Hypersonic weapons of the U.S., China, and Russia: Implications for Nuclear Deterrence and Arms Control*

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Abstract

Hypersonic weapons fly at speeds over Mach 5, making their flight paths and impact points difficult to predict. Furthermore, these weapons are capable of complex maneuvers while in flight, which makes them extremely difficult to detect and intercept with current defensive systems. This article focused on the United States, China, and Russia, and examined the implications of the development of hypersonic weapons for nuclear deterrence and arms control in these three countries. In terms of nuclear deterrence, the development and deployment of hypersonic weapons is unlikely to destabilize the nuclear deterrence relationship between the United States, China, and Russia, unless they are deployed on a large scale to neutralize each other's nuclear retaliatory capabilities. However, if the use of such weapons leads to a misunderstanding that it is a pre-emptive strike against the national command centers of the three countries, it could be a risk of destabilizing nuclear deterrence. As for arms control, it is desirable to take measures to reduce the risk of potential misunderstandings regarding the use of hypersonic weapons, while building momentum for hypersonic weapons regulation negotiations between the United States, China, and Russia. This article also discussed the implications that the United States' strengthening of its defense posture against hypersonic weapons will have on nuclear deterrence and arms control.

Introduction

Among the issues currently of concern for international security is the development of hypersonic weapons, which various countries are proceeding with. Such weapons fly at speeds of over Mach 5 (five times the speed of sound) and their flight paths and impact points are difficult to predict. Detection and interception of these weapons are also extremely problematic tasks for current defensive systems, since they are capable of complex maneuvers during flight. The United States, China, and Russia are the three countries leading the development of hypersonic weapons. In particular, both China and Russia have announced that they already deployed dual-capable hypersonic missiles that could break through U.S. missile defense systems. In response, the United States has begun considering a new missile defense system to intercept hypersonic weapons while proceeding with the development of non-nuclear hypersonic weapons.

Reflecting on this situation, debate over hypersonic weapons has increased in recent years. Some argue that these weapons should be seen as a game changer in future warfare and that research

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and development, as well as field deployment, should be expedited.[1] Conversely, however, there are also those who forward the view that a cautious approach should be taken for the development of hypersonic weapons, arguing that these weapons cannot be a game changer due to their technical difficulties.[2] It has further been stated that, in order to reduce the risk of destabilizing nuclear deterrence due to the introduction of hypersonic weapons, arms control measures regarding such weapons should be considered at an early stage.[3] Furthermore, there are negative opinions on the United States deploying a new defense posture against hypersonic weapons.[4]

Trends in the development of hypersonic weapons should have important implications for Japan's national security policy. This article focuses on the United States, China, and Russia, examining the implications of the development of hypersonic weapons for the relationship among these three countries, and in particular for nuclear deterrence and arms control.

1. Issues Surrounding Hypersonic Weapons

(1) Previous Studies and Points of Discussion

Recent studies on hypersonic weapons have discussed various effects on the nuclear deterrence relationship between the United States, China, and Russia. Dean Wilkening, at Johns Hopkins University, points out that the Unites States' non-nuclear hypersonic weapons will destabilize nuclear deterrence relations with China and Russia, as these weapons pose a threat to the two countries' nuclear retaliatory capabilities, especially to the road-mobile intercontinental ballistic missiles that form the core of those capabilities.[5] Conversely, Jeffrey Hill, of the U.S. Air Force, argues that the development and deployment of hypersonic weapons will have little impact on the U.S.–China–Russia nuclear deterrence relationship, since the three countries already have sufficient nuclear weapons to carry out assured retaliation against each other.[6] Additionally, Nathan Terry, again of the U.S. Air Force, has analyzed that even if the United States were to develop and deploy hypersonic weapons equipped with nuclear warheads, it would not destabilize the nuclear

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1 Caleb Larson, "This U.S. Missile Can Kill Any Target on the Planet (in Less Than an Hour)," *National Interest*, June 23, 2020, https://nationalinterest.org/blog/buzz/us-missile-can-kill-any-target-planet-less-hour-163303; Audrey Quintin and Robin Vanholme, "Hypersonic Missiles and European Security: Challenges Ahead," Finabel European Army Interoperability Centre, last updated July 28, 2020, https://finabel.org/hypersonic-missiles-and-european-security/; Steve Simon, "Opinion: Hypersonic Missiles are a Game Changer," *New York Times*, January 2, 2020, https://www.nytimes.com/2020/01/02/opinion/hypersonic-missiles.html.

2 David Wright and Cameron Tracy, "The Physics and Hype of Hypersonic Weapons," *Scientific American*, August 1, 2021, https://www.scientificamerican.com/article/the-physics-and-hype-of-hypersonic-weapons/; Jyri Raitasalo, "Hypersonic Weapons are No Game-Changer," *National Interest*, January 5, 2019, https ://nationalinterest.org/blog/buzz/hypersonic-weapons-are-no-game-changer-40632.

3 Shannon Bugos and Kingston Reif, "Understanding Hypersonic Weapons: Managing the Allure and the Risks," Arms Control Association, September 2021, https://www.armscontrol.org/sites/default/files/files/Reports/ACA_Report_HypersonicWeapons_2021.pdf.

4 "The U.S. Should be Realistic about Missile Defense," *Washington Post*, November 9, 2021, https://www.washingtonpost.com/business/the-us-should-be-realistic-about-missile-defense/2021/11/09/c48f68de-415d-11ec-9404-50a28a88b9cd_story.html.

5 Dean Wilkening, "Hypersonic Weapons and Strategic Stability," *Survival*, vol. 61, no. 5 (September 2019), pp. 129-148, https://www.tandfonline.com/doi/full/10.1080/00396338.2019.1662125.

6 Jeffrey Hill, "Hypersonic/Highly-Maneuverable Weapons and Their Effect on the Deterrence Status Quo," in *Assessing the Influence of Hypersonic Weapons on Deterrence*, ed. Paige P. Cone (Air University, June 2019), chap. 4, 57–73, https://media.defense.gov/2019/Sep/25/2002187108/-1/-1/0/59HYPERSONICWEAPONS.PDF.

deterrence relationship with China and Russia.[7]

The stability of the nuclear deterrence relationship among the United States, China, and Russia can be maintained by ensuring that none of the three countries has an incentive to launch a first strike with nuclear weapons. However, to that end, it is necessary for the three countries to have the capability to survive even if they suffer a first strike, maintain sufficient nuclear retaliatory power to break through the other country's defense network, and reliably carry out mass destruction.[8] In this paper, based on previous studies, the first point of discussion is how to evaluate the impact of hypersonic weapons on the nuclear retaliatory capabilities of the United States, China, and Russia.

Many past research projects have discussed arms control regarding hypersonic weapons. John Hursh, from the Stockholm Center for International Law, states that the best option is to conclude an international arms control treaty to regulate hypersonic weapons, while also taking the pessimistic view that it will be nearly impossible to even begin treaty negotiations given the current international environment, which is in the midst of great power competition.[9] For this reason, Douglas Barrie at the International Institute for Strategic Studies (IISS) suggests starting with bilateral arms control negotiations by countries developing hypersonic weapons.[10] In light of these difficulties with arms control treaties, there are calls for self-regulation by countries developing hypersonic weapons. For example, Cameron Tracy, from the Union of Concerned Scientists, argues that the United States should reconsider its policies concerning the development of hypersonic weapons to avoid an arms race over them.[11]

Based on the above studies, the second point of discussion in this paper is how to regulate the development and deployment of hypersonic weapons.

