinel's attributes do not justify this cost, and thus recommends cancelling the Sentinel program. It also finds that the purported benefits of maintaining ICBMs in general do not justify the costs, and thus recommends retiring the Minuteman III ICBM in addition to cancelling the Sentinel.

To evaluate the purported benefits of the Sentinel and ICBMs more broadly, this report examines the goals of the U.S. nuclear arsenal as articulated in the 2022 Nuclear Posture Review (NPR) and questions the utility of ICBMs in supporting those goals compared to other elements of the nuclear arsenal.

Regarding the goal of a "safe, secure, and effective nuclear deterrent," deployed U.S. nuclear bombers, nuclear-capable fighters, and ballistic missile submarines carry warheads with a combined explosive yield many thousands of times greater than the yield of the nuclear bomb dropped on Nagasaki, Japan on August 9, 1945, making them more than sufficient to deter U.S. adversaries. Contrary to the NPR's claim that each leg of the nuclear triad offers complementary benefits relating to "effectiveness, responsiveness, survivability, flexibility,

and visibility," this report demonstrates that ICBMs are outperformed by the sea and air legs of the triad in terms of effectiveness, survivability, and flexibility. It also shows that their greater responsiveness is a risk rather than a benefit, and their visibility is immaterial to their efficacy as a deterrent.

Regarding the NPR's goals of reducing the risk of nuclear war and supporting U.S. nonproliferation goals, this report shows that the Sentinel undermines both by fueling the proliferation of nuclear weapons and flouting the U.S. commitment under the Nuclear Nonproliferation Treaty to pursue nuclear disarmament, thus undermining U.S. credibility in future arms control negotiations. It also shows that ICBMs increase the risk of nuclear war due to their high responsiveness combined with their stationary status, presenting the president with a "use it or lose it" dilemma in the event of a nuclear attack, which could lead to a catastrophic miscalculation in the event of a false alarm.

Regarding the NPR's goal of reducing U.S. reliance on nuclear weapons, plans to field the Sentinel through 2075 run counter to this goal, and actively undermine the realization of geopolitical conditions that the NPR cites as necessary for any significant progress toward achieving this goal.

Lastly, the report examines alternatives to the Sentinel, including life-extending the Minuteman III and eliminating the land-based leg of the nuclear triad entirely.

Based on this analysis, ICBMs do not meaningfully support and, in some cases, actively undermine the goals laid out in the NPR. Moreover, those goals can be met at significantly lower costs to taxpayers without ICBMs by continuing to field U.S. ballistic missile submarines, nuclear bombers, and nuclear-capable fighters.

Therefore, Taxpayers for Common Sense calls for the elimination of land-based ICBMs through the cancellation of the Sentinel program, the retirement of the Minuteman III program, and the recalibration of U.S. nuclear weapons strategies for a nuclear dyad rather than a triad.

U.S. Nuclear Posture

On October 27, 2022, the Biden administration published its Nuclear Posture Review (NPR) as part of its broader National Defense Strategy (NDS).[1] The NPR, a report mandated by Congress, outlines the administration's views on U.S. nuclear strategy, policy, posture, and forces.

In its first section, the NPR offers an overview of the administration's goals relating to nuclear weapons and its strategies for achieving those goals. It "reaffirms a continuing commitment to a safe, secure, and effective nuclear deterrent and strong and credible extended deterrence," and states that "to deter aggression and preserve our security in the current security environment, we will maintain nuclear forces that are responsive to the threats we face."

The NPR also states, "While ensuring our security, our goal is to extend this (more than 75-year) record of non-use (of nuclear weapons) and reduce the risk of a nuclear war that could have catastrophic effects for the United States and the world."

It highlights the shared commitment reaffirmed by the permanent members of the UN Security Council "to their disarmament-related obligations under the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and their intent to strengthen stability and prevent an arms race."

The NPR also offers the heavily caveated "goal of reducing reliance on nuclear weapons," suggesting that any meaningful progress will "require enduring improvement in the security environment, a commitment to verifiable arms control among the major nuclear powers, further progress developing non-nuclear capabilities, and an assessment of how nuclear-armed competitors and adversaries may react."

Regarding the Sentinel program, the NPR states the administration's intent to "fully fund the Sentinel ICBM replacement program of record in the 2023 – 2027 Future Years Defense Program." It also asserts that "any

alternative to the Sentinel program of record that extends MMIII life and replaces it in the future would increase risk and cost."

A central question of this report is whether the Sentinel program is a necessary and prudent investment given its costs. Therefore, it is essential to evaluate both the program's cost and its likely impact on the goals enumerated in the NPR. This report will show that the Sentinel program, and land-based ICBMs in general, are not necessary to meet the NPR's goal of "a safe, secure, and effective nuclear deterrent," and run counter to the NPR's goals of extending the record of non-use of nuclear weapons, reducing the risk of nuclear war, advancing disarmament-related obligations under the NPT, and reducing U.S. reliance on nuclear weapons.

ICBMs Past and Present

Nuclear-armed intercontinental ballistic missiles (ICBMs) were first deployed by the United States in 1959. Since then, the U.S. has maintained ICBMs at launch facilities in North Dakota, Montana, Wyoming, Colorado, and Nebraska. Housed in hardened concrete missile silos, U.S. ICBMs are kept "on alert," meaning they can be launched within minutes of an order. Once launched, they cannot be recalled.[2]

Minuteman III test launch at Vandenberg Air Force Base, California. U.S. Air Force photo.

In the early 1960s, the first generation of ICBMs was replaced by the Minuteman I missile, which used solid fuel instead of liquid fuel.[3] Using solid fuel meant that the missiles did not need to be fueled immediately before launch, reducing the time it took to launch after receiving a launch order.

By 1969, most Minuteman I missiles had been replaced by their successor, the Minuteman II, which boasted a new and improved guidance system, better reliability, greater range, and increased payload capacity.[4]

Minuteman III (MMIII) ICBMs, the version of these missiles currently deployed at nuclear launch facilities, were first deployed in the early 1970s. It was the first ICBM equipped with multiple independently targetable reentry vehicles (MIRVs), allowing a single missile carrying multiple warheads to hit multiple targets after the warheads separate from the missile. The MMIII can carry three nuclear warheads, though to comply with the New START treaty, which limits the number of nuclear warheads the U.S. and Russia can deploy, the MMIII missiles are currently deployed with only one warhead each.[5]

While the MMIII was originally equipped with 170 kiloton (kT) yield W62 warheads, it is likely now equipped with W78 warheads, which have a yield of 335 to 350 kT, and W87 warheads, which have a yield of 300 to 475 kT.[6]

To put these yields into perspective, the atomic bombs the U.S. dropped on Hiroshima and Nagasaki had 15 kT and 25 kT yields respectively, meaning the warheads now equipped on the Minuteman III are each between 12 and 19 times as powerful as the bomb dropped on Nagasaki.

The Minuteman III has undergone multiple life-extension programs, most recently in the late 2000s.[7]

The Sentinel

In 2014, the Air Force conducted an Analysis of Alternatives (AOA), which remains classified, and determined that the Air Force would replace MMIII with a new missile system.[8] That new weapon, originally named the Ground Based Strategic Deterrent (GBSD), is now known as the LGM-35A Sentinel.

