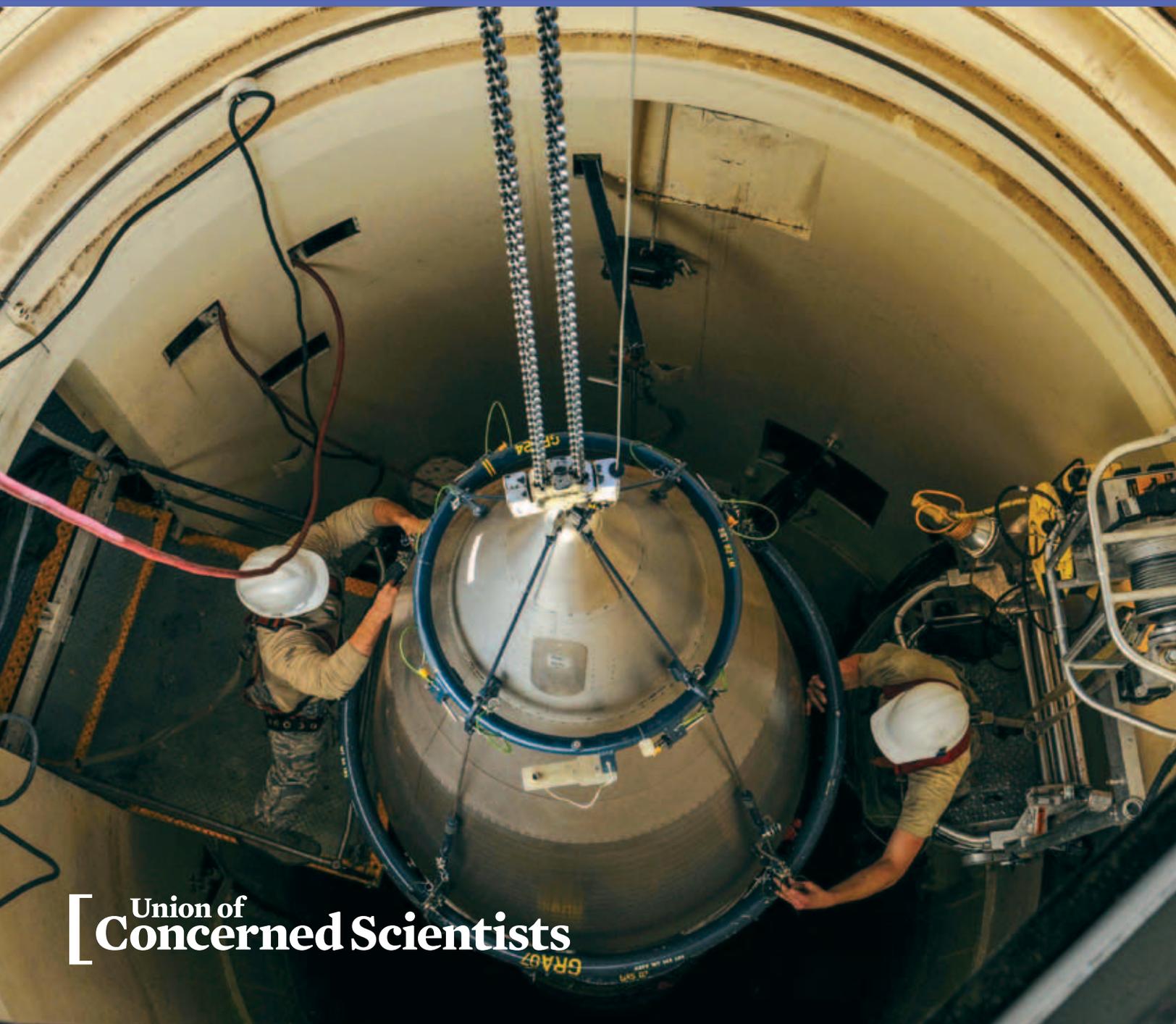


Rethinking Land-Based Nuclear Missiles

Sensible Risk-Reduction Practices for US ICBMs



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Airmen from the 90th Missile Maintenance Squadron prepare a reentry system for removal from the F. E. Warren Air Force Base missile complex in Wyoming in 2018.

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Executive Summary

The United States developed its core nuclear weapons policies—what types of weapons to field and when to use them—early in the Cold War, some 60 years ago.

Given the life-and-death consequences of these policies, most Americans—policymakers as well as the general public—no doubt trust that government experts have carefully crafted US nuclear policies based on security considerations and have modified them over the years in response to technological advancements. They naturally assume, then, that changing these policies would be dangerous and would weaken US security.

This trust is misplaced.

These policies were shaped by the limitations of weapons technology at the time, yet remain largely the same today despite the fact that these technical limitations have not existed for several decades. US policy remains unchanged because influential groups benefit from these weapons programs, and many policymakers assume that the status quo is a result of careful deliberation and that changing it would be foolhardy and dangerous.

In particular, US policy on land-based missiles is outdated and should be changed. This policy creates the risk that the United States could launch these missiles by mistake in response to a false alarm—and start a nuclear war. The reasons that led the United States to accept this risk in the 1960s are no longer valid.

US Nuclear Missile Policies

When the United States first developed ballistic missiles, the land-based intercontinental-range ballistic missiles (ICBMs) were more accurate and carried more powerful warheads

than did the submarine-launched ballistic missiles (SLBMs), allowing them to destroy Soviet land-based missiles while the SLBMs could not. The Pentagon was also not confident in its ability to securely communicate with submarines at sea. For these reasons, the United States believed that ICBMs were essential.

As Soviet missile technology improved, US ICBMs became increasingly vulnerable to a Soviet attack. In response, the United States placed these missiles on high alert so they could be launched quickly on warning of an incoming attack. Because it takes only 30 minutes for an ICBM to reach the United States from Russia, this policy required the United States to develop a highly time-compressed process for assessing a warning of an attack and making a decision to launch. This created the risk that the United States would launch a nuclear attack by mistake on false warning, which would almost certainly have led to Soviet nuclear retaliation against the United States. Indeed, a number of false warnings have occurred over the years, some of which prompted preparations for launch.

However, for decades now, SLBMs have been at least as accurate as ICBMs and armed with powerful warheads, and the Navy has had a highly reliable and secure communication system for the submarines. Moreover, SLBMs have the advantage of being essentially invulnerable to attack when the submarines are hidden at sea.

Yet despite these technological advances, the United States continues to keep its ICBMs on high alert and maintains an option of launching them quickly on warning of an attack. The original rationale for ICBMs—and for keeping them on alert—no longer applies.

While ICBM proponents offer new reasons for continuing to field these weapons, many security experts conclude there is no military reason to continue to deploy ICBMs and that the United States should retire the ICBM force.

However, the United States appears unlikely to retire the ICBM force anytime soon. Political barriers—having nothing to do with security—stand in the way. In particular, senators in the ICBM Coalition greatly value the jobs and economic benefits the Air Force bases that host ICBMs bring to their states, the Air Force is loath to give up a major weapons program, defense contractors are eager to build a new ICBM system, and—perhaps most important—political and military officials are generally reluctant to challenge the status quo and to question the value of the nuclear triad (ICBMs, SLBMs, and nuclear bombers).

The Air Force is in the early stages of building a new generation of ICBMs—the Ground-Based Strategic Deterrent (GBSD)—with the first one slated for deployment around 2030. The current official cost estimate for developing and producing these new missiles is \$100 billion.

A Better Policy

The technical limitations of SLBMs that led the United States to rely on ICBMs no longer exist, and SLBMs have the advantage of being invulnerable to attack when at sea. The United States should retire its ICBM force and rely on its nuclear submarine and bomber forces.

In any event, the United States should immediately remove its ICBMs from high alert, which can be done quickly by using the existing safety switch in each silo. It should also eliminate from military plans the option of launching on warning of attack, which would preclude the option of re-alerting the missiles. Re-alerting would be particularly risky during a time of crisis.

Finally, it should develop a new warning-assessment and launch-decision process that is not constrained by the 30-minute flight time of a ballistic missile from Russia to the United States, as it is today. A more deliberative process should take its place.

The United States should retire its ICBM force and rely on its nuclear submarine and bomber forces.

The United States should immediately remove its ICBMs from high alert.

By taking these steps, the United States would eliminate the possibility of a mistaken US launch and a likely Russian counterattack. Doing so would increase US security, regardless of whether Russia reciprocates.

ICBM proponents offer several rationales for retaining a large ICBM fleet. Some argue that any Russian first strike would have to include attacks on all US ICBMs, which would serve as a “sponge” to soak up Russian warheads and leave fewer to attack other targets. Another, related argument is that a Russian attack on all US ICBMs would be so large that it would be a “tripwire” for a US nuclear counterattack. This would be obvious to Russia, which would therefore be deterred from launching an attack in the first place. Without a large ICBM fleet, the argument goes, Russia could launch a much smaller nuclear attack, and might assume the United States would not respond.

Proponents also argue that, in principle, future underwater detection technologies could make submarines vulnerable, and the ICBMs could serve as a hedge against this possibility by providing a backup missile force to the SLBMs. However, these objectives can equally well be met with missiles that are off-alert. A Russian first strike would still include attacking all the ICBMs to prevent the United States from re-alerting and using them. And, were SLBMs to become vulnerable in the future, the United States could re-alert the ICBMs at that time.

Extending the Lifetime of the Existing ICBM Fleet

If the United States continues to field an ICBM force, there is no technical reason for it to build new missiles. Continuing to maintain and upgrade the existing Minuteman III ICBMs would be far less expensive than proceeding with the GBSD program. The Air Force already uses a straightforward process to refurbish and upgrade its ICBMs, and today the Minuteman missiles are “basically new missiles except for the shell,” according to an Air Force analyst. Official studies show that the Air Force can continue to extend the operational life of the Minuteman missiles for many decades.

Accurately estimating rocket motor lifetime. An important factor limiting the service lifetime of a missile is the aging of the rocket motors. However, the Air Force’s pro-

cess for estimating the operational lifetimes of ICBM motors appears to be overly conservative. Because the Air Force provided the rocket motors from the retired Minuteman II missiles to be used for other purposes, there are data on the actual performance of these motors—which show the Air Force lifetime estimates were significantly low.

Therefore, it is important that the Air Force incorporate better methods for monitoring and assessing the aging process of missiles—such as using sensors and integrating nondestructive testing methods and technologies into the monitoring process. If the actual operational lifetime of the current Minuteman III motors is also significantly longer than the estimated lifetime, the current ICBM force could be retained with less need for refurbishment.

Ensuring sufficient missiles for testing. Data from the past 20 years show that the Air Force has flight tested an average of three missiles per year during this time to provide statistical information on the reliability of the missiles. The estimated current stockpile of Minuteman III missiles would allow the Air Force to continue flight testing at the current rate for about 30 years—until around 2050.

However, because hundreds of past flight tests of the Minuteman III have provided a great deal of data, the Air Force may be able to assess reliability using fewer annual tests going forward. Moreover, a RAND study for the Air Force found that continued advancements in monitoring the aging effects of missile motors and improved modeling and simulation of the aging effects will likely reduce the number of flight tests needed to achieve the same level of confidence in the performance of the missiles.

A modest reduction in the number of fielded missiles in the distant future would provide more for testing, if needed. If the Air Force continues to conduct three flight tests per year, it would need to reduce the number of fielded ICBMs by three per year starting around 2050—to 370 by 2060 and 340 by 2070. It is reasonable to expect that these reductions could be made in the context of a future US-Russian arms agreement. Moreover, if the United States wanted to maintain the current overall level of deployed warheads during this process, it could slowly increase the number of warheads on SLBMs.

Recommendations

Based on these findings, we recommend the following actions.

1. The United States should retire the US ICBM force.
2. Until that time, it should immediately:
 - Remove ICBMs from high alert, to eliminate the possibility of launching these missiles on false warning and starting a nuclear war by mistake.
 - Eliminate launch-on-warning options from US war plans, which would preclude the option of re-alerting the ICBMs.
 - Revise the current process for making launch decisions, which is currently constrained by the short time available to launch ICBMs before incoming missiles could land.
3. Moreover, the United States should continue to extend the operational life of the Minuteman III missiles and should not build the new GBSD missile.
4. As part of this effort it should commission an independent study to:
 - Develop better ways to assess the aging effects of Minuteman III missiles, including incorporating sensors and nondestructive testing methods and technologies to allow evaluations of individual motors.
 - Validate these new methods of assessing aging, as well as the current one, against actual test and launch data from Minuteman II motors used in the Rocket Systems Launch Program.
 - Determine the number of flight tests required to assess the reliability of US ICBMs, taking into account advanced monitoring and nondestructive tests as well as data collected from past tests.

Introduction

The United States developed its core nuclear weapons policies—what types of weapons to field and when to use them—early in the Cold War, some 60 years ago.

Given the life-and-death consequences of these policies, most Americans—policymakers as well as the general public—no doubt trust that government experts have carefully crafted US nuclear policies based on security considerations and have modified them over the years in response to technological advancements. They naturally assume, then, that changing these policies would be dangerous and weaken US security.

This trust is misplaced, for two reasons.

First, many of today's nuclear weapons policies were developed decades ago and remain in place despite the fact that the technical limitations that shaped US policy early in the nuclear age no longer exist. Weapons technologies have changed radically over the past decades, but key policies have not adjusted to reflect those changes.