As the United States continues to consider interception systems for hypersonic weapons, there have begun to emerge preliminary studies discussing the necessity of such systems and the impact they would have on U.S.–China–Russia relations. Douglas Fraser, at the National Defense University, argues, along with his colleagues, that despite China and Russia accelerating the development of hypersonic weapons, the United States does not currently have the means to intercept them; the aforementioned scholars further discuss that the United States should develop such means before China and Russia take advantage of the U.S.'s vulnerability.[12] Conversely,

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7 Nathan B. Terry, "Hypersonic Technology: An Evolution in Nuclear Weapons?" *Strategic Studies Quarterly*, vol. 14, no. 4 (Summer 2020), pp. 74-99, https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-14_Issue-2/Terry.pdf.

8 Robert Legvold, "Contemplating Strategic Stability in a New Multipolar Nuclear World," Workshop Report, American Academy of Arts & Sciences, August 2019, pp. 4-5, https://www.amacad.org/sites/default/files/publication/downloads/Contemplating-Strategic-Stability.pdf.

9 John Hursh, "Let's Make a Deal: How to Mitigate the Risk of Hypersonic Weapons," *Just Security*, May 6, 2020, https://www.justsecurity.org/70025/lets-make-a-deal-how-to-mitigate-the-risk-of-hypersonic-weapons/.

10 Douglas Barrie, "Unstable at Speed: Hypersonics and Arms Control," International Institute for Strategic Studies, last updated October 18, 2019, https://www.iiss.org/blogs/military-balance/2019/10/hypersonics-arms-control.

11 Cameron Tracy, "Slowing the Hypersonic Arms Race: A Rational Approach to an Emerging Missile Technology," Union of the Concerned Scientists, May 2021, pp. 9-10, https://www.ucsusa.org/sites/default/files/2021-04/slowing-the-hypersonic-arms-race.pdf.

12 Douglas M. Fraser, Frank Gorenc, and John S. Shapland, "Hypersonic Defense Requires Getting Space Sensor System Right," *Real Clear Defense*, May 13, 2020, https://www.realcleardefense.com/articles/2020/05/13/hypersonic_defense_requires_getting_space_sensor_system_right.html.

Michael Klare, at Hampshire College, points out that the United States' development of a defense system against hypersonic weapons could encourage China and Russia to develop their own counter-hypersonic weapons systems and more sophisticated offensive systems.[13]

Since there is an insufficient number of previous studies discussing the development of defense systems to intercept hypersonic weapons, it is desirable to consider this topic while looking ahead to relevant future research trends. For this reason, the third point in this paper is what impact the strengthening of defense posture against hypersonic weapons might have on U.S.–China–Russia relations.

(2) Types and Characteristics of Hypersonic Weapons

Hypersonic denotes speeds greater than Mach 5. Indeed, new weapons systems, termed hypersonic weapons, along with flying through the atmosphere at over Mach 5, currently have the military advantage of being able to maneuver during flight and avoid interception by air and missile defense systems.[14] As discussed below, various types of hypersonic weapons have been developed, but they are broadly categorized into unpowered hypersonic glide vehicles (HGV), which are launched by rocket boosters, and powered hypersonic cruise missiles (HCM), which are powered by scramjet engines.[15] A scramjet engine is an advanced propulsion mechanism that compresses air taken into the engine at supersonic speeds, mixes it with fuel, and combusts it to obtain propulsive force in the hypersonic range.[16] In order to operate a scramjet engine, the HCM must be accelerated to supersonic speed before igniting the engine.

As well as hypersonic weapons, there are also other weapon systems with flight speeds exceeding Mach 5. For example, existing intercontinental ballistic missiles (ICBMs) can reach speeds of up to Mach 20 when re-entering the atmosphere. In contrast, HGV technology aims toward continued flight through the atmosphere at hypersonic speeds and is different from existing ballistic missiles in this respect.[17] Additionally, while ballistic missiles have predictable flight paths, HGVs follow unpredictable paths toward their targets. This, combined with the ability to maneuver during flights, makes them much more difficult to deal with than ballistic missiles.[18] There is also a view that gun-launched systems, such as railguns, are included in the hypersonic

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13 Michael T. Klare, "Pentagon Awards Anti-Hypersonic Missile Contracts," Arms Control Association, January/February 2022, https://www.armscontrol.org/act/2022-01/news/pentagon-awards-anti-hypersonic-missile-contracts.

14 Travis Hallen and Michael Spencer, "Hypersonic Air Power," Air Power Development Centre, Royal Australian Air Force, June 25, 2018, p. 2, https://airpower.airforce.gov.au/sites/default/files/2021-03/BPAF01-Hypersonic-Air-Power.pdf.

15 Kolja Brockmann and Markus Schiller, "A Matter of Speed? Understanding Hypersonic Missile Systems," Stockholm International Peace Research Institute, last updated February 4, 2022, https://www.sipri.org/commentary/topical-backgrounder/2022/matter-speed-understanding-hypersonic-missile-systems.

16 Ameya Paleja, "US Military Successfully Tests Its Hypersonic Cruise Missile," *Interesting Engineering*, September 28, 2021, https://interestingengineering.com/us-military-successfully-tests-its-hypersonic-cruise-missile.

17 Jon Kelvey, "Why China's Hypersonic Missiles Don't Mean Nuclear Armageddon," *The Inverse*, December 11, 2021, https://www.inverse.com/innovation/what-is-going-on-with-chinas-hypersonic-missile-tests.

18 Paul Bernstein and Dain Hancock, "China's Hypersonic Weapons," *Georgetown Journal of International Affairs*, January 27, 2021, https://gjia.georgetown.edu/2021/01/27/chinas-hypersonic-weapons/.

weapons category,[19] given that the speed of their shells can reach over Mach 5. However, this paper solely focuses only on HGVs and HCMs as hypersonic weapons.

The unpredictability of HGV flight paths poses a problem. For example, it may not be clear what a launched HGV's target is, and its impact point cannot be determined in advance.[20] Regarding this issue, it has been pointed out that a potentially catastrophic situation could occur. For instance, China and Russia might mistakenly assume that an HGV – launched by the United States to attack a third country other than China or Russia – is heading into their own territory, simply because the flight path of the HGVs cannot be predicted.[21]

HCMs have a shorter range than HGVs, and it is thought that an HCM with a range of 1,000 km can reach its target in a few minutes, leaving defenders with limited time to respond. In addition to this, HCMs are extremely difficult to intercept, reportedly flying at high altitudes of 20 to 30 km in order to compress supersonic airflow inside their scramjet engines. HCMs can also maneuver during flight in the same way as HGVs, and their flight paths are unpredictable, which could disable missile defense and other interception systems.[22]

2. Development Status of Hypersonic Weapons by the United States, China, and Russia

(1) United States

Since the early 2000s, the United States has been developing hypersonic weapons as part of its Conventional Prompt Global Strike (CPGS) initiative. As the name CPGS suggests, the hypersonic weapons being developed by the United States are not designed to carry nuclear warheads, and are instead intended to be used exclusively as non-nuclear weapons. Currently, the Army, Navy, Air Force, and Defense Advanced Research Projects Agency (DARPA) are each working on the development of hypersonic weapons.[23]

The U.S. Army is developing the Long-Range Hypersonic Weapon (LRHW) – a ground-launched HGV that glides through the upper atmosphere at speeds over Mach 5, and has a reported range of 1,725 miles (approximately 2,776 km). The warhead and rocket booster of the LRHW are being shared with those of the U.S. Navy, and the warhead is called the Common Hypersonic Glide Body (C-HGB). The rocket booster is a two-stage type that is loaded with a C-HGB warhead and stored in a special canister, which can be mounted on a large trailer vehicle for transport, deployment, and launch.[24]

Meanwhile, the U.S. Navy is proceeding with the development of a Conventional Prompt

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[19] John T. Watts, Christian Trotti, and Mark J. Massa, "Primer on Hypersonic Weapons in the Indo-Pacific Region," Atlantic Council, August 2020, pp. 5-6, https://www.atlanticcouncil.org/wp-content/uploads/2020/08/Hypersonics-Weapons-Primer-Report.pdf.

