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The Value of the LRSO in an Uncertain Future Environment

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Introduction

The Long-Range Standoff missile (LRSO) will be a nuclear-armed air-launched cruise missile (ALCM) the U.S. Air Force is scheduled to first deploy in the early 2030s. The current ALCM, the AGM-86B, is expected to age out of the force at around the same time as the LRSO is introduced as a replacement. Research and development of the LRSO is well underway, with Raytheon and Lockheed Martin both receiving contracts to begin initial development studies, and a final decision on which company will be the sole producer is expected to be made by the government in 2022.¹ There is some controversy in the U.S. Congress over the LRSO's necessity and cost.² Given the timeline for the LRSO program, this debate is likely to continue for the foreseeable future.

It is prudent, therefore, to examine three fundamental questions facing U.S. policy makers regarding LRSO: First, why do U.S. defense officials believe a replacement ALCM is necessary? Second, what deterrence characteristics will this replacement ALCM have? And third, how will these characteristics contribute to U.S. security interests and missions, and at what cost? This paper will outline answers to these three questions in an effort to assess the strategic value of LRSO.



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Why the Need for a Replacement ALCM?

According to U.S. defense officials, there are three main reasons why the current U.S. ALCM needs to be replaced: first, the AGM-86B's components are rapidly aging in ways that raise potential issues regarding its reliability and sustainability; second, the AGM-86B's effectiveness in the future threat environment may be questionable, especially given rising air defense threats posed by certain adversaries; and third, forgoing a replacement nuclear-armed ALCM – perhaps only equipping bombers with conventional standoff missiles – would be a mistake operationally, and likely harmful to deterrence, assurance, and damage-limitation missions. These reasons will be examined in turn.

Maintenance and Reliability

First, it is inarguable that the AGM-86B has exceeded its initial lifespan estimate several times over. It was initially deployed in 1982 with an expected service life of 10 years – and with current life extension programs it is expected to stay in the force until around the year 2030, or about 38 years beyond its planned service life.³ The current life extension programs include “critical telemetry, encryption, and flight termination components.”⁴ Despite these past and present updates, U.S. defense officials cite a number of reasons why further life extension programs will no longer meet operational requirements. For instance, the Obama administration's Under Secretary of Defense for Acquisition, Technology and Logistics, Frank Kendall, stated in 2015 Congressional testimony, “The air launched cruise missile is showing a lot of reliability problems right now. It is becoming harder to maintain, and it is going to have to be replaced as well.”⁵

Maintaining an aged system with stringent operational capability requirements is similarly becoming more difficult. As General John Hyten, Commander of U.S. Strategic Command, has stated, “...the ALCM is encountering sustainability and viability issues from age related material failures... and diminishing manufacturing sources. Parts and materials designed for a 10-year service life are now 35 years old, and are obsolete. Three Service Life Extension Programs (SLEP) are funded, but cannot keep pace with the rate of discovery of deficiencies.”⁶ These issues must be monitored as the ALCM approaches its expected retirement date. Closely related to the AGM-86B's maintenance difficulties is the growing problem of having enough of the missiles to conduct regular maintenance and operational tests. As General Hyten stated succinctly, “Operational and surveillance testing will reduce ALCM quantities below operational needs in 2030.”⁷

Survivability Against Advanced Air Defenses

There are two interrelated survivability issues with the AGM-86B: the survivability of the aircraft launching the missile and the survivability of the missile itself. The B-52H is the only U.S. bomber that can launch the AGM-86B,⁸ but, as General Selva has explained concerning the



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B-52H, “... the airframe itself cannot penetrate Russian air defenses – or Chinese air defenses, for that matter – and, as a consequence, must have a standoff weapon that is capable of contributing to its leg of the deterrent.”⁹ If the AGM-86B is allowed to age out of the force without replacement by the LRSO, the B-52H bomber may effectively lose its role in the U.S. nuclear mission – which could significantly degrade U.S. deterrence capabilities. Speaking on the growing threat to U.S. bombers from potential opponents’ advanced air defenses, General Stephen Wilson, Vice Chief of Staff of the Air Force, testified, “Deterrence and demonstrated combat capability remain vital instruments of power, especially as our enemies are committed to denying our attacks from the air. Only 12% of our current bomber fleet is survivable in such an environment.”¹⁰ U.S. defense officials cite this figure and others to demonstrate the need for a new penetrating and stealthy bomber – the B-21 – which is expected to reach initial operating capability in the “mid 2020s” and will be able to carry the LRSO.¹¹

