

# Conventional Prompt Global Strike and Long-Range Ballistic Missiles: Background and Issues

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## Summary

Members of Congress and Pentagon officials have placed a growing emphasis on U.S. programs to develop hypersonic weapons as a part of an effort to acquire the capability for the United States to launch attacks against targets around the world in under an hour. Conventional prompt global strike (CPGS) weapons may bolster U.S. efforts to deter and defeat adversaries by allowing the United States to attack high-value targets or “fleeting targets” at the start of or during a conflict. Congress has generally supported the PGS mission, but restricted funding for several years. Recently, efforts to develop a long-range prompt strike capability, along with other efforts to develop extremely fast hypersonic weapons, have garnered increased support.

CPGS weapons would not substitute for nuclear weapons, but would supplement U.S. conventional capabilities. Officials have argued that the long-range systems would provide a “niche” capability, with a small number of weapons directed against select, critical targets. Some analysts, however, have raised concerns about the possibility that U.S. adversaries might misinterpret the launch of a missile with conventional warheads and conclude that the missiles carry nuclear weapons. The U.S. Department of Defense (DOD) is considering a number of systems that might provide the United States with long-range strike capabilities.

The Air Force and Navy have both pursued programs that would lead to the deployment of conventional warheads on their long-range ballistic missiles. During the 2000s, the Air Force and the Defense Advanced Research Projects Agency (DARPA) sought to develop a hypersonic glide delivery vehicle that could deploy on a modified Peacekeeper land-based ballistic missile, but test failures led to the suspension of this program; research continues into a vehicle that might be deployed on air-delivered or shorter-range systems. In the mid-2000s, the Navy sought to deploy conventional warheads on a small number of Trident II submarine-launched ballistic missiles, but Congress rejected the requested funding for this program. Since then, the Pentagon has continued to develop a hypersonic glide vehicle, now known as the Common Hypersonic Glide Body, which could be deployed on long-range missiles. This vehicle is likely to be deployed on intermediate-range missiles on Navy submarines, for what is now known as the Prompt Strike Mission. Congress may review other weapons options for the deployment of hypersonic weapons, including bombers, cruise missiles, and possibly scramjets or other advanced technologies.

The Pentagon’s FY2021 budget request continues to show significant increases in funding for the Navy’s Conventional Prompt Strike (CPS) program. In FY2019 this program, which was funded through a DOD-wide account, received \$278 million. The Navy received \$512 million for this program in FY2020 and requested \$1.1 billion for FY2021; Congress authorized \$1.03 billion. The budget request shows continuing increases in funding over the next five years, with \$5.3 billion allocated to the program between FY2021 through FY2025. This shows the growing priority placed on the program in the Pentagon and the growing interest in Congress in moving the program forward toward deployment.

When Congress reviews the budget requests for prompt global strike and other hypersonic weapons programs, it may question DOD’s rationale for the mission, reviewing whether the United States might have to attack targets promptly at the start of or during a conflict, when it could not rely on forward-based land or naval forces. It might also review whether this capability would reduce U.S. reliance on nuclear weapons or whether, as some critics have asserted, it might upset stability and possibly increase the risk of a nuclear response to a U.S. attack. At the same time, Members of Congress and officials in the Pentagon have both noted that Russia and China are pursuing hypersonic weapons, leading many to question whether the United States needs to accelerate its efforts in response, or whether an acceleration of U.S. efforts might contribute to an arms race and crisis instability.

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## Introduction

Members of Congress and Pentagon officials have placed a growing emphasis on U.S. programs to develop hypersonic weapons as a part of an effort to acquire the capability for the United States to launch attacks against targets around the world in under an hour. Hypersonic weapons, like all long-range ballistic missiles, can travel faster than Mach 5, or about 1 mile to 5 miles per second.<sup>1</sup> This interest is driven by both the perceived mission need for conventional prompt strike systems and concerns about falling behind Russia and China in the development of these technologies.<sup>2</sup> The United States is pursuing two key technologies for this purpose: boost-glide systems that place a hypersonic glider atop a ballistic missile booster or shorter-range rocket systems, and hypersonic cruise missiles that would use scramjet technologies.<sup>3</sup>

## Policy Focus

This report focuses, primarily, on the Pentagon's ongoing program to develop ballistic missile-based conventional prompt strike systems. This effort has been underway for nearly 20 years. The George W. Bush Administration demonstrated an interest in the use of conventional weapons for precision, long-range strike missions in the 2001 Nuclear Posture Review (NPR). This study called for the integration of precision conventional weapons with strategic nuclear forces in a new category of "offensive strike" weapons.<sup>4</sup> Several other Pentagon studies published during the Bush Administration also called on the United States to develop the capability to attack targets around the world, in under an hour, with conventional warheads.

