Nuclear Policy Re(V)iew from the Periscope: SLBM and SLCM Policy Options for the 2022 Biden White House

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ABSTRACT

Advances in nuclear weapon technologies from – and the corresponding evolution in the threat landscape posed by – non-allied nations over the past four years underscores the exigency of the United States (U.S) in updating its stated national security policies. Here we review and suggest options for the 2022 Nuclear Posture Review (NPR) regarding the low-yield submarine-launched cruise missile (SLCM-N) and submarine-launched ballistic missile (SLBM) programs. The 2018 NPR called for programmatic changes to counteract the evolving threat environment and allow for greater deterrence flexibility. These programs include modernization of existing technologies and creation of novel weapons systems. Of these changes, two new programs were started to develop low-yield, sea-based, non-strategic weapons. These options are designed to counter any perceived gaps in U.S. regional deterrence capabilities. We enumerate several policy options likely to be considered by the Biden White House. Our proposed solution calls for maintenance of the W76-2 program and the continuance of the low-yield SLCM-N program; we present our argument along the axes of technical and cost considerations, service system preferences, tailored response capabilities, ensured support and defense of our allies, and prevention of escalation to war.

KEYWORDS

Low-Yield SLCM-N; Deterrence Gap; Nonstrategic Deterrence; Extended Deterrence; Deter Aggression; Nuclear Posture Review; Biden Administration; National Security Policy

1. Introduction

The major national security threats facing the United States (U.S.) today come from two sources: renewed great power competition and the continued threat from aggressive, regional powers.¹ The Russian Federation (R.F.) and The People's Republic of

1. George Perkovich and Pranay Vaddi, *Proportionate Deterrence: A Model Nuclear Posture Review* (Washington DC: Carnegie Endowment for International Peace, 2021), https://carnegieendowment.org/files/Perkovich_Vaddi_NPR_full1.pdf.

China (P.R.C.) have become increasingly assertive in matters relating to security, diplomacy, and economics in an effort to degrade the rules-based international order and replace it with a framework more amenable to their own interests. The Democratic People’s Republic of Korea (D.P.R.K.) and Iran also pose continuing threats to the U.S. and its allies by conducting increasingly aggressive campaigns of provocation and maligned influence in their respective regions. The scope and scale of these campaigns are amplified by their nuclear ambitions. Table 1 below summarizes the main objectives, strategic threats to U.S. interests, and nuclear ambitions of each state.

State	Main Objective	Strategic Threat to U.S. Interests	Nuclear Ambitions
R.F.	Expanding perceived sphere of influence, alleviating historically rooted insecurity, and increasing the nation’s own perceived security. ^{2,3}	Nuclear coercion in the near abroad, undermining Western democratic institutions, and willingness to violate regional neighbor sovereignty. ^{4,5}	Modernize forces to ensure ability to win should conflict ensue.
P.R.C.	Replacing the U.S. as the predominant global superpower and supplanting the U.S.-led liberal international order with an authoritarian regime. Seeking territorial revision in the South China Sea, Taiwan, and the Philippines, and control of strategic shipping routes. ^{6,7}	Seizure of territory belonging to US allies, economic and military coercion of democratic powers, erosion of freedom of navigation in vital shipping lanes.	Plans to have up to 1000 operational warheads by 2030 and an air-based delivery vehicle to complete its nuclear triad. ⁸ Modernizing strategic and theater-level weapons to counter ballistic missile defenses and include more MIRVs. Likely that more Jin-class SSBNs will be deployed. Hypersonic glide vehicle projects are additionally underway. ⁹
D.P.R.K.	Developing a nuclear arsenal to ensure regime survival, and to coerce neighbors and neighbors’ allies ¹⁰	Decoupling the U.S. and R.O.K, by developing a nuclear deterrent with the ultimate goal to reunify the peninsula on terms favorable to Pyongyang.	Develop functioning nuclear capabilities to establish itself as a nuclear power.
Iran	Becoming a preeminent power in the Middle East, establishing friendly governments in neighboring states, and deterring U.S. intervention in the region.	Hindering US intervention in the region, and establishing control over shipping lanes	Develop the ability to act with impunity throughout the middle east.

Table 1. Overview of U.S. Threat Environment.

It can be seen from Table 1 that the nuclear ambitions of a country are heavily dependent on their nuclear arsenals. Russia is currently looking to modernize its large arsenal. It is pursuing non-strategic weaponry with increased accuracy and lower yields intended to defeat theater and strategic missile defense systems. As well, it is continuing its well-established research programs in hypersonic systems, nuclear-armed unmanned underwater vehicles, and nuclear-powered unmanned aerial systems.¹¹ China currently has around 200 warheads but is in the process of modernizing and expanding their arsenal with the DOD projecting that its warhead count may exceed 1000

11. *Annual Report On Implementation Of The New Start Treaty*, technical report (U.S. Department of State, 2018), <https://www.state.gov/documents/organization/280780.pdf>.

