EXPLAINING THE DOD AND DOE ROLES IN THE U.S. NUCLEAR ENTERPRISE

- AND -

COMPARING MODERNIZATION EFFORTS BETWEEN THE U.S., CHINA, AND RUSSIA

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INTRODUCTION

The United States has a long, storied history of assuring U.S. national security through the development and forward deployment of nuclear weapons. Since WWII, the United States has developed and brought into service ninety-nine types of warheads and multiple delivery systems.[1] During the Cold War, the U.S. continuously modernized and developed new, advanced nuclear weapons and delivery systems to stay ahead of and deter the Soviet Union from conducting a nuclear strike. After the fall of the Soviet Union, the new geopolitical environment saw the United States go through a period of defense reductions that shifted focus toward domestic concerns. National Security Strategy focused the defense sector on planning for regional conflicts where the United States would have technological advantages over its adversaries, most of which would not possess nuclear weapons. Following the collapse of the Soviet Union, the Base Force Design and the Bottom-Up Review cut funding for the Department of Defense. After September 11, 2001, the defense sector saw a boost in funding but directed most of these funds to efforts in the Middle East to combat terrorism.

While the War on Terror continued to be the main priority of the United States, funding for nuclear weapon modernization was given a lower priority. This relegation was explained in the 2010 Nuclear Posture Review (NPR) and altered the nuclear weapons strategy of the United States. In the NPR, the executive branch took a hard stance that focused on reducing the role of nuclear weapons in U.S. strategy. The review devoted an entire chapter to discussing the policy shift and listed reducing the role of nuclear weapons as its second highest priority, behind nuclear nonproliferation and ahead of maintaining strategic deterrence.[2] Nuclear weapon modernization efforts were further constrained after the signing of the New Strategic Arms Reduction Treaty (New START) in 2010 between the U.S. and Russia, which specified limits on the number of deployable weapons and delivery systems for both countries and significantly reduced those quantities from previous treaty levels, and by the 2011 Budget Control Act which set limits on defense appropriations. This period of rapprochement and strained budgets further justified the reduced emphasis and role of nuclear weapons in U.S. National Security Strategy. The strategy outlined in the 2010 Nuclear Posture Review would be the leading nuclear weapons strategy until another review was published in 2018. The 2018 Nuclear Posture Review concluded that reducing the role of nuclear weapons was not producing the intended results and began adjusting the focus back to modernization.

> "Despite concerted U.S. efforts to reduce the role of nuclear weapons in international affairs and to negotiate reductions in the number of nuclear weapons, since 2010, no potential adversary has reduced either the role of nuclear weapons in its national security strategy or the number of nuclear weapons it fields. Rather, they have moved decidedly in the opposite direction. As a result, there is an increased potential for regional conflicts involving nuclear-armed adversaries in several parts of the world and the potential for adversary nuclear escalation in crises or conflict."[3]

The refocused efforts on nuclear modernization in 2018 has carried forward in budget request documents through the current administration. However, in the 2022 Nuclear Posture Review, an emphasis on reducing the role of nuclear weapons returned. Nevertheless, the review also outlined (indirectly) that modernization efforts enacted under the previous administrations would continue.

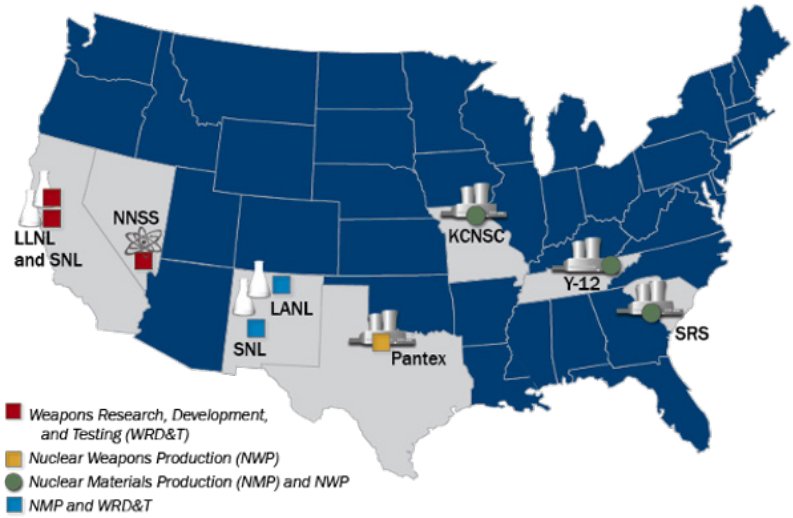

Figure 1. NNSA Nuclear Security Enterprise. Retrieved from Nuclear Matters Handbook 2020 Chapter 5: NNSA Nuclear Security, pp.52.