The Obama Administration, in the 2010 NPR, also emphasized the role that long-range, non-nuclear systems could play in supporting "U.S. regional deterrence and reassurance goals." The 2010 NPR indicated that conventional power projection capabilities were part of "effective regional security architectures,"<sup>5</sup> arguing that these capabilities could help the United States assure and defend its allies, while reducing the role of nuclear weapons in U.S. security strategy.

The Trump Administration's Nuclear Posture Review did not address the role of advanced conventional weapons in U.S. nuclear posture, but the Administration has shown continuing support for the development of long-range precision conventional weapons, with significant increases in funding in its budget requests since FY2019. It has also supported a joint Air Force/Navy/Army effort to develop and deploy hypersonic capabilities by the early 2020s.<sup>6</sup> Moreover, Michael Griffin, the Under Secretary of Defense for Research and Engineering, has

<sup>1</sup> Jason L. Sherman, "The Hypersonic Arms Race Heats Up," *The Daily Beast*, December 3, 2017, <https://www.thedailybeast.com/the-hypersonic-arms-race-heats-up>. See, also, Paul McCleary, "China Loves DoD Acquisition Culture, Says R&D Chief Griffin," *Breaking Defense*, March 6, 2018, <https://breakingdefense.com/2018/03/china-loves-dod-acquisition-culture-says-r/>.

<sup>2</sup> "HASC Seapower Chair Wittman Presses For Hypersonic Focus," *Breaking Defense*, February 22, 2018, <https://breakingdefense.com/2018/02/hasc-seapower-chair-wittman-presses-for-hypersonic-focus/>.

<sup>3</sup> For a summary of current U.S. hypersonic weapons programs, see CRS Report R45811, *Hypersonic Weapons: Background and Issues for Congress*, by Kelley M. Saylor.

<sup>4</sup> U.S. Congress, Senate Committee on Armed Services, Hearing on the Nuclear Posture Review, Statement of the Honorable Douglas J. Feith, Under Secretary of Defense for Policy, February 14, 2002, p. 4.

<sup>5</sup> U.S. Department of Defense, *Nuclear Posture Review*, Washington, DC, April 6, 2010, p. 34, [https://dod.defense.gov/Portals/1/features/defenseReviews/NPR/2010\\_Nuclear\\_Posture\\_Review\\_Report.pdf](https://dod.defense.gov/Portals/1/features/defenseReviews/NPR/2010_Nuclear_Posture_Review_Report.pdf).

<sup>6</sup> Steve Trimble and Guy Norris, "Sandia's Swerve Could Lead To First-gen Hypersonic Production Line," *Aviation Week*, October 11, 2018, <http://aviationweek.com/air-dominance/sandia-s-swerve-could-lead-first-gen-hypersonic-production-line>.

spoken often about the challenges presented by Russian and Chinese hypersonic weapons programs and about the need for the United States to accelerate its efforts. In testimony before Congress, he noted that the United States does not “have systems which can hold them at risk in a corresponding manner, and we don’t have defenses against those systems.” He said, “It is among my very highest priorities to erase that disadvantage, creating our own systems to hold them at risk and to provide defense.”<sup>7</sup>

## **Mission and Programs**

In 2003, the Department of Defense (DOD) specifically identified a new mission—prompt global strike (PGS)—that sought to provide the United States with the ability to strike targets anywhere on Earth with conventional weapons in as little as an hour, without relying on forward-based forces. DOD argued that this capability would bolster U.S. efforts to deter and defeat adversaries by providing the United States with the ability to attack high-value targets or “fleeting targets” that might be visible for only a short amount of time promptly, at the start of or during a conflict. DOD has considered a number of systems that might provide the United States with long-range strike capabilities. These include bombers, cruise missiles, ballistic missiles, and boost-glide technologies that would mate a rocket booster with a hypersonic glide vehicle.

During the George W. Bush Administration, analysts began to note that long-range ballistic missiles armed with conventional warheads would be an ideal weapon for this mission. They argued that these weapons, based in the United States or on submarines at sea, could attack targets worldwide with a high degree of precision in a short amount of time. However, during the latter years of the Bush Administration and the early years of the Obama Administration, DOD’s programs began to focus on hypersonic glide vehicles mounted on rocket boosters<sup>8</sup> as the technology of choice for this mission. In addition, in 2012, the Pentagon changed the focus of the program from “prompt global strike” to “prompt strike,” which allowed the program to consider the deployment of a hypersonic glider on a sea-based intermediate-range missile. The Pentagon is also conducting research, through DARPA and the Air Force, into shorter-range, air-delivered, hypersonic cruise missiles.