In addition, U.S. defense officials appear to believe there are missions ALCMs can accomplish that penetrating bombers alone cannot; as Robert Scher, then-Assistant Secretary of Defense for Strategy, Plans, and Capabilities explained in 2016, “The current ALCM is designed to launch from a bomber flying outside an adversary’s territory and reach targets inaccessible to even stealth aircraft. Retaining this capability requires that we replace the ALCM during the coming decade, and we are developing the LRSO to do just that.”¹²

The second survivability issue of the AGM-86B is its ability to survive modern air defenses once launched from the B-52H. As STRATCOM Commander General Hyten testified before Congress recently, “Intended for Soviet-era threats, the ALCM’s survivability in modern air defense environments is deteriorating.”¹³ Put another way, General Robin Rand stated, “The ALCM has significant capability gaps that will only worsen through the next decade.”¹⁴ This assessment appears supported by the growing trend of advanced air defense networks in states of interest.

Advances in Russia’s air defenses, for instance, are worth monitoring as they relate to the AGM-86B cruise missile. The Defense Intelligence Agency (DIA) recently reported: “Russian doctrine places a great deal of emphasis on aerospace defense as a key component in its overall A2/AD [anti-access/area-denial] strategy. Though still in development, Russia’s 21st century integrated air defense system will be designed to integrate future and existing systems around a central command structure that is designed to promote the interaction of all air defense forces and weapons. *Capabilities optimized against cruise missiles are key to this defense component, not just those optimized to target aircraft.*”¹⁵ As the DIA goes on to note, Russian defense officials have examined U.S. military operations abroad since Operation Desert Storm and concluded that once the United States can strike from the air with impunity then the cause is likely lost – thus making the procurement of an advanced air defense system all the more important.¹⁶

China has also learned from previous U.S. air operations and is reportedly pursuing a dual-track strategy of buying advanced air defense systems from Russia while also producing its



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own systems domestically.¹⁷ As the Department of Defense notes, “The PLAAF [People’s Liberation Army Air Force] possesses one of the largest forces of advanced long-range SAM systems in the world, consisting of a combination of Russian-sourced SA-20 (S-300PMU1/2) battalions and domestically produced CSA-9 battalions. China has contracted with Russia for the S400/Triumpf SAM system, as a follow-on to the SA-20 and CSA-9, to improve strategic long-range air defenses; delivery could take place by the end of the decade.”¹⁸ The Russian S-300 and S-400 systems, according to the U.S. Department of Defense, have an advertised capability to shoot down cruise missiles.¹⁹

In addition, China’s Integrated Air Defense System (IADS) could have implications for U.S. bomber and cruise missile survivability. As the Department of Defense states:

China has a robust and redundant IADS architecture over land areas and within 300 nm (556 km) of its coast that relies on an extensive early warning radar network, fighter aircraft, and a variety of SAM systems. China is also placing radars and air defense weapons on outposts in the South China Sea, further extending its IADS. It also employs point defense primarily to defend strategic targets against adversary long-range cruise missiles and airborne strike platforms. China has increasing numbers of advanced long-range SAMs, including its indigenous CSA-9, Russian SA-10 (S-300PMU), and SA20 (S-300PMU1/PMU2), all of which have the advertised capability to protect against both aircraft and low-flying cruise missiles.²⁰

These developments appear to signal China’s determination to seriously pursue defense capabilities against cruise missiles.

