Space and Defense

Volume 12
Number 3 *Volume 12 Issue 2 (Summer 2021)*

Article 8

June 2021

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Introduction

Whether it is troop movement across terrain, the performance of military aircraft, or the time required responding with national force, speed has always been a critical element in securing U.S. national security objectives.Indeed, Sun Tzu acknowledged that speed is the essence of war, and an essential component in speed is technology. Emerging technologies influence and alter strategic analyses as they are developed and deployed.

Russian hypersonic weapons have been the most recent to make the news, touting capabilities which can maneuver past missile defense systems.[1] With that in mind, China is also developing this type of weapon system, but the U.S. was the first to test it.These weapons present myriad risks and threats to nuclear deterrence, strategic stability, and crisis stability because of their unique capabilities.

The hypersonic velocity regime is defined by NASA as an object moving between five and 25 times the speed of sound at sea level (Mach 5 to Mach 25).[2] There are two types of hypersonic weapon operating in this speed regime. The first group is air-breathing vehicles which use incoming air towards and through the missile as a means of propulsion. Air-breathing vehicles, or cruise missiles, tend to fly close to the Earth's surface, making them difficult to monitor with current detection technology and methods. The second group of hypersonic weapons is the hypersonic glide vehicles (HGVs). These are launched into the exo-atmosphere with one or more rocket stages before the reentry vehicle is released, and then glides to its target. The rocket-propelled period is referred to as the boost phase; all HGVs use a boost phase and are sometimes called boost-glide vehicles (BGVs).

The HGV name refers to two types of glide: glide and skip-glide. Proceeding from the ballistic phase, the glide vehicle dives and then performs a perigee pull-up maneuver. Depending on design, the vehicle may then enter an equilibrium glide trajectory before diving to the target. Alternative designs will, after pulling up, enter a skip-glide trajectory which allows the RV to bounce across the surface of the upper atmosphere. Given the performance principles of air-breathing hypersonic weapons, such weapons would be subject to the limitations set forth in the INF Treaty and New START as they are unmanned and utilize onboard power plants and lift-generating surfaces together for half or more of the trajectory.[3]

HGVs, on the other hand, do not fully meet either cruise or missile definition. A HGV may use lift and may be unmanned for most of its trajectory but does not utilize a power plant. The HGVs' manipulation of aerodynamic forces to reach the

target and to ensure a stable glide means that HGVs are guided and do not act exclusively under the effects of drag and gravity. The boost-glide trajectory is hence non-ballistic. The brief ballistic moments in HGV trajectories comprise only a fraction of total flight time, not meeting the 50% ballistic parameter in New START.[4] The significance of these facts is that HGVs are unregulated technologies that pose new capabilities and new military threats, raising questions for strategic stability.

This paper will present the strategic reasons for U.S., Chinese, and Russian development and the benefits and risks of both national and foreign hypersonic weapons development. This paper will then provide policy recommendations, ultimately concluding that the U.S. should clearly and cohesively establish a large strategic conventional hypersonic glide vehicle capability and lead foreign developers of similar technologies towards arms control agreements to secure both long-term strategic and crisis stability with Russia and China.

The Strategic Context of Hypersonic Weapons: U.S., Russia, and China

As the capabilities and designs of hypersonic weapons become more refined, consistent, and reliable, the strategic context of their development and use become increasingly critical to the discussion surrounding the political, security, and stability implications.

U.S.

The U.S. development of hypersonic weapon technology was initiated under the Conventional Prompt Global Strike (CPGS) program following other projects exploring conventional strike options.[5] CPGS does not have a formal definition but refers to the capability to strike – without the use of a nuclear warhead – quickly anywhere in the world with great precision. CPGS was developed by President George W. Bush's administration to meet DoD initiatives and needs for swift global strikes, though discussions of such a capability predates the administration. Most prominently, the program spent considerable effort exploring the feasibility of putting conventional warheads on ICBMs, rather than nuclear warheads.[6] General Cartwright in 2006 stated that a small class of targets existed that the U.S. would only be able to eliminate with nuclear warheads, though using such nucelar assets against this small range of targets would be inappropriate.[7] In 2008, the National Academy of Sciences concluded that "high-value targets having time-sensitive urgency could not be effectively engaged by currently available conventional systems",[8] acknowledging that there are a few select types of military targets that could not warrant a nuclear strike but were unreachable by existing non-nuclear options. Under the Bush administration, these types of scenarios would have been targeted with long-range ballistic missiles with conventional warheads, launched from the U.S. or submarines.