[20] Joseph Henrotin, "Hypersonic Weapons: What are the Challenges for the Armed Forces?" IFRI, June 18, 2021, p. 4, https://www.ifri.org/sites/default/files/atoms/files/henrotin_hypersonic_weapons_2021.pdf.

[21] James M. Acton, "Silver Bullet? Asking the Right Questions about Conventional Prompt Global Strike," Carnegie Endowment for International Peace, 2013, p. 118, https://carnegieendowment.org/files/cpgs.pdf.

[22] Richard H. Speier, et al., "Hypersonic Missile Proliferation: Hindering the Spread of a New Class of Weapons," RAND Corporation, 2017, pp. 11-13, https://www.rand.org/content/dam/rand/pubs/research _reports/RR2100/RR2137/RAND_RR2137.pdf.

[23] Congressional Research Service (hereinafter CRS), *Hypersonic Weapons: Background and Issues for Congress*, by Kelley M. Sayler, R45811 (Updated January 10, 2023), pp. 1-5, https://crsreports.congress.gov/product/pdf/R/R45811/33.

[24] CRS, *The U.S. Army's Long-Range Hypersonic Weapon (LRHW)*, by Andrew Feickert, IF11991 (Updated January 12, 2023), https://crsreports.congress.gov/product/pdf/IF/IF11991.

Strike (CPS) missile system. The CPS is a sea-launched HGV that is currently scheduled for deployment aboard Zumwalt-class guided missile destroyers and Virginia-class nuclear-powered attack submarines in the fiscal years 2024 and 2028, respectively.[25] Although the range of the CPS has not been made public, it is presumed to be approximately the same range as the LRHW, since it is said to be an intermediate-range missile[26] and uses the same warhead and rocket booster as the U.S. Army's LRHW.

The U.S. Air Force is focusing on developing the Air-launched Rapid Response Weapon (ARRW). The ARRW is a HGV designed to be launched from its mother aircraft, namely B-52H strategic bombers; it uses a rocket booster to lift and accelerate when separated from the mother aircraft, and then shifts to unpowered glide flight after booster separation; it is said to have a maximum flight speed of Mach 20 and a range of 575 miles (approximately 925 km); and the development of the ARRW was scheduled to be completed by the end of 2022.[27] However, all three tests conducted in 2021 (April, July, and December) ended in failure, forcing the U.S. Air Force to review its ARRW development plan.[28] Subsequently, in 2022, after two successful booster tests (May and July), the first test launch was successfully conducted in December, and it appears that the development of the ARRW has some prospects.[29]

DARPA is working with the U.S. Air Force on two projects: the Tactical Boost Glide (TBG) and the Hypersonic Air-breathing Weapon Concept (HAWC). The TBG is an air-launched HGV that can fly at speeds over Mach 7, although its range is unknown, and DARPA is said to be considering the possibility of installing it in the vertical launch system of U.S. Navy vessels.[30] In addition, the HAWC is an air-launched HCM that is envisioned to be used as an air-to-air weapon.[31]

Alongside these offensive systems, the United States has also begun developing defensive systems to intercept hypersonic weapons. The U.S. Missile Defense Agency (MDA) is moving forward with a plan for a sea-launched Glide Phase Interceptor (GPI) to be installed on Aegis ships,[32] and DARPA also launched the Glide Breaker plan in 2018, which aims to improve the

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25 Justin Katz, "Navy Defends $80M Industrial Expansion to Fill Hypersonic Missile Gap," *Breaking Defense*, December 1, 2021, https://breakingdefense.com/2021/12/navy-defends-80m-industrial-expansion-to-fillhypersonic-missile-gap/.

26 "Intermediate Range Conventional Prompt Strike (CPS) Weapon System," GlobalSecurity.org, December 3, 2019, https://www.globalsecurity.org/wmd/systems/cps.htm.

27 "AGM-183A Air-launched Rapid Response Weapon," *Airforce Technology*, September 2, 2020, https://www.airforce-technology.com/projects/agm-183a/.

28 Valerie Insinna, "Air Force Hypersonic Weapon Runs into Trouble after a Third Failed Test," *Breaking Defense*, December 20, 2021, https://breakingdefense.com/2021/12/air-force-hypersonic-weapon-runs-into-trouble-after-a-third-failed-test/.

29 Stephen Losey, "Air Force Conducts First Launch of Prototype Hypersonic Missile," *Defense News*, December 13, 2022, https://www.defensenews.com/air/2022/12/12/air-force-conducts-first-operational-launch of-arrw-hypersonic-missile/.

30 CRS, *Hypersonic Weapons*, p. 9; "Tactical Boost Glide (TBG)," GlobalSecurity.org, March 17, 2019, https ://www.globalsecurity.org/military/systems/munitions/tbg.htm.

31 "Hypersonic Air-Breathing Weapon Concept (HAWC), USA," *Airforce Technology*, November 5, 2021, https://www.airforce-technology.com/projects/hypersonic-air-breathing-weapon-concept-hawc-usa/.

32 Steve Trimble, "MDA Unveils GPI in Retooled Counter-Hypersonic Plan," *Aviation Week*, February 4, 2021, https://aviationweek.com/defense-space/missile-defense-weapons/mda-unveils-gpi-retooled-counter-hypersonic-plan.

United States' ability to defend against all hypersonic threats.[33] Furthermore, the U.S. Space Development Agency (SDA) and MDA are planning to launch a constellation of small satellites to detect and track hypersonic weapons from space.[34] This plan is termed the Hypersonic and Ballistic Tracking Space Sensor (HBTSS), and satellite launches are scheduled to begin in 2023.[35]

(2) Russia

In his annual State of the Union address to the Federal Assembly of the Russian Federation in March 2018, President Vladimir Putin harshly criticized the United States' missile defense program and announced that hypersonic weapons and various new types of weapons were being developed to counter it.[36] Currently, Russia is developing both HGVs and HCMs, but the development of HGVs is thought to have inherited the results of research on HGVs conducted by the former Soviet Union in the 1980s.[37]

The HGV Avangard, which Russia is currently developing, is a non-powered glide weapon that is launched by the SS-19 intercontinental ballistic missile and has a range of more than 6,000 km, with flight speeds of Mach 20. It has a warhead weight of approximately 2 tons,[38] is said to be capable of delivering both nuclear and conventional warheads, with the capability to carry a 2Mt nuclear warhead, and is reportedly capable of horizontal and vertical maneuvers while flying at hypersonic speeds.[39] Two flight tests of Avangard conducted in 2016 were deemed successful, and although a test in October 2017 ended in failure, a test in December 2018 was successful and achieved Mach 20.[40] According to the TASS Russian news agency, the Avangard was deployed to a missile regiment stationed in Orenburg in the Urals region in December 2019.[41]

In addition to HGVs, Russia is also developing a sea-launched HCM – the Zircon (3M22). The Zircon missile has a maximum range of around 1,000 km, and is launched from a submarine or other vessel, and then accelerated to over Mach 5 using a scramjet engine to strike targets at

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33 Joseph Trevithick, "DARPA Starts Work on 'Glide Breaker' Hypersonic Weapons Defense Project," *The Drive*, September 6, 2018, https://www.thedrive.com/the-war-zone/23398/darpa-starts-work-on-glide-breaker-hypersonic-weapons-defense-project.