Figure 1. Overview of Nuclear Weapon Inventories. (A) Nuclear arsenal breakdown by country colored by weapons as declared strategic or non-strategic. (B) Nuclear arsenal breakdown by country colored by weapon classification in terms of launch location and missile type (GLBM: ground-launched ballistic missile, GLCM: ground-launched cruise missile, ALBM: air-launched ballistic missile, ALCM: air-launched cruise missile, ALGB: air-launched bombs, SLBM: submarine-launched ballistic missile, SLCM: submarine-launched cruise missile, ABM: anti-ballistic missile, HGV: hypersonic glide vehicle, ND: non-determined weapon type).

by 2030.^{12,13} The D.P.R.K. is still in the early stages of its nuclear weapon program, claiming an arsenal of 30-40 nuclear weapons and enough fissile material to produce 6-7 weapons annually; this has not been confirmed by the US or any atomic agencies.¹⁴ In 2010, it revealed a centrifuge facility which can produce highly enriched uranium for weapons. U.S. intelligence suspects there are more such facilities. The DPRK has also been operating a 5 MW heavy water graphite-moderated reactor to extract Plutonium for nuclear warheads on and off since August 2013. In 2016, they began operations at a reprocessing facility extracting usable uranium from the spent fuel.¹⁵ Iran does not currently possess nuclear weapons. Its enrichment capabilities were limited under the Joint Comprehensive Plan of Action (JCPOA); it is suspected that they have increased nuclear research and development since U.S. withdrawal from the agreement. The arsenals of these states in addition to the remaining nuclear weapon states are presented in Figure 1. Figure 1A covers the deployment status by warhead number of each arsenal while 1B breaks down the arsenals by the number of warheads on each

12. *Military and Security Developments Involving the People's Republic of China 2021*, technical report (Washington, DC: U.S. Department of Defense, 2021), <https://media.defense.gov/2021/nov/03/2002885874/-1/-1/0/2021-cmpr-final.pdf>.

13. Vavasseur, *US DoD's 2021 China Military Power Report: PLAN Is The Largest Navy In The World*.

14. Kelsey Davenport, Reif Kingston, and Daryl G. Kimball, *Nuclear Weapons: Who Has What at a Glance*, technical report (Washington, DC: Arms Control Association, 2021), <https://www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat>.

15. Davenport, Kingston, and Kimball.

Figure 2. Evolution of Threat Environment. **(A)** Plot of range [km] and Yield [kT] for nuclear weapon states. The dotted line corresponds to the separation between short-range and medium range weapons. **(B)** Timeline of nuclear weapon deployments since 2010 colored by nation with shapes indicating weapon system classification. The colors from (B) also correspond to the nations in (A).

type of delivery vehicle.^{16,17,18,19,20,21}

1.1. A New Low-yield Nonstrategic Missile Gap

The threat environment posed by nuclear weapon states such as Russia and China has evolved with the development of new weapon systems such as the hypersonic glide vehicle (HGV). An analysis of the nuclear weapon arsenal in terms of range and yield as shown in Figure 2A demonstrates that specific gaps have opened in U.S. Capabilities in the low yield / low range space. This space is typically associated with nonstrategic or tactical weapons. We adopt the threshold for low-yield as 8 kilotons yield or less, where standard yield will be yields exceeding this.²² Moreover, this evolution can be glimpsed when reviewing the timeline of weapon deployments since 2010 as shown in Figure 2B. Here we can see that the U.S. has only deployed a single system in the past 10 years while China and Russia have deployed multiple weapon systems.

16. Hans M Kristensen and Matt Korda, “North Korean nuclear weapons, 2021,” *Bulletin of the Atomic Scientists* 77, no. 4 (2021): 222–236, <https://doi.org/10.1080/00963402.2021.1940803>, <https://doi.org/10.1080/00963402.2021.1940803>.

17. Hans M Kristensen and Matt Korda, “Russian nuclear weapons, 2021,” *Bulletin of the Atomic Scientists* 77, no. 2 (2021): 90–108, <https://doi.org/10.1080/00963402.2021.1885869>, <https://doi.org/10.1080/00963402.2021.1885869>.

18. Hans M Kristensen and Matt Korda, “United Kingdom nuclear weapons, 2021,” *Bulletin of the Atomic Scientists* 77, no. 3 (2021): 153–158, <https://doi.org/10.1080/00963402.2021.1912309>, <https://doi.org/10.1080/00963402.2021.1912309>.

19. Hans M Kristensen and Matt Korda, “Indian nuclear forces, 2020,” *Bulletin of the Atomic Scientists* 76, no. 4 (2020): 217–225, <https://doi.org/10.1080/00963402.2020.1778378>, <https://doi.org/10.1080/00963402.2020.1778378>.

20. Hans M Kristensen and Matt Korda, “Chinese nuclear forces, 2020,” *Bulletin of the Atomic Scientists* 76, no. 6 (2020): 443–457, <https://doi.org/10.1080/00963402.2020.1846432>, <https://doi.org/10.1080/00963402.2020.1846432>.

21. Hans M Kristensen and Matt Korda, “Pakistani nuclear weapons, 2021,” *Bulletin of the Atomic Scientists* 77, no. 5 (2021): 265–278, <https://doi.org/10.1080/00963402.2021.1964258>, <https://doi.org/10.1080/00963402.2021.1964258>.

22. Hans M Kristensen and Matt Korda, “United States nuclear weapons, 2021,” *Bulletin of the Atomic Scientists* 77, no. 1 (2021): 43–63, ISSN: 0096-3402.

1.2. Inventory of U.S. Submarine-Launched Arsenal

Understanding the current state of the U.S. arsenal is the first step to making decisions that best support its future relevancy. The sea-based arsenal consists of varying warheads that are all mounted on Trident II D5 missiles. The current warhead distribution is summarized in Table 2.²³

In addition, the U.S. has also considered developing the W93, but funding for the W93 is not currently designated in the 2021 and 2022 defense budgets and it is unknown if the program will continue. If developed, this would be yet another standard yield warhead that uses the same delivery vehicle as the low-yield W76-2. The U.S. does not currently have any nuclear SLCMs in the arsenal. However, it does have a history with the weapon as it still uses the TLAM cruise missile, which once had a nuclear version, the TLAM-N. All TLAM-Ns were dismantled during the Obama administration. As previously mentioned, the 2018 NPR called for an investigation into future SLCM-N technologies.