With the re-ignition of great power competition, codified by the rise of Russia and China as great power competitors, the United States must now assess its nuclear modernization efforts to compete with the changing geopolitical environment. As these two nations challenge the U.S.-led rules-based international order, with Russia invading Ukraine and suspending its participation in New START and China increasing its nuclear weapons modernization and procurement activities, the current administration must make tough choices that will affect the ability of the U.S. nuclear enterprise to continue to deter aggression from its adversaries. The following paragraphs will explain the U.S. nuclear weapons enterprise, outline the different responsibilities of the Department of Defense and Department of Energy for nuclear modernization and maintenance, provide a brief overview of the budgeting process that is directed towards modernizing the nuclear enterprise, discuss current modernization programs, and compare the current and future capabilities of the U.S., Russia, and China.

U.S. NUCLEAR WEAPONS ENTERPRISE: DOD AND DOE

The U.S. Nuclear Weapons Enterprise consists of the U.S. Nuclear Weapons Complex, managed by the Department of Energy (DOE), and Strategic Nuclear Forces, managed by the Department of Defense (DOD). The Nuclear Weapons Complex is comprised of the leading facilities used to maintain and develop U.S. nuclear weapon stockpiles. It consists of nine facilities across seven states and the Tennessee Valley Authority (TVA) nuclear reactor.[4] Figure 1 depicts a map of the nuclear weapons complex.

The Department of Energy's sub-agency, the National Nuclear Security Agency (NNSA), oversees "the research, development, test, and acquisition programs that produce, maintain, and sustain nuclear warheads."[5] To fulfill this mission, the NNSA controls and manages facilities around the U.S. that are involved in the procurement, production, and/or enrichment of plutonium, uranium, lithium, and tritium, all of which are part of the weapons package that produces nuclear yield. The NNSA also works with the National Labs to align research and support requirements to meet the enterprise's objectives.

While the NNSA is tasked with warhead development, the Department of Defense is tasked to "develop, deploy, and operate the missiles, submarines, and aircraft that deliver nuclear warheads and generate the military requirements for the warheads carried on those platforms."[6] DOD manages the United States' nuclear triad – the combination of nuclear warheads, launchers, and delivery platforms – the purpose of which is to deter strategic nuclear attacks on the United States, as well as other types of attacks on the U.S. and its allies. The nuclear triad deters attacks by guaranteeing that the U.S. has a global capability to launch a nuclear first-strike or counter-strike. The U.S. nuclear triad has three legs – air, land, and sea – and consists of 14 Ohio Class ballistic missile submarines (SSBN), 400 LGM-30G Minuteman III ground-based intercontinental ballistic missiles (ICBMs), and 66 heavy bomber aircraft (20x B-2As and 46x B-52s).[7] The United States also

maintains fighter aircraft (F-15E), designated as Dual Capable Aircraft (DCA), that can carry conventional missiles or gravity bomb nuclear payloads. These aircraft are not considered strategic systems because of the limited ranges that the aircraft can fly. U.S. dual capable aircraft are forward stationed in Europe under NATO guidelines.

The United States designates nuclear payloads as either bombs (B) or warheads (W). Payloads designated with (B) are gravity bombs that are dropped from an aircraft onto a target. The United States currently deploys two different bomb designs: the B61 and B83.[8] Payloads designated with a (W) are warheads carried by missiles to a target. They are deployed on submarines and in-ground silos and can be deployed from aircraft using air-launched cruise missiles (ALCM). The United States' current force structure consists of five types of warheads: W76, W78, W80, W87, and W88.[9] The United States' last newly developed nuclear warhead was the W88, designed and produced over three decades ago.

BUDGETING

The DOD and NNSA use the Planning, Programming, Budgeting, and Execution (PPBE) process for requesting funding and developing future year budgets. Once assessed by the Office of Management and Budget (OMB) and approved by the President, the proposals are sent to Congress for further vetting, markups, and approval. Congress then authorizes and appropriates the funding. Funding for both is allocated through the National Defense budget identified as the "050" account. As stated in the Nuclear Matters Handbook, "this account is divided into sub-accounts: 051 for DoD national security funding; 052 for classified budgeting for certain specific national security activities; 053 for Department of Energy (DOE)/National Nuclear Security Administration (NNSA) defense programs; and 054 for defense-related activities in other departments."[10] All nuclear modernization efforts are funded through one of these accounts.