34 Theresa Hitchens, "DoD Launching Experiment for Space-Based Hypersonic Missile Detection," *Breaking Defense*, August 10, 2021, https://breakingdefense.com/2021/08/dod-launching-experiment-for-space-based-hypersonic-missile-detection/.

35 Jason Sherman, "Hypersonic Weapons Can't Hide from New Eyes in Space," *Scientific American*, January 18, 2022, https://www.scientificamerican.com/article/hypersonic-weapons-cant-hide-from-new-eyes-in-space/.

36 President of Russia, "Presidential Address to the Federal Assembly," March 1, 2018, http://en.kremlin.ru/events/president/news/56957.

37 United Nations Office of Disarmament Affairs, *Hypersonic Weapons: A Challenge and Opportunity for Strategic Arms Control*, February 2019, p. 10, https://unidir.org/sites/default/files/publication/pdfs/hypersonic-weapons-a-challenge-and-opportunity-for-strategic-arms-control-en-744.pdf.

38 Missile Defense Project, "Avangard," *Missile Threat*, Center for Strategic and International Studies, July 31, 2021, https://missilethreat.csis.org/missile/avangard/.

39 Nikolai Novichkov, "Russia Announces Successful Flight Test of Avangard Hypersonic Glide Vehicle," *Janes*, January 3, 2019, https://www.janes.com/defence-news/news-detail/russia-announces-successful-flight-test-of-avangard-hypersonic-glide-vehicle.

40 CRS, *Hypersonic Weapons*, p. 15.

41 "Russia's 1st Regiment of Avangard Hypersonic Missiles to Go on Combat Alert by Yearend," *TASS*, August 10, 2021, https://tass.com/defense/1324415.

sea or on land.[42] At the end of December 2021, successful test launches of Zircon were carried out from frigates and submarines.[43] According to the Presidential Executive Office of Russia, the Russian military conducted a Zircon firing exercise in mid-February 2022, when Russia's aggression against Ukraine was imminent.[44] During the Navy Day Parade in St. Petersburg at the end of July 2022, President Putin announced that the Zircon would be deployed to the navy within the next few months.[45]

Russia, in the same way as the United States, appears to have begun developing means to intercept hypersonic weapons. The Ministry of Defence of Russia has announced that the Russian Aerospace Force has tested a new interceptor missile in Kazakhstan, which, according to Russian experts, is capable of intercepting hypersonic weapons. Although specific details, such as the missile's performance specifications and production/deployment schedule, have not been confirmed,[46] the name of the missile is presumed to be S-550.[47] The new S-500 Prometheus surface-to-air missile, which is also being developed by Russia, is viewed as having the ability to intercept HCMs.[48]

In addition, Russia has announced that the air-launched ballistic missile Kinzhal (KH-47M2), which has a range of 2,000 km and can be launched from MiG-31 fighter jets, is a hypersonic weapon. However, Kinzhal is a traditional ballistic missile derived from Russia's Iskander-M ground-launched short-range ballistic missile, and is not considered a hypersonic weapon.[49]

(3) China

At the 70th anniversary military parade held in Beijing in October 2019, China unveiled, for the first time, the DF-17 (Dongfeng-17) – a medium-range missile with a range of 1,800–2,500 km that can carry HGVs. The HGV mounted on the DF-17 is called DF-ZF (Dongfeng ZF).[50]

In addition to DF-ZF, China is developing StarrySky2, which is considered a type of HCM. StarrySky2 is a HCM that is launched with a rocket booster and uses a scramjet engine to accelerate

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42 "SS-N-33 – T3K22 Zircon/ Tsirkon/ 3M33 rocket," GlobalSecurity.org, September 13, 2021, https://www.globalsecurity.org/military/world/russia/zircon.htm.

43 "Russia Test-Fires New Hypersonic Tsirkon Missiles from Frigate, Submarine," *US News*, December 31, 2021, https://www.usnews.com/news/world/articles/2021-12-31/russia-test-fires-new-hypersonic-tsirkon-missiles-from-frigate-submarine.

44 "Russia Launches Hypersonic Missiles as Part of Nuclear Drill," *US News*, February 19, 2022, https://www.usnews.com/news/world/articles/2022-02-19/russia-launches-hypersonic-missiles-as-part-of-nuclear-drills.

45 Anders Anglesey, "Vladimir Putin Says Navy to Get New Zircon Hypersonic Missiles in Months," *Newsweek*, July 31, 2022, https://www.newsweek.com/vladimir-putin-says-navy-get-new-zircon-hypersonic-missiles-months-1729421.

46 Mark Episkopos, "Russian Interceptor Missiles Take Another Step Forward," *National Interest*, November 15, 2021, https://www.newsweek.com/vladimir-putin-says-navy-get-new-zircon-hypersonic-missiles-months-1729421.

47 "Russia Tests S-550 System Capable of Hitting Spacecraft, Hypersonic Targets," *TRT World*, December 29, 2021, https://www.trtworld.com/europe/russia-tests-s-550-system-capable-of-hitting-spacecraft-hypersonic-targets-53127.

48 Ryan White, "Counter-Hypersonics: Defeating the Invincible (Hypersonic Weapons Part-3)," *Naval Post*, May 15, 2020, https://navalpost.com/counter-hypersonics-defeating-the-invincible-hypersonic-weapons-part-3/?nowprocket=1.

49 Missile Defense Project, "Kinzhal," *Missile Threat*, Center for Strategic and International Studies, July 31, 2021, https://missilethreat.csis.org/missile/kinzhal/.