It should also be noted that U.S. defense officials do not see the threat from adversary integrated air defenses to bombers and cruise missiles as static, but rather a dynamic and evolving threat that will likely persist into the future. The Joint Chiefs of Staff, for example, envision future scenarios where an adversary quickly takes land near its borders and then extends its air defense network to deny a quick and effective U.S. response – which in turn would allow the adversary to consolidate gains and prepare for further advances.²¹ Similarly, the National Intelligence Council recently drew attention to the likely proliferation of advanced air defense systems in the near future and the negative potential impacts on U.S. power-projection capabilities.²² Thus, the current and perhaps future threat environment appear to support U.S. defense officials’ concerns over the AGM-86B’s continued survivability.

Problems with a Conventional for Nuclear Substitution

A final reason why U.S. defense officials have supported the LRSO as a replacement for the AGM-86B is the potential problems with using alternative existing conventional cruise missiles as substitutes for the AGM-86B’s missions. That is, the AGM-86B must be replaced by another nuclear air-launched cruise missile because conventional air-launched cruise missiles are



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unable to effectively meet the same deterrence requirements. U.S. defense officials offer two major reasons why conventional ALCMs are insufficient substitutes for either the AGM-86B or the LRSO: first, conventional ALCMs are limited in operational ways that the AGM-86B and LRSO are not; and second, conventional ALCMs do not have the same deterrent effect as that of the AGM-86B and LRSO.

One example of a major operational difficulty of substituting conventional ALCMs for nuclear ALCMs is the precipitous drop in range capability. The U.S. Air Force publicly lists the range of the nuclear-capable AGM-86B as “1,500 plus miles” (~1300 nautical miles), while the conventional variants – the AGM-86C/D – have publicly listed ranges of about 690 miles (~600 nautical miles), less than half that of the AGM-86B.²³ The two other available land attack cruise missiles (LACMs) are the AGM-158A (Joint Air-to-Surface Standoff Missile, JASSM) with a listed 200+ nautical mile (~230 mile) range, and the AGM-158B (JASSM-ER, Extended Range) with a 500+ nautical mile (~575 mile) listed range.²⁴ These ranges are especially important given the growing air defense capabilities of states like Russia and China. In essence, if non-stealthy bombers are forced to fly closer to an adversary’s homeland and air defense system to launch the shorter-range conventional ALCMs, then there may be a greater probability of detection and a smaller chance of survival.²⁵ This potential vulnerability logically could degrade the system’s deterrent value.

In addition, U.S. defense officials have stated their belief that the deterrent effect of conventional ALCMs cannot substitute for nuclear-armed cruise missiles for the deterrence of adversaries and assurance of allies. For example, Robert Scher, then-Assistant Secretary of Defense for Strategy, Plans, and Capabilities, stated in 2016 testimony before Congress:

Although the United States continues to strengthen non-nuclear capabilities and plan non-nuclear strike options, conventional weapons cannot duplicate the physical effects of nuclear weapons. Nor are they capable of fulfilling the nuclear-armed cruise missile's contribution to and role in effective deterrence and reassurance of U.S. allies. Arguments that the LRSO should be judged solely on its ability to destroy a given target set miss the key point that nuclear weapons are not just another military capability. Their fundamental role is deterrence, not warfighting, and effective deterrence requires that an adversary believes the United States can and may respond in kind to a nuclear attack.²⁶

Admiral Cecil Haney, then-Commander of USSTRATCOM, stated at the same Congressional hearing: “No conventional weapon or combination of conventional weapons can attain a comparable deterrent effect or maintain strategic stability as well as the combined attributes of the B21, LRSO and B61-12 against a nuclear armed adversary.”²⁷ While conventional ALCMs are indeed necessary and capable weapons, as demonstrated with their use in multiple U.S. military engagements, according to senior U.S. defense officials, for deterrence purposes, they



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serve as a complement to, not a substitute for, nuclear weapons. This point has led U.S. defense officials to advocate for a new nuclear-armed air-launched cruise missile, the LRSO.