The Congressional Budget Office conducted a study estimating the costs for the U.S. nuclear enterprise from 2021-2030. The study assesses that the U.S. will require $551 billion to maintain and modernize its nuclear enterprise during this period. The allocation of the $551 billion is divided into four separate cost sections, which are strategic ($297 billion) and tactical ($17 billion) nuclear delivery systems and weapons, DOD's Nuclear Command and Control System (NCCS) and early warning system ($94 billion), and DOE's nuclear weapons facilities and supporting activities ($142 Billion).[11]

Additionally, within the CBO analysis of the $551 billion estimated for the U.S. nuclear weapons complex from 2021 to 2030, $188 billion is anticipated for nuclear modernization, of which $175 billion would be dedicated to the strategic nuclear triad.[12] Of the $188 billion estimate, $154 billion would be programmed for DOD and dedicated to modernizing delivery systems. In comparison, the remaining $34 billion would be programmed for DOE to develop new warheads, refurbish current warheads, and develop a new naval nuclear reactor.[13] Notably, within the CBO cost estimate was also an anticipated requirement of $35 billion to modernize DOE facilitates.

The NNSA divides its funding allocations across all its mission sets, which include stockpile management and development, nonproliferation, counterterrorism, and naval nuclear reactor missions, each of which is a line item within its budget. Stockpile management, development, and modernization are all listed together in NNSAs budget under the title "Weapons Activities" and historically consume the most significant portion of its budget. For example, in FY2022, the NNSA was allocated $20.37 billion, of which $15.92 billion was allocated to weapons activities.[14]

After reviewing the Department of Energy and NNSA budget requests and future years' planning, weapons activities continue to receive and request increased funding from FY2022 to FY2028. From FY 2022 to 2023, the budget increased by 7% from $15.92 billion to $17.12 billion.[15] The current FY 2024 budget requests an additional increase of 10.3%, which is well above the yearly inflation estimate, currently at 6%.[16] The FY 2024 budget requests $18.83 billion and projects steady increases in funding to $20.7 billion by 2028.[17] The future estimates within the budget increase NNSA funding by less than 6% from 2024 to 2025 and level off to approximately 2% increases from 2025 to 2028. The NNSA would receive a boost in real dollars of funding from FY 2024 to FY 2028. However, since the Federal Reserve has a target inflation rate of 2% the funding analysis depicts that these requests are only set to keep pace with a standard inflation rate of 2%, effectively flatlining the budget for NNSA weapons activities. Figure 2 provides an overview of NNSA's budget forecasts along with inflation data.

NNSA Weapons Activities Budget Forecast			
Year	**Request**	**% Change**	**Inflation Rate/ Anticipated Rate**
FY 2022	$15,920,000.00	-	6.5%
FY 2023	$17,116,119.00	7.5%	6%
FY 2024	$18,832,947.00	10.03%	2.4%
FY 2025	$19,390,942.00	2.9%	2.3%
FY 2026	$19,818,932.00	2.2%	2.3%
FY 2027	$20,285,683.00	2.35%	2.3%
FY 2028	$20,747,386.00	2.27%	2.3%

Figure 2. Data retrieved from Budget Justification and inflation rates obtained through OECD websites at: https://knoema.com/kyaewad/us-inflation-forecast-2022-2023-and-long-term-to-2030-data-and-charts.

NUCLEAR MODERNIZATION

Modernization is advancing from one generation of weapons systems to the next. It involves enhancing the capability or capacity of modernized items by using more advanced technologies. Modernization of the U.S. nuclear enterprise consists of not only nuclear warheads but also modernizing the weapon's delivery platforms, delivery vehicles, and the NCCS. Government agencies and executive administrations have also used the term modernization to describe upgrading the facilities and infrastructure of the nuclear weapons enterprise, specifically when discussing stockpile development and management under NNSA. As stated in the 2018 NPR, "Over half of NNSA's infrastructure is over 40 years old, and a quarter dates back to the Manhattan Project era."[18] When reviewing NNSA budget documents, line items for facilities are designated as modernization efforts. For example, under its "Production Modernization" sections, the NNSA has requested funding for modernizing its plutonium production capabilities at Los Alamos National Lab and the Savannah River Plutonium Processing Facility.[19]

NNSA Modernization

It has been argued that the nuclear weapons complex has fallen prey to the train wreck thesis, which states that since the Cold War, the U.S. has not properly or consistently modernized. The current stockpile of warheads in the U.S. arsenal were all developed in the 1970s and 1980s and had initial design lives of 20 years.[20] Since the end of the Cold War, the United States has invested predominantly in modernizing delivery platforms and vehicles, choosing to conduct life extension programs (LEP), modifications (MOD), and alterations (ALT) on most warheads. LEPs are conducted to address aging and performance issues of the warhead over time and are intended for the warhead to maintain its designed capability. MODs use different types of components to change the operational characteristics of a nuclear package but are based on the design of the original weapon. For example, the B61 has twelve different modifications. These MODS are designated by adding the modification number after the design, i.e., B61-1 to B61-12. ALTs occur when minor changes are made to modified designs but do not result in a change to the system's operational performance.