Some analysts have questioned the need for these programs, raising concerns, for example, about the possibility that U.S. adversaries might misinterpret the launch of a missile with conventional warheads and conclude that the missiles carry nuclear weapons. They have also questioned whether existing U.S. military capabilities might meet the need for prompt, conventional attacks in most potential conflict scenarios without raising the risk of miscalculation or misunderstanding. Some have also questioned whether the United States should accelerate its hypersonic glide vehicle and prompt strike programs in response to Russian and Chinese programs. Some argue that the United States should not only focus on maintaining a technological edge in this area, but should also counter Russian and Chinese hypersonic weapons

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<sup>7</sup> Christian Davenport, “Why the Pentagon fears the U.S. is losing the hypersonic arms race with Russia and China,” *Washington Post*, June 8, 2018, [https://www.washingtonpost.com/business/economy/why-the-pentagon-fears-the-us-is-losing-the-hypersonic-arms-race-with-russia-and-china/2018/06/08/7c2c3b4c-57a7-11e8-b656-a5f8c2a9295d\\_story.html?mkt\\_tok=eyJpIjoiWTJJelkySXhaRFI5TkRNeSIsInQiOiJRazRKdXVNSnlSeU1DZIBBS1VXUG1WYXFSZEtlN1wvRDBxb1lSV1wvMUUpTOGV2WTlpeDVR0g3ZUdHK0N3UDN1QlJzcXNvSG1oUHBlcHlhSmIzYUhdSYrU3I2SIN2TmJTK3JlRWrtNEQ5NjFJN1dmaU9UME54N1JZbEZhZ0Q0c2c2In0%3D&utm\\_term=.57f7b133e662](https://www.washingtonpost.com/business/economy/why-the-pentagon-fears-the-us-is-losing-the-hypersonic-arms-race-with-russia-and-china/2018/06/08/7c2c3b4c-57a7-11e8-b656-a5f8c2a9295d_story.html?mkt_tok=eyJpIjoiWTJJelkySXhaRFI5TkRNeSIsInQiOiJRazRKdXVNSnlSeU1DZIBBS1VXUG1WYXFSZEtlN1wvRDBxb1lSV1wvMUUpTOGV2WTlpeDVR0g3ZUdHK0N3UDN1QlJzcXNvSG1oUHBlcHlhSmIzYUhdSYrU3I2SIN2TmJTK3JlRWrtNEQ5NjFJN1dmaU9UME54N1JZbEZhZ0Q0c2c2In0%3D&utm_term=.57f7b133e662).

<sup>8</sup> Many analysts refer to these boost-glide systems as “hypersonic weapons” because the booster can deliver a gliding reentry vehicle to its target at hypersonic speeds. However, all ballistic missiles, even those armed with reentry vehicles that cannot glide to targets, travel at hypersonic speeds. The difference with these new types of systems is not their speed but their ability to change course and maneuver after launch, either to evade missile defenses or to improve their accuracy upon approach to their targets.

with similar U.S. weapons. Others, however, argue that an “arms race” in hypersonic weapons could be destabilizing, as the weapons’ speed would shorten attack and response times and could possibly prompt early use during a crisis.

Congress has generally supported the rationale for the prompt strike mission. In the past, it has restricted funding and suggested changes in the direction of specific programs, but, recently, it has pressed the Pentagon to place a higher priority on the program and to accelerate its development. Congress is likely to continue to review the technologies and programs related to this mission as a part of the annual authorization and appropriations process.

This report provides an overview of the rationale for the PGS/prompt strike mission and the possible deployment of conventional warheads on long-range ballistic missiles or boost-glide systems in support of this mission. It then reviews the Air Force and Navy efforts to develop these systems. It summarizes congressional reaction to these proposals, and provides a more detailed account of the issues raised by these concepts and programs.

## Background

### The Prompt Global Strike Mission (PGS)

#### Rationale for the PGS Mission

Throughout the Cold War, the United States maintained military bases overseas so that it could position its troops to deter, and if necessary, respond promptly to an attack from the Soviet Union or its allies. These forward bases were located, for the most part, in Europe and Asia—regions where conflict seemed most likely to occur. These overseas bases and forces were believed not only to increase preparedness, but also to deter conflict by their very presence in unstable regions. However, with the demise of the Soviet Union and the end of the Cold War, analysts argued that the United States must be prepared to fight in unexpected areas against a wide range of potential adversaries who may possess a great variety of military capabilities. Although the United States continues to deploy its military forces at bases around the world, it has begun to restructure, and, in many cases, reduce, its forces based overseas. It has also sought to improve its ability to move military forces into a region quickly when and if a conflict occurs. Moreover, as some observers have noted, the United States can no longer be certain that these bases are located close to the most likely areas of conflict.