LRSO Deterrence Capabilities for the Future Threat Environment

A necessary part of assessing the potential value of LRSO in the future threat environment is briefly reviewing some of its characteristics – as described in open U.S. government sources – that will be relevant to U.S. deterrence efforts. In order for the LRSO to be a credible deterrent in the minds of future adversaries, it must be seen as effective. The bipartisan *President's Commission on Strategic Forces*, better known as the “Scowcroft Commission,” described this deterrence requirement in 1983, stating:

In order, then, to pursue successfully a policy of deterrence and verifiable, stabilizing arms control we must have a strong and militarily effective nuclear deterrent. Consequently, our strategic forces must be modernized, as necessary, to enhance to an adequate degree their overall survivability and to enable them to engage effectively the targets that Soviet leaders most value... the deterrent effect of our strategic forces is not something separate and apart from the ability of those forces to be used against the tools by which Soviet leaders maintain their power. Deterrence, on the contrary, requires military effectiveness.²⁸

Given this requirement for deterrence, it is useful to review the LRSO's expected related characteristics.

First, as its name indicates, the weapon will have a “long range.” USSTRATCOM Commander General John Hyten has confirmed that the LRSO's standoff range, combined with the range of the B-52H and prospectively the B-21 will give the United States “access” to “very large countries” like Russia and China.²⁹ Vice Chairman of the Joint Chiefs of Staff, General Paul Selva, described the LRSO's range as significantly reducing “a potential adversary's ability to achieve sanctuary within his borders.”³⁰ The LRSO's long range also provides the added benefit of allowing “complicated” routes for the missile to avoid adversary defenses.³¹

In addition, U.S. officials describe the LRSO's capability to penetrate adversary air defenses as “improved” over the AGM-86B.³² Generals Selva and Hyten have commented that the LRSO will be “low observable” – making detection, tracking, and intercept attempts for the adversary more difficult.³³ These characteristics will likely support U.S. deterrence efforts by minimizing a potential adversary's belief that it could defend effectively against the U.S. deterrent.

Department of Defense officials have also announced that W80-1 nuclear warhead on the AGM-86B will be life-extended and updated for use on the LRSO.³⁴ The warhead's new designation will be the W80-4.³⁵ U.S. defense officials have variously described the W80-4 as having “lower”³⁶ or a “low”³⁷ yields. This may well contribute to effective deterrence because



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having a “spectrum of yield options,” as the 2018 *Nuclear Posture Review* explains, supports “the most effective tailoring of [deterrence] strategies across a range of adversaries and contingencies.”³⁸

Potential Value in Future Threat Environment

Given the characteristics listed above, plus the current and possible future threat environment, the LRSO will contribute to U.S. security in at least three main areas: maintaining the deterrent effect of the bomber leg of the triad, imposing additional costs on adversary defenses, and contributing to assurance. Each area will be examined in turn below.

Maintaining the Deterrent Effect of the Bomber Leg of the Triad

The LRSO will likely provide a valuable contribution to U.S. deterrence efforts. Without a survivable, flexible, and limited nuclear option like LRSO, an adversary could doubt the credibility of U.S. deterrent threats – a view supported by a senior DoD official: “Retaining an effective cruise missile capability ensures that the President does not have to rely solely on high-yield ballistic missiles that may lack credibility for responding to a calibrated nuclear attack on an ally or U.S. forces abroad.”³⁹

Also of potential deterrent value, a critical way of demonstrating intent is through a visible signaling capability, such as the LRSO being loaded onto bombers and placed on alert. Bombers are also recallable in the event political leaders decide that would be a useful signal during a crisis. Bombers with LRSOs could also serve as a deterrent signal with their large upload capacity in response to adverse geopolitical or technical changes in the security environment – as described in the 2018 *Nuclear Posture Review*.⁴⁰

Without the LRSO, penetrating bombers would likely have to plan and execute more dangerous flights to utilize free-fall gravity bombs. As one defense official summarized this problem, “Without LRSO, our only air-delivered nuclear response option would be gravity bombs, which bring increased mission risk by forcing bombers to fly over targets – likely multiple targets within enemy territory for each flight.”⁴¹ In short, the LRSO “extends the reach of the bomber force” allowing it to accomplish more missions, with fewer risks to the pilots, while presenting a greater air defense challenge to adversaries.⁴²