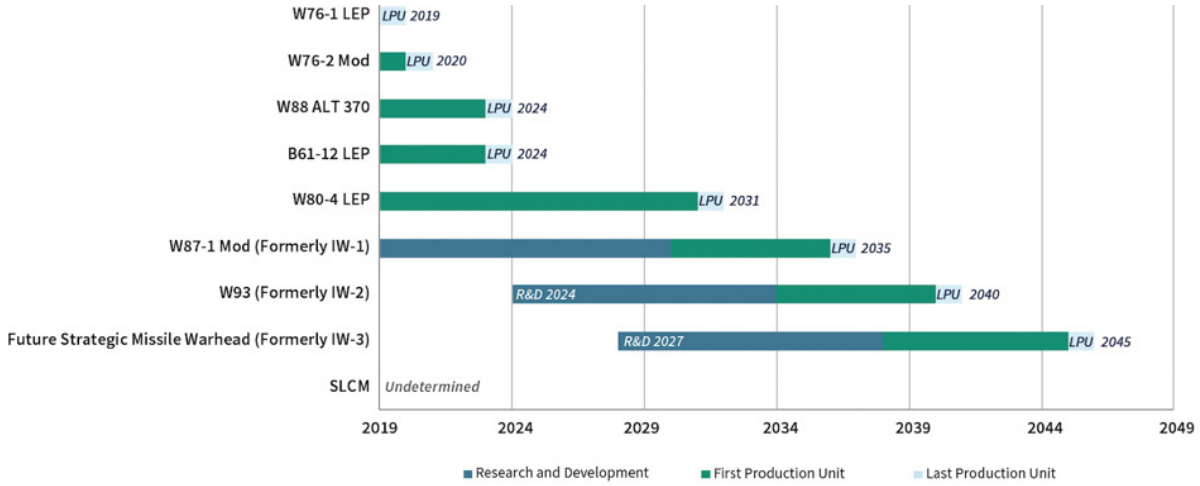

Figure 3. Chart retrieved from CSIS article "US Nuclear Warhead Modernization and 'New' Nuclear Weapons" pp. 3.

For example, the B61-4 has a program to increase its security features. The alteration of this program results in the warhead naming convention of B61-4 ALT 370. LEPs, MODs, and ALTs are essential to ensure the reliability of U.S. nuclear warheads, but definitionally, does not constitute modernization of the warhead. The U.S. has continuously increased the service life of its warheads using the LEP, MOD, and ALT systems to upgrade features and exchange deteriorating pieces and parts.

The NNSA currently has seven appropriations in its budget classified as warhead modernization programs. These are the B61-12 LEP, the W88 ALT 370, the W80-4 LEP, the W80-4 ALT-SLCM, W87-1 MOD, the W93, and the Future Strategic Missile Warhead.[21] Figure 3 displays NNSA's most recent modernization efforts. It has six active or scheduled modernization programs and two recently completed programs. Six of the eight programs are considered MODs, LEPs, or ALTs. The total appropriated funding for these programs in FY 2023 is $2.9 billion, with the FY 2024 budget requesting a 6.9% increase to $3.1 billion.[22]

The SLCM-N annotated in Figure 3 was a program focused on developing a low-yield sea-launched cruise missile like the tomahawk land-attack cruise missile that was deployed during the Cold War and retired in 2013. The 2022 Nuclear Posture Review officially canceled the program, and funding was removed from the FY 2024 budget, citing prohibitive cost acquisition.[23] The removal of funding for the system is annotated in the NNSA FY 2024 budget under W80-4 ALT SLCM, which has an allocation of $0 for FY 2024 – FY 2028.[24] Both the Secretary of Defense and Chairman of the Joint Chiefs confirmed to Congress the value of having the SLCM-N within the U.S. arsenal, nevertheless, the current administration has decided the capabilities of the W76-2, a modification completed in 2020, provides a sufficient deterrent to cover the gaps.[25] However, unlike the Cold War era tomahawk nuclear cruise missile, the W76-2 is not designed for deployment on surface ships or attack submarines.[26] Therefore, the number of W76-2's deployed on strategic nuclear submarines is limited by New START treaty obligations, whereas the ability to deploy the SLCM-N on attack submarines and surface ships, which do not count towards treaty obligations, would allow the U.S. additional options to combat the growing threat and quantity of the Chinese and Russian arsenals.[27] These fundamental differences, among others, have caused debate in the defense community on whether the SLCM-N should be reconsidered in the future. Although the choice has been made to cancel the program, future administrations may choose to restart it.