Type/Designation	No.	Year deployed	Warhead x yield (kT)	Warheads available
SLBMs				
UGM-133A Trident II D5/LE	240 ¹			
Mk-4A		2008 ²	1-8 W76-1 x 90 (MIRV)	1,511 ³
Mk-4A		2019	1-2 W76-2 x 8 (MIRV) ⁴	25 ⁵
Mk-5		1990	1-8 W88 x 455 (MIRV)	384
Total	240			1920 ⁶

Table 2. US SLBM nuclear forces, 2021.¹Only counts 240 SLBMs for 12 deployable ballistic missile submarines. Two other ballistic submarines are in refueling overhaul for a total of 280 launchers. There are a total of 448 SLBMs in the inventory, of which about half are for spares and flight tests. The life-extended D5 LE is replacing the original missile.

²The W76-1 is a life-extended version of the W76-0 that was first deployed in 1978.

³All W76-0 warheads are thought to have been replaced on the ballistic missile submarines by W76-1 warheads, but several hundred are still in storage, and more have been retired and are awaiting dismantlement.

⁴The W76-2 is a single-stage low-yield modification of the W76-1 with an estimated yield of 8 kilotons.

⁵Assumes two SLBMs, each with one W76-2, available for each deployable SSBN.

⁶Of these SLBM warheads, approximately 1,000 are deployed on missiles loaded in ballistic missile submarine launchers.

2. Nuclear Posture and Policy

The purpose of a Nuclear Posture Review (NPR) is to develop and propagate declaratory nuclear policy for transparent and clear communication with other nuclear players. A successful NPR will help deter nuclear proliferation, maintain strategic deterrence and stability, reassure U.S. allies and partners, and sustain a safe, secure, and effective nuclear arsenal. Both the 2010 NPR²⁴ and the 2018 NPR²⁵ sought to reach these goals, though their individual approaches varied from one another. In the last decade alone, the changes to the nuclear landscape have necessitated a reevaluation of how to best ensure credible and effective deterrence leading to the differences in the declared postures.

23. Kristensen and Korda, “United States nuclear weapons, 2021.”

23. Ibid.

24. *Nuclear Posture Review Report*, technical report (Washington, DC: U.S. Department of Defense, 2010), https://dod.defense.gov/portals/1/features/defensereviews/npr/2010_nuclear_posture_review_report.pdf.

25. *Nuclear Posture Review Report*, technical report (Washington, DC: U.S. Department of Defense, 2018), <https://media.defense.gov/2018/feb/02/2001872886/-1/-1/1/2018-nuclear-posture-review-final-report.pdf>.

The 2010 NPR prioritized Life Extension Programs (LEP) for components in each leg of the triad and initiated a survey of the arsenal for readiness and contemporary relevance. It strongly recommended that no new weapons technologies should be developed or tested; production of new nuclear components would only be overridden if the deployed units could not be reused. An underlying theme of this NPR was maintenance of deterrence with proactive movement and advocacy for global disarmament and non-proliferation.

The 2018 NPR prioritized modernizing and expanding the U.S. nuclear arsenal capabilities and deployment methods. The 2018 NPR explicitly moved to replace aging systems, beginning with development tracks for the Columbia-class SSBN, the B-21 Raider, and an alternative for the Minuteman III. Furthermore, it called for novel low-yield weapons programs, which led to the deployment of the W76-2 in 2019, and the beginning of the SLCM-N track with a projected first production unit in 2029.²⁶ An underlying theme of this NPR was expansion of the available levels of response within the arsenal and advocacy for extended deterrence.

2.1. *Potential Policy Options*

2.1.1. Expansion on Low-Yield Nuclear Options

Given the evolution of regional threats to U.S. allies, the development of additional non-strategic capabilities is necessary for the credibility of extended deterrence. Prior to the introduction of the W76-2, the sole nonstrategic nuclear weapon in the modern U.S. arsenal was the B61 gravity bomb. However, the survivability of the delivery systems for this weapon is in question given adversaries' rapidly advancing air defense technologies. An adversary may consider the use of a strategic weapon by the U.S. in response to limited aggression as disproportionate, and therefore not credible – although this is a matter of judgement. Russia's suspected posture of 'escalate to de-escalate' relies on this perception and deterrence is undermined from this perceived gap. The recent addition of low-yield SLBMs provides a rapid yet measured response to the changing nuclear landscape and the development of SLCM-Ns will provide further flexibility to respond to emerging threats. Continuing the 2018 NPR's plan to maintain low-yield SLBMs and develop low-yield SLCM-Ns improves U.S. deterrence credibility while mitigating the perceived advantages held by nuclear adversaries in nonstrategic conflicts.

2.2. *Reduction in Low-Yield Nuclear Options*

The deployment of low-yield nuclear weapons may be perceived by some adversaries and allies as destabilizing. There is concern that the presence of the low-yield option could lower the nuclear threshold and trigger another arms race.²⁷ Developing low-yield nuclear weapons could be interpreted as a signal that the U.S. is seeking more "usable" weapons for use in smaller-scale conflicts. Of additional concern to U.S. national security is China's speculated "anti-access/area denial" (A2/AD) tactic. The presence of low-yield weapons may pressure China to adopt a "use it or lose it"

26. *Fiscal Year 2021 Stockpile Stewardship and Management Plan – Biennial Plan Summary*, technical report (Washington, DC: U.S. Department of Energy, 2021), <https://www.energy.gov/sites/prod/files/2020/12/f82/FY2021.SSMP.pdf>.