That said, the original drivers of CPGS appear to be technological opportunism rather a mission. A 1995 RAND study on conventional ICBMs and SLBMs commented, "Why not [develop the capability]? [It is] Relatively cheap and may be just what we need some day", suggesting such an option should be explored simply because it is possible.[9] Dennis Gormley, moreover, asserts little thought went into what the strategic perceptions in Beijing and Moscow would be if Trident missiles were given conventional warheads.[10] A 2004 Defense Science Board report argued that large sunk costs could be leveraged with existing ICBM and SLBM systems for conventional payload delivery.[11] Technology was the tail wagging the policy dog; as James Acton characterizes early CPGS, it was a "missile in search of a mission".[12]

The Defense Science Board explored multiple scenarios which might require a CPGS option as a response and to close the capability gap between nuclear delivery platforms and conventional means:

1.A near-peer competitor has used an emerging counter-space capability to destroy a U.S. satellite.

2.The U.S. needs to intercept or destroy a package of special nuclear material (SNM) being transported by a terrorist organization while the location is known.

3.The U.S. needs to eliminate an uncharacterized WMD in a static small package while the location is known.

4.Terrorist organization leadership is expected to gather at a certain location, and the U.S. needs to eliminate the meeting participants.

5.The U.S. needs to totally deny a rogue state the capability to deliver any nuclear weapons.[13]

These scenarios framed the CPGS capability as a limited-use, tactical-in-application mission, but the justifications for such a program shifted slightly under the Obama administration. In the 2010 NPR, CPGS became the means to "continue to strengthen conventional capabilities and reduce the role of nuclear weapons in deterring non-nuclear attacks".[14] The Obama administration, under this goal, linked ballistic missile defense development with advanced conventional weaponry. CPGS development during this period, though unimpeded during the transition between administrations, moved away from conventionally modified ICBM/SLBMs and focused on hypersonic weapons. Hypersonic weapons continue to be the main technology pursued by CPGS.

The current and unresolved question is whether CPGS is a niche limited-use program or a strategic-scale platform for high-intensity conflict. Most development objectives and the envisioned uses of the hypersonic weapon technology remain creating a capability for a precise, powerful, small-scale strike on time-sensitive and

difficult-to-reach targets for which no non-nuclear U.S. capability currently exists. The technology is intended for a niche role in U.S. conventional strike capability.[15]

Russia

Unlike the two other nations which are developing hypersonic weapons, Russia's development of the technology is part of recent national and international strategic developments. In the most recent national security strategy white paper put out by the Russian Federation, sovereignty, growth, social stability, cultural integrity, and a competitive economy are its named long-term strategic goals.[16] Most forward, though, is the stated goal of "consolidating the Russian Federation's status as a leading world power, whose actions are aimed at maintaining strategic stability and mutually beneficial partnerships in a polycentric world".[17] Russian thought anticipates a new rise in capability and prestige, and also regaining regional and global influence. *Derzhavnost*, or 'greatpowerness', is a potent and deep-rooted concept in Russian strategic thinking and this notion forms the basis of Russia's national strategies.[18]

Russian acknowledgement of the above factors as elements the military itself will achieve suggests a growing link between military policy and other internal goals. The implication is a strategic recoupling of the military to Russia's core geo-strategic interests and security policy.[19] National strategy, deterrence, strategic stability, and crisis stability hence depend on military means and policy and the degree to which Russia and its institutions desire to assert themselves as a great power.

Russian strategic thought and objectives over the past few years have prioritized operational flexibility while simultaneously denying potential adversaries the same decision-making latitude.[20] Part of this involves developing a robust national defense infrastructure, but not purely in a symmetrical shape to that of the U.S. and NATO. This newer military posture is an offensive defense, and preemptive in character. To Russians, a defense strategy cannot, unlike Western conceptions, cede territory in exchange for decision space in a conflict.[21] Defense strategies and war-planning must be outward looking, while ensuring inviolable border integrity.