Second, over the years, US nuclear weapons and policies have often been shaped by factors unrelated to security. These include efforts by the two military branches that operate nuclear forces—the Navy and Air Force—to obtain a greater proportion of the defense budget; the inertia endemic to all large institutions that allows existing programs and policies to remain in place well beyond their usefulness; support by congressional delegations from states that host nuclear weapons facilities and thereby provide jobs; and lobbying by defense contractors that manufacture the aircraft, missiles, and submarines that deliver nuclear weapons.

The result is US nuclear weapons policies that are long outdated and remain in place for reasons that have little to do with security and protecting the US public. Not only do the

policies waste resources, they increase the risk of an unintentional US-Russian nuclear war and needlessly place the US public—and the rest of the world—in grave danger.

The Future of Land-Based Missiles

The fleet of land-based intercontinental-range ballistic missiles (ICBMs) is a particularly relevant example of this dynamic. ICBM policy no longer matches technical realities, and security considerations have given way to other factors.

This issue is especially important now because Congress and the Pentagon are ramping up a project to replace the existing land-based missile force, at an estimated cost of \$100 billion (Reif 2017; Insinna 2019).

By the mid-1960s, the United States fielded long-range missiles both in underground silos and on submarines. At that time, the accuracy and explosive yield of the silo-based missiles was greater than that of the submarine-launched ballistic missiles (SLBMs)—meaning they could destroy key Soviet targets while SLBMs could not. Moreover, although submarines at sea were invulnerable to attack, the Pentagon could not reliably and securely communicate with them. For these technical reasons, US military and political leaders believed the silo-based missiles were essential.

Soon, however, the accuracy of Soviet nuclear missiles improved to the point where they could destroy US missiles in their silos.

In response, in the early 1970s the Air Force placed its silo-based missiles on constant high alert so that it could launch them in a matter of minutes before they were destroyed, if there was warning of an incoming Soviet nuclear attack.

The US warning system consisted of ground-based radars and satellite-based sensors, which would send data to Pentagon computers that would then assess whether an attack was under way. Pentagon officials would consider this assessment, and if they believed it was an actual attack they would contact the president. Because it takes only about 30 minutes for a long-range missile to travel from Russia to the United States, the president would have to make the momentous decision to launch the ICBMs in a matter of minutes—without knowing whether the warning was accurate.

Numerous false alarms—due to technical glitches and human errors—have occurred over the years, some of which prompted the United States or the Soviet Union to begin preparations for a nuclear response. These incidents highlight the risk that these two countries could start a nuclear war by mistake.

However, for the past several decades, submarine-based missiles have been more accurate than land-based ones, and the Navy has had a secure communication system for submarines at sea. The original reason for deploying vulnerable silo-based missiles and keeping them on high alert is no longer valid. Regardless, today 400 missiles sit in silos in Colorado, Montana, Nebraska, North Dakota, and Wyoming, still vulnerable and still on high alert so they can be launched in response to a warning that Russia has launched an attack (Kristensen and Korda 2020).

As noted, the Air Force is developing and preparing to build a new generation of ICBMs slated for deployment in the

2030s. Proponents of the new missile, the Ground-Based Strategic Deterrent (GBSD), argue that the current silo-based Minuteman missiles are aging and should be replaced with a more capable missile. The new missiles will be placed in the same silos as the current missiles and be equally vulnerable to a Russian nuclear attack; the incentive to keep them on high alert will remain.

Why does the United States retain ICBMs and plan to do so for the indefinite future?

Some ICBM proponents argue that ICBMs remain important for security. These arguments are examined in the chapters that follow. However, a primary reason for retaining ICBMs is the influence of strong nonsecurity factors: The Air Force wants to retain the weapons under its control, members of Congress want to keep jobs in their states, and defense contractors want the estimated \$100 billion of military investment that it will cost to build the new ICBMs.

This report considers in detail the historical reasons the United States fields large numbers of ICBMs and maintains them on high alert. It discusses the political reasons that this policy remains unchanged, despite its inherent dangers. It also assesses the Air Force plan to produce a new fleet of ICBMs and considers the merits and feasibility of instead extending the operational life of the existing Minuteman III missiles. Finally, it recommends policy changes that would reduce the risk of nuclear war, increasing US and international security.

The original reason for deploying vulnerable silo-based missiles and keeping them on high alert is no longer valid. Regardless, today 400 missiles sit in silos, still vulnerable and still on high alert.

Origins of the ICBM Force and the Triad

The development of US nuclear weapons policy was heavily influenced by available weapons technology at the time. But it was also shaped by the intense rivalry between the Air Force, which oversees nuclear bombers and land-based ICBMs, and the Navy, which oversees submarines that carry SLBMs.

The Technologies

The earliest US nuclear weapons were bombs that could be dropped from airplanes, such as the ones that destroyed the Japanese cities of Hiroshima and Nagasaki. Both the United States and Soviet Union built nuclear-armed bombers in the late 1940s and 1950s. Bombers would take many hours to reach targets in the other country and could be vulnerable to air-defense systems. For more than a decade, however, bombers were the only delivery option, since neither country had developed long-range missiles.

During that time, the United States was concerned about the vulnerability of its air bases to a Soviet attack, so it kept numerous bombers armed with nuclear weapons in the air at all times between 1958 and 1968 (Grant 2011). If there had been a Soviet attack, these bombers would have flown to pre-determined Soviet targets and dropped their bombs. Then as now, even if bombers are not kept airborne, they can be kept ready to take off quickly during a crisis to prevent their destruction. They can then be recalled or ordered to continue on to their targets.

During the 1950s, both countries developed land-based ICBMs to carry nuclear warheads and began to field them in 1959. The first missiles were the US Atlas and Soviet R-7A (SS-6). ICBMs generally have a range of about 6,000 miles

(10,000 kilometers) or longer, and travel much faster than bombers. It would take an ICBM only about 30 minutes to reach a target in the other country. The ICBMs' extremely high speed also makes them more difficult to shoot down than bombers.

The Air Force based early ICBMs above ground, leaving them vulnerable to a Soviet attack. Later, the Air Force housed some of them in horizontal underground concrete facilities, but it still had to raise them to the surface and fuel them in the open. By the mid-1960s, both countries began placing missiles vertically in underground silos, which allowed them to be launched without coming to the surface. The Soviet Union knew where the US silos were located, but only a nuclear explosion very close to the silos could destroy them. Neither country had weapons with such high accuracy at that time. Therefore, the ICBMs in underground silos were essentially invulnerable to attack.

During the 1950s, the United States and Soviet Union were also developing missiles that could be launched from submarines. Both countries conducted successful missile launches from submerged submarines in 1960 and began patrols of submarines carrying nuclear-armed missiles shortly thereafter. Early SLBMs were smaller and had much shorter ranges than ICBMs. The US Polaris-A1 SLBM had a range of about 1,600 miles (2,600 kilometers) while the Soviet R-21/SS-N-5 SLBM had a range of about 950 miles (1,500 kilometers). Moreover, at that time, it was difficult for submarines to determine their precise location and hence the exact location of an SLBM launch, making SLBMs less accurate than ICBMs. However, there was more at play in the US decision to include all three types of weapons in its nuclear arsenal.

The Air Force and Navy had compelling bureaucratic and budgetary reasons to maintain and expand the nuclear forces under their purview.

Competition between the Air Force and Navy

As the Pentagon was developing nuclear systems and policies during the 1940s and 1950s, there was a fierce competition between the Air Force and the Navy. In the period following World War II, these two branches of the military saw that nuclear weapons were about to become a significant and growing part of US military forces and believed that controlling part of the nuclear arsenal was important to their futures.¹ In the late 1940s, the Navy tried unsuccessfully to get part of the bomber mission by proposing to build very large aircraft carriers that could be used for nuclear bombers, which were much bigger than the aircraft launched from carriers during World War II. However, during the 1950s, the Air Force and Navy recognized that long-range missiles would become the backbone of the US nuclear arsenal and lobbied hard for funding to develop their own distinct missile systems. (See Appendix A for more detail on this history.)

The two services began to promote different nuclear doctrines that relied on the missiles they controlled. In the late 1950s, the Air Force argued that the United States should target military sites in the Soviet Union rather than cities. (Since the purpose of attacking military sites would be to counter enemy forces, this doctrine is referred to as “counterforce.”) Because military sites are considerably smaller than cities, this mission required missiles with relatively high accuracy, which ICBMs but not SLBMs were capable of at that time.

The Navy argued just as strongly for a different doctrine that could be carried out by SLBMs: The United States should target major Soviet cities, which required less accuracy than

The Air Force and Navy had compelling budgetary and bureaucratic reasons to maintain and expand the nuclear forces under their purview.

attacking military sites. (Because there are far fewer cities than military sites, this doctrine is dubbed “finite deterrence,” since it would require the United States to target a relatively small number of sites (Burr 2009). This would also allow the United States to have a smaller nuclear force.) The Navy also argued that because SLBMs were invulnerable at sea, they should make up the bulk of the US nuclear force, since reliance on vulnerable ICBMs could lead the United States to launch its ICBMs in a crisis to prevent their destruction. The Navy argued that this use-it-or-lose-it dynamic in a crisis could lead to a nuclear war.

This doctrine put the Navy in the uncomfortable position of arguing for attacking cities, but doing so made it possible for the Navy to make a case for investing in sea-based, rather than ground-based, missiles. (As we discuss in Chapter 4, the United States soon developed more accurate SLBMs, which allowed the Navy to embrace a counterforce doctrine and argue that SLBMs played a vital role in this doctrine.)

Because US nuclear weapons technology and nuclear doctrine were continuing to evolve, the United States kept all of the systems—the bombers, ICBMs, and SLBMs. Perhaps equally significant, this decision also reduced the infighting between the Air Force and Navy over their nuclear roles.

¹ During the 1950s, the Army began to deploy short-range “tactical” nuclear weapons for use on the battlefield. During the Cold War, the United States deployed some 7,000 nuclear weapons, primarily in Europe (Woolf 2019). It also kept tactical nuclear weapons in South Korea from 1958 to 1991 (Kristensen 2005). The Army is now out of the nuclear business. The remaining tactical weapons—bombs based in Europe and bombs and air-launched cruise missiles based in the United States—are controlled by the Air Force.

The Evolution of ICBM Technology and Policy

Since the 1960s, the technical sophistication of both US and Soviet ICBMs advanced considerably, and, in response, both countries changed their policies governing their use.

Efforts to Reduce ICBMs' Vulnerability

In the 1970s both countries focused on improving ballistic missile accuracy, but as accuracy increased, silo-based missiles became more vulnerable to nuclear attack because both countries knew exactly where each other's silos were located.

The two nations responded in several ways. First, they continued to harden their missile silos by encasing them in concrete to resist attacks by all but very accurate missiles with powerful nuclear warheads. But as missile accuracy continued to improve, hardening became less viable.

In addition, the Soviet Union began fielding some of its ICBMs on mobile launchers to hide their locations from the United States. These mobile ICBMs are still part of its force. The United States considered doing the same, but ultimately decided not to go that route. Subsequent US studies of a mobile-launcher option have likewise concluded that it would not be worth pursuing (Woolf 2020).

Both countries also tried to reduce the vulnerability of their silo-based ICBMs by building the infrastructure to enable them to launch the missiles before an incoming attack could destroy them. Given that it takes only about 30 minutes for an ICBM to reach the other country, doing so was a very demanding task. Both countries built large early warning systems consisting of ground-based radars and satellite sensors to provide warning of an incoming missile attack. They developed computers that would use this sensor data to provide a warning that includes information

about the number of the attacking missiles and their targets.

Finally, they developed launch-on-warning options (see box) that would allow them to fire their silo-based missiles within minutes of a decision to do so (BACVC 2015; Burr 2001). Implementing such a plan requires keeping the ICBMs on high alert around the clock so that they are ready to launch immediately.

“Launch on Warning” vs. “Launch under Attack”

While the US option of launching ICBMs quickly on warning of an incoming nuclear attack is frequently called “launch on warning,” the Defense and State Departments instead use the term “launch under attack.” According to the State Department, a decision to launch US missiles “under attack” would be based on an “attack assessment that considers and confirms warning information from multiple, independent sensors” and “also considers the apparent intent of the incoming attack in the context of the international situation” (BACVC 2015). The implication is that the United States would launch only if it *knew* that a nuclear attack was under way—but this is not the case since the United States could not know this until it detected nuclear explosions. Like launch on warning, launch under attack assumes that US missiles would be launched before attacking warheads detonated. Thus, the term “launch under attack” is misleading and this report uses as the term “launch on warning.”

Carrying out the launch-on-warning option requires a multistep process, which would play out in the United States as follows. Satellites would detect a Russian missile within three minutes of its launch. At that point, personnel monitoring the warning systems would have three or four minutes to try to assess whether the warning was real and, if they believed it was, to pass that information up the chain of command. Senior military leaders would have a few minutes to confer and, if they decided it was warranted, quickly contact and brief the president and present him or her with options for a response. This briefing would last no more than 60 seconds. The president would then have to make a decision with a couple minutes remaining to transmit launch orders to ICBM crews so that the missiles could leave their silos before incoming missiles hit. This process provides at most 10 minutes for the president to confer with military briefers and decide whether to launch (Wright, MacDonald, and Gronlund 2016; Lewis 2017).

Launch on warning gives the president at most 10 minutes to confer with military briefers and decide whether to launch.