27. Anneke R Taylor, "Nuclear Deterrence and Low-Yield Nuclear Weapons in Russia and the United States," *The Commons: Puget Sound Journal of Politics* 1, no. 2 (2021): 4.

mentality in the case where its co-located delivery systems and Command, Control, Communications, Computers Intelligence, Surveillance and Reconnaissance (C4ISR) systems are neutralized in a counter-force attack. Furthermore, the development of low-yield weapons could be viewed as a violation of Article VI of the 1970 Treaty on the Non-Proliferation of Nuclear Weapons (NPT) clause on pursuing good-faith measures “relating to the cessation of the nuclear arms race.”²⁸

2.3. *Transition to New Low-Yield Nuclear Options*

The U.S. currently deployed low-yield warhead, the W76-2, is delivered via the Trident II D5 missile which can also be equipped with the standard-yield W76-1 and W88 warheads.²⁹ This introduces a discrimination problem, in which an adversary may not be able to determine the yield of a launched missile until detonation. The ambiguity may force an adversary to assume the U.S. is using strategic force.³⁰ This discrimination problem is illustrated via possible scenarios, as shown in Table 3.

Target Interpretation	U.S. Launch	
	Low-Yield Launch	High-Yield Launch
Low-Yield Interpretation	Target nation responds with equivalent force and use of strategic forces is avoided. Low-yield launch achieves its goal.	Target nation incorrectly responds to a limited attack while the high-yield warhead causes devastation. U.S. launch achieves its goal.
High-Yield Interpretation	Target nation responds with its strategic force of which the U.S. responds with its strategic forces. General thermonuclear war ensues.	Target nation correctly responds to the high-yield attack under the principles of mutually-assured destruction. General thermonuclear war ensues.

Table 3. Possible Outcomes of a U.S. Trident II D5 Missile Launch.

The development of the W76-2 provides a readymade, proportionate response to limited nuclear use or a limited first strike capability. However, the transition to the proposed SLCM-N would alleviate the discrimination issue with warhead ambiguity on the Trident II D5, as it would clearly demonstrate a non-strategic option and fulfill the role for a low-yield option, while being potentially less destabilizing than the W76-2.

2.4. *Policy Option Synthesis and Suggestion*

The position of this paper is that the W76-2 and the SLCM-N will both fulfill important roles in the U.S.’s nuclear arsenal for maximizing the flexibility of options and maintaining extended deterrence capabilities. Furthermore, we contend that the

28. *Treaty on the Non-proliferation of Nuclear Weapons*, technical report (Stockholm, Sweden: International Atomic Energy Agency, 1970), <https://www.un.org/disarmament/wmd/nuclear/npt/>.

29. Kristensen and Korda, “United States nuclear weapons, 2021.”

30. Vipin Narang, “The discrimination problem: Why putting low-yield nuclear weapons on submarines is so dangerous,” *War on the Rocks* 8 (2018).

low-yield weapons programs are a cornerstone to this extended deterrence, and the W76-2 systems should remain deployed at current levels, while the SLCM-N should eventually be maintained at quantitatively lower levels. It is imperative that the development of the SLCM-N still be pursued and ultimately deployed on a reasonable timescale.

The development of other low-yield, non-strategic capabilities by strategic competitors is a threat to regional deterrence, if not mitigated appropriately. It is precisely because these other states are developing and testing similar weapons that U.S. production and deployment of low-yield SLCM-Ns is not a threat to the existing nuclear threshold, but rather a necessity to maintaining options at all levels of escalation. Having both of these low-yield, non-strategic capabilities available is necessary to maximize the options for the dynamic nuclear landscape. While it may be worthwhile to remedy in the future, the discrimination problem of the W76-2 is outweighed by its utility and support to the arsenal, and that this capability is already available. It is a further recommendation that the development of the SLCM-N may include some measures to help prevent indistinguishability between it and conventional cruise missiles, in order to prevent unwarranted escalation during conventional exchanges once this capability is deployed.

3. Synthesis Arguments

3.1. *Maximizing Capabilities to Respond to Ever Changing Threats*

The U.S. faces nations with varied levels of nuclear development. Developing and introducing the SLCM-N alongside the W76-2 provides greater ability to tailor responses to the heterogeneous nuclear threat landscape. During the Defense Department FY 2022 Budget Request, General Mark Milley, Chairman of the Joint Chiefs of Staff, emphasized that when it comes to nuclear deterrence it is best that the U.S. maintains as many options as possible for the White House to consider.

3.1.1. *Keeping Pace With Peace*

The continued development of weapons programs by various states, primarily R.F., P.R.C., and the D.P.R.K., creates the potential for regional deterrence gaps. In the 2018 Presidential Address to the Federal Assembly, Vladimir Putin expressed that Russia desires to grow its military power. In this speech, President Putin revealed that Russia was developing three different kinds of strategic nuclear weapons. Russia has since deployed an intercontinental hypersonic glider, Avangard, and is developing a nuclear powered cruise missile, Burevestnik, and a nuclear powered torpedo, Poseidon.³¹ China plans to increase its number of land-, sea-, and air-based nuclear weapons delivery systems, to support its pursuit of a nuclear triad.³² Its efforts are focused primarily on expanding air-launched and sea-based capabilities, and China also plans to increase its nuclear warhead stockpile several fold by 2030.^{33,34} The D.P.R.K.

31. Vladimir Putin, *Presidential Address to the Federal Assembly*, Moscow, Russia, March 2018, <http://en.kremlin.ru/events/president/news/56957>.

32. *Military and Security Developments Involving the People's Republic of China 2020: Annual Report to Congress*.

33. *Military and Security Developments Involving the People's Republic of China 2021*.