Putin has condemned the Bush administration's withdrawal from the Anti-Ballistic Missile Treaty in 2001, creation of a Ballistic Missile Defense Agency, and the Obama administration's implementation of ballistic missile defense systems in Eastern Europe each as destabilizing.[22] [23] [24] While the U.S. claims these systems do not undermine Russian missile capabilities, Russia still considers them threats to its strategic nuclear deterrents.[25] What is more, nuclear weapons are very much a core element in the Russian conception of great powerness.[26] Whether real or a misplaced fearful perception, the implication of an undermined nuclear capability by means of missile defense systems, they suggest a Western aim and ability to limit Russia's claim to great power status.

It is within this strategic context – an offensive defense, ballistic missile defenses at the border, and the U.S. testing of hypersonic weapons – Russia has initiated reforms of its military. Russia anticipates an aerospace theater of military operations that fuses the air and space domains typically considered separate in traditional U.S. schools of thought and has thus made organizational reforms to account for this.[27] The most rigorous reform so far is the creation of the *Vozdushno-kosmicheskie sily* (VKS), or Aerospace Forces, combining the Air Force and the Aerospace Defense Forces.[28] This signals the merging of the air domain with the space domain in Russian strategic thought.

Hypersonic weapons, both glide and cruise vehicles, operate in this domain, and the U.S. CPGS and hypersonic capabilities have driven much of the reasoning for reform.[29] There exists, moreover, widespread disbelief in Russia that the U.S. pursuit of hypersonic weapons is motivated by any state other than Russia, despite the public U.S. discussions of the weapons' use for rogue actors and terrorist scenarios.[30] Indeed, this is why, in addition to the development of Russian hypersonic weapons and defenses, Russia has indicated that a conventional strategic strike by the U.S. could still prompt a nuclear response from Russia.[31]

Specifically, Russia is developing a hypersonic glide vehicle under Project 4202. The platform is otherwise referred to as the Yu-71.[32] This HGV is claimed to be able to penetrate missile defense systems – both in Europe and the U.S..[33] There are plans, furthermore, for the Yu-71 to carry nuclear warheads, in addition to conventional warheads.[34] Russian development of such a system demonstrates that its acquisition is driven by national and military strategies, targeting the threat and obstacles of missile defense systems that would undermine Russian gains in a crisis or war. A hypersonic capability provides Russia an additional means of holding potential adversaries at risk. That said, current Russian capabilities and effectiveness of this platform are still unclear.[35]

Russian reasons for developing hypersonic weapons stem from a strategic need. The merging and re-conception of the air and space domains into the aerospace theater of military operations, and anticipating the need to provide dominant domain control in the maintenance of an offensive defense to ensure territorial integrity, both call for a hypersonic capability. The U.S. development of such penetrating ability has prompted a Russian exploration into the same, and into protection against it (for example, deployment of the S-500 system).[36] The ability to project *derzhavnost*, furthermore, justifies national acquisition of hypersonic weapons. There exists some commentary that hypersonic weapons are part of Russian nuclear modernization. This, however, is not the case; hypersonic weapons development precipitates from greater considerations: strategic need, shifting military thought, and identity assertion.

China

Of the three powers developing hypersonic weapons, open-source information suggests that China has made the most tests and appears to have the most developed program. The purposes and drivers of weapons development, however, are much less clear than the U.S. or Russian cases. That said, China's nuclear and strategic thought may provide insight into the reasons for development and potential applications of hypersonic weapons.

A critical component for Chinese national security strategy and for its armed forces is to "maintain strategic deterrence and carry out nuclear counterattack".[37] This is a straightforward mission with similar goals to U.S. and Russian nuclear enterprises, but Chinese nuclear thinking and strategy tend not to align with such modes of thought. China maintains a no-first-use policy for its nuclear weapons. That is, China has publicly committed itself not to strike first with nuclear weapons in a conflict. This posture and thought originates from China's historical experience with foreign nuclear weapons and its own nuclear capability: the nullification of potential nuclear coercion, or blackmail.