Deployment Plans

The Air Force is currently planning to procure 642 Sentinel ICBMs, 400 of which it plans to deploy.[9] The program is expected to reach initial operational capacity in 2030, with nine missiles deployed and on alert. Complete deployment is expected in 2036. The program is currently expected to reach the end of its lifecycle in 2075. The Sentinel will be equipped with W87-0/Mk21 and W87-1/Mk21A warheads and aeroshells. In addition to building new missiles and some new warheads, the Sentinel program includes plans to upgrade the ground launch control facilities that will house the missiles and the command-and-control systems that enable the president to order a launch and the commanders in the field to carry out the order.[10] This is no small undertaking.

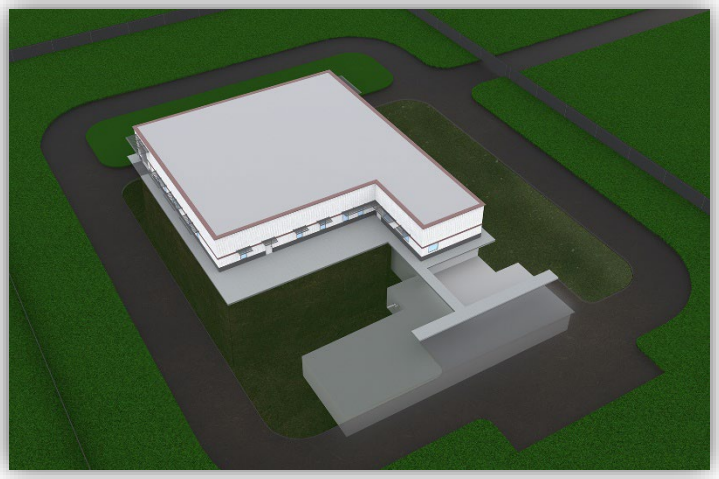


Illustration of an LGM-35A Sentinel launch center, of which the Pentagon plans to build at least 24. U.S. Air Force illustration.

Construction and modification plans at missile alert and launch facilities include demolishing all 45 missile alert facilities (MAFs), constructing a communication support building at each MAF location, building launch centers at no fewer than 24 of the MAFs, and renovating all 450 existing launch facilities to "like-new condition." To secure the utilities needed for the program, plans call for establishing about 3,100 miles of new utility corridors and securing easements to ensure access. To ensure smooth communications, the program calls for building 62 300-foot-tall communications towers within the program's three missile fields. To support the necessary workforce, the program calls for creating temporary worker outposts for up to 2,500 to 3,000 employees and establishing temporary construction laydown areas throughout the missile fields. Lastly, it calls for decommissioning and disposing of the Minuteman III and its associated facilities.[11]

Development Improvements and Challenges

Unlike the Minuteman III program, the Sentinel program employs a modular design and open systems architecture, both of which could reduce the costs and timelines for upgrading the missile in the future. Modular design, which opts for highly compartmentalized components, should make it easier to replace or upgrade aging or outdated components of the missile at a lower cost. Open systems architecture means the Air Force will have control over the intellectual property behind the missile, allowing multiple contractors to compete for any future upgrades to the program.[12]

While this approach may reduce long term costs and the time it takes to upgrade components in the future, it does little to mitigate cost and schedule growth in the program's current nascent state. According to the Government Accountability Office's (GAO) annual weapon systems assessment, only three of the Sentinel's 18 critical technologies are mature. Fourteen are approaching maturity, and one is immature.[13] According to the GAO, "starting development before technologies are mature can increase the risk of cost and schedule growth later in the program." For example, the Sentinel's digital engineering environment (DEE), a digital engineering tool that can increase confidence in a program's functionality prior to production, was incomplete as of June 2023, raising concerns about schedule delays.

Software and cybersecurity for the program are also adding to the risk of cost and schedule growth. This is partly due to varying levels of classification involved in the program data, which can require multiple agencies to approve data transfers. A shortage of skilled workers with the right security clearances is slowing the program's software and cybersecurity development.[14] Macroeconomic factors such as material shortages and long lead times are also fueling schedule delays for the Sentinel.

As a result, according to the GAO weapon systems assessment, the Sentinel's planned initial operational capability (IOC)—the point at which some portion of the units or organizations linked to the program receive the system and have the ability to employ and maintain it—won't be reached until April to June of 2030, rather than in May of 2029, the goal laid out in the Pentagon's most recent Selected Acquisition Report (SAR).[15]

Capabilities

The main capability difference between the Sentinel and the Minuteman III stems from the material used for their boosters. The MMIII uses heavy steel casings to house the fuel for the rocket engines. The engines for the Sentinel will use a composite material that is much lighter, increasing the range and potential payload of the missiles. By increasing the potential payload, this design could enable the Air Force to develop and equip the missiles with countermeasures that could help it defeat future ballistic missile defense systems.[16] While the range and payload capacities would be an immediate capability shift, the potential for improved ability to defeat ballistic missile defenses is purely hypothetical at this point.

Another capability difference owing to the Sentinel's modular design could be improved security at nuclear launch facilities. According to the Air Force, maintenance on the MMIII currently requires the launcher closure door, the door between the missile and the outside world, to be open, creating security concerns around unauthorized access or observation. The Air Force currently addresses these concerns by increasing security around the warhead while the doors are open. The Sentinel's modular design, however, could allow some of the maintenance to take place behind closed doors, mitigating the security concerns. That, in turn, could also mean fewer security personnel are needed to conduct maintenance, potentially reducing costs.[17]

Illustration of the LGM-35A Sentinel missile silo. U.S. Air Force illustration.

The Sentinel will carry two types of warheads, the W87, also known as the W87-0, and the W87-1. In 2019, the W87-1 was chosen to replace the W78 warheads still deployed on some of the Minuteman III missiles. The W87-1 offers no new military capabilities compared to the W87 but does offer safety and security improvements, according to the National Nuclear Security Administration.[18] The W87 has an explosive yield of 300 kT, 12 times the explosive yield of the bomb dropped on Nagasaki.[19]

Cost

In 2015, the Air Force published a preliminary estimate of the Sentinel's total acquisition cost, which includes the costs of procurement, research, development, test and evaluation, and military construction, of $62 billion from Fiscal Year (FY) 2015 through FY 2044, adjusted for inflation over the thirty-year period.[20] In 2016, an independent cost assessment (ICE) conducted by the Cost Assessment and Program Evaluation (CAPE) office within the Office of the Secretary of Defense (OSD) estimated the total acquisition cost of the Sentinel at between $85 billion and $140 billion.[21]

In 2017, CAPE's annual report attributed the difference between the Air Force and CAPE estimates to CAPE's use of additional data. While the Air Force largely relied on data from the Minuteman and Peacekeeper ICBM programs, CAPE also incorporated data from the Navy's Trident II and the Missile Defense Agency's Ground Based Interceptor programs. Despite drawing on a broader set of historical data, CAPE acknowledged that "it was unusually difficult to estimate the cost of a new ICBM program because there was no recent data to draw upon, and the older historical data was of very questionable quality or was nonexistent." As the report put it, "this leads to considerable uncertainty and risk in any cost estimate."[22]

Following CAPE's assessment, the Pentagon's chief procurement officer at the time Frank Kendall, now the Secretary of the Air Force, updated the Air Force's official estimate to align with CAPE's low-end estimate of $85 billion.[23]

In the first Selected Acquisition Report (SAR) for the Sentinel program, published in April 2022, the program's total acquisition cost was estimated at $95.8 billion in then-year (TY) dollars.[24] The original baseline estimate in the first SAR for the Sentinel's per unit cost, referred to as the Program Acquisition Unit Cost (PAUC), was $118 million in base year (2020) dollars, and $145 million in TY dollars.[25] In the program's second and most recent publicly available SAR (April 2023), the current baseline estimate for the Sentinel's PAUC held at $118 million.[26] However, on January 18, 2024, the Air Force informed Congress that the Sentinel's PAUC projection had jumped to $162 million.[27] The cost growth could put the total acquisition cost for the program somewhere between $125 billion and $130 billion.[28]

The 37 percent jump from $118 million to $162 million in per unit cost constituted a critical breach of the Nunn-McCurdy Act, a law enacted in the 1980s that requires the Pentagon to report to Congress when major weapons systems experience significant cost growth.