This limited time from attack warning to ordering a nuclear counterstrike has prompted the US and Russian militaries to develop and practice nuclear launch procedures that can be carried out quickly and almost reflexively. General James Cartwright, a retired US Marine Corps four-star general who headed the US Strategic Command from 2004 to 2007 and served as vice chair of the Joint Chiefs of Staff from 2007 to 2011, describes this process as “gearing the nuclear command-control-communications and warning system from the president on down to the individual launch commanders for rapidly executing the forces in the opening phase of a nuclear conflict” (Examining the Proper Size 2012).

Even if the president ultimately decided not to launch in response to a warning, maintaining the *option* of launching nuclear weapons quickly creates intense time pressure on military officers and decisionmakers to act with incomplete,

ambiguous, or conflicting information, thus undermining sound decisionmaking. Moreover, if a warning were to occur in the midst of a US-Russian crisis, militaries on both sides would likely assess the warning as more credible than they would otherwise.

Cartwright and retired Russian General Vladimir Dvorkin,² both of whom have extensive experience with nuclear weapons, have warned that this short timeline can lead to a terrible decisions, writing:

For either side, these timelines are very compressed and the opportunities for ill-considered decisions very real. Launch on warning puts enormous strain on the nuclear chains of command in both countries (Cartwright and Dvorkin 2015).

Similarly, Air Force General Michael Hayden, former director of the National Security Agency (1995–2005) and of the Central Intelligence Agency (2006–2009), stated that the process for making a nuclear launch decision “is designed for speed and decisiveness. It’s not designed to debate the decision” (Belvedere 2016).

Human and Technical Errors Leading to Close Calls

This highly streamlined and time-constrained warning-assessment and launch-decision process creates the very real risk of launching nuclear weapons by mistake in response to a false or ambiguous warning. Such false alarms due to human and technical errors have occurred a disturbing number of times over the past 40 years. Several of them led to uncomfortably close calls.

For example, in 1979 a training tape of a scenario for a large-scale Soviet nuclear attack on the United States began to play on an operational computer at the North American Aerospace Defense Command (NORAD), indicating such an attack was under way. A year later, a failed computer chip in a Pentagon computer system triggered a false warning of a large incoming Soviet missile attack. In both cases, operators discovered the errors in time to avert a mistaken response. But they could easily have concluded in each case that an attack was under way and passed the alarm up the chain of command (UCS 2015b).

Other types of false warnings have occurred. In 1983, Soviet early warning satellites reported an incoming US missile attack. The false alarm was apparently caused by the

² Vladimir Dvorkin is a retired major general and former head of the research institute of Russia’s Strategic Rocket Forces (1993–2001).

sun reflecting off high-altitude clouds on the fall equinox—a possibility that the Soviets had not considered. In 1995, Russian early warning radars accurately detected a missile launch, but operators believed that a small rocket launched from Norway as part of a science experiment was a nuclear missile from a submarine.

None of these cases, or a number of others, led to a nuclear launch, but in several instances US military aircraft took off and missile crews began preparations for a launch. And errors and ambiguities continue to happen. Some military experts believe that such a mistaken launch of ICBMs on false or ambiguous warning is now the most likely way that a nuclear war would start (Cartwright and Dvorkin 2015; Jameson and Gronlund 2015).

The Pentagon is aware that the current policy of keeping ICBMs on alert risks a mistaken launch and a subsequent ex-

change of nuclear weapons between the United States and Russia. During the Cold War, the Pentagon recognized that the vulnerability of US ICBMs might lead the Soviet Union to launch a nuclear attack to destroy them in certain situations. Even so, it considered the capabilities of the US ICBM force as central to US nuclear strategy and believed the option to launch on warning was necessary to deter a potential Soviet attack.

Ironically, the US launch-on-warning capability does not make ICBMs invulnerable to destruction. Although the system can respond quickly enough to launch the ICBMs if the United States detects an incoming attack by Russian ICBMs, it may not be able to respond quickly enough to an attack from Russian SLBMs. Submarines can get much closer to their targets, and the SLBM flight time could be as short as 15 minutes, far less than an ICBM's 30-minute flight time.

A highly streamlined and time-constrained warning-assessment and launch-decision process creates the very real risk of launching nuclear weapons by mistake in response to a false or ambiguous warning.

The Evolution of SLBM Technology and Implications for ICBMs

As noted above, both the United States and Soviet Union started fielding nuclear missiles on submarines in the 1960s. Submarines have the advantage that they are hidden in the ocean when out at sea, making them essentially invulnerable to attack. However, early SLBMs were less accurate than ICBMs and carried less powerful warheads, and could not destroy hardened Soviet silos. Moreover, communicating with submarines at sea is inherently more difficult than communicating with ICBM launch crews, and at the time the communications system for submarines was less reliable than for ICBMs.

That situation changed more than 20 years ago. US submarine-based Trident II missiles, which were first fielded in 1990 and made up the entire SLBM force a decade later, are more accurate than the Minuteman III land-based missiles (MDP 2018b, 2018a). They also carry more powerful warheads. One of the two types of Trident warheads (the W88) has a yield of 455 kilotons, greater even than the 300- and 335-kiloton yields of the two types of Minuteman warheads (the W78 and W87, respectively) (Kristensen and Korda 2020). Therefore, a Trident II SLBM armed with a W88 warhead is *more* capable than US ICBMs of destroying hardened targets. Moreover, the smaller SLBM warhead (the W76-1) has recently been upgraded with a new fuse that significantly increases its ability to destroy hardened targets (Kristensen, McKinzie, and Postol 2017).

Similarly, the ability to communicate with submarines at sea improved dramatically by the 1980s. The Pentagon has

spent considerable effort and money over the past several decades to make the systems that communicate with these submarines more reliable and robust, and those efforts are ongoing. It has designed US nuclear command-and-control systems to survive a large-scale Russian nuclear attack so the United States would still retain a large number of submarine-based warheads and the ability to use them (Refuto 2011).

As the Trump administration's 2018 Nuclear Posture Review noted about the US nuclear-armed submarines, "when on patrol, SSBNs are, at present, virtually undetectable, and there are no known, near-term credible threats to the survivability of the SSBN force" (OSD 2018).³

Today, the United States deploys most of its nuclear weapons—some 900—on highly accurate SLBMs. By contrast, less than half of those—400—are on siloed ICBMs. The Navy has 14 nuclear-armed submarines. Two are in port for overhauling at any time, a few are en route to their underwater patrol areas, and 8 to 10 are typically submerged at sea, ready to launch and invulnerable to attack (Kristensen and Korda 2020).

Importantly, the reason for maintaining ICBMs on high alert in the first place—reducing the vulnerability of the leg of the triad the Pentagon deemed necessary to deter a Soviet nuclear attack—is no longer valid. There is no military reason to continue this practice. The United States can eliminate the dangerous use-it-or-lose-it trap in which it has placed itself and remove the risk of launching land-based missiles on false warning by either retiring the ICBMs or, at a minimum, taking them off high alert.

³ SSBN is an abbreviation of *Ship, Submersible, Ballistic, Nuclear*, where "nuclear" refers to the reactors that power the submarine.

Retiring the ICBM Force

Experts Call for Eliminating ICBMs

A growing number of highly respected experts, including former top military officials, have called for the complete elimination of the ICBM force, leaving a nuclear “dyad” of bombers and SLBMs.

Over the past several years, former Secretary of Defense William J. Perry has been particularly outspoken about eliminating the ICBMs. In a 2016 opinion piece in the *New York Times*, “Why It’s Safe to Scrap America’s ICBMs,” he wrote that eliminating ICBMs would save money that could be used to address other security challenges and that ICBMs are “some of the most dangerous weapons in the world. They could even trigger an accidental nuclear war” (Perry 2016).

Perry, who was undersecretary of defense for research and engineering in 1980 when a Pentagon computer falsely reported that there were 200 Soviet ICBMs heading toward the United States, noted that in such a situation a president would have a dangerously short time frame to determine whether such a threat was real and decide whether to launch US ICBMs. Even if the risk of a mistaken launch due to false warning or other problems is small, Perry emphasized that the consequences of a mistaken launch are great—putting millions of lives at risk. He believes that this is a risk the United States should no longer take, since ballistic missiles launched from invulnerable submarines and nuclear-armed bombers would be more than enough to dissuade any nation from attacking the United States.

In a 2015 presentation to the Defense Writers Group, Perry argued for getting rid of the ICBM leg of the triad even if Russia maintained its ICBMs, leaving the two countries with “asymmetric” forces. He said that:

Any reasonable definition of deterrence will not require that third leg. . . . It’s destabilizing because it invites an attack. . . . [ICBMs are] uniquely destabilizing, uniquely dangerous. . . . Deterrence is deterrence, and you can achieve it with an asymmetrical force, and you can achieve it with fewer numbers (Perry 2015).

General James Cartwright, former Joint Chiefs of Staff vice chair and former US Strategic Command director, also has spoken out on numerous occasions about the need to eliminate ICBMs, noting that doing so would lower the risk of an accidental launch that could lead to a nuclear exchange (Cartwright and Blair 2016).

With Perry, he wrote the following in a 2017 *Washington Post* op-ed:

Today, the greatest danger is not a Russian bolt but a US blunder—that we might accidentally stumble into nuclear war. As we make decisions about which weapons to buy, we should use this simple rule: If a nuclear weapon increases the risk of accidental war and is not needed to deter an intentional attack, we should not build it. . . . Certain nuclear weapons, such as the [air-launched] cruise missile and the ICBM, carry higher risks of accidental war that, fortunately, we no longer need to bear. We are safer without these expensive weapons, and it would be foolish to replace them (Perry and Cartwright 2017).

General Lee Butler, who headed US strategic nuclear forces from 1991 to 1994, also favors eliminating ICBMs. In a 2015 interview conducted around the release of his memoir *Uncommon Cause* (Butler 2015), Butler stressed his opposition

to ICBMs and referenced the Air Force's interest in keeping them:

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. . . . 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 component 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 (Kazel 2015).

More recent secretaries of defense—including former Senator Chuck Hagel, who served under President Obama from 2015 to 2017, and General James Mattis, who served under President Trump from 2017 to 2019—questioned the need for ICBMs only to backtrack when they became a member of the president's cabinet. Their abrupt about-face on the matter appears to have more to do with pressure from Congress and the Pentagon than a change of mind regarding the need for ICBMs.

Hagel was a member of the 2012 Global Zero commission that made a cogent argument for eliminating land-based nuclear-armed missiles (GZUSNPC 2012). However, he reversed course during his January 2013 Senate confirmation hearings under withering criticism by Senators Deb Fischer (R-NE), whose state is home to US Strategic Command headquarters; Kelly Ayotte (R-NH); Jeff Sessions (R-AL); and James Inhofe (R-OK) (Nomination of Hon. Charles T. Hagel 2013).

For his part, General Mattis asked in congressional testimony in 2015, “is it time to reduce the triad to a dyad, removing the land-based missiles? This would reduce the false alarm danger” (Hearing on Global Challenges 2015).

But when pressed about this issue in January 2017 during his Senate confirmation hearing to become secretary of defense, he defaulted to the standard argument for the triad, stating that the ICBM force creates a “targeting challenge” for an adversary (Confirmation Hearing 2017).

While discussing Mattis's thoughts on the matter, a *Washington Post* article in February 2018 noted the political backlash Mattis would have faced if he had come out against the ICBM or any other element of the Pentagon's nuclear modernization plan. “To have done otherwise,” the *Post* reported, “would have forced him to confront tremendous pressure from Congress, the military, and the White House, all of which backed the new policy [of replacing all three legs of the nuclear triad with upgraded versions]” (Sonne 2018).

The Impetus for Continued Deployment of ICBMs

For several decades now, US SLBMs have more than matched ICBMs in military capabilities and are invulnerable at sea. Yet, the United States continues to keep its ICBMs and maintain them on high alert, requiring a dangerously rushed warning-assessment and launch-decision process that greatly increases the risk of starting a nuclear war by mistake.

Why hasn't the United States changed this policy? Largely because there are influential people in the Pentagon, Congress, and elsewhere who are committed to maintaining the status quo regardless of the risks.

NEW MILITARY RATIONALES FOR ICBMS

While the original military rationale for deploying ICBMs is no longer valid, ICBM proponents have offered new ones.

First, advocates say the ICBMs would serve as a “sponge” to soak up Russian warheads—any Russian first strike would have to target all of the ICBM silos, leaving far fewer weapons for it to use to destroy other targets. They also argue that because a Russian first strike would entail detonating hundreds of nuclear weapons in the US heartland, Russia would presume that the United States would launch a massive counterattack and thus be deterred from attacking in the first place. Finally, they state that submarines could possibly become more detectable someday or something could go wrong with the SLBM warheads, and the United States could compensate by adding more nuclear warheads to its ICBMs, which now carry only one.

Whatever the merits of these arguments, the ICBMs would still offer these nominal benefits if they were off-alert. This is discussed in more detail in Chapter 6.

POLITICAL BARRIERS TO CHANGE

In addition, and perhaps more importantly, there are people and organizations that have strong financial and other interests in retaining ICBMs for reasons that have little or nothing to do with US security, and who lobby strongly to sustain the status quo.

First, the Air Force owns and manages the ICBM force and receives significant military funding every year to do so. Moreover, the ICBMs provide a career path for Air Force personnel, which the service naturally values. As a 2014 RAND report noted, “decreasing the [ICBM] force to or below 300 will impact key nuclear career fields,” which is “of interest to Air Force personnel and career field managers” (Caston et al. 2014, xx).

The ICBM Coalition is another interest group that wants to retain the ICBM force. The coalition consists of senators from states that host ICBM bases, which employ thousands of people. And, while nuclear warheads are produced by US government labs, the big-ticket items—the planes, missiles, and submarines that carry them—are manufactured by defense contractors, which have a strong financial interest in maintaining all three legs of the triad.