Given these advantages, the LRSO should help support the deterrence missions of the bomber force and act as a hedge against possible adversary technological advances against the other two legs of the U.S. nuclear triad.⁴³



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Imposing Additional Costs on Adversary Defenses

Beyond its potential contribution to deterrence, the LRSO will also likely impose serious additional costs on adversaries as they are forced to configure their air defense network against a standoff capability in the B-52H and a penetrating capability in the B-21.⁴⁴ As General Hyten has testified, “The combination of LRSO attributes (ability to launch beyond range of adversary defenses, hold large geographical area at risk, low observable signature, multi-axis routing, large attack packages) severely challenges the effectiveness of even the most advanced Integrated Air Defense System (IADS). Huge investments and technological advancements in detection, tracking, command and control, and area/point defenses are required to challenge LRSO viability.”⁴⁵ Instead of trying to detect and intercept one low-observable bomber with nuclear gravity bombs, adversaries would be forced to try and detect and intercept “many more small and low-observable penetrators.”⁴⁶ As Robert Scher has stated, “The stark reality is that forgoing the LRSO would allow potential adversaries to focus on acquiring the ability to detect a single type of aircraft in an effort to render the entire U.S. strategic nuclear bomber force ineffective.”⁴⁷ And, as General Wilson noted on the spending an adversary would have to devote to defense against the LRSO, “This investment in defensive systems diminishes the amount of resources a potential adversary can expend on the development and fielding of offensive capabilities.”⁴⁸ The LRSO, in this sense, will be a valuable asset in a strategy of imposing disproportionate costs on potential adversaries.

Contributing to Assurance

The LRSO could also potentially contribute to U.S. assurance efforts. Bombers are a highly visible weapon system that have been used in assurance missions in the past. Both the Obama and Trump administrations have viewed the LRSO as a valuable means of signaling commitment to allies and partners.⁴⁹ As then-Under Secretary of State for Arms Control and International Security, Rose Gottemoeller, stated in 2016, “It [the LRSO] will assure our allies of our ability to meet our extended deterrence commitments. This is not just our view. We’ve heard from our allies about the value of the LRSO during our extended deterrence discussions.”⁵⁰ In addition, the LRSO, according to Robert Scher, “will support U.S. nonproliferation objectives by reinforcing allied confidence in extended deterrence.”⁵¹

The Question of Cost

All the potential value listed above, however, does come with a cost. The Congressional Budget Office estimates the LRSO will cost about \$28 billion through the year 2046, and about \$200 million a year to sustain after that until its service life ends around the year 2060 (an additional \$2.8 billion total).⁵² The LRSO’s costs represent about two percent of the total expected costs of modernizing the U.S. nuclear deterrent through 2046, counting both the costs to the Department of Defense and Department of Energy.⁵³ In a given year over its lifespan, on average, and assuming a very conservative notional annual defense budget of \$600 billion, the



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LRSO's costs would be about one sixth of one percent of the total defense budget. Given the priority deterrence mission DoD assigns to nuclear forces, and potential importance of LRSO to that mission, these costs appear both sustainable and prudent.

Conclusion

The AGM-86B has served a useful function in the U.S. nuclear deterrence force for over thirty years, but the approaching end of its extended service life and advances in potential adversaries' air defenses point to the need for a replacement. The LRSO will prove a valuable replacement for the AGM-86B. With its low observability and standoff capability, the LRSO will help maintain the deterrence effectiveness of the bomber leg of the triad, impose additional costs on adversary defenses, and contribute to assurance. It will provide these contributions at a reasonable cost in the context of an uncertain future threat environment.