The Nunn-McCurdy Act

A critical breach of the Nunn-McCurdy Act occurs when a program's Program Acquisition Unit Cost (PAUC) or Procurement Unit Cost (PUC) increases by 25 percent or more over the current baseline estimate, or 50 percent above the original baseline estimate. A critical breach requires the Secretary of Defense to conduct an analysis of the root causes of the cost growth that led to the breach. It also requires the Secretary of Defense, in consultation with the Director of CAPE, to assess the program's estimated cost if the current requirements remain unchanged, the program's estimated cost if requirements are changed, the estimated cost of reasonable alternatives, and the degree to which other programs will be cut to cover the program's cost growth. The Pentagon must also issue a new Selected Acquisition Report (SAR) for the program, detailing updates to the program's cost, schedule, performance, per unit cost, and cost breach. This new SAR is due within 45 days of the submission of the President's budget request. As the President's FY25 budget request was submitted on March 11, 2024, the due date for the new SAR was April 25, 2024, though as of this writing no new SAR has been made publicly available.

Then, after the root-cause analysis and no later than 60 days after the new SAR is submitted to Congress, the Secretary of Defense must either cancel the program, or certify in writing that the updated program is essential to national security, that the Director of CAPE determined that the program's new cost projections are reasonable, that the program is a higher priority than any of the programs whose funding will be cut to cover the program's cost growth, and that the management structure of the program is able to control future cost growth.

If the program is not terminated, it must be restructured to address the root causes of the cost growth, its prior milestone approvals must be rescinded, and it must receive approval for new milestones before moving forward on any contracts without approval from the Milestone Decision Authority. The Pentagon must also inform Congress of any funding cuts to other programs made to cover the program's cost growth.

Sources:
"The Nunn-McCurdy Act: Background, Analysis, and Issues for Congress." Congressional Research Service. Updated May 12, 2016. https://crsreports.congress.gov/product/pdf/R/R41293
Flatoff, Libby. "Sentinel ICBM Exceeds Projected Cost by 37 Percent." Arms Control Today. March 2024. https://www.armscontrol.org/act/2024-03/news/sentinel-icbm-exceeds-projected-cost-37-percent

Despite the Nunn-McCurdy Act's extensive reporting requirements, Air Force leaders were quick to assert that the Sentinel program would be fully funded, suggesting that they view the requirements as a box-checking exercise rather than a mandate to reevaluate the program and its alternatives. As Lt. Gen. Richard Moore, the Deputy Chief of Staff for Plans and Programs, put it, "Sentinel will be funded. We'll make the trades that it takes to make that happen." He also claimed that extending the life of the Minuteman III is "not a viable option." Air Force Undersecretary Kristyn Jones echoed that sentiment, saying, "my hope is that throughout the end of this process, we'll be able to fine-tune the program and reduce risk moving forward. But there won't be a decision made that we can live without it."[29]

In 2020, the Pentagon estimated the Sentinel's lifecycle cost, a combination of acquisition costs and long-term operations and sustainment costs, at $264 billion.[30] Accounting for the cost increase that triggered the Nunn-McCurdy Act, the Sentinel's lifecycle cost could reach $300 billion.[31] This does not include production costs for the W87-1 warhead, which the Government Accountability Office (GAO) estimates to be between $8.9 billion and $15.6 billion.[32]

According to Undersecretary Jones, the increased cost is rooted "primarily in the civil works aspects of the program," in other words, the infrastructure to support the program rather than the missiles themselves. She cited inflation, supply chain issues, and labor costs as contributing factors to the cost growth.[33]

Air Force Secretary Frank Kendall testifies before the House Armed Services Committee for the Department of the Air Force FY25 budget request, Washington, D.C., April 17, 2024. U.S. Air Force Photo by Eric Dietrich.

Addressing the perceived need to find funding in the budget to cover the Sentinel's roughly $35 billion cost overrun, Secretary Kendall said that "it would be very difficult to pay for out of just the Air Force's budget. So, I think we're going to take a look at the totality of the budget."[34]

As the reports required by the Nunn-McCurdy Act have either not been finalized or not been made available to the public, it is unclear where the Pentagon might cut funds to cover the Sentinel's cost growth. Regardless, the U.S. is on track to spend up to $315 billion on the Sentinel and its warheads over the course of the program's lifecycle. It is against this tremendous cost to taxpayers that any presumed benefits of the Sentinel must be weighed.

A Safe, Secure, and Effective Nuclear Deterrent?

Is the Sentinel ICBM necessary to achieve the Nuclear Posture Review's goal of a safe, secure, and effective nuclear deterrent? Are U.S. nuclear-armed submarines, bombers, and fighters capable of achieving this goal on their own? Additionally, if the Sentinel is built, will it be safe and secure? Answering these questions requires an analysis of U.S. nuclear weapons platforms.

Ballistic Missile Submarines

The U.S. Navy currently has 14 nuclear-armed Ohio-class ballistic missile submarines (SSBNs) in its arsenal, with at least 10 required to be operational at any given moment.[35] Eight of these 14 Ohio-class SSBNs are homeported at Bangor, WA, and six are homeported at Kings Bay, GA. Maintaining 14 submarines allows the Navy to conduct midlife refueling overhauls and other planned maintenance without dropping below the requirement for 10 operational SSBNs. The last Ohio-class submarine to undergo midlife refueling returned to full operational status in 2023, meaning all 14 Ohio-class boats could theoretically be deployed until the first boat retires in 2027. Due to occasional repair needs however, the number of Ohio-class submarines at sea at any given moment is likely between eight to ten.[36]

The Ohio-class submarines, sometimes called Trident SSBNs or just Tridents, are each equipped with 24 submarine launched ballistic missile (SLBM) tubes. However, to comply with the New START Treaty, only 20 of these tubes are currently outfitted to carry SLBMs. The Navy's 14 Ohio-class submarines are thus capable of carrying a combined 280 SLBMs, though the U.S. has said it will deploy no more than 240.[37]