Currently, the United States is designing two warhead capabilities that are in various stages of the RDT&E process. The first, the W93, is designed to be a submarine-launched ballistic missile and will either complement or replace the W88 and/or the W76, both deployed on Ohio Class Submarines. The W93 completed Phase 6.1 (Concept Assessment) of the Phase 6.X process in FY 2022 and funds have been allocated to complete Phase 6.2 (Feasibility Study) from 2023 to 2024, with the first production scheduled for FY 2034.[28] The second warhead, the Future Strategic Missile Warhead, is slated to conduct Phase 6.1 assessment in FY 2027, with the first production approximately scheduled for 2038.[29] NNSA has forecasted a requirement of $70 million in funds for the program for FY 2027 and $112 million for FY 2028. (See Figure 4 for Phase 6.X Process)

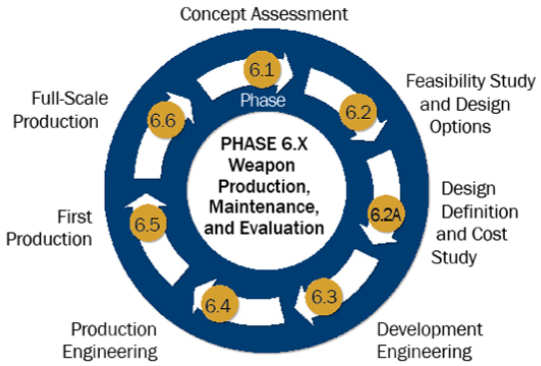

Figure 4. Displays the Phase 6.X Process for Developing Nuclear Weapons. The Chart was retrieved from the Nuclear Matters Handbook 2020 Chapter 7: Nuclear Weapons Life Cycle pp. 79.

Although the nuclear weapons complex continues to modernize, there are signs that the enterprise may have fallen prey to the train wreck thesis. This is mostly seen within the production facilities of the nuclear weapons complex. For example, the ability of the U.S. to produce plutonium pits has been degraded since 1989, and its current stockpile of low-enriched uranium (LEU) will run out by the mid-2020s.[30] In the 2022 Nuclear Posture Review, the NNSA was tasked with instituting a Production-based Resilience Program (PRP) to ensure the United States develops and maintains an infrastructure system to produce plutonium pits for its nuclear weapons. Officials estimated a requirement to produce 80 pits annually by 2030 to replace the entire

stockpile's pits by 2080. However, in the 2023 House Armed Services Committee Summary of the Fiscal Year 2023 National Defense Authorization Act, Congress acknowledged that the NNSA plan to produce 80 pits a year needed to be revised and tasked DOD and the NNSA to develop more realistic pit production plans.[32] Furthermore, based on a 2017 assessment, the United States will soon be unable to produce enough tritium for its nuclear weapons after shutting down its only LEU processing center in 1998.[33] This facility generated the LEU required fuel to produce tritium, which, by law, must be made in the United States. Without this capability, the United States risks not being able to produce enough tritium to replace its warheads by 2030.[34]

DOD Modernization

As stated, the DOD manages and maintains the country's nuclear triad. Modernization programs have begun for each leg, including developing new delivery systems, platforms, and launchers. The Air Force is the lead management agency responsible for modernizing the air and ground legs of the nuclear triad. It operates the heavy bomber and DCA fleet and maintains the ground-based Minuteman III missiles. The Air Force has three air-leg modernization programs and one ground-leg modernization program currently in development. The air modernization programs are the development of the B-21 heavy bomber, acquiring a new air-launched cruise missile named the Long-Range Standoff Weapon (LRSO), and the certification of the F-35 fighter aircraft as a DCA.