DEFENDING LAND-BASED MISSILES: THE ICBM COALITION

The ICBM Coalition includes the senators—both Republicans and Democrats—from Montana, North Dakota, and Wyoming, which host the Air Force bases that are responsible for the ICBM silos and provide local jobs and other economic benefits. (Missile silos are also based in Colorado and Nebraska, but they support very few jobs.) Utah’s senators are also members of the coalition because ICBM support and maintenance is carried out at Hill Air Force Base (Hill AFB 2016). In addition, Northrop Grumman began building a new plant in Utah in August 2019 to support production of the new ICBM, which the company says could generate 2,500 new jobs in the state (Northrop Grumman 2019b).

In 2020, the members of the coalition are John Hoeven (R) and Kevin Cramer (R) from North Dakota; Jon Tester (D) and Steve Daines (R) from Montana; John Barasso (R) and Mike Enzi (R) from Wyoming; and Mike Lee (R) and Mitt Romney (R) from Utah. Hoeven and Tester are co-chairs (Hoeven et al. 2019). (See Appendix B for more information about the coalition.)

Over the years, the coalition has played an important role in ensuring the US nuclear arsenal includes a significant number of ICBMs. For example, the US-Russian 2010 New START agreement limits the total number of fielded SLBMs, ICBMs, and nuclear-armed bombers to 700. The United States is free to choose the mix of systems, so the more ICBMs it fields, the fewer SLBMs and bombers it can field. The coalition pushed hard to keep 400 ICBMs fielded, cutting the total by only 50 missiles. It also pushed hard to prevent the Pentagon from cutting the 50 missiles by eliminating a single missile squadron of 50 missiles. Each of the three Air Force bases have three such squadrons and the Senators from those states did not want to lose one of them. The upshot was that the Air Force cut five or six missiles from each of the nine squadrons, so that none were eliminated (Cloud 2014).

The coalition also wanted to keep the remaining 50 empty silos on “warm status,” which would enable the Air Force to easily return them to operation and would allow each of the nine US missile squadrons to continue overseeing 50 silos. The Air Force instead wanted to destroy the silos, as it had

done when previous arms agreements called for fewer ICBMs. Maintaining 50 empty silos costs money, and the Air Force wanted to use those funds for other things. Moreover, New START limits the total number of deployed and non-deployed launchers; therefore, maintaining 50 non-deployed silos would require the United States to decrease the total number of SLBMs and bombers.

The coalition won that battle.

In 2014, two of its members—Tester and Hoeven—served on the Senate Appropriations Committee and added a provision to the defense appropriations bill that prohibited the Defense Department from spending funds to conduct an environmental assessment of the impact of eliminating ICBM silos. By law, the department could not proceed without conducting such an assessment. A press release issued in April of that year by coalition co-chair Enzi summed up what happened: “The Defense Department tried to find a way around the Hoeven-Tester language, but pressure from the coalition forced the department to back off” (Senator Mike Enzi 2014). It is not surprising that this group of senators supports maintaining ICBMs since these weapons bring jobs and economic benefits to their states. This is particularly true for Wyoming, Montana, and North Dakota, which host the three Air Force bases that oversee ICBMs.

Frances E. Warren Air Force Base in Cheyenne, Wyoming, is the largest employer in the state. It is the home of the 90th Missile Wing, which is responsible for 150 Minuteman ICBM sites and directly employs some 3,700 full-time workers (more than 80 percent military)—approximately 8 percent of the local labor force around Cheyenne. Taking into account the ripple effect of spending by base personnel on local goods and services, the base accounts for another 4 percent of jobs—so-called indirect jobs—putting the overall employment figure at around 12 percent. Statewide, direct employment due to the base accounts for about 1.3 percent of the labor force. If the ICBM force were eliminated, the base would almost certainly close.

Malmstrom Air Force Base near Great Falls, Montana, is home to the 341st Missile Wing, which is also responsible for 150 ICBM sites. The base employs some 4,000 people (more than 80 percent military staff), which accounts for more than 10 percent of the Great Falls–area labor force and perhaps 16 percent when including the indirect jobs supported by the base and its workforce. Eliminating the ICBM force would also likely result in Malmstrom closing.

Minot Air Force Base, outside of Minot, North Dakota, is home to the 91st Missile Wing, which is responsible for the remaining 150 ICBM sites. Unlike the other two ICBM bases, Minot hosts a second nuclear force, the 5th Bomb Wing, which consists of 26 B-52 bombers that carry nuclear

weapons. In this case, the base would likely remain open even if the United States eliminated its ICBMs.

Some 6,200 people (nearly 90 percent military personnel) currently work at the Minot base, divided between the 91st Missile Wing and the 5th Bomb Wing. They directly account for 13 percent of the Minot-area labor force and indirectly another 7 percent of local jobs. The direct employment at Minot accounts for 1.5 percent of North Dakota's total labor force.

Closing the Warren and Malmstrom airbases and cutting jobs at Minot would have a substantial impact on their respective local economies. But this situation is not unique: Hundreds of military installations have been shut down since the mid-1990s. To prevent local economic interests from interfering with Pentagon decisions about how best to reconfigure its forces following the end of the Cold War, the United States established the Base Realignment and Closure (BRAC) process, which provided Congress with a slate of closures that it could vote up or down as a whole (Wikipedia 2020). That process resulted in shutting down more than 350 military installations over the last 30 years, requiring many local communities to adapt.

POLITICAL INFLUENCE: THE DEFENSE INDUSTRY AND ICBM CONTRACTORS

Defense contractors help underwrite election campaigns and spend tens of millions of dollars annually to hire lobbyists to urge members of Congress to fund their weapon systems. The bigger the program budget, the more intense the efforts to secure funding. The development and production of new ICBMs is expected to cost \$100 billion (in 2020 dollars) (Reif 2017)—a high price tag even in the world of costly military programs.

Northrop Grumman expects to win the contract to build a new generation of ICBMs—the GBSD—to replace the existing Minuteman fleet over the next 20 years. Northrop Grumman is the only defense contractor that can readily produce ICBMs, and after Boeing dropped out of the competition, the Pentagon announced in December 2019 that it will award Northrop Grumman a non-competitive contract. Some members of Congress are concerned that such a contract may reduce incentives for cost savings and staying on schedule (Erwin 2019). The conference report to the FY20 National Defense

Authorization Act requires a Pentagon report to Congress assessing “the risks and costs resulting from receiving only one bid” for engineering and manufacturing development phase of the GBSD program (House of Representatives 2019, 1449).

Northrop Grumman and its subcontractors that would be involved in the new ICBM program employ a total of 524 lobbyists, a large fraction of whom have passed through the revolving door from senior positions in government (see Appendix B).

Northrop Grumman not only lobbied for the new GBSD program, it also lobbied heavily to prevent a government feasibility study on extending the service life of the current ICBMs to 2050, which would have postponed the GBSD program for years. In particular, the company helped defeat an amendment to the House version of the fiscal year 2020 defense bill requiring a study that would estimate the cost savings from delaying the GBSD, assess how new technologies that might be developed for the GBSD could be incorporated into existing Minuteman missiles to extend their service life, and analyze alternative and potentially better methods for assessing the service life of Minuteman missiles (House Amendment 528 to H.R. 2500 2019). It was defeated in a floor vote.

Defense companies also fortify their influence over Congress by hiring subcontractors across the United States to create jobs and support economic development in numerous states and congressional districts. In 2019, for example, Northrop Grumman announced the “nationwide team” it was putting together to develop and build the new ICBM:

This Northrop Grumman nationwide GBSD industry team includes Aerojet Rocketdyne, BRPH, Clark Construction, Collins Aerospace, General Dynamics, Honeywell, L3Harris, Lockheed Martin, Parsons, and Textron Systems, along with hundreds of other small, medium, and large businesses across the United States (Northrop Grumman 2019a).

A large program such as the GBSD can accommodate many subcontractors. A map on Northrop Grumman's website shows “GBSD workforce locations” in 35 states (Northrop Grumman 2020), a broad distribution of jobs that strengthens congressional support for the program.

Eliminating Launch-on-Warning Options

Many high-ranking US experts, including former defense secretaries and nuclear weapons commanders, argue that the United States should eliminate ICBMs. We agree, and we strongly recommend retiring the ICBM force.⁴

However, this is unlikely to occur soon, because members of the Senate ICBM Coalition greatly value the jobs that the ICBM bases support in their states, the Air Force is loath to give up a major weapons program, defense contractors are eager to build the \$100 billion replacement missile system, and—perhaps most important—political and military officials are generally reluctant to challenge the status quo and the assumed need for a nuclear triad.

Immediate Steps

Fortunately, the United States can take immediate steps to reduce the risks posed by ICBMs short of retiring them. We strongly recommend that the United States take the following actions:

1. Take ICBMs off high alert, which would eliminate the possibility of launching these missiles on false warning and starting a nuclear war by mistake.
2. Eliminate from US war plans the option of launching ICBMs on warning of attack. By doing so, the United States would forgo the option of re-alerting its missiles during a US-Russian crisis. Putting US ICBMs back on high alert could lead to a dangerous dynamic by leading Russia to believe the United States is preparing to attack.
3. Revise the current process for making launch decisions, since there would be no need for such a time-constrained launch process if ICBMs were no longer on high alert to allow launch on warning. Revising the process would allow much more time than the current 30 minutes the Pentagon currently has to determine whether an attack has actually occurred and to deliberate with the president and other officials.

The first two actions would only require a presidential order and could be done very quickly. Physically, US ICBMs can be taken off high alert by using an existing safety switch in the silos that maintenance crews routinely use to prevent a launch while they are working in the silo (UCS 2015a).

By taking these steps, the United States would eliminate the possibility of a mistaken US launch and a likely Russian counterattack. Doing so would increase US security, regardless of what Russia does. A US declaration that it had taken its ICBMs off high alert and eliminated the option of launch on warning could prompt Russia to follow suit. (The Soviet Union apparently did not have a launch-on-warning option, and Russia may not have one today (Podvig 2019).) However, US actions should in no way be tied to Russian reciprocity. The United States should take these steps immediately because they would reduce the risk of nuclear war and increase the safety of Americans and others around the world.

⁴ *Retiring the ICBM force would not require the United States to reduce the overall number of deployed warheads, as it can deploy additional warheads on existing SLBMs, which are capable of carrying more warheads than they currently do.*

Meeting Security Goals with an ICBM Force That Is Off-Alert

ICBM proponents offer several rationales for retaining a large ICBM fleet. Regardless of whether their reasons have merit, their goals can be met by ICBMs that are off-alert.

THE SPONGE

Some proponents argue that the United States should continue to maintain large numbers of ICBMs so that Russia would need to attack these hundreds of targets as part of a first strike intended to disarm US nuclear forces, leaving Russia far fewer warheads to attack other US nuclear targets. ICBMs would serve as a “sponge” to soak up Russian warheads (Kroenig 2018).

However, the ICBMs would equally well serve as a sponge if they were off-alert. If Russian planners were contemplating an attack, they would want to destroy the de-alerted ICBMs to prevent the United States from re-alerting them following the attack and launching them in retaliation. Moreover, even empty silos that are kept “warm” and ready for use, with their ICBMs stored elsewhere, could serve as a sponge since Russia would want to destroy those silos to prevent the United States from reloading ICBMs after the attack.

THE TRIPWIRE

Proponents also argue that retaining large numbers of ICBMs is critical to deterring a Russian attack because Russia would have to launch a massive nuclear attack on US soil to destroy these weapons. They argue that Russia would have to assume that such a large attack would be a tripwire for a devastating counterattack by US SLBMs, and thus would be deterred from attacking in the first place (Senate ICBM Coalition 2016; Kroenig 2018).

Conversely, this argument goes, if the United States eliminated its ICBMs, Russia would only need to attack the three main nuclear bomber bases (in Barksdale, Louisiana; Whiteman, Missouri; and Minot, North Dakota) and two submarine bases (at Kings Bay, Georgia, and Bangor, Washington), hoping to strike US nuclear forces with a small enough attack that the United States would decide not to retaliate. ICBM proponents argue that this scenario would make Russia more likely to attack.

However, even if Russia’s attack on these bases were successful, the United States would retain the ability to retaliate since most of its submarine force would be at sea and bombers could be dispersed upon warning of an attack.

Therefore, the ICBM proponents’ assertion is that the United States would *choose* not to use these weapons, not that it would be unable to.

But even if this argument made a convincing case for retaining the US ICBM force, it would not matter whether the ICBMs were on- or off-alert. If Russia considered launching a nuclear attack on the United States, it would still target ICBM silos to prevent the United States from re-alerting and launching the missiles in response.

ADDRESSING POTENTIAL FUTURE SUBMARINE VULNERABILITY

According to the Pentagon, “when on patrol, SSBNs are, at present, virtually undetectable, and there are no known, near-term credible threats to the survivability of the SSBN force” (OSD 2018).

However, some people argue that future technologies could make it easier to detect submarines at sea, making them more vulnerable than they are today (Miller and Fontaine 2018). They therefore argue that the United States needs to maintain its ICBMs to serve as a hedge against the possibility that submarines could become vulnerable by providing a backup missile force to the SLBMs.

The Pentagon takes submarine vulnerability seriously and conducts research on a variety of anti-submarine warfare technologies for its own use and to provide information about technologies Russia and other militarily advanced nations may acquire. In any case, there is no need to keep ICBMs on alert to address this concern. No change of any significance could occur quickly and there would be adequate time to change US ICBM policy or otherwise respond should any concerns arise.