As a result, many analysts and military officials have argued that the United States must maintain and enhance its *long-range* strike capability so that it can strike anywhere in the world with forces that are based in or near the United States,<sup>9</sup> or with forces that have the range to reach targets across the globe from wherever they are deployed. This would not only allow the United States to pursue an adversary without relying on forward bases, it would also allow the United States to reach targets deep inside an enemy’s territory if that area were out of the range of U.S. forces deployed at bases or on naval forces in the region. Moreover, if an adversary developed air defenses or other capabilities that could deny U.S. aircraft access to critical targets, a long-range strike capability based on ballistic missile technologies could prove valuable if launched early, as a “leading-edge” capability that degraded an opponent’s defenses. Analysts argue that these types

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<sup>9</sup> See, for example, Watts, Barry D., *Long-Range Strike: Imperatives, Urgency, and Options*. Center for Strategic and Budgetary Assessments. April 2005.

of systems would be far less sensitive to an adversary's anti-access and area denial (A2/AD) efforts.

Further, some analysts argue that the United States must be able to attack targets across the globe in a matter of hours or less, either at the start of a conflict or during ongoing operations. This is because U.S. adversaries might adapt to the U.S. precision-strike capability by denying targeting information with concealment techniques or mobility, leaving the United States with little time to attack after it identified relevant targets. Moreover, many have noted that adversaries could seek to protect their assets by deploying them in buried or hardened facilities, leading to a requirement for improvements in the U.S. ability to defeat hardened and deeply buried targets promptly, before the adversary employed the hidden capabilities.

The need for prompt long-range, or global, strike capabilities was addressed in general defense policy studies, such as the 2001, 2006, and 2010 Quadrennial Defense Review (QDR) Reports. The 2001 QDR noted that the U.S. defense strategy “rests on the assumption that U.S. forces have the ability to project power worldwide.”<sup>10</sup> The 2006 QDR expanded on the need for prompt global strike capabilities, noting that they would provide the United States with the ability “to attack fixed, hard and deeply buried, mobile and relocatable targets with improved accuracy anywhere in the world promptly upon the President’s order.” This QDR went on to call for the deployment of a prompt global strike capability, using Trident submarine-based ballistic missiles armed with conventional warheads, within two to four years.<sup>11</sup> The 2010 QDR also noted that “enhanced long-range strike capabilities are one means of countering growing threats to forward-deployed forces and bases and ensuring U.S. power projection capabilities.” It noted that DOD is pursuing a number of programs to meet this need, and, as a part of this effort, “plans to experiment with conventional prompt global strike prototypes.”<sup>12</sup>

DOD also addressed the prompt global strike mission in specific reports on Air Force doctrine, which have noted that “rapid power projection based in the continental United States has become the predominant military strategy.” In May 2003, the Air Force issued a formal Mission Need Statement for the Prompt Global Strike (PGS) Mission. This statement indicated that the United States should be able to strike globally and rapidly with joint conventional forces against high-payoff targets, that the United States should be able to plan and execute these attacks in a matter of minutes or hours—as opposed to the days or weeks needed for planning and execution with existing forces—and that it should be able to execute these attacks even when it had no permanent military presence in the region where the conflict would occur.<sup>13</sup>

Officials in the George W. Bush Administration viewed the prompt global strike mission as a means to extend the U.S. capability to address global contingencies that could threaten U.S. security and U.S. interests. For example, Admiral James O. Ellis, the commander of U.S. Strategic Command (STRATCOM) from 2002 to 2004, explained that PGS would “provide a wider range of options to the President in responding to time-critical global challenges.”<sup>14</sup>

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<sup>10</sup> U.S. Department of Defense, *Quadrennial Defense Review Report*, Washington, DC, September 29, 2001, p. 43, <http://www.comw.org/qdr/qdr2001.pdf>.

<sup>11</sup> U.S. Department of Defense, *Quadrennial Defense Review Report*, Washington, DC, February 6, 2006, pp. 49-50, <http://www.globalsecurity.org/military/library/policy/dod/qdr-2006-report.pdf>.

<sup>12</sup> U.S. Department of Defense, *Quadrennial Defense Review Report*, Washington, DC, February 2010, pp. 32-33, <http://archive.defense.gov/qdr/QDR%20as%20of%2029JAN10%201600.pdf>.

<sup>13</sup> This document was written by Air Force Space Command, coordinated with officials in the Joint Staff and the Office of the Secretary of Defense, and validated by the Joint Requirements Oversight Council (JROC). See, General John Jumper, U.S. Air Force, Final Mission Need Statement. “Prompt Global Strike,” May 2, 2003.