34. Julia Masterson and Shannon Bugos, *Pentagon Warns of Chinese Nuclear Development*, technical report (Washington, DC: Arms Control Association, 2020), <https://www.armscontrol.org/act/2020-10/news/>

is also aiming to develop its nuclear capabilities and programs; in 2016, Kim Jong-un expressed that North Korea was successful in a hydrogen bomb test, though the veracity of this claim is unverified.³⁵ In 2017, Kim Jong-un also promised the development of ICBMs. U.S. intelligence confirmed through seismic data that explosions in North Korea occurred, however some skepticism remains regarding whether or not the source was thermonuclear. The development of non-strategic systems by other states does not obligate the U.S. to respond in kind. However, we assess that the potential for deterrence gaps exists and there are missions in which low-yield weapons would be preferred.

3.1.2. *Consistency in Ever-Changing Environments*

The 2010 NPR stated that nuclear-armed cruise missiles were no longer strategically necessary and the US subsequently decommissioned the TLAM-N in 2013 without initiating any replacement programs.³⁶ The 2018 NPR stated that maintaining deterrence in the current threat environment necessitated developing a new low-yield SLCM-N and SLBM.³⁷ The SLBM program has been completed, leading to the production and deployment of the W76-2 in 2019. However, the SLCM-N will not have the first production unit until 2029, as the development program has yet to move past the initial planning stages.³⁸ Due to how quickly the nuclear landscape changes and how long development programs take, capabilities needed today are coming into effect years down the line in a completely new environment. Even though a specific capability might not be needed at the present time, it is important that it will be readily available when it is needed, and not a nine year development program away; commissioning or decommissioning capabilities at the time of need is ineffective. It is important to develop the SLCM-N so that the U.S. is prepared to deter aggression in current and future scenarios. The SLCM-N provides the White House a different low-yield nuclear option, that in conjunction with the W76-2 creates credible, flexible, and tailorable deterrence options to address not only present threats, but also to develop resiliency to emerging nuclear threats.^{39,40,41,42}

3.2. *The Discrimination Problem*

The discrimination problem arises when an adversary cannot tell what type of payload will be delivered by an incoming missile, forcing them to act under the assumption of

pentagon-warns-chinese-nuclear-development.

35. *North Korea Threat Initiative*, technical report (Washington, DC: Nuclear Threat Initiative, 2021), <https://www.nti.org/analysis/articles/north-korea-nuclear/>.

36. *Nuclear Posture Review Report*.

37. *Nuclear Posture Review Report*.

38. *Fiscal Year 2021 Stockpile Stewardship and Management Plan – Biennial Plan Summary*.

39. James M Acton, Thomas D MacDonald, and Pranay Vaddi, *Revamping nuclear arms control: five near-term proposals* (Carnegie Endowment for International Peace., 2020).

40. *Military and Security Developments Involving the People's Republic of China 2020: Annual Report to Congress*.

41. Choe Sang-Hun, "US confirms North Korea fired intercontinental ballistic missile," *New York Times* 4 (2017).

42. Damin Jung, *Kim Jong Un inspects thermonuclear weapon to be loaded in ICBM warhead*, Wilmington, DE, September 2017, <https://www.nknews.org/2017/09/kim-jong-un-inspects-loading-of-thermonuclear-warhead-to-long-range-missile/>.

the worst case-scenario.⁴³ There are two versions of this problem: (1) when a missile cannot be identified as conventional or nuclear; and (2) when a nuclear warhead cannot be determined as low- or standard-yield prior to detonation. It is important that a state employing a nuclear weapon minimizes the risk of escalation that the discrimination problem can cause.

3.2.1. *Conventional vs. Nuclear Discrimination*

A concern with the SLCM-N is that under most conditions, a nuclear sea-launched cruise missile can not be distinguished from its conventional counterpart.⁴⁴ The current development program aims to make the SLCM-N a proportional, discriminate, and survivable threat, as outlined by the 2018 NPR.⁴⁵ The survivability of the missiles can be maximized by only deploying them on submarines, which are inherently less vulnerable than surface ships, ensuring that the SLCM-N is a credible threat. The best case-scenario for ensuring discrimination of the weapon would be if the development of the SLCM-N includes a mechanism to make it differentiable upon detection in flight from conventional cruise missiles. The U.S. Air Force and the U.S. Navy are separately pursuing new cruise missiles, either of which could be branched to develop a vehicle for a low-yield weapon that addresses concerns about discrimination and deployment logistics. However, if this is not an option, it is still worthwhile to trade off differentiability for the survivability of the missile and the additional option it would provide; the systems themselves are better assets and more credible due to their decreased vulnerability. The discrimination problem of the SLCM-N does not inherently allow for escalation to strategic warfare; if a conventional weapon was interpreted as the low-yield SLCM-N, the appropriate response by the adversary would keep the conflict in the domain of non-strategic, regional warfare.

3.2.2. *Low- vs. Standard-Yield Discrimination*

A concern with the W76-2 is that under most conditions it cannot be distinguished from its standard-yield counterpart. The W76-2 is the only low-yield option currently available to the U.S. arsenal, having an expected yield of 8 kilotons. The Trident II D5 also carries two standard-yield warheads: the W76-1 and the W88.⁴⁶ No adversary can distinguish whether the Trident II D5 is carrying either of the two standard-yield warheads or the low-yield warhead prior to detonation.⁴⁷ When faced with this uncertainty, the target nation will have no choice but to interpret a launch of the Trident II D5 to contain standard-yield warheads, and thus respond proportionately with strategic forces; deploying the W76-2 on the Trident II D5 missiles greatly increases the risk of strategic forces being used, as described in Table 3. The SLCM-N could be developed to potentially avoid the heightened risk associated with the current deployment of W76-2 warheads on Trident II D5 missiles. The development of the SLCM-N could potentially reduce the risk of unintentional escalation and resolve this discrimination

43. Narang, “The discrimination problem: Why putting low-yield nuclear weapons on submarines is so dangerous.”

44. Narang.

45. *Strengthening Deterrence and Reducing Nuclear Risks, Part II: The Sea-Launched Cruise Missile-Nuclear (SLCM-N)*, technical report (Washington, DC: U.S. Department of State, 2020), <https://www.state.gov/wp-content/uploads/2020/07/t-paper-series-slcm-n-final-508.pdf>.