The B-21 heavy bomber is being designed as a dual-capable aircraft (DCA) that can carry both conventional and nuclear munitions and will replace the aging B-2A and B-1 bomber aircraft.[35] Its estimated unit cost is $692 million (2022 dollars), and the first unit is scheduled to enter service in the mid-2020s.[36] The AGM-86 is a nuclear air-launched cruise missile (ACLM), which enhances the survivability of the B-52 heavy bomber by allowing the aircraft to hold targets at risk without entering an adversary's airspace. The LRSO is set to replace the aging AGM-85 ALCM, which has been used since 1982 and is designed for use on the B-52 and the B-21.[37] The certification of the F-35 as a DCA does not have a solidified date, but the U.S. plans to have the aircraft certified to use the B61-12 by NATO's stated required operational date of January 2024.[38]

The Air Force is also procuring the Sentinel ICBM, formerly the Ground Based Strategic Deterrent, to replace the 400 Minuteman III missiles in current operation. The Air Force also plans to modernize all 450 U.S. missile silos to accommodate the new Sentinel missiles. The Air Force plans to procure a total of 659 Sentinel ICBMs at an estimated price tag of $93 - $96 billion and will conduct a one-for-one swap with the current missiles while maintaining a non-deployed stockpile of spares.[39] Although the price tag seems high, each missile is designed for a 60-year lifespan and will incorporate an open technology architecture which allows the missiles to accept technology upgrades as they are developed over time.[40]

The Navy is the lead management agency responsible for modernizing the sea leg of the triad. It operates 14 Ohio Class strategic ballistic missile submarines. It plans to replace the Ohio Class with 12 of the next-generation Columbia Class ballistic missile submarines, the first of which is scheduled for delivery to the Navy in FY 2027. Each Columbia Class submarine has a scheduled 6-year timeline from the beginning of construction to delivery of the vessel.[41] Although it will receive its first ship in FY 2027, the Columbia Class is not expected to begin its first patrol until FY 2031. Due to funding shortfalls stemming from the FY 2013 Defense Budget, the procurement schedules of the Columbia Class were delayed. As a result, the Navy's original plan to retire one Ohio Class with the introduction of one Columbia Class became unfeasible. The Navy plans to retire two Ohio Class submarines before the first Columbia Class enters service. This means the U.S. Navy will only operate ten instead of the planned twelve strategic nuclear missile submarines beginning in FY 2029 and will reach the planned twelve in FY 2041.[42] The Navy addresses the coverage gaps in its FY 2024 budget justification, which requests increased funding for the Columbia Class program to speed up the delivery schedules of the next-generation submarine.[43] Additionally, the Navy has stated that it is considering short-term life extensions for up to five Ohio Class submarines to cover the gap; however, an official decision has yet to be made.[44] The Ohio Class was brought online in the 1970s with an original design life of 30 years. The Navy conducted a life extension program on these ships, extending its design life to 42 years, but five of the current Ohio Class ships will exceed 42 years in service by 2030.[45]

The Navy is also pursuing an LEP on the Trident II D5 submarine-launched ballistic missile. The LEP is being conducted to extend the life of the Trident II D5 through 2042 and consists of upgrading its flight guidance systems and refreshing internal components.[46]

The Trident II D5 missiles are deployed on Ohio Class submarines and will also be deployed on the Columbia Class. Each Ohio Class submarine can carry up to 20 Trident II D5 missiles, and each missile can carry up to eight nuclear warheads; however, due to New START limits, the U.S. currently only deploys four warheads per missile, giving each strategic submarine a total of 80 warheads.[47]

It is important to note that the Ohio Class was initially designed with twenty-four missile tubes per vessel. However, four tubes in each Ohio Class vessel were permanently sealed to account for New START obligations. The Columbia Class submarine is being procured with only sixteen missile tubes, or only 2/3 the number of tubes than the original Ohio Class. Although the Columbia Class is the most technologically advanced submarine the United States has designed and will build, the procurement strategy may require re-evaluation. The decreased procurement quantities of the submarine, coupled with a decrease in missile capacity, may decrease the credibility of the sea leg og the nuclear triad. A counterargument to this line of analysis may lie in the Common Missile Compartment (CMC), which was jointly developed by the US and UK for use on both the Columbia Class and the UK Dreadnought Class SSBNs and carry Trident II D5 missiles.[48] Although the U.S. is reducing it carrying capacity, it is increasing its interoperability with a strategic ally, while reducing its costs for deterrence. Notwithstanding this development, a way to expand capcity would be to increase the number of warheads per submarine; however, that would result in the U.S. going over the limits prescribed in New START. With Russia suspending its participation in New START and the treaty expiration approaching in 2026, the United States should develop a strategy addressing these concerns before the treaty expires.