Moreover, the nuclear bomber force already provides an alternative means of delivery. Bombers can be airborne quickly in a crisis and recalled if not needed. Currently, the United States fields more than 60 nuclear-capable bombers and about 300 nuclear bombs and air-launched cruise missiles, with another 550 bombs and cruise missiles in storage (Kristensen and Korda 2020).

ADDRESSING A POTENTIAL TECHNICAL PROBLEM WITH AN SLBM WARHEAD

The United States deploys two types of warheads on ICBMs and two other types on SLBMs. One purpose for this approach is to provide backup for a faulty warhead type. If technical problems arose with one type, the United States could deploy more of the other to keep the same number of fielded warheads while it fixed the problem with the faulty one. However, this

approach requires that the United States have enough weapons in storage to replace the faulty type, which is not true for one of those carried by SLBMs.

Each of the two SLBMs warheads—the W88 and W76-1—accounts for roughly half of the total fielded SLBM warheads.

However, virtually all of the existing W88 warheads are fielded; none are in storage.⁵ Therefore, if the other SLBM warhead developed a technical problem, there would be no W88 warheads to replace them, and the number of fielded SLBM warheads would be reduced by half, at least for some time. ICBM proponents argue the United States could compensate by increasing the number of fielded ICBM warheads by “uploading” warheads in storage onto those ICBMs that can carry more than one warhead. However, retaining ICBMs to allow this option does not require keeping ICBMs on alert.

In any event, there are apparently no specific concerns about the W76-1 warheads, which have recently completed an extensive life-extension program that entailed refurbishing and upgrading all of their components (Fleck 2004). Moreover, the Department of Energy is in the early stages of developing a third SLBM warhead type—the W93—slated to be fielded by 2040 (Mehta 2020), which could provide the desired redundancy for SLBM warheads.

Upgrading and Extending the Lifetime of Minuteman ICBMs

If the United States decides to retain an ICBM force—on- or off-alert—it should extend the lifetime of the current Minuteman III missiles rather than build the planned new GBSD missiles.

As discussed, the GBSD program would develop and produce 642 missiles at an estimated cost of \$100 billion (Woolf 2020). The Air Force would field 400 of these missiles in existing silos, and the remaining missiles would be available for flight testing to assess the reliability of the fleet. The new GBSD missiles are reported to have an expected service life of 60 years (Woolf 2020).

The first Minuteman III ICBM was fielded in 1970, but since the early 1990s, the Air Force has undertaken numerous programs to both maintain and improve the performance of these missiles. These refurbishments and upgrades have been extensive; the Air Force has built or replaced almost every component, including the rocket motors. In 2012, an Air Force analyst described the Minuteman as “basically new missiles except for the shell,” noting that “over the last decade we’ve

done more than \$7 billion worth of upgrades to 450 missiles” (Pampe 2012).

Similarly, in April 2017 the Air Force wrote:

Through continuous upgrades, including new production versions, improved targeting systems, and enhanced accuracy, today’s Minuteman system remains state of the art and is capable of meeting all modern challenges (AFGSC 2017).

In 2009, the Air Force decided to extend the service life of the missiles to 2020 (Pampe 2012). It now plans to extend the lifetime to into the 2030s, when the Minuteman III missiles would be replaced by the new ICBMs, beginning in 2029 and completed by 2036 (GAO 2020).

Is further extending the lifetime of the Minuteman missiles a viable alternative to building the GBSD missiles?

The Navy recently decided to conduct a second life extension for the Trident II SLBMs so they can serve through the entire lifetime of the new Columbia submarines, which are expected to age out beginning in 2084 (Eckstein 2019). The Trident II missiles were fielded beginning in 1990; this effort will extend their operational lifetimes to 95 years.

Similarly, several studies and assessments of ICBM options demonstrate that significantly extending the lifetime of the current Minuteman missiles is a viable option.

The military services are required to conduct an “Analysis of Alternatives” for any major new weapon system. In preparation for its GBSD assessment, the Air Force commissioned a 2014 RAND study on possible ICBM alternatives through 2075. The study noted that “the Air Force successfully demonstrated its ability to extend the service life of the Minuteman III at low cost and low program risk through service life extension programs (SLEPs)” and that “sustaining Minuteman III through SLEPs and gradual upgrades is a relatively inexpensive way to retain current ICBM capabilities.” Its analysis concluded:

Any new ICBM alternative will very likely cost almost two times—and perhaps even three times—more than incremental modernization of the current Minuteman III system. The only viable argument for developing and fielding an alternative would therefore have to be requirements driven. Options would be relevant only insofar as warfighting and deterrence demands push ICBM requirements beyond what an incrementally modernized Minuteman III can offer (Caston et al. 2014).

⁵ *The United States planned to build far more W88 warheads, but a key production facility was shut down in 1989 by the Federal Bureau of Investigation for environmental and health concerns, bringing the program to a halt (Grenoble 2017).*

The 2014 Air Force Analysis of Alternatives for the GBSD system included two options in which the Minuteman III missiles would begin retirement in 2075. These missiles were first fielded in 1970, so these options would extend their operational lifespan to greater than 100 years (Woolf 2020). While the Air Force did not choose either of these options, its own analysis makes clear that the current missiles can be maintained for decades to come.

More recently, the Congressional Budget Office analyzed the option of extending the lifetime of the Minuteman ICBMs to 2045, to allow the deployment of the new ICBM to be delayed for about 20 years until the mid- to late 2040s (CBO 2017). Under this option, the Air Force would replace the rocket engines and guidance systems in the missiles as well as continue with the planned refurbishment of silos and the command-and-control infrastructure. The analysis found such a delay would significantly cut costs over the next two decades. The Air Force currently assumes it will take 10 years to develop and produce the first fielded GBSD missiles; so, under this option the GBSD program would start in 2035. This option would save \$37 billion (in 2017 dollars) through 2036, when the demand for funding to rebuild the nuclear arsenal is projected to be the highest (CBO 2017, 31).

A 2017 report by the Center for Strategic and International Studies found that the current ICBM inventory could be maintained through the 2060s, stating that “the missiles could go through another propellant replacement program, as they did in the 2000s, to re-core the missiles and extend their lives for another 30 years” (Harrison and Linck 2017).

Since the Air Force plans to use the existing Minuteman silos and launch facilities for the GBSD, it will have to extend the life of the silos, launch facilities, and related equipment and infrastructure regardless of whether it extends the Minuteman lifetime or builds a new missile. A March 2020 report by the US Government Accountability Office discusses several problems the Minuteman program needs to resolve, including the security clearance backlog and subsequent shortage of missileers and maintenance workers.

In addition, the Air Force is in the process of refurbishing all launch facilities over the next eight-year period and reportedly plans to replace the command-and-control systems in the missile facilities by 2037 (Woolf 2020). The Air Force will be faced with the same tasks independent of which missile is put in the silos (GAO 2020).

THE NEED FOR MORE ACCURATE LIFETIME ASSESSMENTS

An important factor limiting the service lifetime of a missile is the aging of the rocket motors. As the solid propellant ages, it can develop cracks that could lead to uneven burning of the

propellant and missile launch failures. Accurately estimating the operational lifetimes of the rocket motors is therefore essential.

However, the Air Force’s lifetime estimates appear to be overly conservative. For example, performance data on the Minuteman II Stage 3 rocket motors indicate that the actual operational lifetime of these motors is considerably longer than the Air Force estimate of 13.5 years (GAO 1990).

As Minuteman II missiles were retired and replaced with Minuteman III missiles, the Air Force gave their rocket motors to its Rocket Systems Launch Program to use in launching satellites and sub-orbital payloads, as well as conducting static tests in which the motor is strapped down and ignited. The 25- to 40-year-old motors performed successfully in 60 of 64 launches and all 34 static tests. A record of 94 successes in 98 firings is an impressive 96 percent success rate. These data suggest that the Air Force estimate for the lifetime of the Stage 3 motor was low by a factor of two to three (Fetter and Reif 2019).

In the same way, its methodology has likely led the Air Force to underestimate Minuteman III motor lifetimes. If, as was the case for the Minuteman II rocket motors, the actual operational lifetime of the Minuteman III motors is significantly longer than the estimated lifetime, the Minuteman III force could be retained with need for less refurbishment.

Because underestimating motor lifetimes has significant consequences, it is important that the Air Force develop tools that would allow a more accurate lifetime assessment. As noted in Chapter 5, the House draft FY20 National Defense Authorization Act mandated a study that would include “an analysis of alternative and potentially better methods for assessing the service life of the Minuteman III missiles” (House Amendment 528 to H.R. 2500 2019). Unfortunately, the requirement was removed by the House Armed Services Committee, in part due to intense lobbying by Northrop Grumman—which presumably did not want an assessment that might cast doubt on the need for the GBSD it would be building.

THE NEED FOR FLIGHT TESTING

Proponents of a new ICBM note that a diminishing number of Minuteman III missiles are available for routine flight testing to provide statistical information on the reliability of the missiles. Since missiles are destroyed during flight testing, the number of missiles the Air Force has drops with each test. To conduct these tests, the Air Force removes a missile from its silo, replaces its warhead with a dummy one, brings it to Vandenberg Air Force Base on the coast of California, and launches it over the Pacific Ocean. The Air Force takes a missile from storage and loads it into the silo.

From 2000 to 2019, the Air Force conducted an average of 3.1 operational tests of Minuteman III missiles annually (McDowell 2020). Nearly a decade ago the Air Force reportedly considered increasing the rate to four tests per year, but as recently as 2019 it has conducted only three (Caston et al. 2014; McDowell 2020).

Reports from 2014 and 2017 gave the number of missiles available for flight testing as about 100, assuming a deployed force of 400 (Caston et al. 2014; Harrison and Linck 2017). Taking into account the number of flight tests since those reports were published, the Air Force has roughly 80 to 90 missiles for testing as of the beginning of 2020. At a rate of four tests per year, these would last until 2040 to 2042. If the Air Force continues testing at an average rate of three tests per year, as it has for the past 20 years, these missiles would allow testing through 2047 to 2050.

Because there have already been hundreds of flight tests of the Minuteman III that have provided a great deal of data, the Air Force may need fewer annual tests to assess reliability—unless there were several failures that suggested a problem had emerged. A missile modification might also warrant a short-term increase in testing.

Indeed, in 1990, the Strategic Air Command decided to reduce the number of annual Minuteman III flight tests from seven to four, noting that the proven reliability of the system and the large database of performance data would allow it to maintain confidence in the missile performance with fewer flight tests (GAO 1990).

Similarly, the 2014 RAND report noted that continued advancements in monitoring missile motors as well as modeling and simulation of aging effects “will likely reduce the

number of required destructive tests necessary to achieve the same level of confidence” (Caston et al. 2014).

The Air Force should study ways to incorporate sensors and nondestructive testing methods and technologies into the monitoring process, develop physics- and chemistry-based models and nondestructive measurements to assess the properties of individual motors, and validate these new methods and the current one of assessing aging against actual test and launch data from Minuteman motors used in the Rocket Systems Launch Program (Fetter and Reif 2019). This information is key to understanding the tradeoffs between the options of maintaining the Minuteman missiles and building a fleet of new missiles.

Second, reducing the number of fielded missiles would provide more for testing. Once the stockpile of stored missiles was used up, the Air Force would not replace missiles that were removed for flight testing. If the Air Force conducted four tests per year starting now, this process would reduce the number of fielded ICBMs by four per year starting in the early 2040s—to 360 by the early 2050s and 320 by the early 2060s.

If instead the Air Force continued to conduct three tests per year, the number of fielded ICBMs would decrease by three a year starting in the late 2040s—to 370 by the late 2050s and 340 by the late 2060s.

These reductions are modest. Moreover, they would not begin until three decades from now, and it is reasonable to expect that these reductions could be made in the context of a future US-Russian arms agreement. If the United States wanted to maintain the current overall level of deployed warheads, it could slowly increase the number of warheads on SLBMs.

Studies and assessments demonstrate that significantly extending the lifetime of the current Minuteman missiles is a viable option.

Findings and Recommendations

The United States developed its core nuclear weapons policies early in the Cold War, which were shaped by the weapons technologies at the time. This was particularly true for ICBMs and SLBMs. Since then, these technologies have changed significantly, but the United States continues to field large numbers of ICBMs and keep them on high alert. This long-standing policy increases the risk of a mistaken nuclear war and should be changed.

ICBMs Are Outdated

When the United States first developed ballistic missiles, ICBMs were more accurate and carried more powerful warheads than did SLBMs, allowing them to destroy Soviet land-based missiles which the SLBMs could not. The Pentagon was also not confident in its ability to securely communicate with submarines at sea. For these reasons, the United States believed ICBMs were essential. As these weapons became increasingly vulnerable to a Soviet missile attack, the United States responded by placing them on high alert so they could be launched on warning of an incoming Soviet attack—creating the very real risk that the United States could mistakenly start a nuclear war in response to a false alarm. However, for decades now, SLBMs have been at least as accurate as ICBMs and armed with powerful warheads, and the Navy has had a highly reliable and secure communication system for the submarines. Moreover, SLBMs are essentially invulnerable to attack when the submarines are hidden at sea.

Political Barriers to Change

ICBM proponents have offered new reasons for continuing to field these weapons. Many security experts, however, conclude there is no military reason to continue to deploy ICBMs and that the United States should retire the ICBM force.