<sup>14</sup> Statement of Admiral James O. Ellis, Commander, U.S. Strategic Command, House Armed Services Committee,

General James Cartwright, who served as commander of STRATCOM between 2004 and 2007, defined the global strike mission by stating that “it provides to the nation the ability to rapidly plan and rapidly deliver effects anyplace on the globe.” The capability would not necessarily be nuclear, and a regional combatant commander could “tailor it for his target and deliver it very quickly, with very short time lines on the planning and delivery, any place on the face of the Earth.”

General Cartwright also emphasized that the global strike capability involved much more than just the delivery of a weapon to a target, stating that “it encompasses both the ability to plan rapidly, to apply the precision to the intelligence and gather that intelligence in a very rapid manner, and then to apply that intelligence to the target and understand the effect we want to create.”<sup>15</sup> The intelligence requirements for the PGS mission could, however, prove quite demanding. General Michael Hayden, then the CIA Director, noted in mid-2007 that the PGS mission will require “very convincing intelligence” before any attacks occur.<sup>16</sup> He stated “If you are going to strike suddenly ... it has to be based on very powerful, very convincing intelligence.” In addition, the intelligence may need to be released to the public, to demonstrate both the military need and time restraints that made the attack necessary. Moreover, most analysts agree that the United States does not yet have the capability to meet the intelligence demands of the PGS mission.

The Obama Administration’s description of the prompt global strike mission focused more on regional than global challenges. As was noted above, the 2010 QDR described the PGS mission as one possible means to address “growing threats to forward-deployed forces and bases and ensuring U.S. power projection capabilities.” The 2010 Nuclear Posture Review similarly viewed PGS as an important component of U.S. regional deterrence capabilities when it noted that “these capabilities may be particularly valuable for the defeat of time-urgent regional threats.”<sup>17</sup> This change in focus was reflected in Pentagon guidance in 2012; the program was then known as Conventional Prompt Strike (CPS), rather than Conventional Prompt Global Strike (CPGS).

The Trump Administration did not address either a prompt global strike or prompt strike mission in its National Defense Strategy or its Nuclear Posture Review. However, it has continued to support funding for hypersonic glide technologies in its defense budget requests. Funding requests have increased from \$181.3 million for Defense-wide Prompt Global Strike Capability Development in FY2017 to \$3.2 billion for Army, Navy, and Air Force programs in FY2021.<sup>18</sup> Michael Griffin, when serving as the Pentagon’s Under Secretary for Research and Engineering, emphasized that the Pentagon did intend to place a high priority on pursuing U.S. prompt strike programs.<sup>19</sup>

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March 13, 2003.

<sup>15</sup> U.S. Congress, Senate Committee on Armed Services, Subcommittee on Strategic, Testimony of Admiral James E. Cartwright, Commander, U.S. Strategic Command, Hearing, April 4, 2005.

<sup>16</sup> Grossman, Elaine, M., “Hayden: ‘Prompt Global Strike’ Raises Bar for Intel Community.” *Inside The Air Force*, June 22, 2007.

<sup>17</sup> U.S. Department of Defense, *Nuclear Posture Review*, Washington, DC, April 6, 2010, p. 34, [https://dod.defense.gov/Portals/1/features/defenseReviews/NPR/2010\\_Nuclear\\_Posture\\_Review\\_Report.pdf](https://dod.defense.gov/Portals/1/features/defenseReviews/NPR/2010_Nuclear_Posture_Review_Report.pdf).

<sup>18</sup> U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *Defense Budget Overview*, Washington, DC, February 2020, p. 1-8.

<sup>19</sup> Paul McCleary, “China Loves DoD Acquisition Culture, Says R&D Chief Griffin,” *Breaking Defense*, March 6, 2018, <https://breakingdefense.com/2018/03/china-loves-dod-acquisition-culture-says-r/>.

## **PGS and the U.S. Strategic Command**

In October 2002, STRATCOM, which was in charge of plans and operations for U.S. strategic nuclear weapons, merged with U.S. Space Command (SpaceCom), which commanded military space operations, information operations, computer network operations, and space campaign planning.<sup>20</sup> This merger gave the new STRATCOM the “ability to project power around the globe through space and information warfare.” Further, in late 2002 and early 2003, the Pentagon restructured the new STRATCOM so that it could take on new missions, including the planning and execution of the prompt global strike mission.<sup>21</sup> This change in the command structure highlighted the growing emphasis on long-range, strategic missions in conventional warfighting doctrine.