50 "Dongfeng-ZF/ DF-17 Hypersonic Glide Vehicle (HGV)," GlobalSecurity.org, October 25, 2021, https://www.globalsecurity.org/wmd/world/china/df-17.htm.

up to Mach 6 after the booster separates; its first flight test was conducted in August 2018,[51] and it is estimated that StarrySky2 will begin operation around 2025.[52]

In October 2021, it was reported that China had conducted, in August of the same year, a test launch of a new hypersonic weapon capable of carrying a nuclear warhead. The warhead appears to be a HGV, and seems to have been launched by a Long March rocket. During this test, China is said to have used a technology similar to the Fractional Orbital Bombardment System (FOBS), deployed by the former Soviet Union during the Cold War and later scrapped, in combination with HGVs. Using FOBS technology, China's new HGVs will be able to attack the U.S. mainland even from the Antarctic direction, meaning that the U.S. missile defense system, which has focused on threats from around the North Pole, may not be able to counter them. A spokesperson for the Ministry of Foreign Affairs in China explained that the test was conducted to verify the reusability of the spacecraft, and was not a test involving the launch of a hypersonic weapon.[53] General Mark Milley, Chairman of the Joint Chiefs of Staff, stated that he was "very concerned" about China's test launch.[54]

The status of China's development of means to intercept hypersonic weapons is unknown. China's missile defense systems are said to have relied heavily on Russia, but in recent years China has been focusing on building its own systems, with an example being the development of the domestically-produced medium-range ballistic missile defense system HQ-19.[55] The Global Times reports that in February 2021, China conducted a test launch of a missile defense system, which intercepts ballistic missiles at midcourse, although it is unclear whether this system has the ability to intercept hypersonic weapons.[56] Currently, the People's Liberation Army is said to be seriously aware of the need for means to intercept hypersonic weapons, and appears to be considering how to build a series of systems, from those capable of detecting signs of hypersonic weapon launch using early warning satellite constellations to actual interception, and to those capable of the elemental technologies necessary for this. However, these considerations are still at the conceptual stage and do not appear to have moved to the development stage yet.[57]

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51 "Xingkong-2/ Starry Sky 2," GlobalSecurity.org, October 18, 2021, https://www.globalsecurity.org/wmd/world/china/xingkong-2.htm.

52 CRS, *Hypersonic Weapons*, p. 18.

53 Demetri Sevastopulo and Kathrin Hille, "China Tests New Space Capability with Hypersonic Missile," *Financial Times*, October 16, 2021, https://www.ft.com/content/ba0a3cde-719b-4040-93cb-a486e1f843fb.

54 "Top US General Says China Hypersonic Test is 'Very Concerning'," *CNN*, October 28, 2021, https://edition.cnn.com/2021/10/27/politics/milley-china-hypersonic-concerning/index.html.

55 "China, Russia Developing 'Increasingly Capable' Missile Defenses: Pentagon," *Defense World*, July 29, 2020, https://www.defenseworld.net/news/27529/China__Russia_Developing__Increasingly_Capable__Missile_Defenses__Pentagon.

56 Liu Xuanzun, "China Conducts Mid-course Antiballistic Missile Test, System 'Becomes More Mature and Reliable'," *Global Times*, February 5, 2021, https://www.globaltimes.cn/page/202102/1215042.shtml.

57 Holmes Liao, "China's Development of Hypersonic Missiles and Thought on Hypersonic Defense," *China Brief*, vol. 21, no. 19 (October 8, 2021), https://jamestown.org/program/chinas-development-of-hypersonic-missiles-and-thought-on-hypersonic-defense/.

3. Implications for US-China-Russia Relations

(1) Nuclear Deterrence

This section explores how to assess the impact of hypersonic weapons on the nuclear retaliatory capabilities of the United States, China, and Russia. We shall start with the discussion on the impact of the U.S. hypersonic weapons on China and Russia's nuclear retaliatory capabilities.

Since the United States does not plan to equip hypersonic weapons with nuclear warheads, their hypersonic weapons are assumed to be non-nuclear weapons. Andrew Futter, of Leicester University, points out that if a nuclear-armed state perceives that its nuclear retaliatory capabilities are vulnerable to counterforce attacks by non-nuclear hypersonic weapons, nuclear deterrence may be destabilized because non-nuclear weapons are considered to have a lower threshold for use than nuclear weapons.[58]

In fact, reportedly, China and Russia fear the scenario in which the United States launches a pre-emptive strike against these two countries' nuclear forces with non-nuclear hypersonic weapons, and even if the two countries attempt to retaliate with their remaining nuclear forces, all of them might be shot down by the United States' missile defenses.[59] In this case, the United States would be able to neutralize the nuclear retaliatory capabilities of China and Russia without using nuclear weapons. The reason why China and Russia are developing hypersonic weapons capable of carrying nuclear warheads is to ensure that their own nuclear retaliatory capabilities are not neutralized by maintaining second-strike nuclear forces that can break through missile defenses. Tong Zhao, from the Carnegie Endowment for International Peace, points out that the aim of China and Russia's development of hypersonic weapons is to break through U.S. missile defenses.[60]

However, some view that carrying out such counterforce attacks using non-nuclear warheads would require thousands of hypersonic weapons.[61] In this regard, it is believed that at least one or two nuclear warheads are required to destroy one hardened ICBM stored in underground silos.[62] In the case of using non-nuclear warheads, which are inferior to nuclear weapons in terms of destructive power, there is no choice but to use more warheads. Thus, certainly, a considerable number of weapons will be required. Meanwhile, the United States is envisioning a scenario in which non-nuclear hypersonic weapons could be used, for example, to selectively attack the leadership of a terrorist organization in the territory of a neutral country. Therefore, currently no plan is in place to deploy such weapons on a large scale for counterforce attacks against China and Russia.[63] For this reason, in terms of capabilities, it can be said that the scale of the United States'

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58 Andrew Futter, "Explaining the Nuclear Challenges Posed by Emerging and Disruptive Technology: A Primer for European Policymakers and Professionals," *Non-Proliferation and Disarmament Papers,* no. 73 (March 2021), pp. 3-4, https://www.sipri.org/sites/default/files/2021-03/eunpdc_no_73_0.pdf.

59 CRS, *Hypersonic Weapons*, p. 17.

60 Tong Zhao, "Conventional Challenges to Strategic Stability: Chinese Perception of Hypersonic Technology and the Security Dilemma," Carnegie Endowment for International Peace, July 23, 2018, pp. 17-18, https ://carnegieendowment.org/files/Conventional_Challenges_to_Strategic_Stability.pdf.

61 Seth D. Baum, "Winter-safe Deterrence: The Risk of Nuclear Winter and its Challenge to Deterrence," *Contemporary Security Policy*, vol. 36, no. 1 (2015), pp. 134-135, https://www.tandfonline.com/doi/pdf/10.1080/13523260.2015.1012346?needAccess=true.

62 Ryan Snyder, "The Future of the ICBM Force: Should the Least Valuable leg of the Triad Be Replaced?" Arms Control Association, March 2018, https//www.armscontrol.org/policy-white-papers/2018-03/future-icbm-force-should-least-valuable-leg-triad-replaced.

63 CRS, *Conventional Prompt Global Strike and Long-Range Ballistic Missiles: Background and Issues*, by Amy F. Woolf, R41464 (Updated July 16, 2021), pp. 6-10, https://sgp.fas.org/crs/nuke/R41464.pdf.

hypersonic weapons will not be large enough to neutralize the nuclear retaliatory capabilities of China and Russia, and they will not destabilize nuclear deterrence.

Still, there is a possibility that China and Russia may misunderstand Unites States' intentions regarding the use of non-nuclear hypersonic weapons, leading to destabilization of nuclear deterrence. In particular, hypersonic weapons have unpredictable flight paths and impact points. Therefore, for example, in a scenario where the United States launches a non-nuclear, long-range hypersonic missile targeting a terrorist organization hiding in northern Pakistan, a situation could arise in which China and Russia detect a missile launch and mistakenly believe that it is an attack targeting their own territory. China and Russia may also misidentify the missile as a nuclear missile rather than a non-nuclear missile.[64] Since hypersonic missiles hurtle through the upper atmosphere at speeds exceeding Mach 5, China and Russia may consider that ordering retaliation after the point of impact is known would result in missing the timing and having their own nuclear retaliatory capabilities destroyed. In this way, if China and Russia prematurely decide on nuclear retaliation, the risk of nuclear deterrence failing increases.