46. Kristensen and Korda, “United States nuclear weapons, 2021.”

47. Narang, “The discrimination problem: Why putting low-yield nuclear weapons on submarines is so dangerous.”

problem, if it were deployed on a delivery vehicle with no standard-yield counterpart – in accordance with its current development track. However, this does not discredit the larger role of the W76-2 to deterrence, as it is ready-made and provides a low-yield option with more range and penetrative power than the SLCM-N, and it should therefore be the larger component of the low-yield arsenal.

3.3. *Service System Preferences*

The development of nonstrategic weapons systems does not occur in vacuum; the services deploying these systems have preferences and limitations that influence development decisions. While the SLCM-N and the W76-2 share similar deployment platforms and missions, they do not place an equal burden on the infrastructure of the Navy. These concerns are often overlooked in public debates on the issue, as the services tend to be less publicly vocal about political decisions so as to maintain appropriate civil-military relations.

The SLCM-N is described in the 2018 Nuclear Posture Review as a robust non-strategic option which can “provide additional diversity in platforms, range, and survivability, and [be] a valuable hedge against future nuclear ‘break out’ scenarios.”⁴⁸ However, some in the Navy contend that the SLCM-N will reduce the ability of the Navy to project force in conventional conflicts and incur considerable costs on an already over-strained service.⁴⁹

The exact impacts vary based on the deployment mode. If loaded aboard SSBNs, the SLCM-N will necessarily displace Trident D5 tubes used for strategic capabilities. This could be seen as undercutting the Navy’s role in the nuclear triad and an inadvisable move given the high marginal value of each tube aboard the most survivable nuclear platform in the fleet. Though expansions in the fleet may obviate this criticism, current budgetary limitations prevent this in the near term.

Moving the deployment modality to SSGNs does not alleviate the issue, as these submarines will require significant security upgrades to host nuclear weapons, in addition to launch-tube retrofitting should the SLCM-N be incompatible with existing VLS systems.⁵⁰ Furthermore, these submarines will be less able to participate in conventional conflicts if there is a chance of a nuclear-armed third party becoming involved by alliance or physical proximity. Due to the inherent discrimination problem introduced by the adoption of nuclear-armed cruise missiles aboard a SSGN, the use of conventional arms from this nuclear-capable platform could elicit nuclear retaliation.

If the SLCM-N is loaded on surface vessels, those vessels will additionally require a Marine Corps protective force, and retrofitting to meet standards for nuclear-armed vessels. Aside from domestic regulation and retrofitting, external forces may constrain the freedom of movement of such vessels should they deploy nuclear arms.⁵¹

Due to nuclear-weapons-free zones and states signatory to the Treaty on the Prohibition of Nuclear Weapons (TPNWs),⁵² there may be limitations on ports-of-call imposed on the surface fleet. As the Navy has historically refused to confirm or deny

48. *Nuclear Posture Review Report*.

49. Mallory Shelbourne and Sam LeGrone, *Lawmakers Question Navy’s Decision to Abandon Nuclear Cruise Missile*, Annapolis, MD, June 2021, <https://news.usni.org/2021/06/10/lawmakers-question-navys-decision-to-abandon-nuclear-cruise-missile>.

50. Shelbourne and LeGrone.

51. *USS Buchanan Refused Entry to New Zealand*, February 1985, <https://nzhistory.govt.nz/page/uss-buchanan-refused-entry-new-zealand>.

52. U N General Assembly, “Treaty on the prohibition of nuclear weapons,” in *A/CONF*, vol. 229, 2017 (2017), 8.

nuclear armament, the impact of deploying nuclear weapons on the surface fleet may have extremely broad ramifications. Countries with positive defense relationships with the US may additionally face pressure to disengage from war gaming activities that see them operating alongside nuclear-armed vessels.

In some scenarios, it is conceivable that the ability to engage in conventional conflicts may be limited by the adoption of nuclear armaments on surface vessels. In a purely conventional conflict in which a conventionally-armed state has a large presence of nuclear-armed state troops, or if that state maintains an alliance with a nuclear-armed state, the introduction of a nuclear-armed surface ship could result in escalation. The possibility of this miscommunication may engender restraint on the US side that is otherwise unwarranted.

3.4. *Technical Considerations*

While ballistic and cruise missiles may carry payloads of any yield and can be used as either strategic or non-strategic systems, they are inherently non-interchangeable. Ballistic and cruise missiles operate in fundamentally different flight regimes, may carry dramatically different payloads, and often serve different missions. Ballistic missiles have served as the backbone of the U.S. strategic nuclear forces since the 1960s. In their modern form, they are capable of lofting up to a half-dozen independently targetable reentry vehicles on trajectories spanning up to 15,000km. Propelled by solid or liquid-fueled rocket engines, ballistic missiles spend the majority of their flight time outside of the earth's atmosphere, and can re-enter at velocities exceeding Mach 18⁵³. A typical minimum-energy trajectory puts a ballistic missile on target on the opposite side of the globe in approximately thirty minutes, resulting in a dramatically short timeline for countermeasures, making interception difficult.⁵⁴

The high kinetic energy of a reentry body allows a variety of applications for which gravity bombs or cruise missiles are not ideal. Ballistic missiles offer the possibility of multiple warheads timed such as to avoid warhead fratricide. Should large numbers of warheads be needed for a single target, such as a bunker, a MIRV'd ballistic missile is likely the best option. Likewise, if a target is likely to relocate, the short flight time can be an asset as the target can be hit before it moves. In the case of buried targets, reentry vehicles can be designed to detonate after digging themselves many meters into the media, resulting in better shockwave coupling and improved single-shot probability of kill (SSPK) with limited total yield.