In July 2006, STRATCOM established its joint functional component command for global strike (JFCC-GS). According to its mission statement, JFCC-GS “is designed to optimize planning, execution and force management for the assigned missions of deterring attacks against the United States, its territories, possessions and bases.” Among other tasks, it “provides integrated global strike capabilities to deter and dissuade threats and when directed, defeat adversaries through decisive joint global kinetic and non-kinetic combat effects.”<sup>22</sup>

## **Potential Targets for the PGS Mission**

Analysts have identified a number of potential targets that the United States might need to strike promptly, either at the start of or during a conflict with a regional adversary.<sup>23</sup> For example, if an adversary deployed air defense or antisatellite weapons that could disrupt the U.S. ability to sustain an attack, the United States might choose to strike promptly at the start of a conflict with weapons that could penetrate and destroy the defenses. A prompt strike against an adversary’s ballistic missiles or caches of weapons of mass destruction (WMD) might allow the United States to destroy these weapons before an adversary could use them. The United States might also use prompt, long-range weapons to attack an adversary’s command and control capabilities, to degrade or undermine its operations early in a conflict.

The United States might also be faced with circumstances during an ongoing conflict when it would need to destroy targets that could appear quickly and remain vulnerable for short periods of time. These might include leadership cells that could move during a conflict or mobile military systems that the adversary had chosen to keep hidden prior to their use. These types of targets might only be vulnerable to weapons that the United States could launch promptly and direct to their targets quickly. Analysts have noted that PGS might provide the means to attack such targets if the United States did not have the necessary weapons located near the conflict.

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<sup>20</sup> U.S. Department of Defense, “DOD Announces Merger of U.S. Space and Strategic Commands,” June 26, 2002.

<sup>21</sup> According to Admiral James O. Ellis, the Commander of STRATCOM, these missions included global strike planning and execution; information operations; global missile defense integrations; and oversight of command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) in support of strategic and global operations. See Statement of Admiral James O. Ellis, Commander United States Strategic Command, before the House Armed Services Committee, March 13, 2003, p. 4.

<sup>22</sup> <http://www.stratcom.mil/factsheets/gs/>.

<sup>23</sup> A description of some of these scenarios can be found in the National Academies Study on Prompt Global Strike. See Committee on Conventional Prompt Global Strike Capability, National Research Council of the National Academies, *U.S. Conventional Prompt Global Strike: Issues for 2008 and Beyond*, Washington, DC, 2008, pp. 31-33.

The Defense Science Board outlined several of these potential scenarios in a March 2009 report prepared by the Task Force on Time Critical Conventional Strike from Strategic Standoff. This report “formulated five representative scenarios” that might require a “very rapid strike response to a developing situation.”<sup>24</sup> These scenarios included several cases:

- A near-peer competitor had used its emerging counterspace capability to destroy a U.S. satellite.
- The United States wanted to destroy a package of special nuclear materials that a terrorist organization had shipped to a neutral country.
- A small package of weapons of mass destruction was located temporarily in a rural area of a neutral country.
- The leadership of a terrorist organization had gathered in a known location in a neutral country.
- A rogue state armed with a nuclear weapon was threatening to use that weapon against a U.S. ally.

Each of these cases provided scenarios where the United States might want to attack promptly at the start of, or during, a conflict with a regional adversary. However, as some analysts have noted, long-range prompt strike weapons may not always prove the best solution in all circumstances. Even if the weapon could arrive within a relatively short amount of time, the United States might not have the intelligence needed to pinpoint the target, particularly if it were moving. Moreover, an adversary might detect the launch of the weapon and move it before the weapon arrived. As a result, in some cases, a weapon that could loiter in or near the area of the conflict, and strike within minutes when the target became evident, may be better than a weapon that could launch promptly but might take more than an hour to arrive.<sup>25</sup> The need for prompt, but regional, attack capabilities seems to be part of the rationale for the Pentagon’s interest in developing hypersonic capabilities for medium- and intermediate-range delivery systems.

## **Conventional Ballistic Missiles and the PGS Mission**

The Obama Administration noted, in the 2010 NPR, that the Pentagon “is studying the appropriate mix of long-range strike capabilities, including heavy bombers as well as non-nuclear prompt global strike, in follow-on analysis to the 2010 QDR and the NPR.” The United States might use a number of different weapons systems for this purpose. In the near term, these could include medium- or long-range aircraft, cruise missiles launched from bombers or submarines, and ballistic missiles based at sea or on land in the United States.<sup>26</sup> But conventional aircraft,

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<sup>24</sup> U.S. Department of Defense, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, *Time Critical Conventional Strike from Strategic Standoff*, Report of the Defense Science Board Task Force, Washington, DC, March 2009, p. 2, <https://www.acq.osd.mil/dsb/reports/2000s/ADA498403.pdf>.

<sup>25</sup> For a description of a range of possible scenarios, and the different requirements for prompt response, see James M. Acton, *Silver Bullet? Asking the Right Questions About Prompt Global Strike* (Washington, DC: Carnegie Endowment for International Peace, 2013), pp. 9-29.