Despite that, the United States appears unlikely to retire the ICBM force anytime soon. Political barriers—having nothing to do with security—stand in the way. In particular, senators in the ICBM Coalition greatly value the jobs and economic benefits the Air Force bases bring to their states, the Air Force is loath to give up a major weapons program, defense contractors are eager to build the \$100 billion new ICBM system, and—perhaps most important—political and military officials are generally reluctant to challenge the status quo and question the value of a nuclear triad (ICBMs, SLBMs, and nuclear bombers).

De-Alerting ICBMs

Until it retires the ICBM force, the United States should immediately remove its ICBMs from high alert and eliminate from military plans the option of launching on warning of attack. It should also develop a new warning-assessment and launch-decision process that is not constrained by the 30-minute flight time of a ballistic missile from Russia to the United States, as it is today. By taking these steps, the United States would significantly reduce the risk of nuclear war. As noted above, ICBM proponents offer several rationales for retaining the ICBM fleet. However, their objectives can equally well be met with missiles that are off-alert.

Extending the Lifetime of Current ICBMs

If the United States continues to field an ICBM force, there is no technical reason for it to build new missiles. Continuing to maintain and upgrade the existing Minuteman III ICBMs would be far less expensive than proceeding with the GBSD program. The Air Force already uses a straightforward process to refurbish and upgrade its ICBMs, and today the Minuteman missiles are “basically new missiles except for the shell,” according to an Air Force analyst. Official studies show that the Air Force can continue to extend the operational life of the Minuteman missiles for many decades.

ACCURATELY ESTIMATING ROCKET MOTOR LIFETIME

An important factor limiting the service lifetime of a missile is the aging of the rocket motors. However, the Air Force’s process for estimating the operational lifetimes of ICBM motors appears to be overly conservative. Because the Air Force provided the rocket motors from the retired Minuteman II missiles to be used for other purposes, there are data on the actual performance of these motors—which show the Air Force lifetime estimates were significantly low.

Therefore, it is important that the Air Force incorporate better methods for monitoring and assessing the aging process of missiles—such as using sensors and integrating nondestructive testing methods and technologies into the monitoring process. If the actual operational lifetime of the current Minuteman III motors is also significantly longer than the estimated lifetime, the current ICBM force could be retained with less need for refurbishment.

ENSURING SUFFICIENT MISSILES FOR TESTING

Data from the past 20 years show that the Air Force has flight tested an average of three missiles per year during this time to provide statistical information on the reliability of the missiles. The estimated current stockpile of Minuteman III missiles would allow the Air Force to continue flight testing at the current rate for about 30 years—until around 2050.

However, because hundreds of past flight tests of the Minuteman III have provided a great deal of data, the Air Force may be able to assess reliability using fewer annual tests going forward. Moreover, a RAND study for the Air Force found that continued advancements in monitoring the aging effects of missile motors and improved modeling and simulation of the aging effects will likely reduce the number of flight tests needed to achieve the same level of confidence in the performance of the missiles.

A modest reduction in the number of fielded missiles in the distant future would provide more for testing, if needed. If the Air Force continues to conduct three flight tests per year, it would need to reduce the number of fielded ICBMs by three per year starting around 2050—to 370 by 2060 and 340 by 2070. It is reasonable to expect that these reductions could be made in the context of a future US-Russian arms agreement. Moreover, if the United States wanted to maintain the current overall level of deployed warheads during this process, it could slowly increase the number of warheads on SLBMs.

Recommendations

Based on these findings, we recommend the following actions.

1. The United States should retire the US ICBM force.
2. Until that time, it should immediately:
 - Remove ICBMs from high alert, to eliminate the possibility of launching these missiles on false warning and starting a nuclear war by mistake.
 - Eliminate launch-on-warning options from US war plans, which would preclude the option of re-alerting the ICBMs.
 - Revise the current process for making launch decisions, which is currently constrained by the short time available to launch ICBMs before incoming missiles could land.
3. Moreover, the United States should continue to extend the operational life of the Minuteman III missiles and should not build the new GBSD missile.
4. As part of this effort it should commission an independent study to:
 - Develop better ways to assess the aging effects of Minuteman III missiles, including incorporating sensors and nondestructive testing methods and technologies to allow evaluations of individual motors.
 - Validate these new methods of assessing aging, as well as the current one, against actual test and launch data from Minuteman II motors used in the Rocket Systems Launch Program.
 - Determine the number of flight tests required to assess the reliability of US ICBMs, taking into account advanced monitoring and nondestructive tests as well as data collected from past tests.

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Non-Security Factors in Developing the ICBM Force

Politics Trumps Strategy: Origins of the ICBM and the Nuclear Triad

The origins of the nuclear triad have as much to do with rivalry between branches of the military and the fight for funding as they do with the development of a coherent nuclear strategy. There is no question that the Soviet nuclear threat was real, and developments like the Soviet Union's 1953 hydrogen bomb test and its 1957 launch of the Sputnik satellite, utilizing a launch vehicle that had capabilities similar to those needed for a long-range intercontinental ballistic missile, helped spur intensive activity by the US military to develop new nuclear warheads and delivery vehicles. But the systems developed to meet that threat were shaped by a fight among the Air Force, Navy, and Army over who would control the nuclear mission and the lion's share of Pentagon funding that would come with it.

The Air Force secured the early lead in the race for funding when it gained control of the development and deployment of both long-range bombers and intercontinental-range ballistic missiles (ICBMs), two of the three legs of what later came to be known as the nuclear triad. In recent decades the Air Force, Army, and Navy have garnered roughly equal shares of the overall Pentagon budget—about one-third each. But in the 1950s, in part because of its dominance of the nuclear mission, the Air Force received 45 percent of Pentagon funding (Friedman, Preble, and Fay 2013). It would not be until the development and large-scale deployment of the Navy's submarine-based Polaris ballistic missile in the early 1960s—accompanied by a shift in strategy by the Kennedy administration that put more emphasis on counterinsurgency and conventional forces—that the balance of the Pentagon budget shifted to the point where the services had roughly equal shares.

The substantial funds devoted to nuclear weapons in the 1950s were in line with the Eisenhower administration's doctrine of "massive retaliation." Under this doctrine, Soviet activities that threatened the United States or its allies—from a nuclear attack to a conventional invasion of Western Europe—would be met with a large nuclear response that

would destroy the Soviet Union as a functioning society. Eisenhower felt that this approach was the most effective way to deter potential Soviet aggression, believing that Moscow would never risk the consequences of a massive retaliatory strike by the United States. But the doctrine had a budgetary rationale as well: Eisenhower saw relying on nuclear weapons as the first line of defense as a way to hold the line on military spending rather than developing the more costly option of building large-scale conventional forces that could repel a Soviet attack on Western Europe (Dulles 1954).

Competing ideas over nuclear strategy emerged over the course of the 1950s, but the real war was not one of ideas but rather a struggle over bureaucratic turf. Its first post-World War II manifestation was the so-called Revolt of the Admirals, which occurred in 1949 in response to sharp cuts in the Navy budget. As Fred Kaplan describes it in his history of US nuclear strategy, "the entire top echelon of naval officers broke all tradition of subordination and testified against the official emphasis being placed on the atomic bomb, the Strategic Air Command, [and] on the Air Force's B-36 bombers" at the expense of traditional Army and Navy weapons systems, especially aircraft carriers (Kaplan 1983, 232). Part of the issue was Secretary of Defense Louis Johnson's decision to cancel a massive, 65,000-ton Navy supercarrier that would have been capable of carrying strategic bombers. Getting a fleet of these carriers would have advanced the cause laid out in a secret December 1947 memo by Navy Vice Admiral David V. Gallery in which he stated that the Navy was "the branch of the National Defense destined to deliver the Atom Bomb" (Meilinger 1989, 84).

In his history of this incident, Philip S. Meilinger summarized what was in stake in the revolts as follows:

At the controversy's most basic level, the two services disagreed over the division of the defense budget. The Navy wanted the largest share of the defense dollar in order to build more aircraft carriers—specifically supercarriers capable of launching large multi-engine aircraft. The Air Force, in turn, argued that it should receive the largest slice of the defense pie in order to expand to 70 combat groups (Meilinger 1989, 81).

The Navy lost the fight, and several officers lost their jobs in the process. But the fight over policy and dollars continued (Kaplan 1983). Meilinger argued that for the Navy, it was not just a question of competition for funding: “the Revolt of the Admirals, as the confrontation has often been called, was far more than a mere budgetary squabble. Naval leaders saw their very future at stake” (Meilinger 1989, 81).

As part of their fight for funding and to ensure a prominent nuclear role, the Air Force and the Navy supported contrasting nuclear doctrines, each of which provided a rationale for more of that service’s preferred nuclear delivery vehicles. President Eisenhower’s favored approach—massive retaliation—called for an arsenal of nuclear forces adequate to destroy Soviet society, but it was silent on what mix of weapons systems might be needed to achieve that goal. In contrast the “counterforce” doctrine that was being developed called for weapons that could destroy Soviet nuclear capabilities, including Soviet ICBMs in their silos. ICBMs at this point were more accurate and carried more powerful warheads than submarine-launched ballistic missiles (SLBMs), so the counterforce doctrine required ICBMs and the development and deployment of even more accurate and more destructive missiles.

The theory behind counterforce targeting was that rather than risk all-out nuclear war over a provocative action like a Soviet invasion of Western Europe, the United States should have the capability to destroy the bulk of Soviet nuclear forces before they were launched, with enough US weapons held in reserve to kill the bulk of the Soviet Union’s civilian population if Moscow refused to back down from its intervention in Western Europe. The counterforce concept was developed at the RAND Corporation, an Air Force–funded research and development think tank. As Fred Kaplan notes, “the Air Force was locked in a ferocious battle with the Navy, and counterforce seemed just the weapon to help them win the war” (Kaplan 1983, 232).

For its part, the Navy came to prefer a doctrine known as finite deterrence, a development led in part by Admiral Arleigh Burke, which called for building an arsenal of nuclear weapons sufficient to destroy a “‘finite’ group of Soviet urban-industrial targets,” which it saw as sufficient to deter Soviet attacks without a focus on specifically targeting Soviet nuclear forces (Burr 2009). The Navy argued that SLBMs, which were relatively invulnerable to attack, put leaders under less pressure to launch quickly in a crisis, and since they lacked a first-strike, counterforce capability, they would be less threatening to an adversary and therefore less likely to provoke an attack. But, since they were still more than capable of destroying cities and industrial centers of the Soviet Union, they should be the preferred system for implementing a finite

deterrence strategy. The idea of targeting cities had previously been anathema to the Navy, but this service’s views evolved based on what would allow it to contribute to play a major role in nuclear planning (Kaplan 1983, 235). A study commissioned by the Navy suggested that relying on the Air Force’s ICBMs put the United States “in the new uncomfortable position of relying largely on the size of our striking forces to offset their vulnerability,” which the study described as “a prescription for an arms race, and also an invitation to the enemy for preventive-war adventurism” (Kaplan 1983, 234).

The debates between the Air Force and the Navy over nuclear doctrine—and funding—were fierce. In the late 1950s, when the Air Force had the inside track on taking charge of nuclear targeting—which would determine what kind of nuclear forces, with what level of accuracy and destructive power, would be needed—Admiral Arleigh Burke denounced what he viewed as improper backroom maneuvering, saying of the Air Force leadership that “they’re smart and they’re ruthless. . . . It’s the same way as the Communists” (Kaplan 1983, 235; Burr 2009). If the Air Force controlled targeting, Burke complained, “then our [Navy] budget is going to be in a very sad way indeed. We’ll be buying B-70s” (B-70s were a follow-on to the Air Force’s B-52, which were later canceled by the Kennedy administration) (Kaplan 1983, 266).

Earlier in the 1950s the two services had given actual lobbying and advocacy instructions to current and retired officers to promote their respective doctrines. In the late 1950s, Arleigh Burke gave a series of speeches on the value of submarine-based nuclear forces, a “mobile deterrent” that could destroy enemy cities without the downside of vulnerability to attack represented by the Air Force’s ICBM force. Burke sent a letter with a summary of the naval study that supported his arguments on behalf of SLBMs to all retired naval officers and encouraged them to speak out publicly on the issue as often as possible.

In response to the Navy’s efforts, the director of Air Force Plans and Policy sent a note to his counterpart at the Strategic Air Command suggesting that “there is an all-out battle going on right now” (Kaplan 1983, 236). To counter the Navy’s argument, the Air Force leadership coalesced behind the counterforce doctrine, which had been elaborated upon by RAND analyst William Kaufman. Kaufman’s analysis attacked the Polaris SLBM directly, arguing that it could not replace ICBMs because it lacked the accuracy and explosive power “to pursue meaningful counterforce and damage limiting strategies.” Subsequently, an Air Force general pushed to get funding for RAND to do a more detailed study of the benefits of counterforce over city destruction. The Secretary of the Air Force, General Tommy White, eventually embraced

Kaufman's approach, and as a result he sent a letter to all Air Force commanders instructing them that all of their public speeches and briefings should "strongly stress the importance of our maintaining a proper strategy" and "thoroughly explain counterforce" (Kaplan 1983, 245).

The Missile Gap: Politics Driving Nuclear Weapons Spending

A discussion of the development of the Air Force's ICBMs would be remiss if it excluded a discussion of the "missile gap" controversy, in which Air Force intelligence estimates and the presidentially commissioned 1957 Gaither Commission asserted that the United States was falling behind the Soviet Union in deploying land-based strategic missiles. The Gaither report, which was released the day after the Soviet launch of its Sputnik II satellite, sparked fears that the United States was falling behind in the technological arms race and recommended an investment to "strengthen our deterrent and offensive capabilities" at an estimated cost of \$19 billion over the years from 1959 to 1963 (Gaither Committee 1957, 23).