Before China developed nuclear weapons, the U.S. threatened the PRC with nuclear weapons during a conflict with Taiwan.[38] The specter of being coerced into a particular course of action by a nuclear power – blackmail – was unacceptable to Chairman Mao, and the means of preventing such coercion was the acquisition of nuclear weapons for a nuclear second-strike capability.[39] Nuclear weapons, given the purpose of preventing coercion and the massive damage they could inflict during early periods of acquisition, were – and are – not considered particularly useful on the battlefield.[40] Conventional force, active defense, and the people's war are the governing factors in armed victory.[41] This means that China's military growth will depend on two key factors: the survivability of its nuclear deterrent and the conventional strength China aims to deliver. That said, it is important to note that if an adversary's capability credibly and sufficiently threatens China's retaliatory ability, it may be incentivized to use nuclear weapons before it loses the ability to do so.[42]

"China will unswervingly follow the path of peaceful development, pursue an independent foreign policy of peace and a national defense policy that is defensive in nature, oppose hegemonism and power politics in all forms" in its pursuit of the "Chinese Dream" of national rejuvenation, as stated in its 2015 Defense White Paper.[43] Opposition to power politics and hegemonism indicates a resolve to assert regional influence, and this perhaps is best manifested in the strategic requirement of combining the "offshore waters defense" doctrine of the past with the new "open seas protection".[44] China's defense posture is no longer simply concerned with protecting its border but is now looking outward and regionally in power projection

to contend with other regional actors. This requires an increased ability to operate and contend with other naval and military presences, and swift, precise, undetectable anti-ship missiles seem to be a means of achieving this end – a capability a hypersonic missile could easily accomplish.

China believes the U.S.-proposed Terminal High Altitude Area Defense system (THAAD) and other existing regional ballistic missile defense systems undermine its ability to project a conventional capability in the South China Sea. These U.S. missile defense capabilities, moreover, may be able to undermine China's second-strike capability against the U.S. As China's strategy depends on the maintenance of open-seas protection and the survivability of its second-strike capability, regional U.S. missile defenses appear to China as threats to such objectives and may have prompted the development of hypersonic weapons to circumvent such challenges.

A latent nuclear Japan is another strategic threat to China and may also be a strategic driver of hypersonic capability development. Possessing large plutonium stocks, Japan may have the ability to develop a nuclear weapon should the U.S. nuclear umbrella lose credibility.[45] Should such a scenario arise, as may likely be the consequence of successful Chinese assertion in the region, the ability to eliminate a nuclear weapons facility, or to maneuver around a missile defense system placed in Japan, is of great strategic benefit.

The technology lag between U.S. and Chinese advancements may be a strategic fear which China is attempting to mitigate by responding to U.S. tests with a Chinese hypersonic program. China often pursues military and nuclear development efforts to master new technology to avoid lagging. The fear of instability resulting from a technical lag, and the fear of being attacked resulting from lagging behind in the development of military technology, are prominent in the Chinese strategic security paradigm.[46] When the U.S. developed its hypersonic weapons tests, Chinese military and strategy policymakers may have seen such a capability as one with which China could fall behind.

China's development of hypersonic weapons seems to align with strategic goals, in addition to strategic fears of lagging behind in technical development, and the specter of a latent nuclear Japan. That said, the application of DF-ZH seems to be less clear than the cases of U.S. or Russia. The DF-ZH missile may be intended for theater use at sea-based targets, but it may also be developed for long-range applications to hold the U.S. at risk while circumventing missile defense systems.[47] There is, as usual, the possibility of placing a nuclear warhead on the DF-ZH as well.