COMPARING ARSENALS AND MODERNIZATION PROGRAMS: U.S., RUSSIA, CHINA

Although the United States is modernizing its nuclear weapons enterprise, it is essential to compare the U.S.' pursuits with those of its two peer adversaries – China and Russia. Figure 5 offers a comparison of current delivery systems and deployed missiles.

Country	US	Russia	China
Silo Based ICBM Launchers	450	399	354
Deployed ICBMs	400	812	142
Mobile ICBM Launchers	0	180	28
Heavy Bombers	66	75	20
Ballistic Missile Submarines	14	11	6
Deployed SLBMs	240	166	72

Figure 5. China, Russia, and the US' current numbers of delivery systems and deployed missiles. Data retrieved from the 2022 IISS Military Balance and the Nuclear Notebook referenced in citations published by the Bulletin of the Atomic Scientist.

Russia currently possesses 5,977 strategic nuclear warheads, of which approximately 1,588 are deployed. Its current strategic arsenal consists of air, land, and sea delivery systems, a nuclear triad like the United States. Its strategic sea capability comes from eleven sub-surface nuclear ballistic submarines (SSBN) with a carrying capacity of 576 submarine-launched ballistic nuclear missiles (SLBM-N).[49] It has 399 land-based launchers with 812 intercontinental ballistic missiles (ICBMs) and approximately seventy-six bomber aircraft capable of delivering over 200 nuclear-enabled ballistic missiles and gravity bombs.[50] Russia also possesses an estimated 2,000 non-strategic nuclear warheads not factored into the verified counts of strategic nuclear warheads. These warheads are not subject to treaty limitations, and the status of these non-strategic nuclear warheads is unknown.[51]

Russia has been modernizing its nuclear weapons and developing new delivery platforms over the last 20 years. Modernization efforts are occurring for both its strategic and non-strategic stockpiles. Although the U.S. and Russia are modernizing nuclear forces, the most alarming Russian efforts are the development of new capabilities that the United States is not currently pursuing. These new capability investments have been in nuclear-powered cruise missiles and the development of the Poseidon autonomous underwater vehicle. Both delivery systems seek to operate autonomously, powered by nuclear reactors, allowing them to patrol

the oceans and skies for extended periods and over extremely long distances, making it more difficult for the United States to deter an attack. Both systems would also be able to carry low-yield nuclear weapons, decreasing the threshold for nuclear employment during conflict.

China also possesses a nuclear triad, but its current systems have lesser capabilities than those of the United States and Russia. It currently employs the H-6N and H-6K bombers, which have ranges over 3,100 km. For comparison, the United States and Russian strategic bombers have a maximum range of 10,000 – 14,000 km. China has an estimated total of twenty bombers. The H-6N bombers can launch one nuclear-capable Air-Launched Ballistic Missile (ALBM), while the H-6K bomber can carry one nuclear gravity bomb.[52] Its sea leg contains six Type-094 Jin Class nuclear-powered ballistic missile submarines, each carrying up to twelve JL-2 submarine-launched nuclear ballistic missiles. The ground leg of China's triad consists of approximately 450 land-based ICBM launchers. China is estimated to have 142 ICBMs deployed across its 450 launchers.[53]

China has exerted immense amounts of time, money, and effort to build up its nuclear forces at an astounding rate. In 2020 the U.S. estimated that China had 100 ICBM launchers. As of October 2022, the U.S. estimated that China increased the quantity of its ICBM launchers to 450.[54] Furthermore, in 2015 it was estimated that China possessed 250 nuclear warheads, but as recently as March 2023, that estimate has grown to 410.[55] At its current pace of modernization and buildup of its nuclear forces, the Pentagon estimates that China will have a total of 1,500 warheads by 2035.[56] China is able to maintain this pace because of its economic power. According to the World Bank, China boasted a GDP of $17.9 trillion in 2022, which ranked second in the world behind the U.S. at $25.4 trillion.[57] For comparison, Russia's GDP in 2022 was only $2.4 trillion, or less than 10% of that of the United States. The continued growth of the Chinese economy will allow it more access and opportunity to devote more of its resources toward furthering its nuclear aspirations.

The Russian Federation and the People's Republic of China also have hypersonic capabilities. The United States is also pursuing a hypersonic capability and U.S. defense industries are developing counter-hypersonic systems.[58] However, the U.S. needs to catch up in its development compared to its competitors. Furthermore, the United States has explicitly stated that its future hypersonic capability is intended for conventional use only, while Russia and China are designing nuclear capable hypersonic missiles. Moreover, Russia and China also possess a mobile ICBM capability that the United States does not. This mobile capability makes Russian and Chinese systems more survivable as they become increasingly harder to detect as they move around the battlefield.