However, due to the shape of the trajectory, highly energetic propulsion systems, and flight dynamics, ballistic missile launches and re-entries are eminently detectable. Space-based infrared detection systems (SBIRs), ground-based radar systems, and airborne detection platforms have been developed with the specific intent of locating and reporting strategic missile launches. Due to this detectability and their inherent strategic role, it is generally agreed that to use ballistic missile systems is to enter general thermonuclear war. Thus any usage for any application mandates careful consideration to prevent false alarm or escalation.

Cruise missiles have more in common with aircraft than ballistic missiles. These systems are most typically subsonic, carry a single warhead, and have ranges under 5000km. Cruise missiles are typically powered by sub-MW-class turbine engines, and therefore have little thermal signature making them much harder to detect at launch.

53. 18 times the speed of sound

54. L S Glover and J C Hagen, *The motion of ballistic missiles*, technical report (1971).

They skim terrain at extremely low altitudes where they can get lost in ground radar clutter to avoid detection. Many designs additionally employ construction techniques that minimize radar cross-section.

Historically, nuclear armed cruise missiles have been employed as ground-launched intermediate-range systems and as sea-launched strategic and nonstrategic systems. In the configuration proposed, the SLCM-N would not be capable of striking hardened targets without high yield warheads, which may pose an issue should nonstrategic targets be hardened. It is in part because of these reasons, we recommend having both the low-yield SLBM W76-2 and SLCM-N in the arsenal, to provide a variety of capabilities while remaining aware of their shortcomings and advantages.

3.5. *Considering U.S. Allies*

U.S. allies rely on extended deterrence in which U.S. nuclear forces are committed to extraterritorial defense. The Biden administration made it a key point on the 2020 campaign trail that the United States would be much more engaged with our allies and partners under his administration. They reaffirmed this commitment to unified opposition to Russia and China’s attempts to undermine democracy and the rules-based international order.⁵⁵

Regional deterrence relies on the scalability and flexibility of the United State’s nuclear posture. Russia is the most imposing threat to strategic stability and NATO allies. The 2018 NPR suggested that there was a deterrence “gap” that could be exploitable by Russia in the event of a low-yield nuclear conflict.⁵⁶ Collectively, NATO allies have yet to explicitly agree to the presence of said “gap,” but still express concern in the U.S. ability to deter Russian low-yield, nuclear attacks. Developing the SLCM-N should help close this gap since it gives the U.S. a properly-scaled response option. This should be more palatable to our NATO allies, many of whom have much more substantial economic relations with Russia than the United States.

The United Kingdom is a crucial, longtime ally with the United States on global security issues. In early 2021, the U.K. initiated an increase in its nuclear stockpile for the first time in decades due to changes in the security environment.⁵⁷ While it is not entirely clear as to how the larger stockpile will aid U.K. deterrence efforts, it does give them flexibility with targeting options. Developing the SLCM-N is in line with the U.K.’s anti-reduction stance and helps the U.S. stay in alignment with one its closest allies. Furthermore, the U.K. has long been utilizing U.S.-designed SLBMs. Its primary warhead, the Holbrook, is allegedly based on the W-76 and is so similar that it is included on the U.S. DOE’s maintenance schedule.⁵⁸ The technology sharing between the U.S. Navy and the Royal Navy only stands to be strengthened by the development of the SLCM-N and an increased deterrence reliance on low-yield options.

Current nuclear weapon deployment on submarines provides strategic deterrence, but is incapable of being brought to bear in small-scale conflicts, and SLCM-Ns meet that need. Their mere presence provides a constant deterrence against expansionism and also provides the US with low-yield strike capability to deter escalating conven-

55. Joseph Biden, “Remarks by President Biden on America’s place in the world,” *speech*, Washington, DC, February 4 (2021).

56. Jacek Durkalec, *The 2018 US Nuclear Posture Review, NATO’s Brussels Summit and Beyond*, technical report (2018).

57. Hans M Kristensen, *British Defense Review Ends Nuclear Reductions Era*, technical report (Federation of American Scientists, March 2021), <https://fas.org/blogs/security/2021/03/british-defense-review-2021/>.

58. Kristensen.

tional conflicts. Furthermore, with their exact location at any given moment being unknown to adversaries, that deterrence will be felt world-wide. The stealth capabilities of U.S. submarines allow them to remain undetected, providing first or second strike capability regardless of an adversaries' efforts. In contrast, surface fleets are constantly tracked, visible, only provide reassurance in their local region, and are inherently more vulnerable than submarines. Submarine deployment of SLCM-Ns prepares the U.S. to meet and counter the deployment of similar low-yield weapons by other nuclear states, while maintaining overall nuclear deterrence and potentially preventing escalation of conventional conflict.