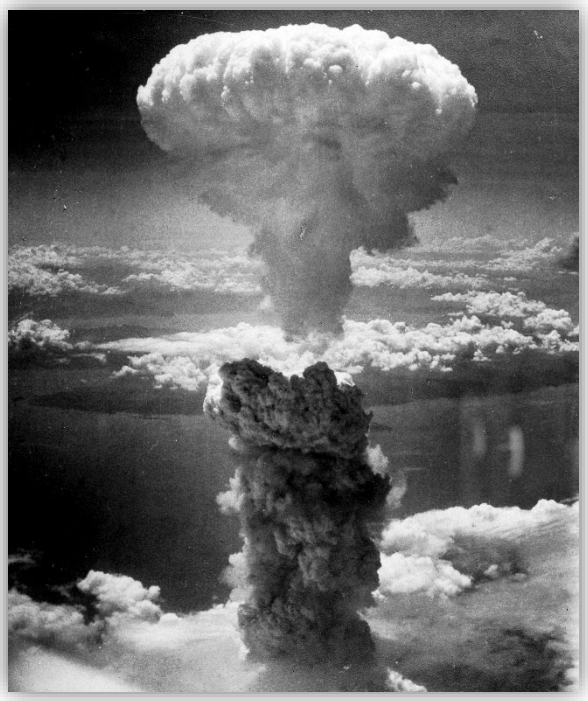
According to the Congressional Research Service, the mission of SSBNs is to "remain hidden at sea with their SLBMs, so as to deter a nuclear attack on the United States by another country by demonstrating to other countries that the United States has an assured second-strike capability, meaning a survivable system for carrying out a retaliatory nuclear attack."[38]

To accomplish this mission, the Ohio-class boats are currently armed with Trident D-5 SLBMs. Also known as the UGM-133 Trident II D-5, the Trident D-5 has a range of about 12,000 km and a payload capacity of up to 2,800 kg.[39] Its Post-Boost Vehicle (PBV) can carry up to 12 Reentry Vehicles (RVs); however, under the New START Treaty, it is limited to carrying eight RVs, each of which can carry one nuclear warhead. In practice, Trident D-5s carry four or five warheads on average, meaning each Ohio-class submarine is generally equipped with 80-100 nuclear warheads. While the payloads on each missile are thought to vary considerably to offer more mission flexibility, each submarine is believed to carry an identical combination of missile payloads.[40]

The reentry vehicles on the Trident D-5 are mostly Mk4A aeroshells containing W76-1 warheads, or Mk5 aeroshells containing W88 warheads. Starting in 2017, the Navy began a life extension program for some of its Trident missiles. Known as Trident II D5LE, these refurbished missiles, which will eventually replace all of the Trident D-5s currently aboard SSBNs, are equipped with Mk6 aeroshells that offer improved accuracy.[41] W76-1 warheads have an explosive yield of 90 kT, and W88 warheads have a yield of 455 kT.[42]

Under the Trump administration, the Navy also deployed the W76-2 warhead on some of its Trident D-5 missiles. The W76-2 is an 8 kT warhead designed to offer the U.S. military a low-yield weapon that it hopes will help deter the use of low-yield nuclear weapons by U.S. adversaries by demonstrating that the U.S. could retaliate for such a nuclear attack without escalating the situation with a higher-yield attack. Precise details of this deployment have not been publicized, but the Federation of American Scientists estimated at the time that "one or two of the 20 missiles on the USS Tennessee (the first Ohio-class submarine armed with the W76-2) and subsequent subs will be armed with the W76-2, either singly or carrying multiple warheads."[43]

If one assumes that each Ohio-class submarine is carrying two Trident D-5s each equipped with two W76-2 warheads, nine Trident D-5s each equipped with four W76-1 warheads, and nine Trident D-5s each equipped with four W88 warheads, then each submarine would be carrying warheads with a combined explosive yield of nearly 20,000 kT, or 20 megatons (mT). Considering the Navy's minimum of 10 operational SSBNs, the ballistic missile submarine fleet may well be carrying warheads with a combined explosive yield of 200 mT—roughly 8,000 times the explosive yield of the bomb dropped on Nagasaki. If the combinations of warheads deployed on the Trident missiles were configured differently, their combined yield could be far higher.



The atomic bombing of Nagasaki on August 9, 1945, created a plume of smoke over 60,000 feet high. Photo by Charles Levy.

As part of its plans to revamp the entire U.S. nuclear arsenal, the Biden administration is working to replace the Ohio-class submarines, the first of which will reach the end of its service life

in 2027, and the last of which will reach the end of its service life in 2040. The replacement program, called the Columbia-class submarine, calls for the procurement of 12 new submarines. Because the Columbia-class boats only require about two years for their mid-life refueling overhauls rather than the four years required by the Ohio-class boats, only 12 rather than 14 submarines are needed to ensure that the Navy maintains 10 operational SSBNs at any given time.[44]

Like the Ohio-class, the Columbia-class submarines will carry Trident D-5 SLBMs, or Trident II D5LEs. When the refurbished missiles reach the end of their planned service life in 2040, the D-5s will undergo a second life extension program to extend their service lives to 2084.[45] In contrast to the Ohio-class, the Columbia-class submarines will each be outfitted with 16 SLBM tubes, rather than 24.

If one assumes a similar configuration of warheads for the Columbia-class with four fewer missiles per boat—such as two missiles per submarine equipped with two W76-2s, seven equipped with four W76-1s, and seven equipped with four W88s—then each submarine will be carrying an explosive yield of over 15 mT, meaning the combined explosive potential of the 10 minimum operational Columbia-class submarines would be 150 mT—roughly 6,000 times the explosive yield of the bomb dropped on Nagasaki. Again, a different configuration of warheads could mean significantly greater explosive potential.

Nuclear Armed Bombers

In addition to its ballistic missile submarines, the U.S. maintains many nuclear-capable bombers equipped with gravity bombs and air-launched cruise missiles.

The U.S. Air Force currently maintains a fleet of 20 B-2A Spirit bombers, stationed at Whiteman Air Force Base in Missouri.[46] The Bulletin of the Atomic Scientists estimates that 18 B-2As are assigned nuclear missions, though New START data from 2022 showed that only 10 B-2As were deployed at the time.[47] The B-2 is a dual-capable bomber, meaning it can carry both nuclear and conventional bombs. On the nuclear side, the B-2 can carry up to 16 nuclear bombs with yields ranging from 0.3 kT to 1.2 mT.[48] About 100 nuclear bombs are deployed on the B-2A fleet.[49]

Calculating the precise explosive yield of nuclear weapons deployed on the B-2 fleet is challenging given the widely variable yields of the bombs and the unknown counts of bomb types. If one assumes an even distribution of bomb types, and that each variable bomb is set to its minimum yield (an extremely conservative assumption), the combined explosive yield of warheads deployed on the B-2 fleet would be over 10 mT—roughly 400 times the explosive yield of the bomb dropped on Nagasaki.[50] If one assumes each bomb is set to its maximum yield, the combined yield would be over 50 mT, roughly 2,000 times the explosive yield of the bomb dropped on Nagasaki.

The Air Force also has 87 B-52H Stratofortress bombers stationed at two bases in Barksdale, LA and Minot, ND.[51] The B-52H can be equipped to carry both nuclear and conventional air-launched cruise missiles (ALCMs), though only 46 are currently nuclear-capable. Of those 46, the Bulletin of the Atomic Scientists estimates that 42 B-52Hs are assigned nuclear missions, and New START data from 2022 showed that only 33 were deployed at the time.[52] The AGM-86B Air-Launched Cruise Missile (ALCM) is a long-range missile offering U.S. bombers the ability to launch an attack from outside the range of an adversary's anti-aircraft systems. It currently carries W80-1 warheads, which have a yield ranging from 5 to 150 kT. The B-52H can carry up to 20 ALCMs, meaning the nuclear-capable portion of the B-52H fleet could theoretically carry 920 ALCMs, but only about 200 ALCMs are deployed.[53]

This means the combined explosive yield of the nuclear warheads deployed on the B-52H fleet ranges from 1 to 30 mT—between 40 and 1,200 times the explosive yield of the bomb dropped on Nagasaki.