Strategic Considerations: The Multilateral Dynamic

Foremost, it is important to consider that the United States' hypersonic weapons programs may have spurred the development of other nations' programs; U.S. exploration of the technology raised fears about its capability and intent. Within China, and Russia, the U.S. prompt global strike program – which, as it currently stands, is oriented almost exclusively around hypersonic weapons – is discussed as an inherently pre-emptive and destabilizing system.[48] For those two nations, the U.S. HGV is a strategic weapon, not a limited-use, niche conventional weapon. In turn, this has prompted their development of technology to symmetrically meet their perceived fears of U.S. intentions. While this may imply future destabilizing conditions, the U.S. could do more to communicate the program's intent. Unfortunately, as with the history of CPGS as a whole, the program has not managed its vision and policy direction cohesively and has thus communicated various and conflicting intentions. This is further confounded when public affairs conversations from the DoD and military industry officials cite Chinese and Russian development of hypersonic weapons as a reason for the U.S. to accelerate its own research into the technology, suggesting the weapon is indeed intended to be a strategic platform.[49, 50, 51]

The variance in strategic postures and the governing reasons for hypersonic weapons technology acquisition show that a dyadic conception of deterrence will not guarantee stability. China is developing hypersonic weapons in response to Russia as well as a response to the U.S..[52] The actions the U.S. might take to deter potential escalation, or to respond to evolving scenarios in one region to improve stability, may in fact undermine stability in another. For example, a U.S. symmetrical response to Russian vertical hypersonic weapon proliferation might actually reach a point of strategic and deterrence stability, but such an increase in hypersonic arms would certainly threaten China's confidence in its second-strike capability, prompting their own increased production. This could also create a potential for crisis instability should a crisis arise between the U.S. and China. The implications of a three-actor arms race cannot be ignored.

Benefits of U.S. Development, Acquisition, and Deployment

The U.S. development, acquisition, and deployment of hypersonic weapons technology present, chiefly, two benefits: increased options for various crises and escalatory scenarios, and for increased credibility globally.

Within the increased responsive capability hypersonic weapons provide, the U.S. would be able to strike a located terrorist, much like Osama bin Laden, or a meeting of high-profile insurgency leaders.[53] This seems to be one of the more likely scenarios explored by the Defense Science Board, and hypersonic weapons seem to offer a capability to eliminate the targets outside the operating ranges of U.S. UAVs. Another possible example for hypersonic weapons use is to eliminate a near-peer

competitor's anti-satellite (ASAT) capability, needing to get past air defense and missile defense systems for a precise strike.[54] Perhaps most salient, though, is the ability to strike rogue nuclear states. Should the DPRK or Iran develop a nuclear missile, hypersonic weapons offer the ability to strike these missiles before they leave the launch pad. Within these possible scenarios, hypersonic weapons offer a limited-use means of achieving overarching strategic goals.

Under the policy direction under the Obama administration, hypersonic weapons with conventional – or non-nuclear – configurations offer the opportunity to develop weapons that can act with the same destructive power and precision as tactical nuclear weapons. They also offer a means of reducing U.S. dependence on nuclear weapons as a response to crises.[55] Given their speed and maneuverability, hypersonic weapons enhance the United States' ability to respond credibly to scenarios that require much greater speed and precision than most other U.S. conventional forces can provide.[56] This means that the U.S. nuclear threshold would be raised by the introduction of hypersonic weapons as a response option, eliminating a dichotomy between doing nothing or using a nuclear weapon.[57] Strategically, this improves U.S. credibility for action as a conventional hypersonic weapon strike is substantially more usable than even a tactical nuclear weapon.This improves U.S. posturing and ability to deter regional threats. For this to be an effective increase in credibility in addition to a reduction in nuclear weapons dependence, the number of hypersonic weapons required would be larger than the niche role for which it was initially intended.

A potential, but highly questionable, benefit of hypersonic weapons is the possibility of delivering a nuclear weapon. If missile defense systems have become robust enough to undermine the effectiveness of existing nuclear weapon delivery systems such that a potential adversary cannot be held sufficiently at risk to maintain an effective deterrence relationship, hypersonic delivery of nuclear weapons may help achieve this. It should be noted, though, that this also assigns a strategic role to hypersonic weapons at the same status of ICBMs and SLBMs. Additionally, the nuclear option would likely prompt an imbalanced three-actor delivery vehicle arms race. At best, a nuclear hypersonic weapon would be a strategic benefit for symmetrical deterrence in the distant future – not as a near-term strategic benefit during this period of exploratory testing and development by the U.S., China, and Russia.

Finally, increased research and development of hypersonic capabilities may also improve efforts to develop missile defense systems to protect against the threat foreign hypersonic weapons pose to the U.S..