Given the ongoing contest for territory in East Asia and the South China Sea as well as the persistent U.S. goal of maintaining a global presence, deployment of SLCM-Ns on underwater craft is the most effective path forward to assure key allies, such as South Korea and Japan, and also dissuade North Korean military adventurism. South Korean opinion polls circa 2017 generally support the employment of U.S. tactical nuclear weapons in the region, in part because there was a lack of credibility regarding the U.S. nuclear umbrella in the Korean Peninsula at the time.⁵⁹ The South Korean public expressed the sentiment that the U.S. would not put Los Angeles at risk to save Seoul.⁶⁰ Versatile, reliable, and credible low-yield options like the W76-2 SLBM and the eventual SLCM-N will demonstrate the U.S.'s willingness to defend against conflicts at a variety of escalation levels. Extended nuclear deterrence to South Korea must be resilient and survivable in the case of not only potential nuclear attacks but also conventional attacks. As such, submarine-launched warheads are the best option for second-strike resiliency.

Japan also depends on a credible and robust United States nuclear umbrella, particularly in regards to extended deterrence related to China. The Japanese have active geopolitical disputes with China revolving around the Senkaku Islands, which both countries claim. Despite the 2017 U.S.-Japan joint statement which reaffirmed U.S. commitments to defend Japan even with nuclear capabilities, the Japanese public has a low opinion of nuclear weapons and extended deterrence.⁶¹ The Japanese government, however, does generally approve of the current nuclear arrangement with the United States.^{62,63} A high-yield-only posture would likely not be seen as credible to deter geopolitical disputes of that magnitude. However, the incorporation of low-yield weapons helps to meet the needs of Japan, in part by deterring varied levels of Chinese aggression towards the disputed territory.

3.6. Cost Considerations

The Congressional Budget Office (CBO) recently reanalyzed the 10 year projection of the cost for nuclear forces based upon the 2021 budgetary plans of the DOE and DOD. The CBO estimates the cost for the SLCM-N program from 2021 to its completion

59. Michelle Ye Hee Lee, *More than ever, South Koreans want their own nuclear weapons*, Washington, DC, September 2017, <https://www.washingtonpost.com/news/worldviews/wp/2017/09/13/most-south-koreans-dont-think-the-north-will-start-a-war-but-they-still-want-their-own-nuclear-weapons/>.

60. Toby Dalton, "Between Seoul and Sole Purpose: How the Biden Administration Could Assure South Korea and Adapt Nuclear Posture," *War on the Rocks*, 2021,

61. Masakatsu Ota, "Japanese Nuclear Policy After Hiroshima, After Abe, And After Nov. 3," *War on the rocks* 14 (2020).

62. Sayuri Romei, "Nuclear Ban Treaty Offers Rare Chance for Japan," *The RAND Blog*, 2021, <https://www.rand.org/blog/2021/04/nuclear-ban-treaty-offers-rare-chance-for-japan.html>.

63. *Situation of the Senkaku Islands — Ministry of Foreign Affairs of Japan*, April 2014, https://www.mofa.go.jp/a_o/c_ml/senkaku/page1we.000010.html.

in 2030 will be in the range of \$10B to \$17B.⁶⁴ This estimation was based on the ongoing development of the air-launched Long Range Standoff weapon (LRSO) system, assuming that LRSO missile design and W80-4 warhead will be similar to the SLCM-N. It is worth noting that this estimate does not include costs related to training or fielding the SLCM-N onto submarines after this 2030 projected completion date, which will vary considerably depending on uncertain DOD fielding decisions. These funds could alternatively be invested in areas of nuclear defense such as LEPs or other domains, such as counter cyber terrorism. Future analysis could assess threats and integration and fielding costs to weigh the costs of the SLCM-N program against costs of different nuclear engagement scenarios using other existing capabilities.

With the unpredictability of the evolving nuclear landscape, it is imperative to continue the development of the SLCM-N on a reasonable time scale. It was previously speculated there could be a cut to SLCM-N development funding in the 2022 defense budget, however the Biden administration requested \$15 million for the program.⁶⁵ This amount is less than necessary to meet a flat distribution of \$10B or more over the next 10 years. However, this initial \$15 million may be appropriate to support initial planning activities. While the SLCM-N should comprise a lesser level of non-strategic support to the arsenal than the SLBM W76-2, it is still a worthwhile investment and priority by way of it eventually providing greater flexibility in options, protections for the interests of the US and allies, and continued and measured deterrence. The development of this program is also of strategic importance, as it could bring the nuclear-armed Navy from 12 to potentially up to 30 ships.⁶⁶

4. Conclusion

In order for the U.S to be adequately equipped to maintain stable deterrence in the nuclear environment of both today and tomorrow, it is imperative that the U.S. develop and deploy the SLCM-N to act in conjunction with the readymade W76-2 in low-yield deterrence. This changing landscape is a result of other nuclear weapons states developing and testing similar weapons. The production and deployment of these weapons helps to adequately maintain deterrence while ensuring U.S. preparedness. Developing the SLCM-N will provide a reliable, discriminate option that will reduce the risk of escalation, ensuring that it will provide credible deterrence and provide the White House more flexibility and ability to tailor its deterrence strategy.

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64. *Projected Costs of U.S. Nuclear Forces, 2021 to 2030*, technical report (Washington, DC: Congressional Budget Office, 2021), <https://www.cbo.gov/publication/57240>.

65. Reif Kingston, *Biden's Disappointing First Nuclear Weapons Budget*, technical report (Washington, DC: Arms Control Association, 2021), <https://www.armscontrol.org/issue-briefs/2021-07/bidens-disappointing-first-nuclear-weapons-budget>.

66. Aaron Mehta, *The US Navy's new nuclear cruise missile starts getting real next year*, Vienna, VA, February 2020, <https://www.defensenews.com/smr/nuclear-arsenal/2020/02/21/the-navys-new-nuclear-cruise-missile-starts-getting-real-next-year/>.

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