As efforts to revamp the U.S. nuclear arsenal continue, the Air Force is moving forward with plans to procure a minimum of 100 B-21 Raiders, new bombers that will replace the B-1 (which no longer carries nuclear weapons) and the B-2 fleets. The B-21 may also replace the B-52 at some point in the future.[54] The Air Force is planning to replace the AGM-86B ALCM with the AGM-181 Long-Range Standoff Weapon (LRSO) by 2030. The LRSO will carry

W80-4 nuclear warheads, an upgraded version of the W80-1. The B-21 will carry both LRSOs and B61-12 and -13 gravity bombs, in addition to conventional weapons.[55]

Nuclear Capable Fighters

In addition to ballistic missile submarines and nuclear-armed bombers, the U.S. also has about 100 B61-3s and -4s deployed at six bases in Europe that can be delivered by nuclear capable fighters. As the B61-12 becomes available, it will gradually replace these B61-3s and -4s. The air forces of Belgium, the Netherlands, Italy, and Germany are each tasked with active nuclear strike roles, though the nuclear bombs assigned to these roles are under the control of U.S. Air Force personnel stationed at these bases, and they cannot be used without authorization from the U.S. president. Belgium and the Netherlands use F-16 fighter jets for this mission, while Italy and Germany use PA-200 Tornados, though all four countries are planning to replace these fighters with nuclear-capable F-35As. The B61-3s, -4s and -12s have variable yields ranging from 0.3 kT to 170 kT.[56]

ICBMs

Given the expanse of nuclear weapons and delivery vehicles just enumerated, addressing the question of whether U.S. ICBMs, or the Sentinel program specifically, are necessary to maintain deterrence leads to a more specific question: is the deterrent value of the 1,770 warheads currently deployed across the U.S. arsenal greater than the deterrent value of the 1,370 warheads deployed on ballistic missile submarines, nuclear bombers, and nuclear-capable fighters?[57]

Illustration of LGM-35A Sentinel missile in flight. U.S. Air Force illustration.

Evaluating the deterrent value of the arsenal based on explosive yield alone, it would be difficult to argue that reducing the number of deployed nuclear warheads to 1,370 would change the calculation of an adversary—the combined yield of an arsenal of 1,370 warheads would still be enough to destroy most if not all of an adversary's major military installations and civilian centers.[58]

However, maintaining a more explosive arsenal is not the primary argument employed by proponents of maintaining land-based ICBMs. One of the primary arguments appears to be that each leg of the nuclear triad offers something different and useful. The 2022 Nuclear Posture Review states:

> *The three legs of the nuclear Triad are complementary, with each component offering unique attributes. Maintaining a modern triad possessing these attributes – effectiveness, responsiveness, survivability, flexibility, and visibility – ensures that the United States can withstand and respond to any strategic attack, tailor its deterrence strategies as needed, and assure Allies in support of our extended deterrence commitments.*[59]

It was once the case that U.S. ICBMs were more "effective" in the sense that they were more accurate and carried higher-yield nuclear warheads than other legs of the triad. Today, submarine-launched ballistic missiles are at least as accurate as ICBMs and are equipped with even more powerful warheads than those planned for deployment on the Sentinel.[60]

In terms of responsiveness, land-based ICBMs can be launched more quickly than nuclear weapons deployed on the other two legs of the triad. However, this responsiveness is also dangerous. If the president is alerted to an incoming nuclear attack on the United States, they would have fewer than 15 minutes to decide whether to order a

retaliatory attack.[61] While such a retaliatory order could include all three legs of the nuclear triad, the fact that U.S. ICBMs can be launched within several minutes of receiving an attack order and cannot be recalled once launched increases the risk of miscalculation leading to nuclear war. There have been numerous times in history in which the U.S. or Russia mistakenly perceived an incoming nuclear attack.[62] Going forward, if a retaliatory strike order was issued, orders for U.S. nuclear bombers or ballistic missile submarines to launch retaliatory attacks would be carried out on a longer timeframe than orders to launch U.S. ICBMs, during which time they could be rescinded in the event of a false alarm.

Furthermore, this responsiveness combined with the stationary status of U.S. ICBMs would present the president with a "use it or lose it" decision in the event of an attack on U.S. nuclear missile silos. This decision would need to be made quickly and would further increase the risk of a miscalculation leading to nuclear war. Ironically, the main rebuttal to this argument, conveyed by U.S. Strategic Command in response to questions from Arms Control Today, underscores the redundancy of U.S. ICBMs by arguing that they do not present the president with a "use it or lose it" dilemma because "other strategic forces could be directed to respond to an attack."[63]

As far as survivability, ICBMs have always been the least survivable leg of the nuclear triad. Adversaries know exactly where they are, and short of launching the missiles, there is no way to protect them from a nuclear attack. There is also growing concern that hypersonic missile technology may advance to the point of holding the ICBM fleet at risk without the threat of a nuclear attack.[64] Nuclear-capable aircraft come in second, as they can take off from their airfields relatively quickly in the event of an incoming attack. The ballistic missile submarine fleet is widely understood as the most survivable leg of the nuclear triad, as these submarines are virtually undetectable and constantly on the move while deployed.

Still, proponents of ICBMs often argue that ICBMs act as a hedge against future threats to the ballistic missile submarine fleet. Someday, the argument goes, U.S. adversaries may develop the capability to reliably detect and destroy the fleet in a short period of time. This fear is largely unsubstantiated—while progress has been made in the development of acoustic sensors, lasers, signals intelligence, and unmanned undersea vehicles, there is scant evidence that any of these developing technologies threaten the survivability of the fleet.[65] On the contrary, ballistic missile submarines have only gotten quieter since their inception, making them even more difficult to detect.

Regarding flexibility, other than the higher responsiveness of the ICBM force (which, as highlighted above, increases the risk of miscalculation in the event of a false alarm), ICBMs are the least flexible leg of the triad. Ballistic missile submarines carry warheads ranging in yield from 8 kT to 450 kT. Nuclear bombers and nuclear-capable fighters carry warheads with yields ranging from 0.3 kT to 1.2 mT. In contrast, the Minuteman III carries warheads with yields ranging from 300 kT to 335 kT, and the Sentinel will carry W87-0 or W87-1 warheads, which both have a fixed yield of 300 kT.[66]

Lastly, regarding visibility, one could argue the ICBM force is the most "visible" leg of the triad in the literal sense, as they are housed in stationary silos that are visible from satellites. But while nuclear bombers are often sitting in aircraft hangars and ballistic missile submarines are often at sea, the military also regularly conducts drills of all three legs of the triad to test their capabilities and show off their presence to the world. As such, they are all regularly photographed.

Moreover, regardless of which leg of the triad is most visible, the benefits of visibility are dubious at best.