The military services in general and the Air Force in particular welcomed the Gaither panel's push for more military spending, but its recommendation clashed sharply with Eisenhower's desire to balance short-term military investment with the longer-term interest in avoiding large government deficits in order to maintain a sound, sustainable economy. Eisenhower's Treasury Secretary, Robert Anderson, summarized the president's view in an internal December 1958 meeting on the military budget convened a full year after the Gaither report's release:

We have to get into the question of whether the country can invariably afford every right gun and every right target at every right time. . . . When our military people look at all these weapons they must see what other things we are trying to defend and where money is being spent in this country. We must try to protect the American competitive system (Roman 1995, 126).

Secretary of State John Foster Dulles's views reinforced Anderson's concerns. By his own account, he told Anderson that "the United States should not attempt to be the greatest military power in the world. . . . In the field of military capabilities enough is enough. If we didn't realize this fact, the time would come when all our national production would be centered on our military establishment. Eisenhower agreed, noting that "too much [defense spending] could reduce the United States to being a garrison state or ruin the free economy of the nation" (Roman 1995, 122).

On the issue of ballistic missiles in particular, the Gaither Committee recommended upping the number of deployed Atlas ICBMs from 80 to 600 within two years and quadrupling the number of Thor and Jupiter intermediate-range ballistic missiles deployed in Europe to a total of 240 (Gaither Committee 1957, 6-7).

Upon John F. Kennedy's taking office and accessing classified intelligence from Corona satellites and Soviet defectors, the Kennedy administration determined that there was no missile gap and that the United States may in fact have been ahead of the Soviet Union in land-based missile development. But this revelation was too little too late. During Kennedy's campaign for office, Democratic Senators Lyndon Johnson of Texas and Stuart Symington of Missouri had joined Kennedy in pillorying the Eisenhower administration for "irresponsibly" allowing the Soviet Union to surge ahead in missile development. Kennedy hammered on the "missile gap" in the 1960 presidential campaign as part of a larger argument about the Eisenhower/Nixon administration's alleged complacency in the face of the Soviet threat. The impacts of this argument went well beyond the question of missile development itself to provide a rationale for the sharp increases in overall military spending that were implemented when the Kennedy administration took office.

In his book on the subject, Christopher Preble points out that Kennedy's emphasis on the missile gap had a strong political component. Kennedy and his advisors saw stepped-up spending on ballistic missiles and the Pentagon as a way to win the votes of defense workers as well as to boost the larger economy via what later become known as "military Keynesianism," after British economist John Maynard Keynes's theory that increasing government spending when there was a lull in the economy was the best way to restore economic vitality and full employment. This economic theory contrasted sharply with Eisenhower's belief that the most important thing one could do to ensure steady economic growth was to keep federal deficits under control. As Preble noted, Kennedy's belief that increased defense spending could boost his political support was quite explicit:

Kennedy believed that military spending could be used to boost regional economic development. He explicitly appealed for support from defense workers who had been adversely affected by the economics of the New Look [Eisenhower's approach of relying on nuclear forces as a way to curb total military spending]. . . . When Kennedy promised to boost spending on the very weapons systems needed to close the missile gap, the men and women responsible for building those weapons understood precisely what such a policy meant for them (Preble 2004, 8).

Even as Kennedy and other Democratic candidates sought to milk the missile gap controversy for political gain, Eisenhower and his defense officials tried to counter the missile gap argument by pointing out that the United States had multiple means of delivering nuclear warheads—not just via ICBMs but with bombers and sea-based Polaris missiles as well. In short, they suggested, it was not necessary to match the Soviet Union ICBM-for-ICBM in order to deter the Soviet Union from attacking the United States. In hearings in January 1959, General Nathan Twining, the head of the Joint Chiefs of Staff, stated that “our nuclear retaliatory forces continue to provide the United States with a margin of advantage.” In response to a specific question from Kennedy, Twining elaborated: “my point [is] let’s not pick one weapons system and call it a gap.” He cited intermediate-range nuclear missiles in Europe, which he called “better than ICBMs,” as well as bombers near the Soviet border and sea-based systems. “We are surrounding them. The only thing they can hit us with is the ICBM in the missile field, and we can hit them with all kinds of missiles” (Roman 1995, 130). While this argument was helpful in Eisenhower’s internal fight to limit the number and funding of missile programs, it failed to placate Kennedy and his congressional allies.

Equally importantly, it failed miserably with the media and the broader public, allowing the Democrats to take the initiative in essentially branding a Republican ex-general who had helped the United States win World War II as soft on defense. A case in point was congressional testimony by Eisenhower Secretary of Defense Neil McElroy in which he asserted that there was no need to match the Soviet Union “missile for missile” given other US nuclear capabilities. The *New York Times* story on his statement began by stating, “The secretary of defense testified today that the United States was voluntarily withdrawing from competition with the Soviet Union in the production of intercontinental ballistic missiles” (Roman 1995, 131). This was hardly the reassuring message McElroy and the president intended.

Ultimately, Eisenhower saw the missile gap for the fiction it was or, as he put it, a “useful piece of political demagoguery” for his opponents. “Munitions makers,” he insisted, “are making tremendous efforts towards getting more contracts and in fact seem to be exerting undue influence over the Senators” (Roman 1995, 132). The term “undue influence” in the context of the ICBM debate foreshadowed a similar reference in Eisenhower’s famous January 1961 farewell address in which he warned of the dangers of “the acquisition of unwarranted influence . . . by the military-industrial complex” (Eisenhower 1961).

Eisenhower fumed over the levels of missile spending and deployment put forth by the military services, asking,

“how many times do we have to calculate to destroy the Soviet Union?” In another context he asserted that “we are putting too much damn money on Atlas [missiles],” and questioned the need to double the number of Polaris submarines from 6 to 12: “you [can] not win if you [persist] in putting your money on all the colors of the wheel” (Roman 1995, 124–126).

Eisenhower “professed hatred” for interservice rivalry and its impacts on the development of the nuclear force (Friedman, Preble, and Fay 2013). But as author Peter Roman has noted, the triad concept still flowered under his tenure, with substantial funding for bombers and sea- and land-based missiles. Bombers were de-emphasized, but funding for them continued. The Eisenhower administration programmed funding for 810 ICBMs and 384 SLBMs—less than the military services asked for, but not much different from what the Kennedy administration ultimately approved (Roman 1995, 196).

The missile gap controversy and the surrounding political firestorm clearly pressured Eisenhower to increase military spending, even if his expanded missile spending was not enough to win the larger public debate about whether his administration was leaving the nation vulnerable to a Soviet missile attack (Roman 1995, 207–208). And it helped entrench the concept of the nuclear triad, with land-based ballistic missiles firmly established as an essential component.

Consolidating the Triad Concept

The additional funding provided by the Kennedy buildup—which entailed a 15 percent increase in military spending in his first year in office—along with Secretary of Defense Robert McNamara’s commitment to continuing to fund air-, land-, and sea-based nuclear delivery vehicles, helped further ingrain the concept of the nuclear triad (Preble 2004).

To his credit, McNamara limited ICBM procurement to 1,000, one-third of the 3,000 lobbied for by the Air Force and one-tenth of the astonishing goal of 10,000 ICBMs set by the Air Force’s Strategic Air Command. McNamara’s analysts determined that only 600 ICBMs were necessary for deterrence, but the defense secretary feared that Congress would not accept that low of a number (Kaplan 1983). While reducing the expectations of massive growth in ICBM production, McNamara also cut back on the bomber force, phasing out the B-47 bomber and canceling the B-70, the follow-on to the B-52 (Kaplan 1983). Meanwhile, he moved to sharply increase the stocks of Polaris missiles from 304 to 656, more than doubling the number of Polaris submarines in the process (Friedman, Preble, and Fay 2013).

In short, while McNamara did restructure the nuclear strike force, the Kennedy and Johnson administrations still supplied a steady stream of funding for each leg of the nuclear

triad, to the point where the Air Force and the Navy were relatively satisfied that they would each get a healthy share of the nuclear weapons budget.

The rebalancing of the nuclear force, combined with the Kennedy administration's renewed focus on conventional forces in general and the Army and Marines in particular, led to a situation in which the Air Force's 45 percent share of the Pentagon budget fell to about one-third, roughly equal to the shares controlled by the Army and Navy (Friedman, Preble, and Fay 2013). It is not clear precisely how much of the shift was due to increased funding for the Navy's Polaris missiles versus the bulking up of the Army for counterinsurgency or other factors. But the shift in the composition of the nuclear force played a significant role in this shift.

The rough balance among the branches of the military has endured ever since. The fight among the services for larger shares of the nuclear budget largely subsided as they joined hands to emphasize the broader Soviet threat and press for a larger Pentagon top line. To the extent that there are fights over budget share currently, they tend to focus more on issues such as the distribution of non-nuclear aviation assets and the number of personnel in each service.

More recently, in the context of the Pentagon's proposed trillion-dollar plan to rebuild US nuclear forces over 30 years, there will likely be fights for budget share *within* each service, as costly ballistic missile submarines compete with conventional combat ships in the Navy and new strategic bombers and ICBMs compete with costly conventional aircraft such as the F-35 combat aircraft, the KC-46 refueling aircraft, and a new generation of unmanned aerial vehicles (Harrison 2016).

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Non-Security Factors in Retaining the ICBM Force

Defending Land-Based Missiles: The ICBM Coalition

Despite the number of former Pentagon officials who have come out against retaining the intercontinental-range ballistic missile (ICBM) force, the only major initiative inside the Pentagon to eliminate the ICBM force took place during the Clinton administration. This effort followed the George H. W. Bush administration's moves to significantly cut and restructure US nuclear forces in response to the end of the Cold War. Clinton's defense secretary, Les Aspin, instructed the assistant secretary of defense for international security policy, Ashton Carter, to conduct the first official Nuclear Posture Review. In a sharp departure from Cold War practice, the review recommended several potential nuclear force structures that would have eliminated the ICBM leg of the triad, with one involving a "monad" of 10 Trident submarines carrying a total of 1,440 nuclear warheads.

Not surprisingly, these proposals generated a fierce counterattack by the Air Force and key members of Congress, including Democratic Senator Conrad Burns of Montana, the home of one of the nation's three ICBM bases. The Clinton administration was not inclined to invest political capital in fighting the pro-ICBM forces, and Carter's recommendations were shelved (Freidman, Preble, and Fay 2013).

Indeed, members of Congress from the states where ICBMs are deployed and maintained have played an outsized role in ensuring these missiles' continued existence. The composition of the Senate ICBM Coalition has shifted over the last decade as members leave Congress and are replaced, but it has always been a bipartisan group of senators from the states hosting the nation's three ICBM bases—Montana, North Dakota, and Wyoming—and Utah, where the Air Force and its contractors are responsible for maintenance of existing ICBMs and "overseeing the Ground-Based Strategic Deterrent, the ICBM of the future" (Hill AFB 2017). The coalition has been largely successful in fending off any changes in the number of ICBMs and bases, and has quashed initiatives that might make it easier to reduce the ICBM force in the future.

In the Senate, ICBM coalition members include co-chairs John Hoeven (R-ND) and Jon Tester (D-MT), John Barasso (R-WY), Kevin Cramer (R-ND), Steve Daines (R-MT), Mike Enzi (R-WY), Mike Lee (R-UT), and Mitt Romney (R-UT).

The coalition's arguments for sustaining a robust ICBM force are summarized in its 2016 report, *The Enduring Value of ICBMs*, and include the following:

- providing a "large and persistent" deterrent force
- providing widely dispersed silos that present "an essentially impossible targeting problem to potential adversaries"
- providing a "timely response option" for the president
- providing a force that can only be destroyed by a large-scale nuclear attack, which makes potential adversaries less likely to attack since they would thereby provoke a devastating US response (Senate ICBM Coalition 2016)

The report also argues that without ICBMs, an adversary could focus its entire nuclear force on destroying US bombers and submarines, making the entire US nuclear arsenal more vulnerable to a disarming first strike, and that having a third way to deliver nuclear weapons can provide a hedge against technical problems with the other two triad legs.

These arguments, which are the heart of the ICBM coalition's case for land-based strategic missiles, do not acknowledge the invulnerability of US submarine-launched ballistic missiles to attack or the advantage of the bomber leg, which can be recalled in a crisis, thereby protecting against a mistaken launch that would be more likely given the short time frame within which a decision to strike with ICBMs would need to be made.

Over the past decade, the coalition has succeeded in:

- limiting the reduction of deployed ICBMs under the New START treaty to 50, leaving a force of 400;
- keeping the 50 empty silos in "warm status," ready to receive missiles again should there be a shift in US nuclear policy requiring deployment of additional ICBMs;

- preventing the Pentagon from doing a study of the environmental and economic impacts of further reductions in the ICBM force; and
- helping to support the Pentagon’s plans for development of a next-generation ICBM, the ground-based strategic deterrent ICBM.

To do so, the coalition has taken dozens of actions, including letters to the last five secretaries of defense and a succession of chairs of the Senate Armed Services Committee, meetings with key Pentagon and military officials to make the case for continuing the ICBM mission, and amendments restricting the Pentagon’s ability to reduce or take steps that have even a modest chance of leading to a reduction of the ICBM force.¹ The bipartisan nature of the coalition means that a president of either party needs to think twice about a major restructuring, much less elimination, of the ICBM force for fear of harming the political prospects of a key senator of his or her own party at a time when control of the Senate is in play.