Strategic Threats and Risks of U.S. and Foreign Development and Deployment

While a few operational benefits exist, with improved credibility, both U.S. and

foreign development of hypersonic weapons technology represent many threats to U.S. interests and national security.

Perhaps most obvious is the threat foreign weapons capabilities pose. With the speed, maneuverability, and difficulties in detection and elimination, foreign hypersonic weapons may be able to hold the U.S. and its assets at risk. Should China and Russia effectively design weapons to reach U.S. borders, U.S. nuclear assets and C4 infrastructure can be eliminated. This may lend a first-strike incentive to potential adversaries, or to the U.S. for fear of losing a nuclear capability in the early stages of a crisis, escalating the conflict.

Beyond these general threats and risks, though, threats to strategic stability also exist due to the ambiguity that hypersonic weapons introduce. James Acton puts forth three main ambiguities of the U.S. CPGS which pose threats to strategic stability: warhead ambiguity, destination ambiguity, and target ambiguity.[58] Warhead ambiguity refers to the uncertainty of the type of warhead launched: is the warhead nuclear or conventional? The damage and escalatory nature of the weapon depend on the warhead launched. A conventional strike will not be as escalatory as a nuclear strike. In the case of China, this could make the difference between responding with symmetrical conventional force, an escalation of conventional force, a cross-domain response, or a nuclear second-strike. The uncertainty around the incoming warhead may alter a nation's decision calculus in how to respond, and this was the basis of Congress not funding the Conventional Trident Modification.[59] This may be less of a consideration, though, if hypersonic weapons strikes are limited – perhaps as a single launch and single strike – as strategic attacks would likely occur at greater numbers.

Destination ambiguity, moreover, is attributed to the highly maneuverable capabilities of hypersonic weapons. A launch by the U.S. towards the DPRK to eliminate a nuclear weapon facility can appear to China as a weapon launched towards China, or at the very least, a weapon which can still change course and target China. Conversely, perhaps the initial launch profile is meant to misleadingly suggest the weapon is headed for the DPRK but is, in fact, headed elsewhere. This ambiguity is further complicated when viewed in combination with warhead ambiguity. The destination country, and the nature of the attack, can drastically impact national decisions on how to respond.

Finally, target ambiguity is another factor in the destabilizing uncertainties hypersonic weapons may pose. Suppose a nation correctly assesses a hypersonic weapon has been launched and is targeting said nation, and suppose it is able to determine the warhead type, uncertainty still exists regarding whether a conventional or nuclear weapons-related target is being pursued.The fact that nuclear weapons can be targeted undermines a nation's confidence in its ability to

respond with a second-strike.

These three ambiguities together independently undermine strategic stability because of the uncertainty they pose for how a potential adversary should respond or interpret a weapons launch; crisis stability depends on ensuring two competitive actors do not have an incentive to strike first.[60] Hypersonic weapons are capable of eliminating ground and underground targets, which would include hardened nuclear weapons facilities. If nuclear weapons can be eliminated by a hypersonic weapons strike, then the receiving end of a strike may conclude that it no longer has a survivable second strike capability with the advent of hypersonic weapons. As discussed earlier, China maintains a second strike nuclear policy, but this may be threatened by hypersonic weapons capabilities. This may prompt China to use nuclear weapons – even to a limited or theater extent – to pre-empt the possibility of the U.S. using hypersonic weapons to eliminate the Chinese nuclear arsenal.

The ability of HGVs to bypass current missile defense systems eliminates the survivability such defenses are intended to secure. Given Russia's past criticism of U.S. withdrawal from BMD agreements, the possibility of U.S. HGVs penetrating Russian defenses undermines crisis stability between the two states as an asymmetrical HGV capability may incentivize a first strike, similar to the China case discussed above; while a conventional U.S. HGV may increase the U.S. nuclear threshold as it represents a conventional option that may otherwise be achieved by a tactical nuclear weapon. Paradoxically, however, the threat of a U.S. HGV may indeed lower a potential adversary's nuclear threshold in an attempt to offset the potential U.S. advantage.