Two U.S. Air Force B-2 Spirit Bombers flew a bomber task force mission alongside two Royal Australian Air Force F-35s during an exercise over Royal Australian Air Force Base Curtin, Australia, July 18, 2022. U.S. Air Force photo by Tech. Sgt. Dylan Nuckolls.

Deterrence is predicated on the assumption that an adversary must perceive both the U.S. capability to reliably retaliate in response to a nuclear first strike, and the will to do so. The purpose of visibility, then, is to underscore this capability in the minds of adversaries. A secondary purpose, as the NPR states, is to "assure Allies in support of our extended deterrence commitments." In either case, any presumed visibility benefits of the ICBM force over the air- and sea-based legs of the triad rest on the assumption that our adversaries and allies need constant visual reminders of the existence of U.S. nuclear weapons to feel appropriately threatened or appropriately protected by them. In reality, neither U.S. adversaries nor allies require a visual aid to remind them of the power of the U.S. nuclear arsenal.

Looking at each of the desired attributes of the nuclear triad as described in the NPR, ICBMs are no match for the rest of the arsenal's effectiveness, survivability, and flexibility; the higher responsiveness of the ICBM force is a liability disguised as a feature; and the assumed benefits of the visibility of ICBMs are drastically overstated.

Reducing the Risk of Nuclear War?

Do the Sentinel program and ICBMs in general support the Nuclear Posture Review's goal of extending the non-use of nuclear weapons and reducing the risk of nuclear war? Addressing two related questions can help illuminate the answer. The first is what signals the development and fielding of the Sentinel send to U.S. adversaries. This question is specific to the Sentinel. The second is whether stationary land-based ICBMs increase the risk of nuclear war.

Imperfect Signaling

Signaling is the basis of deterrence, comprising signals sent through declaratory statements and through the development, deployment, and perception of capabilities. More bluntly, deterrence relies on demonstrating to potential adversaries that you have both the capability and the willpower to inflict unacceptable harm in retaliation for an attack that crosses a certain threshold.[67] Declaratory statements are meant to demonstrate will, while the fielding of weapons is meant to demonstrate capability. Considering these signals together offers a more complete picture of the ways in which deterrence operates than considering them individually.

Based on its reading of Russia and China's statements and capabilities, the U.S. government views both countries' investments to expand the size and capability of their nuclear arsenals as a threat, and not entirely without reason.

Like the U.S., Russia has not declared a "no first use" policy with respect to nuclear weapons. Its nuclear posture states that "The Russian Federation reserves the right to use nuclear weapons in response to the use of nuclear weapons and other types of weapons of mass destruction against it and (or) its allies, as well as in the event of aggression against the Russian Federation using conventional weapons, when the very existence of the state is threatened."[68] Beyond this stated policy, Russian President Vladimir Putin has consistently underscored the nuclear capabilities under his command in the context of Russia's war against Ukraine. Most observers view these remarks as an effort to discourage the U.S. and other nations from significantly increasing military support for Ukraine, rather than an indication of Russia's willingness to use nuclear weapons to secure battlefield gains in Ukraine. Still, these statements have understandably increased concerns over the possible use of relatively low-yield nuclear weapons in Ukraine, and of escalation leading to a conflict between Russia and NATO, with all the increased nuclear risk associated with such a conflict. In response to both Russia's declared policies and its nuclear weapons capabilities, the NPR characterizes Russia's nuclear arsenal as follows:

> *Russia continues to emphasize nuclear weapons in its strategy, modernize and expand its nuclear forces, and brandish its nuclear weapons in support of its revisionist security policy. Its modern nuclear arsenal, which is expected to grow further, presents an enduring existential threat to the United States and our Allies and partners.*[69]

China has arguably been less threatening than Russia in its public statements about nuclear weapons. This is partly because, unlike Russia and the U.S., China operates under a "no first use" policy regarding nuclear weapons. This policy was reaffirmed as recently as August 2023.[70] Since then, China issued a proposal on global governance that omits any mention of China's "no first use" policy,[71] an omission that some observers have speculated may indicate a change in China's nuclear posture.[72] Still, absent a formal change, China's declared policy continues to reject the first use of nuclear weapons.

The NPR (which was published almost a year before China's proposal on global governance) warns that "while the end state resulting from the PRC's specific choices with respect to its nuclear forces and strategy is uncertain, the trajectory of these efforts points to a large, diverse nuclear arsenal with a high degree of survivability, reliability, and effectiveness," and that "this could provide the PRC with new options before and during a crisis or conflict to leverage nuclear weapons for coercive purposes, including military provocations against U.S. Allies and partners in the region."[73]

The NPR's contentions that Russia's nuclear modernization and expansion pose an existential threat and that China's pursuit of new nuclear weapons capabilities may enable it to leverage nuclear weapons for coercive purposes suggest that the U.S. views the pursuit of increased nuclear weapons capabilities by its adversaries as potentially offensive in nature.

Just as Russia and China claim their nuclear arsenals are defensive, the U.S. asserts through the goals laid out in the NPR that its nuclear arsenal is defensive. Yet it views the pursuit by its adversaries of nuclear capabilities comparable to those of the U.S. arsenal as potentially offensive.

Given this view, it is reasonable to wonder if U.S. adversaries see efforts to revamp the entire U.S. arsenal as potentially offensive in nature. In fact, if an adversary were to study the U.S. nuclear posture (and they certainly do), it would find a declaratory policy relating to the use of nuclear weapons arguably even less constrained than Russia's stated policy. The NPR states that "The United States would only consider the use of nuclear weapons in extreme circumstances to defend the vital interests of the United States or its Allies and partners."[74]

On the declaratory side of the deterrence equation, the thresholds for a threat to "the very existence of the (Russian) state," or for an "extreme circumstance" or a threat to the "vital interest" to the United States, are impossible to predetermine. That may be partly by design, as too narrowly defining these circumstances may preclude a response to an unforeseen type of attack or promise a response when ultimately it is not warranted. It also offers a degree of strategic ambiguity that may complicate an adversary's nuclear war planning, and that could theoretically support deterrence against major non-nuclear attacks by leaving open the possibility of nuclear retaliation.[75]

Despite these presumed advantages, the notion that an adversary may decide to strike first with nuclear weapons based on poorly defined thresholds contributes to a sense of insecurity among national security policymakers across nations. This insecurity, paired with insecurity generated by adversaries developing new nuclear weapons capabilities, has encouraged nations to pursue new nuclear capabilities themselves based on the flawed assumption that greater capabilities equal greater deterrence. Ironically, the pursuit of new capabilities fuels more insecurity by increasing geopolitical tensions that could lead to conflict, and by fueling the proliferation of nuclear weapons.

Potential for Miscalculation

As for ICBMs in general, as highlighted earlier, in the event of a perceived nuclear attack against the United States, U.S. ICBMs present the president with a "use it or lose it" dilemma. Given the possibility of miscalculation, in which the U.S. incorrectly perceives an attack against its ICBM facilities, the pressure to "use it or lose it," imposed largely by the higher responsiveness of U.S. ICBMs, paired with the inability to recall them once launched, increases the risk of nuclear war.

Supporting U.S. Nonproliferation Goals?