<sup>26</sup> In his testimony in 2003, Admiral Ellis specifically mentioned two systems that could contribute to this mission, Trident submarines reconfigured to carry Tomahawk cruise missiles with conventional warheads and the proposed Common Aero Vehicle, which could be used to deploy conventional munitions on long-range ballistic missiles. See the statement of Admiral James O. Ellis, Commander, U.S. Strategic Command, House Armed Services Committee, March 13, 2003. In the longer term, the Air Force and Navy are both exploring the use of ramjets, or scramjets, for long-range attack term. These hypersonic aircraft, which could fly at speeds of Mach 2-Mach 5, are still in the early stages of development. They are envisioned to launch from air bases, like aircraft, but to travel at speeds that far exceed those of U.S. aircraft and may approach the speeds of missiles. See, for example, Pincus, Walter, “Pentagon Has Far-reaching

even if they are based near the theater of operations, could take several hours, or more, to reach their targets. Aircraft may also be vulnerable to enemy air defenses, particularly if they tried to attack targets deep inside enemy territory. Similarly, aircraft or cruise missiles based at sea may be too far from the theater of operations to strike critical targets in a timely manner.

As a result, many analysts suggested that the United States should use long-range ballistic missiles (ICBMs and SLBMs) for the prompt global strike mission.<sup>27</sup> During the Cold War, these long-range ballistic missiles provided the United States with the ability to threaten targets throughout the Soviet Union, and, if necessary, in other nations, from the United States or from submarines patrolling at sea. But these missiles have always carried nuclear warheads.<sup>28</sup> To use them for the conventional prompt global strike mission, the United States would have to deploy these missiles with conventional warheads. The Bush Administration first raised the profile of long-range, conventional strike missiles in the 2001 NPR, when it introduced the concept of the “new triad.” This concept joined long-range nuclear-armed missiles with precision-strike conventional weapons in a category called offensive strike weapons. The Bush Administration argued that the availability of precision conventional weapons would, possibly, provide the President with more options in a crisis, and, therefore, reduce the likelihood of the use of nuclear weapons.

The Pentagon’s Defense Science Board (DSB), in a study published in early 2004, asserted that land-based long-range ballistic missiles have “unique, time-critical characteristics” that include “responsiveness, range, speed, precision, lethality, and freedom of maneuver.”<sup>29</sup> With these capabilities, they could attack targets anywhere in the world within an hour of their launch, without relying on forward bases or supporting military capabilities, such as the tanker aircraft needed to support long-range flights by bombers. They would not be at risk from air defenses, and there would be no risk to flight crews. Further, if the warheads could maneuver to slow their reentry and increase their angle of attack, they might be effective against some types of hardened and deeply buried targets. The DSB study asserted that these weapons could provide “a reliable, low-cost force on continuous alert with a high readiness rate and the capability to immediately react under strict control of the National Command Authority.” In other words, the high levels of reliability, readiness, and command and control that were needed as a part of the U.S. strategic nuclear deterrent during the Cold War are also valuable characteristics for a long-range conventional strike system in the post-Cold War era.

In testimony before the Senate Armed Services Committee in April 2005, General James Cartwright, then the commander of STRATCOM, linked PGS to the “new Triad” concept advanced by the 2001 NPR. General Cartwright noted that “the New Triad concept will enable more precisely tailored global strike operations”<sup>30</sup> by allowing the United States to choose

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Defense Spacecraft in Works,” *Washington Post*, March 16, 2005. p. 3.

<sup>27</sup> See, for example, U.S. Department of Defense, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, *Report of the Defense Science Board Task Force on Future Strategic Strike Forces*, February 2004. See, also, Eric A. Miller and Willis A. Stanley, *The Future of Ballistic Missiles*. National Institute for Public Policy, October 2003.

<sup>28</sup> When the Cold War ended in the early 1990s these missiles carried more than 8,000 nuclear warheads. The United States has reduced its strategic forces, and currently has 2,000 warheads deployed on around 786 ICBMs and SLBMs. U.S. Department of State, *The Legacy of START and Related U.S. Policies*, Washington, DC, July 16, 2009, <https://2009-2017.state.gov/t/avc/rls/126119.htm>. See also, U.S. Department of State, *START Aggregate Numbers of Strategic Offensive Arms*, Washington, DC, July 1, 2009. <http://www.state.gov/t/vci/rls/130149.htm>.

<sup>29</sup> U.S. Department of Defense, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, *Report of the Defense Science Board Task Force on Future Strategic Strike Forces*, February 2004. p. 5-1.