Beyond potential U.S. uses, hypersonic weapons represent a capability which is being increasingly considered critical for national defense. U.S. development of hypersonic weapons technology has stoked Russian and Chinese fears of U.S. intentions and capabilities, prompting their respective exploration of the technology to compete with the U.S.. This exposes the U.S. to the threat and risk of a three-nation arms race. Such a race is naturally less stable than a two-state one, as most recently observed in the Cold War, and may potentially erode crisis stability between any two of the three states. In the best-case scenario of an arms race, the U.S. emerges as the actor with the dominant technology and is able to credibly demonstrate this capability, but the financial burden of doing so is uncertain.The other risk is that either China or Russia ends up with the dominant technology. The threat this poses to U.S. national security is self-evident.

Policy Recommendations

U.S., Chinese, and Russian development of HGVs pose an extensive risk to U.S. national security objectives, but this type of technology has and will continue to be developed; it cannot simply be wished away. If for no other purpose than to keep up

with Chinese and Russian development, the U.S. should continue to explore hypersonic weapons capabilities, but this course of action alone does not reduce the risks of this technology's development. The threats and problems HGVs pose must be addressed head-on, and as such this section proposes a variety of policy options and recommendations.

The first proposition is a test ban. Weapons systems – nuclear warheads, delivery vehicles, or missile defenses – have a deterrent value only when their capabilities are demonstrated through testing. No nation developing hypersonic weapons is currently at a point where it can introduce the system into an active arsenal, but upon operationalizing hypersonic weapons a test ban may be both necessary and feasible.[61] Doing so offers the possibility of mitigating an arms race which could be costly, destabilizing, and result in foreign asymmetric advantages in hypersonic technology development. A test ban additionally offers the ability to limit development by states other than the U.S., Russia, and China, and can mitigate potential concerns on the horizontal proliferation of hypersonic weapons.

A secondary arms control method of reducing the threats posed by HGVs is entering a three-nation ban on long-range HGVs. Limiting the range of HGVs can reduce the target and destination ambiguities by increasing the certainty of where an HGV can strike.

For either of the above to be feasible options, however, the U.S. needs to start confidence-building measures (CBMs) now to develop a basis for negotiations. Unilaterally, this would require the U.S. to publicize launch data recording test subject performance. This may alleviate fears of U.S. capabilities or prompt China and Russia to increase their testing. The former outcome can improve stability and aid in potential negotiations to ensure other parties that the U.S. is not securing an overwhelming weapons capability advantage in a test ban or long-range HGV ban. The latter outcome provides more opportunities for the U.S. to gather information regarding foreign capabilities. Additionally, joint CBMs may strive to develop common detection methods to not only increase U.S., Chinese, and Russian fidelity on tracking hypersonic weapons during flight but also provide a common means of verification should hypersonic arms limitations or arms control regimes arise. The U.S. furthermore should initiate Track 2 and Track 1.5 on the strategic utility these weapons have for each nation developing them.

The U.S. should invest substantially in developing national technical means of detection and tracking. HGVs have very unique flight profiles which can aid in tracking them, but the means of detecting the weapons need to be improved. Satellites that can detect heat signatures of objects in the hypersonic speed regime, and intermittent heat emission patterns indicative of HGV atmosphere "skipping", will be integral to any defenses the U.S. develops against the hypersonic weapons

threat.

Hypersonic missile defenses are critical in minimizing the capability of China and Russia to hold U.S. targets at risk. Kinetic kill vehicles (KKVs) are the current anti-ballistic missile defense method: a warhead is launched to destroy an incoming ballistic missile with kinetic energy alone. This is sufficient when eliminating weapons on a ballistic trajectory as such flight paths are predictable. Hypersonic weapons' high-maneuverability renders KKVs almost useless. That said, KKVs launched in succession may be able to force an HGV to change its trajectory or even force the HGV to take a trajectory which moves it away from the intended target. Developing this method of missile defense against hypersonic weapons may serve as an effective interim defense. Given the current difficulties which exist in transmitting data to and from a launched HGV for tracking and control, jamming – with long-range ground-based technologies or airborne platforms – may offer viable long-term defenses against HGVs. Long-term missile defense development will also need to explore directed energy methods for missile defense and HGV elimination, and exploration into multi-domain anti-HGV methods is a critical requirement for future defenses.