Additionally, even a small number of hypersonic weapons could potentially neutralize the command and control functions of nuclear retaliatory capabilities by destroying the national command center of the other country. Sander Aarten, at the Netherlands Defense Academy, points out that hypersonic weapons offer such a "decapitating first strike" option.[65] Similarly, Richard Speier, at the RAND Corporation, also assesses that hypersonic weapons have the potential to neutralize a country's leadership before it can launch a retaliatory attack.[66] In relation to this point, Vladimir Dvorkin, at the Institute of World Economy and International Relations, mentions a risk that a small number of hypersonic weapons could attack command centers in areas such as Moscow. Nevertheless, if Russia's command center were to be destroyed, it would leave behind huge nuclear forces that are no longer under the control of the state, which could lead to an unpredictable situation. Therefore, Dvorkin points out that the United States will not carry out such an attack.[67]

It should be noted, however, that there is a possibility that China and Russia might misinterpret the aforementioned non-nuclear hypersonic missile attack by the United States targeting terrorist organizations in Pakistani territory as a pre-emptive attack on their own national command centers. In this case, China and Russia will try to determine whether U.S. missiles will pose a threat to their countries. However, as these two countries currently do not have effective means to track and intercept hypersonic weapons, it is difficult to obtain accurate information on the flight paths of launched missiles. In the unlikely event that the country's national command center is destroyed, it will become impossible to determine whether nuclear retaliation is necessary or to issue orders.

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64 Carrie A. Lee, "Technology Acquisition and Arms Control: Thinking Through the Hypersonic Weapons Debate," *Texas National Security Review*, vol. 5, no. 4 (Fall 2022), p. 39, https://repositories.lib.utexas.edu/bitstream/handle/2152/117044/TNSRJournalVol5Issue4Lee.pdf?sequence=2&isAllowed=y.

65 Sander Ruben Aarten, "The Impact of Hypersonic Missiles on Strategic Stability: Russia, China, and the US," *Militaire Spectator*, April 21, 2020, https://www.militairespectator.nl/thema/strategie/artikel/impact-hypersonic-missiles-strategic-stability.

66 Richard H. Speier, "Hypersonic Missiles: A New Proliferation Challenge," The RAND Blog, RAND Corporation, March 29, 2018, https://www.rand.org/blog/2018/03/hypersonic-missiles-a-new-proliferation-challenge.html.

67 Dvorkin, "Hypersonic Threats: The Need for a Realistic Assessment."

Thus, it cannot be ruled out that China and Russia may decide to carry out nuclear retaliation as soon as they detect a missile launch from the United States, which could lead to the collapse of nuclear deterrence.

Next, we shall consider the debate over the impact of Chinese and Russian hypersonic weapons on United States' nuclear retaliatory capabilities.

Sanne Verschuren, of Stanford University, analyzes that even if China deploys new hypersonic weapons, it will not affect the nuclear deterrence relationship between the United States and China for the following reasons: China already possesses sufficient nuclear missiles to attack the United States; the U.S.'s missile defense system is designed to deal with small-scale nuclear missiles from countries such as North Korea and therefore, it is difficult to imagine that the U.S. system is capable of deterring Chinese nuclear retaliatory attacks.[68]

Russia's hypersonic weapons are also thought to have little impact on the nuclear retaliatory capabilities of the United States. Paul Bernstein, at the National Defense University, and his colleagues view that Russia's deployment of the HGV Avangard does not pose a new threat to the United States' nuclear retaliatory capabilities, because it would not increase the vulnerability of U.S.'s ICBMs, nor would it improve Russia's disarming first strike capabilities.[69]

These arguments are valid as long as China and Russia deploy only a small number of hypersonic weapons, but if they were to head toward large-scale deployment, this would pose a threat to the U.S.'s nuclear retaliatory capabilities and become a factor that could destabilize nuclear deterrence.

Even if China and Russia deploy only a small number of hypersonic weapons, the characteristics of these weapons could destabilize their nuclear deterrence relationship with the United States. Patty-Jane Geller, from the Heritage Foundation, argues that the potential for Chinese hypersonic weapons to evade the U.S.'s early warning satellites and radars will raise concerns about a disarming surprise attack on U.S. nuclear retaliatory capabilities and destabilize the deterrence relationship.[70] In addition, Mark Schneider, at the National Institute for Public Policy, argues that Russian hypersonic weapons could be useful as a means for surprise attacks on U.S. national command centers, pointing out that Russia could use such attacks to cause a delay in U.S. decisions on nuclear retaliation and at the same time could conduct further attacks using hypersonic weapons to wipe out the nuclear bomber force.[71] This is similar to the views expressed by Sander Aarten and others regarding U.S. hypersonic weapons. We can evaluate that these discussions highlight the risk of destabilizing nuclear deterrence in the event that an incorrect judgment is made solely based on the characteristics of hypersonic weapons without understanding the intentions of China and Russia regarding the use of such weapons, which are unclear.

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[68] Sanne Verschuren, "China's Hypersonic Weapons Tests Don't Have to Be a Sputnik Moment," *War on the Rocks*, October 29, 2021, https://warontherocks.com/2021/10/chinas-hypersonic-missile-tests-dont-have-to-be-a-sputnik-moment/.

[69] Paul Bernstein and Harrison Menke, "Russia's Hypersonic Weapons," *Georgetown Journal of International Affairs*, December 12, 2019, https://gjia.georgetown.edu/2019/12/12/russias-hypersonic-weapons/.

[70] Patty-Jane Geller, "China's Test of an Orbital Hypersonic Missile Is a Big Deal," Heritage Foundation, October 25, 2021, https://www.heritage.org/defense/commentary/chinas-test-orbital-hypersonic-missile-big-deal.

[71] Mark B. Schneider, "Russia's Hypersonic Missile Threat to the U.S. National Command Authority," *Real Clear Defense*, September 11, 2019, https://www.realcleardefense.com/articles/2019/09/11/russias_hypersonic_missile_threat_to_the_us_national_command_authority_114736.html.

Based on the above examination, hypersonic weapons will not have a major impact on the nuclear retaliatory capabilities of the United States, China, and Russia unless they are deployed on a large scale to neutralize the other's retaliatory capabilities. For this reason, there seems to be a low possibility of destabilization within the nuclear deterrence relationship among the three countries. However, hypersonic weapons could be used as an option for a first strike against the national command centers of the United States, China, and Russia. Thus, it should be noted that if there is a misunderstanding that such an attack will take place, this could pose a risk of destabilizing the nuclear deterrence relationship.

(2) Arms control

This section considers how the development and deployment of hypersonic weapons can be regulated. Based on the considerations in the previous section, in order to avoid destabilizing the nuclear deterrence among the United States, China, and Russia in relation to hypersonic weapons, it seems important that they first take measures to reduce the risk of misunderstandings associated with the use of such weapons.