Although the coalition’s pleas on behalf of maintaining the current ICBM force generally led with strategic arguments, members of the group also tout the economic benefits of land-based missiles to their home states. The economic impacts of ICBMs are hinted at in this passage from the introduction to the coalition’s 2016 report on the enduring value of ICBMs, albeit still against a backdrop of strategic concerns: “While we represent strong local interests in the ICBM mission, we also possess, by virtue of our close relationship to the ICBM force, years of accumulated experience on strategic matters” (Senate ICBM Coalition 2016). Members are less shy about citing this connection in press releases aimed in part at their own constituents, as in a February 2012 statement by Senator Jon Tester (D-MT), who continues to represent Montana in the US Senate: “The base is a critical part of Great Falls’ economy and I am proud to fight for it.” The subtitle of the press release containing the Tester quote states “At Senators’ Urging, Budget Maintains Full Funding for Malmstrom ICBM Force, Jobs” (Tester 2012).

There is no question that the jobs at the ICBM bases in Montana, North Dakota, and Wyoming are significant factors in the local economies of those areas, both at the state level and in the specific communities where the bases are located. For example, Frances E. Warren Air Force Base in Cheyenne, Wyoming, is the largest employer in the state. According to a February 2018 fact sheet contained on the base’s website, the 90th Missile Wing, which is the primary activity at the base—responsible for the maintenance and deployment of 150

Minuteman ICBMs—employs a total of 3,738 full-time personnel, 3,122 military and 616 civilian (Warren AFB 2018). Cheyenne, which is the state capital as well as the largest city in Wyoming, has a population of a little more than 60,000 people, and the Cheyenne metropolitan area has a labor force of 46,000 (FRBSL 2018). This means that direct full-time employment at the Warren base accounts for approximately 8.1 percent of the local labor force, and approximately 12 percent or more once spending by base personnel on local goods and services is taken into account. The statewide labor force in Wyoming was 285,000 as of September 2018, meaning that the direct employment at Warren accounts for about 1.3 percent of the state’s labor force (BLS 2020a).

Minot Air Force Base, located outside of Minot, North Dakota, is home to the 91st Missile Wing, which is responsible for 150 ICBM sites, all within the state of North Dakota. The base’s fact sheet states that the base and the missile sites taken together cover about 12 percent of the land area of North Dakota (Minot AFB 2011). A fact sheet from 2009 reports 6,171 personnel at the base, including 5,494 military and 677 civilian, divided between the 91st Missile Wing and the 5th Bomb Wing, which is also based at Minot (Minot AFB 2009). Unlike the other two ICBM bases, Minot has two major functions. In addition to hosting the ICBM wing, Minot’s 5th Bomb Wing maintains 26 B-52 bombers under the supervision of US Global Strike Command. This dual function suggests that the base might be kept open even if its ballistic missile functions ended.

The Minot statistical area has a labor force of 46,000, which means that the 6,171 full-time personnel at Minot AFB account directly for 13.4 percent of the local labor force, and approximately 20 percent if the impacts of spending by the base and its personnel in the local economy are taken into account (NDHTL 2019). Direct employment at the Minot Air Force Base accounts for 1.5 percent of North Dakota’s total labor force of 411,000. As noted above, not all of these jobs are associated with the 91st Missile Wing.

The third ICBM site is Malmstrom Air Force Base, located near Great Falls, Montana. As with the other bases, Malmstrom is responsible for 150 ICBM sites. The base fact sheet indicates that there are nearly 4,000 personnel engaged in missile-related activities at Malmstrom, including about 3,300 military and 600 civilian (Malmstrom AFB 2012). These personnel account for 10.6 percent of the Great Falls–area labor force of 37,700, and approximately 16 percent or more once local spending by the base and personnel are taken into account (BLS 2020b).

¹ For examples of letters sent and lobbying undertaken by members of the Senate ICBM Coalition, one can go to the website of Senator Jon Tester (D-MT) and search for “ICBM.”

A closure or scaling back of activities at any of the three ICBM bases would have a substantial impact on the state and local economies. Although there is a significant record of communities recovering from base closures over time, and in many cases creating more civilian employment than the base itself provided, each case is unique, and communities like Cheyenne and Great Falls, in particular, would be well advised to diversify their economies as much as possible to provide alternatives in case of a change of status of their local facility (Preble and Hartung 2017).

Political Influence: The Defense Industry and ICBM Contractors

Congressional decisions on nuclear weapons spending in general and ICBM expenditures in particular do not occur in a vacuum. The defense industry has numerous levers of influence it can bring to bear to effect budgetary outcomes, most notably campaign contributions and lobbying expenditures.

Members of the ICBM coalition benefited from more than \$1.3 million in campaign contributions from the defense industry between 2007 and 2018, including more than \$305,000 from major ICBM contractors Boeing and Northrop Grumman (see the table) (Open Secrets Database 2020). Of the contributions from ICBM contractors, \$163,328 came from Boeing, and \$141,888 came from Northrop Grumman. Campaign contributions are a way to ensure access to congressional decisionmakers and/or reward them for taking actions that benefit the company making the donation.

Given the resources at the disposal of major defense contractors, the figures for contributions to members of the ICBM coalition may appear relatively low. This is in part due to federal limits on how much a corporation’s political action committee (PAC) can give to candidates in a given election cycle. These limits are \$5,000 per election (including primary) per candidate, which typically means an allowable contribution of \$10,000 every six years for each Senate seat. These contributions can be supplemented with individual contributions from executives of the firms, but even allowing for this, contributions from ICBM contractors are a relatively small share of the contributions received by the members of the ICBM coalition. The three senators in Table 1 who were up for reelection in 2018 (Barasso, Heitkamp, and Tester) each spent between \$6 million (Barasso) and \$18 million (Tester) on their campaigns (Glum 2018).

However, despite the low cap on allowable dollar amounts, candidates must raise this money for each election, and being able to count on getting the maximum allowable contribution from contractors and often their sub-contractors is important to these offices. Alongside levers like direct

Defense Industry Campaign Contributions to Members of the ICBM Coalition, 2007–2018

Member of the ICBM Coalition in the Senate	ICBM Contractors ^a	Total Defense Industry
Orrin Hatch (R-UT) ^b	\$63,750	\$283,625
John Barasso (R-WY)	\$54,500	\$262,500
Steve Daines (R-MT)	\$49,350 ^c	\$90,600 ^c
John Hoeven (R-ND)	\$42,000	\$219,300
Mike Enzi (R-WY)	\$34,500	\$147,000
Jon Tester (D-MT)	\$34,440	\$289,923
Heidi Heitkamp (D-ND) ^b	\$26,676	\$74,881
Mike Lee (R-UT)	\$10,000	\$54,701
TOTAL	\$305,216	\$1,367,829

Members of Congress use leadership PACs to contribute to the campaigns of other members, which generates goodwill for the member making the contribution. The goodwill often translates into support on key votes or in contests for leadership positions in the House or Senate.

Note: Contributions include donations from company PACs as well as individuals affiliated with defense companies. Contributions include direct donations to a coalition member’s campaign and donations to a member’s “leadership PAC.”

a Boeing and Northrop Grumman. In July 2019 Boeing dropped out of the ICBM competition, leaving Northrop Grumman as the sole bidder. Therefore, going forward Northrop Grumman and its subcontractors will be the key players in lobbying for the next-generation ICBM and the maintenance of existing levels of ICBM deployment (Insinna 2019).

b No longer in the Senate.

c Includes contributions made when Senator Daines was in the House of Representatives

SOURCE: OPEN SECRETS DATABASE 2020.

lobbying and ICBM-related jobs in the states of key members, campaign contributions can serve as “door openers” that allow companies preferred access to congressional offices.

Other key coalition members who are in a position to assist ICBM contractors by funding their systems are those who serve on the strategic forces subcommittees of the House and Senate armed services committees. For example, Representative Mike Turner (R-OH), a staunch advocate for nuclear weapons spending, received more than \$1 million in campaign contributions from the defense industry as a whole from 2008 through 2018, including \$94,500 from Boeing and Northrop Grumman, the two main contractors for the next-generation ICBM. In all, members of the strategic forces subcommittee of the House Armed Services Committee received \$6.55 million in campaign contributions from the defense industry between 2007 and 2018. Representative Mike Rogers (D-AL) was the top recipient at over \$1.2 million, followed by

Representative Mike Turner (cited above). On the Senate side, members of the strategic forces subcommittee received \$2.57 million between 2007 and 2018, with Senator Lindsey Graham (R-SC) the top recipient at \$713,209. Boeing and Grumman alone gave \$535,634 to members of the House Strategic Forces Subcommittee from 2007 to 2018, and \$438,467 to members of the Strategic Forces Subcommittee in the Senate.

In addition to campaign contributions, the defense industry devotes considerable resources to lobbying on a whole range of bills and issues, of which nuclear weapons spending is one. It is difficult to break down how much of this lobbying effort goes toward advocating on behalf of ICBMs, but the figures demonstrate that the industry and the main ICBM contractors have considerable resources at their disposal should they need to lobby on this issue.²

Boeing, which was until recently a competitor for the next generation ICBM, spent \$183.8 million on lobbying from 2008 to 2018, an average of \$16.7 million per year (Insinna 2019). The company employed 15 separate lobbying firms in 2018. The top recipient of lobby funds, at \$240,000, was Norm Dicks and Associates, which is run by a former member of Congress from Washington State who was a staunch defender of Boeing's interests when he served as member of the House Appropriations Committee from 1977 to 2013. Boeing was founded in the Seattle area and has major operations there.

Tied for second on the list is Gephardt Associates, which received \$180,000 in 2018. The firm is run by Dick Gephardt, a former congressman from the St. Louis area who served 28 years in Congress, including a stint as House majority leader from 1989 to 1995. During the final years of his tenure, from 1997 to 2004, Boeing owned and operated factories for its F-15 and F-18 combat aircraft in the St. Louis area, after its 1997 merger with the long-time St. Louis-based defense manufacturer McDonnell Douglas.

The hiring of Dicks and Gephardt to lobby for Boeing represents two key features of the lobbying system—the building of close connections with members who represent areas near company plants, and the revolving door through which powerful decisionmakers go on to work for major contractors after retirement.

In all, Boeing employed 87 lobbyists in 2018, both internally and with external firms. Of that number, 65 went through the revolving door from jobs in Congress or the executive branch that involved working on defense or other issues of interest to the company. The majority of revolving door hires by Boeing and its lobbying firms are former congressional staffers.

Northrop Grumman, the other competitor for the next-generation ICBM, known formally as the ground-based strategic deterrent ICBM, also has an extensive lobbying operation. The firm spent more than \$162 million on lobbying from 2008 to 2018, an average of \$14.7 million per year. The company employed 59 lobbyists, in-house and for-hire, in 2018, 43 of whom came through the revolving door from positions in government.

Northrop Grumman has done a tour of communities hosting ICBM bases, presumably to get them on board to promote the company's bid. In February 2017, before it received the next-generation ICBM development contract, the company sent a delegation to each of the three communities that host ICBM bases. Northrop's vice president for the ground-based strategic deterrent ICBM, Carol Erikson, said: "We are here to interact with local leadership. To really understand the unique challenges and opportunities of fielding the next generation of the ICBM system." She also noted that the company was seeking potential local contractors to work with it on the development of the new ICBM (Ogden 2017).

The Northrop delegation clearly illustrates the revolving door between the company and military personnel deeply involved with the ICBM force, including the following military or retired military personnel, all of whom are now Northrop Grumman executives:

- Retired Lieutenant General James Kowalski, former deputy commander of the US Strategic Command and commander of the Air Force Global Strike Command
- Brigadier General Russ Anarde, former commander of the 91st Missile Wing (the ICBM force based at Minot Air Force Base)
- Retired Colonel Tom Cullen, a 27-year ICBM officer who served in the 740th ICBM missile squadron at Minot and commanded the 10th ICBM missile squadron at Malmstrom Air Force Base in Montana

² Lobbying data and information on the "revolving door" contained in this section are from the Center for Responsive Politics' Open Secrets database (Center for Responsive Politics 2020).

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Rethinking Land-Based Nuclear Missiles

Sensible Risk-Reduction Practices for US ICBMs

The United States continues to keep ICBMs on high alert so they can be launched quickly on warning of an incoming attack—creating the risk of a mistaken nuclear war in response to a false warning.

The United States developed its nuclear weapons policies early in the Cold War—some 60 years ago—and they were shaped by the weapons technologies of the time. These technologies have changed radically since then, but the United States has not modified key nuclear policies to reflect those changes.

In particular, the United States continues to field silo-based nuclear missiles (ICBMs) and keeps them on high alert so they can be launched quickly on warning of an incoming attack—creating the risk of a mistaken nuclear war in response to a false warning. Yet, the original rationale for ICBMs—and for keeping them on alert—no longer applies.

These outdated policies have persisted largely for reasons unrelated to security, including Air Force interests, congressional support for ICBM facilities that bring jobs to their state, and lobbying by defense contractors.

This report examines the rationales for retaining ICBMs and keeping them on alert, as well as the feasibility of extending the lifetime of the current Minuteman ICBMs. It concludes that the United States should retire the ICBM force. In the meantime it should maintain the Minuteman fleet rather than build a new missile, and immediately take these missiles off high alert and eliminate the option of launching them on warning of attack.

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