Most importantly, the U.S. needs to determine and explicitly communicate the role it envisions for its hypersonic weapons. The most problematic element of the U.S. program's history is the lack of clarity for the weapon's purpose, which has contributed to foreign development of hypersonic weapon technology. Generally speaking, there are three potential roles the U.S. can assign hypersonic weapons: niche use, large conventional use, and nuclear-exclusive delivery vehicle.

The niche use is simply a continuation of CPGS's original justification of hypersonic weapons: elimination of time-sensitive and high-value targets with a conventional warhead. This would likely involve limited development and use of HGVs to eliminate specialized targets and would require the U.S. to accept that other nations will develop HGVs for strategic purposes against the U.S.. Likewise, simply having this HGV capability exposes the U.S. to potential foreign misperceptions of a U.S. hedging strategy for its hypersonic weapons.

There are, alternatively, two nuclear-related options. The U.S. could pursue a nuclear-only option, which would posture the U.S. to only use nuclear warheads on its hypersonic delivery vehicles. This would eliminate the question of warhead ambiguity and offer the U.S. a means of penetrating current missile defenses. Crisis stability, target ambiguity, and destination ambiguity will each remain substantial concerns with the nuclear-only option, potentially undermining strategic stability. Additionally, the nuclear-only option would make hypersonic weapons subject to existing U.S. nuclear-use thresholds, maintaining the very capability gap CPGS aimed to eliminate in exploring hypersonic weapons. The other nuclear option –

dual-use – is the least desirable strategy the U.S. could pursue. This is the most destabilizing option as it conflicts with earlier official U.S. statements regarding the weapons and perpetuates the warhead, target, and destination ambiguities.[62]

Departing from the original CPGS direction of hypersonic weapons development, the U.S. could alternatively pursue a large strategic force of conventional payload hypersonic weapons. This strategy for the weapon presents the U.S. usable HGVs to fulfil strategic ends, be it elimination of multiple battlefield targets, pre-emptive strike, or to disable a nuclear arsenal. Strategic and crisis stability concerns will persist as this conventional capability may undermine foreign nuclear capabilities. This is the most straightforward option and in combination with the CBMs and arms control suggestions, is the most feasible option for securing national security objectives and meeting the threat posed by foreign programs.

Conclusion

The development of hypersonic weapons by China, Russia, and the U.S., and the strategic implications of such technology readily demonstrate the challenges of an increasingly multi-polar world the U.S. must overcome. The prospect of a three-nation arms race cannot be overlooked; the world has not seen a multi-polar arms race of similar magnitude since before the First World War.

In pursuing hypersonic weapons, the U.S. should develop the weapon as a conventional delivery vehicle to serve strategic purposes. But it cannot pursue this, or any other hypersonic weapon strategy, without also anticipating the potential for an arms race and arms control negotiations. Such negotiations present an opportunity for the U.S. to develop a hypersonic offensive and deterrent capability while also exercising global influence in leading the way towards arms control agreements on the same technology.

Policymakers must also note that hypersonic weapon development will not mimic the development of ICBMs and subsequently anti-ballistic missile defenses during the Cold War. Hypersonic weapons development and missile defenses against such are being developed concurrently, and this will have significant impacts on crisis stability and the maintenance of strategic stability in the long run. Moreover, hypersonic weapons stress the importance of developing directed energy missile defenses; KKVs may quickly become an out-of-date paradigm.

Above all, the U.S. needs to consider the strategic implications of its technology development and acquisition programs. Under CPGS, hypersonic weapons tests prompted Chinese and Russian exploratory reciprocations out of fear of U.S. potential uses. Acquisition and development programs for hypersonic weapons should have anticipated this, but they did not, and it has led not only to a small disadvantage in terms of development progress but also in terms of generating

relevant strategic policy.

While hypersonic weapons present a significant disruption to current strategic policy and stability globally, the U.S. should clearly and cohesively establish a large strategic conventional hypersonic weapons arsenal and lead foreign developers of similar technologies towards arms control agreements to secure long-term strategic and crisis stability with Russia and China.

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