When comparing future programs, the results depict that the United States is being out modernized in quantity of systems and in certain areas of technological sophistication. The United States is pursuing only one ground-based modernization, the Sentinel ICBM. The Russian Federation is pursuing three and China is pursuing six. Two of Russia's three ground modernization programs, its new ground-launched cruise missile (GLCM) and ICBM, will be fully deployed within the next ten years. China's pursuits are especially alarming because five out of its six ground-based efforts are to design and deploy ICBMs that will be able to reach the mainland of the United States. Four of these programs will be fully deployed by 2030.

At sea, the United States is procuring the Columbia Class submarines,whose procurement schedule has been delayed. Meanwhile, the Russian Federation has already fielded five of its 4th generation Borei class nuclear-powered SSBNs and plans to have ten by 2030. Russia also released design concepts for a next-generation stealth submarine and, in January of 2023, stated that its autonomous nuclear-powered nuclear payload torpedo (Poseidon) is ready for operational deployment.[59] If Poseidon is genuinely ready to be deployed, it will be almost ten years ahead of the United States estimate for its production and deployment. Additionally, China is also ahead of the United States in procurement of its next generation Type 096 Tang Class strategic ballistic missile nuclear powered submarine and upgraded JL-3 missile. China will operate the Type 094 Jin Class and Type 096 Tang Class concurrently and plans to enter two Tang Class submarines into service by 2030, increasing its submarine fleet to eight vessels.[60]

In the air, the United States is leading with its current and future programs. Russia and China currently do not possess stealth bombers, while the U.S B-2 does possess stealth capabilities. The B-21 Raider stealth bomber program has approximately five B-21s in the final stages of production, with test flight trials scheduled for later in 2023. Russia and China both have current

stealth bomber programs. Russia's PAK-DA stealth bomber is estimated to enter service by 2027, while China's H-20 stealth bomber is estimated to enter by 2030.[61]

AN EMERGING THREAT IN NORTH KOREA

The risks described above are further complicated by the Democratic People's Republic of Korea (DPRK) whose nuclear program and relationships with China and Russia should not be overlooked. North Korea, like China, has been expanding its nuclear arsenal at an alarming rate. However, it does not receive the same coverage as great power competitors. North Korea developed its first nuclear weapon in the 1990s and has continued to invest in developing diverse types of weapons and delivery platforms over the last 30 years. Because of North Korea's status as a Hermit Kingdom, information is limited about its program and most unclassified information is estimative in nature. For example, the Institute for Science and International Security has been tracking and estimating DPRK nuclear weapon stockpiles since the 1990s. Its most recent estimate, published in April 2023, discusses three different estimate amounts based on North Korea's access to nuclear materials and probable types of weapon cores (simple, composite, and one-stage thermonuclear).[62] The range of the three estimates varies widely from 17 to 96 nuclear weapons but averages North Korea's arsenal to be between 35 and 63 weapons with varying core combinations.[63] These numbers are up from 2005, where the Institute estimated that North Korea possessed between five and 13 nuclear weapons.[64] Furthermore, the United States and the West's sanctions on Russia for its invasion of Ukraine has resulted in expanded relations between Russia and North Korea as epitomized by Supreme Leader Kim Jong Un's visit to Russia in September 2023. Analysts at the Council on Foreign Relations believe the warming of relations will result in mutually beneficial trade between the nations, primarily in weapons, food, and technology, which would be used to bolster Russia's efforts in Ukraine and elevate the defense capabilities of North Korea.[65]

CONCLUSION

Overall, U.S. next generation delivery platforms and systems remain more technologically superior to competitor systems. Be that as it may, Russia and China are continuously working to close the gap. Under the current geopolitical environment, the United States must consider further modernization efforts and changes to its national security strategy to compete against and deter two peer nuclear-armed adversaries and one endeavoring near-peer nuclear threat. The current pace of China's modernization, Russia's invasion of Ukraine and suspension of New START, and the growing relations between Russia, China, and North Korea have increased the challenge of strategic deterrence. As these adversaries become more nuclear-capable, their commitment to increasing capabilities and capacities may embolden these nations to alter intentions towards the United States. Therefore, the United States must continue to invest in enhancing its capabilities and should consider investing in new and more reciprocal systems that are more survivable, and that will continue to deter adversaries of the United States. ■

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