1. Oriana Pawlyk, "Lockheed, Raytheon to Develop New Nuclear Cruise Missile," *Military.com*, August 23, 2017, available at <https://www.military.com/dodbuzz/2017/08/23/lockheed-raytheon-new-nuclear-cruise-missile>.
2. For an overview and response to the debate by this author, see, Matthew R. Costlow, "The New Nuclear Cruise Missile and the Stability Argument," *Real Clear Defense*, February 8, 2016, available at https://www.realcleardefense.com/articles/2016/02/09/the_new_nuclear_cruise_missile_and_the_stability_argument_109003.html.; See also, William J. Perry and Andy Weber, "Mr. President, kill the new cruise missile," *The Washington Post*, October 15, 2015, available at https://www.washingtonpost.com/opinions/mr-president-kill-the-new-cruise-missile/2015/10/15/e3e2807c-6ecd-11e5-9bfe-e59f5e244f92_story.html?utm_term=.dab9d289190e.; and, Kingston Reif, "Overkill: The Case Against a New Nuclear Air-Launched Cruise Missile," *Arms Control Association*, October 19, 2015, available at <https://www.armscontrol.org/Issue-Briefs/2015-10-19/Overkill-The-Case-Against-a-New-Nuclear-Air-Launched-Cruise-Missile>.
3. Garrett Harencak, "Air Force Nuclear Programs and Policies in the Fiscal Year 2016 Defense Authorization Request and Implementation of Nuclear Enterprise Review Recommendations," *114th U.S. Congress*, Senate Armed Services Committee, April 22, 2015, p. 8, available at https://www.armed-services.senate.gov/imo/media/doc/Harencak_04-22-15.pdf.
4. Robin Rand, "FY19 Posture for Department of Defense Nuclear Forces," *115th U.S. Congress*, House Armed Services Committee, March 22, 2018, p. 12, available at <https://docs.house.gov/meetings/AS/AS29/20180322/108035/HHRG-115-AS29-Wstate-RandR-20180322.pdf>.
5. Frank Kendall, as quoted in, *Department of Defense Authorization for Appropriations for Fiscal Year 2016 and the Future Years Defense Program* (Washington, D.C., Government Printing Office, 2015), testimony before the Senate Armed Services Committee, March 4, 2015, p. 12, available at <https://www.govinfo.gov/content/pkg/CHRG-114shrg22950/pdf/CHRG-114shrg22950.pdf>.



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6. John E. Hyten, "Statement of John E. Hyten, Commander, United States Strategic Command," *115th U.S. Congress, Senate Armed Services Committee*, April 4, 2017, p. 9, available at https://www.armed-services.senate.gov/imo/media/doc/Hyten_04-04-17.pdf.
7. Loc cit.
8. See, U.S. Air Force, "AGM-86B/C/D Missiles," *AF.mil*, May 24, 2010, available at <https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104612/agm-86bcd-missiles/>; and, U.S. Air Force, *U.S. Air Force Long-Range Strike Aircraft White Paper* (Washington, D.C.: U.S. Air Force, November 2001), pp. 20, A-1, available at <https://apps.dtic.mil/dtic/tr/fulltext/u2/a433970.pdf>; and, Defense Science Board, *Defense Science Board Task Force on B-52H Re-Engining* (Washington, D.C.: Department of Defense, June 2004), p. 19, available at <https://www.acq.osd.mil/dsb/reports/2000s/ADA428790.pdf>.
9. Paul Selva, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements* (Washington, D.C.: Government Publishing Office, March 8, 2017), H.A.S.C. No. 115-11, p. 21, available at <https://www.govinfo.gov/content/pkg/CHRG-115hrg24683/pdf/CHRG-115hrg24683.pdf>
10. This figure likely refers to the number of stealthy B-2 bombers in the force compared to the overall number of bombers, which include the B-1B and B-52. See, Stephen Wilson, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., p. 82.
11. Rand, "FY19 Posture for Department of Defense Nuclear Forces," op. cit., pp. 12-13.
12. Robert Scher, "Statement of Robert Scher, Assistant Secretary of Defense for Strategy, Plans, and Capabilities," *114th U.S. Congress, Senate Appropriations Subcommittee on Energy and Water Development*, July 13, 2016, p. 1, available at <https://www.appropriations.senate.gov/imo/media/doc/071316-Scher-Testimony.pdf>.
13. Hyten, "Statement of John E. Hyten, Commander, United States Strategic Command," op. cit., p. 9.
14. Rand, "FY19 Posture for Department of Defense Nuclear Forces," op. cit., p. 13.
15. (Emphasis added) U.S. Defense Intelligence Agency, *Russia Military Power* (Washington, D.C.: DIA, 2017), p. 33, available at <http://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Russia%20Military%20Power%20Report%202017.pdf>.
16. Ibid.
17. For example, see, Andrew Scobell, David Lai, and Roy Kamphausen, eds., *Chinese Lessons from Other Peoples' Wars* (Carlisle, PA: Strategic Studies Institute, November 2011), available at <https://ssi.armywarcollege.edu/pubs/display.cfm?pubID=1090>.
18. U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2018* (Washington, D.C.: Department of Defense, May 16, 2018), pp. 34-35, available at <https://media.defense.gov/2018/Aug/16/2001955282/-1/-1/1/2018-CHINA-MILITARY-POWER-REPORT.PDF>.
19. For the S-300, see U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2018*, op. cit., p. 62.; For the S-400, see, U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2014* (Washington, D.C.:



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- Department of Defense, April 24, 2014), p. 69, available at https://archive.defense.gov/pubs/2014_DoD_China_Report.pdf.
20. U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2018*, op. cit., pp. 61-62.
 21. U.S. Joint Chiefs of Staff, *Joint Operating Environment 2035: The Joint Force in a Contested and Disordered World* (Washington, D.C.: Joint Chiefs of Staff, July 14, 2016), p. 29, available at https://www.jcs.mil/Portals/36/Documents/Doctrine/concepts/joe_2035_july16.pdf?ver=2017-12-28-162059-917.
 22. National Intelligence Council, *Global Trends: Paradox of Progress* (Washington, D.C.: Director of National Intelligence, January 2017), p. 217, available at <https://www.dni.gov/files/documents/nic/GT-Full-Report.pdf>.
 23. U.S. Air Force, "AGM-86B/C/D Missiles," op. cit.
 24. For range information, see, U.S. Department of Defense, *Joint Air-to-Surface Standoff Missile (JASSM) Selected Acquisition Report* (Washington, D.C.: Department of Defense, March 23, 2016), p. 7, available at <https://apps.dtic.mil/dtic/tr/fulltext/u2/1019462.pdf>.
 25. See, Paul Selva, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., p. 21.
 26. Scher, "Statement of Robert Scher, Assistant Secretary of Defense for Strategy, Plans, and Capabilities," op. cit., p. 4.
 27. Cecil D. Haney, "Statement of Admiral C. D. Haney, Commander, United States Strategic Command," *114th U.S. Congress, Senate Appropriations Subcommittee on Energy and Water Development*, July 13, 2016, p. 11, available at <https://www.appropriations.senate.gov/imo/media/doc/071316-Haney-Testimony.pdf>.
 28. President's Commission on Strategic Forces, *Report of the President's Commission on Strategic Forces* (Washington, D.C.: CIA, April 6, 1983), pp. 6-7, available at <https://www.cia.gov/library/readingroom/docs/CIA-RDP85M00364R001101620009-5.pdf>.
 29. John Hyten, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., pp. 23, 63.
 30. Paul Selva, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., p. 93.
 31. This capability has been seen as an advantage for cruise missiles in the United States since the 1970s. For an early example of the "operational concept," see, Kenneth P. Werrell, *The Evolution of the Cruise Missile* (Maxwell Air Force Base, AL: Air University Press, September 1985), p. 137, available at https://www.airuniversity.af.edu/Portals/10/AUPress/Books/B_0006_WERRELL_EVOLUTION_CRUISE_MISSILE.pdf; On the ability of cruise missiles to fly circuitous routes in general, see, U.S. Defense Intelligence Ballistic Missile Analysis Committee and National Air and Space Intelligence Center, *Ballistic and Cruise Missile Threat 2017*, op. cit., p. 35.; See also, American Forces Press Service, "Cruise Missile Provides Flexible, Undetectable Power," *Archive.Defense.gov*, September 4, 1996, available at <http://archive.defense.gov/news/newsarticle.aspx?id=40723>; On the ability to fly "complicated" routes, see U.S. Air Force, "AGM-86B/C/D Missiles," op. cit.; See also, John