Given that China and Russia are concerned about the possibility of their own nuclear retaliatory capabilities weakening due to U.S.'s hypersonic weapons, there are ways to reduce the risk of misunderstanding on the Chinese and Russian sides to some extent. For example, the United States could notify China and Russia in advance of the launch of a non-nuclear hypersonic missile through various means, such as bilateral hotlines, and provide reassurance that the missile scheduled for launch will not be aimed at China or Russia. It would also be effective to use missiles deployed at an air force base in the mainland United States that does not have facilities or equipment for storing or handling nuclear weapons to demonstrate that the missiles are not equipped with a nuclear warhead. Taking such measures may lead to building mutual trust among the United States, China, and Russia.[72] Furthermore, it may be desirable to use these measures as a foundation to increase the momentum for arms control negotiations regarding the regulation of the development and deployment of hypersonic weapons.

There are many voices expressing concern about competition among the United States, China, and Russia to develop and deploy hypersonic weapons. For example, Ethan Paul, at the Quincy Institute for Responsible Statecraft, argues that if the United States were to proceed with the deployment of hypersonic weapons in response to China's deployment, it would only increase military tensions between the two countries, and that a political solution based on diplomacy and arms control should be explored.[73] Meanwhile, Spenser Warren, at Indiana University Bloomington, has recommended that, in exchange for limits on its own hypersonic weapons, the United States should negotiate with Russia to reduce its strategic nuclear weapons and limit its intermediate-range nuclear forces, and set the goal to bring China into such negotiations.[74] In addition, Chris Gowe, at the Asia-Pacific Leadership Network for Nuclear Nonproliferation and

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72 CRS, *Conventional Prompt Global Strike and Long-Range Ballistic Missiles*, pp. 37-40.

73 Ethan Paul, "How Deploying Hypersonic Weapons to Counter China Creates a Collision Course to War," *Responsible Statecraft*, July 29, 2021, https://responsiblestatecraft.org/2021/07/29/how-deploying-hypersonic-weapons-to-counter-china-creates-a-collision-course-to-war/.

74 Spenser A. Warren, "Avangard and Transatlantic Security," Center for Strategic and International Studies, September 23, 2020, https://www.csis.org/blogs/post-soviet-post/avangard-and-transatlantic-security.

Disarmament, suggests starting at the Track 2 or 1.5 level to bring China into hypersonic weapons regulation negotiations.[75]

When starting such arms control negotiations among the United States, China, and Russia, reportedly the focus will likely be the U.S. missile defense system.

Ankit Panda, from the Carnegie Endowment for International Peace, discusses that the United States should include the topic of missile defense in arms control negotiations with China and Russia over hypersonic weapons.[76] James Acton, at the same organization, also argues that the United States should propose to negotiate over regulating missile defenses to curb China and Russia's build-up of nuclear and missile forces, including hypersonic weapons.[77] Since U.S.'s missile defense is a factor in accelerating the modernization of China and Russia's nuclear forces, including hypersonic weapons, aforementioned Sanne Verschuren discusses that it is desirable to bring up missile defense in negotiations with China and Russia, and make realistic proposals, such as joint technical research and transparency measures regarding missile defense.[78]

In contrast, Shaan Shaikh, at the Center for Strategic and International Studies, points out that in exchange for limits on hypersonic weapons, China may force the United States to make significant concessions, such as limits on U.S.'s mainland and regional missile defenses.[79] In this regard, John Erath, from the Center for Arms Control and Non-Proliferation, suggests that the United States should be cautious about including missile defense in negotiations with Russia.[80]

In any case, the current U.S. missile defense system is certainly not perfect in preventing missile attacks of all scales and types. It has been pointed out that not only is it problematic for the system to intercept hypersonic weapons, but even traditional ballistic missiles are difficult to deal with when launched on a trajectory with a shallow launch angle (depressed trajectory).[81] Based on this, if the U.S. missile defense system is brought up in arms control negotiations regarding hypersonic weapons with China and Russia, the United States has to clearly convey to both countries that its own missile defense system is not deployed for the purpose of deterring Chinese and Russian nuclear retaliatory capabilities, and that its capabilities are extremely limited. It will then be important that the United States direct the negotiations towards setting a concrete agenda for regulating the development and deployment of hypersonic weapons, while taking into consideration the concerns of China and Russia.

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75 Chris Gowe, "Getting China on Board with Hypersonic Controls," Asia-Pacific Leadership Network for Nuclear Non-Proliferation and Disarmament (APLN), August 23, 2021, https://www.apln.network/analysis/commentaries/getting-china-on-board-with-hypersonic-control.

76 "China's Hypersonic Missile: Could It Spark a New Arms Race?" *BBC*, October 24, 2021, https://www.bbc .com/news/world-asia-59001850.

77 James M. Acton, "China's Tests Are No Sputnik Moment," Carnegie Endowment for International Peace, October 21, 2021, https://carnegieendowment.org/2021/10/21/china-s-tests-are-no-sputnik-moment-pub-85625.

78 Verschuren, "China's Hypersonic Weapons Tests Don't Have to Be a Sputnik Moment."

79 Shaan Shaikh, "China's Hypersonic Future," *Missile Threat*, Center for Strategic and International Studies, December 12, 2021, https://missilethreat.csis.org/chinas-hypersonic-future/.

80 John Erath, "A Note of Caution on the U.S.-Russia Dialogue," Center for Arms Control and Non-Proliferation, October 22, 2021, https://armscontrolcenter.org/a-note-of-caution-on-the-u-s-russia-dialogue/.

81 Eben Coetzee, "Hypersonic Weapons and the Future of Nuclear Deterrence," *South African Journal of Military Studies*, vol. 49, no. 1 (2021), pp. 46-48, https://scientiamilitaria.ac.za/pub/article/view/1318.

(3) Strengthening Defense Posture against Hypersonic Weapons and its Impact

This section discusses how strengthening defense posture against hypersonic weapons could affect U.S.–China–Russia relations. As mentioned earlier, the United States is considering the deployment of new interception systems for hypersonic weapons. At present, the threat posed by HGVs is perceived to be more important than that by HCMs, [82] and interception systems targeting HGVs are actually under consideration.

HGVs generate high heat while gliding through the atmosphere. Although it is possible to capture this heat source using infrared sensors mounted on current ballistic missile early warning satellites, continuous tracking of the HGV is required in order to actually guide the interceptor to the target. In addition, more sensitive infrared sensors will be needed to reliably capture HGVs' weak thermal signatures. The Hypersonic and Ballistic Tracking Space Sensor (HBTSS) program being advanced by the U.S. Missile Defense Agency (MDA) and others aims to deploy a new group of small infrared detection satellites in orbit that can meet this demand and provide highly accurate tracking data to interceptors.[83]

As a new type of interceptor, the Glide Phase Interceptor (GPI) development program is being advanced to intercept HGVs while they are gliding through the atmosphere. The current U.S. military's PAC-3 and SM-6 mounted on ballistic missile defense Aegis ships are reportedly capable of intercepting HGVs when they complete the glide stage, descend, and approach the target in the terminal stage. However, if these miss the shot, there will be no further chances for interception.[84] Since HGVs are considered to be most vulnerable to attack during their glide stage, the U.S. MDA is working with military companies to develop technologies such as missile seekers, interceptor materials, and propulsion devices that can operate in the atmospheric environment in which HGVs glide.[85]

However, the budget for developing new interceptor systems like GPI is not necessarily sufficient.[86] Tom Karako, at the Center for Strategic and International Studies, and his colleagues point out that the United States is focusing on developing hypersonic weapons, while spending less on developing means to intercept such weapons.[87] Regarding this point, Gillian Bussey, director of the Joint Hypersonic Transition Office (JHTO), Department of Defense, states that the primary focus has been on offensive weapons because attacking is much easier than defending.[88]

In light of this situation, there are opinions calling for strengthening defense posture against

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82 Theresa Hitchens, "Pentagon Needs to Prioritize Hypersonic Defense, not Offense: CSIS," *Breaking Defense*, February 7, 2022, https://breakingdefense.com/2022/02/pentagon-needs-to-prioritize-hypersonic-defense-not-offense-csis/.