Through its ratification of the Nuclear Nonproliferation Treaty (NPT) in 1969, the United States declared its "intention to achieve at the earliest possible date the cessation of the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament."[76] While the arms race referenced in this passage arguably ended with the Cold War, many observers have characterized the current nuclear weapons build-ups in Russia, China, and the U.S. as a new arms race.[77] Moreover, the end of the Cold War did not release the U.S. from its commitment to "undertake effective measures in the direction of nuclear disarmament." Developing and fielding the Sentinel openly flouts this commitment by committing resources to the expansion and planned maintenance of U.S. ICBMs through 2075.[78] In so doing, the U.S. undermines its credibility with respect to its nuclear nonproliferation commitments, potentially complicating future efforts to advance U.S. nonproliferation goals through nuclear arms control negotiations.

As highlighted earlier, the development of new nuclear weapons capabilities fuels the proliferation of nuclear weapons by contributing to a sense of insecurity in other nations, which often leads other nuclear-armed nations to pursue new nuclear weapons capabilities themselves in hopes of strengthening deterrence. Thomas Schelling articulated the theory behind this dynamic and evidence of it in his seminal book on nuclear strategy, *Arms and Influence*.

> *... each of us (the U.S. and the Soviet Union) in his own program must influence the other in some fashion. The influence is surely complicated and uneven, indirect and occasionally irrational, and undoubtedly based often on inaccurate projections of each other's programs. But the influence is there... The American bomber build up in the 1950s was a reflection of the expected Soviet bomber forces and air defenses; the "missile gap" of the late 1950s spurred not only research and development in the United States but also weapon procurement.*[79]

More recent evidence of this dynamic also abounds, manifesting perhaps most prominently through the ongoing calls by certain U.S. policymakers to build up the U.S. nuclear arsenal beyond current expansion plans in response to Russia and China building up their arsenals.[80]

Given the new capabilities of the Sentinel, in particular its increased range and payload capacity owing to its use of lightweight composites, the Sentinel itself is likely contributing to a sense of insecurity among U.S. nuclear-armed adversaries, and in turn likely fueling their own nuclear arsenal expansions. While the promise of greater security from greater nuclear weapons capabilities is at best inconsistent and unreliable, it nevertheless remains a driving force in the expansion of nuclear arsenals around the world.

Reducing U.S. Reliance on Nuclear Weapons?

Building more nuclear weapons in no way reduces U.S. reliance on nuclear weapons. On the contrary, it increases it. The most effective way to reduce U.S. reliance on nuclear weapons is through the negotiation of nuclear arms control and nonproliferation agreements, which the development of the Sentinel clearly undermines.

The 2022 Nuclear Posture Review effectively dismisses this goal as unachievable in the current security environment. The NPR states:

> *While we are taking steps to advance the goal of reducing reliance on nuclear weapons, more far-reaching opportunities to move in this direction will require enduring improvement in the security environment, a commitment to verifiable arms control among the major nuclear powers, further progress in developing non-nuclear capabilities, and an assessment of how nuclear-armed competitors and adversaries may react.*[81]

In essence, this passage conditions any meaningful progress toward the NPR's stated goal of reducing U.S. reliance on nuclear weapons on conditions that the U.S. has frequently impeded, including through the

development of new nuclear weapons like the Sentinel ICBM. It posits the need for an enduring improvement to the security environment, which, as demonstrated, the development of the Sentinel is actively undermining. Similarly, the development of the Sentinel demonstrates the United States' lack of commitment to arms control agreements by flouting the Nuclear Nonproliferation Treaty's commitment to the pursuit of nuclear disarmament.

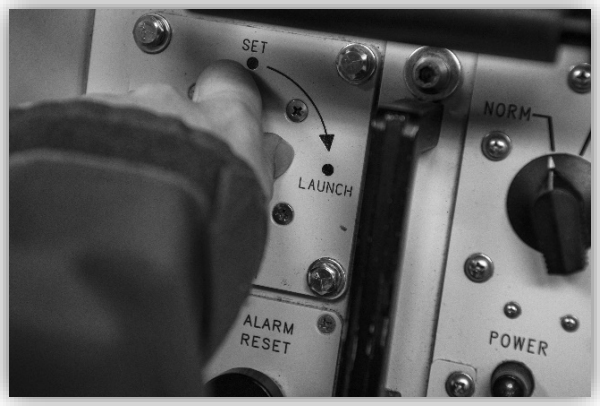
Thus, the development of the Sentinel not only fails to support the goal of reducing U.S. reliance on nuclear weapons, it also actively undermines the realization of conditions that the NPR spells out as prerequisites to any meaningful progress on this goal.

Alternatives to the Sentinel

Building the Sentinel is a choice, and it is not the only one available. Alternatives include extending the life of the Minuteman III and eliminating the land-based leg of the nuclear triad.

Life Extending Minuteman III

The 2022 Nuclear Posture Review states that "any alternative to the Sentinel program of record that extends MMIII life and replaces it in the future would increase risk and cost."[82] This position appears to be largely based on findings that are a decade old and remain classified.



A missile combat crew commander performs a simulated key turn of the Minuteman III weapon system during a simulated test launch inside the launch control center at a missile alert facility in the 90th Missile Wing's missile complex in Nebraska, April 2017. U.S. Air Force photo by Staff Sgt. Christopher Ruano.

In 2014, the Pentagon conducted an Analysis of Alternatives (AOA) focused on assessing two options for maintaining 450 ICBMs through 2075: extending the life of the Minuteman III or building the Sentinel, known then as the Ground Based Strategic Deterrent. The analysis concluded that building the Sentinel was the best option. However, the AOA remains classified, making its findings difficult to scrutinize.[83]

A 2022 report commissioned by the Pentagon and conducted by the Carnegie Endowment for International Peace tasked the authors with assessing "the relative risks and benefits of options for the future U.S. intercontinental ballistic missile (ICBM) force." The authors underscore that they did not "assess whether the United States should deploy ICBMs at all or change its nuclear strategy and doctrine."[84]

Strikingly, the report states that as a result of the Pentagon's lack of transparency, it was not able to assess the option of life extending the Minuteman III:

> *The information we received from the DOD was surprisingly detailed in some instances, yet piecemeal and vague in others. Given the lack of clarity on some issues and timelines involved with replacement or refurbishment of certain Minuteman III system components, as well as the time and information constraints governing this study, we were not able to assess the potential for a Minuteman III extension.*[85]

The report did reveal that during the AOA, the Pentagon found that "there were only enough missile casings ([for the Minuteman] III) to support the ICBM force through… the 2043 time frame," after which point the number of available ICBMs would drop below required levels without the introduction of a new booster. The report authors note, however, that the Pentagon "did not enumerate all the assumptions, including about the rate of missile testing, underlying these estimates. Nor did it describe the precise alternatives and timeframes pertaining to Minuteman III extension considered in the Analysis of Alternatives (which remains a classified document)."[86]

The report went on to recommend that the Pentagon commission "an independent, classified technical study (with an unclassified version) to address outstanding questions relating to the options and timelines in the 2014 Analysis of Alternatives, cost estimates, procurement decisions, and adversary threats to future silo-based ICBMs."[87]

Another study, conducted by the Federation of American Scientists (FAS) in 2021, argued that the Minuteman III could be life extended at current force levels through 2050 with "no discernible effect on strategic stability," and at a far lower cost than building the Sentinel.[88] This would require replacing the Minuteman III's solid rocket motors and guidance systems, as well as reducing its annual testing rate.[89]

While the Air Force contends that the Minuteman III's solid rocket motors will age out between 2029 and 2035, the FAS study argues that they could be used beyond then.