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- Hyten, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., p. 95.
32. James MacStravic, "Fiscal Year 2018 Budget Request for Nuclear Forces," *115th U.S. Congress*, Senate Armed Services Committee, June 7, 2017, p. 6, available at https://www.armed-services.senate.gov/imo/media/doc/Macstravic_06-07-17.pdf.
 33. See Paul Selva and John Hyten, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., respectively on pp. 93, 95.
 34. John Hyten, "Statement of John E. Hyten, Commander, United States Strategic Command," *115th U.S. Congress*, House Armed Services Committee, March 7, 2018, p. 7, available at <http://www.stratcom.mil/Portals/8/Documents/2018%20USSTRATCOM%20HASC-SF%20Posture%20Statement.pdf?ver=2018-03-07-125520-187>.
 35. Department of Energy, "W80-4 Life Extension Program," *Energy.gov*, no date (2018), <https://www.energy.gov/sites/prod/files/2018/05/f51/W80-4%20LEP%20factsheet%202018.pdf>.
 36. Scher, "Statement of Robert Scher, Assistant Secretary of Defense for Strategy, Plans, and Capabilities," op. cit., p. 4.
 37. John Hyten, "Nuclear Posture Review Discussion at National Defense University," *STRATCOM.mil*, February 16, 2018, available at <http://www.stratcom.mil/Media/Speeches/Article/1446542/nuclear-posture-review-discussion-at-national-defense-university/>.
 38. U.S. Department of Defense, *Nuclear Posture Review* (Washington, D.C.: Department of Defense, 2018), p. 44, available at <https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF>, p. 44.
 39. Scher, "Statement of Robert Scher, Assistant Secretary of Defense for Strategy, Plans, and Capabilities," op. cit., p. 3.
 40. U.S. Department of Defense, *Nuclear Posture Review*, 2018, op. cit., p. 47.
 41. Scher, "Statement of Robert Scher, Assistant Secretary of Defense for Strategy, Plans, and Capabilities," op. cit., pp. 2-3.
 42. *Ibid.*, p. 2.
 43. As envisioned by U.S. Department of Defense, *Nuclear Posture Review*, 2018, op. cit., p. 38.
 44. On the B-21 being a "penetrating" platform, see John Hyten, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., p. 62.
 45. John Hyten, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., p. 95.
 46. Paul Selva, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., p. 93.
 47. Scher, "Statement of Robert Scher, Assistant Secretary of Defense for Strategy, Plans, and Capabilities," op. cit., pp. 2-3.
 48. Stephen Wilson, as quoted in, U.S. Congress, *Military Assessment of Nuclear Deterrence Requirements*, op. cit., p. 97.



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49. See, Ash Carter, “Exit Memo: Department of Defense,” *ObamaWhiteHouse.Archives.gov*, January 5, 2017, available at <https://obamawhitehouse.archives.gov/administration/cabinet/exit-memos/department-defense>.; and, John Hyten, “Military Assessment of Nuclear Deterrence Requirements,” *op. cit.*, p. 62.
50. Rose Gottemoeller, “Statement of Under Secretary of State for Arms Control and International Security Rose Gottemoeller,” *114th U.S. Congress, Senate Appropriations Subcommittee on Energy and Water Development*, July 13, 2016, p. 3, available at <https://www.appropriations.senate.gov/imo/media/doc/071316-Gottemoeller-Testimony.pdf>.
51. Scher, “Statement of Robert Scher, Assistant Secretary of Defense for Strategy, Plans, and Capabilities,” *op. cit.*, p. 3.
52. Congressional Budget Office, *Approaches for Managing the Costs of U.S. Nuclear Forces, 2017 to 2046* (Washington, D.C.: Congressional Budget Office, October 2017), p. 35, available at <https://www.cbo.gov/system/files/115th-congress-2017-2018/reports/53211-nuclearforces.pdf>.; On the expected service life of LRSO, see, Rand, “FY19 Posture for Department of Defense Nuclear Forces,” *op. cit.*, p. 13.
53. *Ibid.*, p. 4.

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