83 Abraham Mahshie, "Hypersonic Defense," *Air Force Magazine*, January 19, 2022, https://www.airforcemag .com/article/hypersonics-defense/.

84 Ibid.

85 Kris Osborn, "Pentagon's Emerging Glide Phase Interceptor Will Destroy Hypersonic Missiles," *Warrior Maven*, January 11, 2022, https://warriormaven.com/global-security/glide-phase-interceptor.

86 Vice Admiral Jon Hill, Director of MDA, has indicated that there is not enough funding for GPI development. Megan Eckstein, "Budget Uncertainty 'Throttles' MDA's Development of a Hypersonic Missile Interceptor," *Defense News*, February 3, 2022, https://www.defensenews.com/naval/2022/02/02/budget-uncertainty-throttles-mdas-development-of-a-hypersonic-missile-interceptor/.

87 Tom Karako and Masao Dahlgren, "Complex Air Defense: Countering the Hypersonic Missile Threat," Center for Strategic and International Studies, February 2022, pp. 3, 17-18, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220207_Karako_Complex_AirDefense.pdf?SmaHq1sva9Sk%20.TSlzpXqWY72fg8PdLvA.

88 Hitchens, "Pentagon Needs to Prioritize Hypersonic Defense, not Offense."

hypersonic weapons. Richard Weitz, at the Hudson Institute, argues for strengthening NATO's air and missile defense posture to counter the threat of Russian hypersonic weapons.[89] In addition, Peter Brookes, from the Heritage Foundation, and his colleagues point out that China's development of hypersonic weapons undermines strategic stability in the Indo-Pacific region, and that in the event of a crisis or conflict between the United States and China, it will give the Chinese side a military advantage. For this reason, it has also been argued that, in parallel with hypersonic offensive weapons, the United States should develop and deploy comprehensive and multi-layered missile defense systems, which include space sensor suites to detect and intercept China's hypersonic weapons.[90] Furthermore, James Zumwalt, retired U.S. Marine Corps Lieutenant Colonel, states that the United States should not focus on developing hypersonic weapons; the correct measure to take is to make China and Russia realize that it is pointless no matter how much they increase their offensive missiles, by developing defense postures against hypersonic weapons.[91]

However, if the United States takes the direction to strengthen its defense posture against hypersonic weapons in accordance with the above discussions, China and Russia will, as Zumwalt points out, likely respond by increasing the capacity of their offensive missiles, and the two countries may also embark on large-scale deployment of hypersonic weapons. If that happens, the nuclear deterrence relationship among the United States, China, and Russia would become unstable, and the momentum for negotiations on the regulation of hypersonic weapons could suddenly decline.

If the United States increases its missile defense capabilities to be able to intercept hypersonic weapons from China and Russia, and the two countries determine that there is an increased incentive for a first strike using hypersonic weapons from the United States, China and Russia will raise their nuclear retaliatory alertness to a higher level. This denotes an increased risk of inadvertent nuclear use due to accidents or errors. Discussing a relevant point, the aforementioned Ankit Panda uses the example that, in November 2020, the United States successfully conducted an interception test of a long-range missile for ICBM-class targets with the SM-3 Block IIA mounted on a ballistic missile defense Aegis ship. Panda points out the possibility that China and Russia fear the situation in which the United States attempts to acquire first-strike capabilities by increasing the likelihood of ICBM interception, leading to destabilizing the nuclear deterrence relationship between the United States and the two countries.[92] A similar situation is expected to occur as the possibility of the U.S.'s interception of hypersonic weapons increases.

In order to prevent such a situation from occurring, for the time being, it will be necessary to limit the deployment of new interception systems against hypersonic weapons to a certain extent, rather than deploying them indefinitely. Spenser Warren mentioned above argues that defenses

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89 Richard Weitz, "Managing Multi-domain and Hypersonic Threats to NATO," International Centre for Defence and Security, April 24, 2020, https://icds.ee/en/managing-multi-domain-and-hypersonic-threats-to-nato/.

90 Peter Brookes and John Venable, "Chinese Hypersonic Weapons Developments Must Be Countered," Heritage Foundation, December 8, 2021, https://www.heritage.org/defense/report/chinese-hypersonic-weapons-developments-must-be-countered.

91 James Zumwalt, "Good Defense is the Best Offense with Hypersonic Missiles," *The Hill*, November 4, 2019, https://thehill.com/opinion/national-security/438429-good-defense-is-the-best-offense-with-hypersonic-missiles.

92 Ankit Panda, "A New U.S. Missile Defense Test May Have Increased the Risk of Nuclear War," Carnegie Endowment for International Peace, November 19, 2020, https://carnegieendowment.org/2020/11/19/new-u.s.-missile-defense-test-may-have-increased-risk-of-nuclear-war-pub-83273.

against Russia's Avangard HGV should not be strengthened. According to Warren, even if a small number of Avangard attacks could be thwarted, the United States would remain vulnerable to Russian nuclear attacks, and that deterrence is therefore the best way to prevent Avangard attacks.[93] Since the deployment of a new interception system for hypersonic weapons is still a long way off, it is necessary to fully consider the implications of such an interception system for nuclear deterrence and arms control until then.

Conclusion

This article examined what implications the development of hypersonic weapons by the United States, China, and Russia would have on their trilateral relations. In terms of nuclear deterrence, it is considered unlikely that the development and deployment of hypersonic weapons would destabilize the U.S.–China–Russia's nuclear deterrence relationship, unless these weapons are deployed on a large scale to neutralize the other's nuclear retaliatory capabilities. However, we have pointed out the possibility of a risk of destabilizing nuclear deterrence in the event of the use of hypersonic weapons that leads to a misunderstanding that it is a pre-emptive strike against the national command centers of any of the three countries. In terms of arms control, the article has stated that it is desirable to take measures to reduce the risk of misunderstandings regarding the use of hypersonic weapons, while building momentum for hypersonic weapons regulation negotiations among the United States, China, and Russia. This paper also discussed the implications that the United States' strengthening of its defense posture against hypersonic weapons will destabilize the nuclear deterrence relationship with China and Russia, and pointed out that it could also become a factor, which would slow down momentum for negotiations on regulating hypersonic weapons.

As mentioned above, the United States, China, and Russia are fiercely competing to develop hypersonic weapons. Although there are other countries that are proceeding with development, the United States, China, and Russia have the most advanced development plans.[94] It is no doubt that the policies of these three countries will have a major influence on the future direction of hypersonic weapons. For this reason, it is necessary to keep track of the status of efforts by the United States, China, and Russia regarding hypersonic weapons, and to organize internal and external discussions relevant to this topic.

(National Institute for Defense Studies)

93 Warren, "Avangard and Transatlantic Security."

94 CRS, *Hypersonic Weapons*, p. 20.