> *...the motors of the Minuteman II—which shares its first and second stages with the Minuteman III—continue to perform reliably in their new roles as space launch vehicles and sounding rocket systems. To date, first-stage Minuteman II motors between 27 and 54 years of age have performed successfully in all 27 test launches, as well as 23 static tests. Second-stage Minuteman II motors older than 17 years have achieved success in 60 out of 61 test launches, as well as 26 static tests.*[90]

This suggests that the Air Force may be using an overly conservative rubric for assessing the lifecycle of the Minuteman III's solid rocket motors. The FAS study also notes that when the motors eventually need to be replaced, it would be relatively inexpensive to do so—in the mid-2000s, the Pentagon spent roughly $2 billion to remanufacture 601 solid rocket motors for the Minuteman III.[91]

As for replacing the guidance systems, the Air Force spent $1.6 billion in the mid-1990s on a guidance replacement program, suggesting this could be achieved again at a relatively low cost.[92]

Regarding testing requirements, the Air Force has been testing the Minuteman III at a rate of 4.5 tests per year, a rate which, if maintained, would result in the inventory of ICBMs dropping below 400 by about 2040. But as the FAS report points out, if the Air Force reduced the test rate to its previous frequency of 3 tests per year, which was the status quo prior to FY2017, the inventory would retain at least 400 missiles until 2050. Alternatively, reducing the number of deployed ICBMs to 300 would allow the program to continue through about 2060 at the current test rate.[93]

The Air Force has only spent $7 billion extending the life of the Minuteman III over the course of the program.[94]

Eliminating the Land-Based Leg of the Nuclear Triad

This alternative to the Sentinel would entail canceling the Sentinel program and retiring the Minuteman III either immediately or when it reaches the end of its service life in FY2035. Given the inability of ICBMs to meaningfully contribute to the goals of the 2022 Nuclear Posture Review and given that the Sentinel in fact runs counter to some of these goals, canceling the Sentinel and retiring the Minuteman III is the most practical option for reducing the cost of U.S. ICBMs while supporting the goals laid out in the NPR.

According to a 2017 analysis by the Congressional Budget Office (CBO), the nonpartisan budget scoring arm of Congress, eliminating ICBMs when the Minuteman III reaches the end of its service life would save roughly $120 billion (in 2017 dollars) through 2046. About $90 billion of these savings would come from canceling the Sentinel, while the remaining $30 billion would come from

I would have removed land-based missiles from our arsenal a long time ago.

– Gen. George Lee Butler, former head of U.S. Strategic Command

canceling the production of new warheads. If the Minuteman III were decommissioned immediately (at the time), taxpayers would have saved $149 billion through 2046, according to CBO.[95] Given that current plans for the Sentinel and its warheads involve a lifecycle cost of roughly $315 billion through 2075, taxpayer savings over this period would be significantly higher.

The elimination of ICBMs has garnered support in the scientific community, and among high-profile members of the national security community.

In 2021, nearly 700 scientists and engineers wrote to President Biden urging him to consider a number of changes in the U.S. nuclear posture ahead of the release of the 2022 Nuclear Posture Review. These included reducing the number of deployed strategic nuclear weapons to 1,000, canceling the Sentinel, and considering the elimination of silo-based ICBMs due to their relative vulnerability to attack and the corresponding "risk of a mistaken launch in response to a false warning."[96] They also argued that "ICBMs provide no military capability that is not provided by SLBMs at sea, and there would be no pressure to use SLBMs quickly in response to warning of an incoming attack because they are invulnerable."[97]

In a 2015 interview, Gen. George Lee Butler, the director of U.S. Strategic Command from June 1992 to February 1994, bluntly rejected the need for ICBMs, citing the greater flexibility and survivability of the rest of the arsenal:

> *I would have removed land-based missiles from our arsenal a long time ago. I'd be happy to put that mission on the submarines. I came to develop an extremely high regard for submarines—their flexibility, their invulnerability, etc. And contrary to myth, we can communicate with them very quickly. So, with a significant fraction of bombers having a nuclear weapons capability that can be restored to alert very quickly, and with even a small complement of Trident submarines—with all those missiles and all those warheads on patrol—it's hard to imagine we couldn't get by. Now, the Air Force would take exception to that.*[98]

Similarly, in a Washington Post op-ed, former Secretary of Defense William Perry and retired Marine Corps General James Cartwright, who served as vice chairman of the Joint Chiefs of Staff from 2007-2011, called for eliminating the land-based leg of the nuclear triad, writing that ICBMs "carry higher risks of accidental war that, fortunately, we no longer need to bear."[99]

The American public also appears to support phasing out the ICBM force. According to a survey of registered voters conducted by the Center for International & Security Studies between January 7 and February 1, 2019, "six in ten, including a majority of Republicans, favor phasing out the ICBM force. However, only one-third favor unilaterally reducing the net number of strategic warheads in the U.S. arsenal instead of putting more warheads on submarines and bombers to keep the same total as the Russians."[100]

Conclusion

The Sentinel fails to deliver on its promise of improved deterrence and national security for the American people at any cost, let alone at its currently projected cost of $315 billion. Moreover, the development and deployment of U.S. ICBMs in general do not meaningfully contribute to U.S. national security, and in fact pose several security risks.

According to the Congressional Research Service (CRS), part of the original rationale for the nuclear triad was that each military service branch "wanted to play a role in the U.S. nuclear arsenal." It wasn't until the 1960s and 70s that "analysts developed a more reasoned rationale for the nuclear triad… that these different basing modes had complementary strengths and weaknesses that would enhance deterrence and discourage a Soviet first strike."[101]

CRS highlights that "ICBMs were believed to have the accuracy and prompt responsiveness needed to attack hardened targets such as Soviet command posts and ICBM silos, SLBMs had the survivability needed to complicate Soviet efforts to launch a disarming first strike and to retaliate if such an attack were attempted, and

heavy bombers could be dispersed quickly and launched to enhance their survivability, and they could be recalled to their bases if a crisis did not escalate into conflict."[102]

Since this rationale first developed, a lot has changed. Both ballistic missile submarines and nuclear-armed aircraft carry more accurate and powerful nuclear weapons than they used to, enabling them to hold hardened targets at risk. Communications between U.S. Strategic Command and the submarine fleet have become quicker and more reliable than they once were, reducing the time it would take to order a nuclear attack via the submarine fleet.[103] Technological advancements have also made ballistic missile submarines quieter over the years.[104]

On the other hand, the survivability of U.S. ICBMs has steadily declined as U.S. adversaries have developed more powerful and accurate nuclear weapons. The justification for building new ICBMs rests predominantly on the assumption that they offer indispensable attributes not found in the rest of the triad, but this assumption does not hold up under scrutiny.

Given the failure of the Sentinel and ICBMs in general to meaningfully contribute to U.S. national security goals and the immense costs to taxpayers associated with developing, procuring, operating, and sustaining the Sentinel, the United States should cancel plans for the Sentinel and move to retire the Minuteman III as quickly as possible.

Recommendations

- Cancel plans for the LGM-35A Sentinel ICBM.
- Retire the Minuteman III at the end of its service life or earlier.
- Recalibrate U.S. nuclear strategies and posture based on a nuclear dyad.

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