<sup>30</sup> U.S. Congress, Senate Committee on Armed Services, Subcommittee on Strategic, Testimony of Admiral James E.

conventional rather than nuclear weapons to attack some categories of targets. By replacing some nuclear weapons with conventional weapons in the U.S. strategic war plan the United States might be able to further reduce its reliance on, and, therefore, its number of deployed strategic nuclear weapons.<sup>31</sup>

General Cartwright and others emphasized that the substitution of conventional warheads for nuclear warheads in the U.S. war plan would require significant improvements in the accuracy of U.S. long-range ballistic missiles. If missiles could deliver their payloads more precisely to their targets, then, for some categories of targets, they may not need the explosive yield of a nuclear weapon to destroy the target. Both the Navy and the Air Force have explored advanced guidance and targeting technologies, such as the use of GPS (global positioning systems), to provide their missiles with these improvements in accuracy. This effort had been underway for more than two decades. After General Cartwright sought a study that would allow him to determine what proportion of the targets in the U.S. war plan could be attacked with conventional weapons, an industry analyst estimated that this proportion could be between 10% and 30% of the existing targets.<sup>32</sup>

Subsequently, however, some analysts and military officials questioned whether the United States should seek to substitute conventional warheads for nuclear warheads in the U.S. nuclear war plan. They noted that conventional warheads might lack the deterrent capabilities of nuclear warheads, even if they could damage many targets, because they lack the psychological effects associated with nuclear weapons. According to General Kevin Chilton, the former commander of STRATCOM, this would not be a weapon that “engenders fear, compared to the threat of a nuclear strike.” Instead, General Chilton and other analysts viewed long-range ballistic missiles armed with conventional warheads as a “niche” weapon that might be used to attack some critical targets in scenarios that would not have otherwise called for the use of nuclear weapons.<sup>33</sup>

In other words, instead of substituting for nuclear weapons, a new prompt global strike capability would expand the range of U.S. conventional options. For example, General Chilton noted, in 2008 testimony before the Strategic Forces Subcommittee of the House Armed Services Committee, that this type of weapon could “provide an additional arrow in the quiver, if you will, of the country to address emerging threats, that we might find a nuclear weapon application to be self-deterrent to address that threat.”<sup>34</sup> Even without direct substitution, however, CPGS still might reduce U.S. reliance on nuclear weapons, because, with more conventional options, a President might be less likely to authorize the use of a nuclear weapon to attack a critical target.

The idea that long-range systems armed with conventional warheads could enhance deterrence remained evident in the discussion about a potential CPGS capability during the Obama Administration. In February 2012, James Miller, then the Under Secretary of Defense for Policy, noted that programs like CPGS could help strengthen U.S. non-nuclear forces as a part of the U.S. deterrent.<sup>35</sup> But, as had been evident in other discussions at the time, he referred to these systems’

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Cartwright, Commander, U.S. Strategic Command, Hearing, April 4, 2005.

<sup>31</sup> Grossman, Elaine M., “U.S. General: Precise Long-Range Missiles may Enable Big Nuclear Cuts,” *Inside the Pentagon*, April 28, 2005.

<sup>32</sup> Ibid.

<sup>33</sup> Carlo Munoz, “Chilton: Conventional PGS Cannot Replace Nuclear Deterrent Role,” *Inside the Air Force*, January 22, 2010.

<sup>34</sup> U.S. Congress, House Armed Services, Strategic Forces, *United States Strategic Posture and the Fiscal Year 2009 Budget Request for Strategic Programs*, Hearing, 110<sup>th</sup> Cong., 2<sup>nd</sup> sess., March 27, 2008.

<sup>35</sup> Elaine M. Grossman, “Conventional Arms No Substitute for Nuclear: Strategic Command Official,” February 29,

ability to enhance U.S. conventional capabilities rather than their ability to substitute directly for nuclear weapons.

The Trump Administration continues to emphasize the role that conventional prompt strike weapons can play in enhancing U.S. conventional war-fighting capabilities. The Navy, in its FY2021 budget request, notes that its conventional prompt strike program will enable “precise and timely strike capabilities in contested environments across multiple platforms.” The Pentagon’s focus on deploying hypersonic glide vehicles on shorter and intermediate-range missiles is also an effort to bolster conventional war-fighting capabilities. The FY2020 budget briefing notes that these types of systems will help U.S. warfighters “maintain tactical advantage” on the battlefield.<sup>36</sup>

## Plans and Programs

Both the Air Force and the Navy have studied the possible deployment of conventional warheads on their long-range ballistic missiles in the past. The Air Force briefly studied the penetration capabilities of conventional ICBMs in the mid-1990s. In August 1995 it launched an ICBM armed with a “pointy” front end (and no explosive warhead) against a granite slab that had characteristics similar to reinforced concrete. Press reports indicate that the warhead entered the target at a 90 degree angle and penetrated to a depth of 30 feet, which is greater than the depth of penetration of any existing U.S. weapon.<sup>37</sup> The Navy also sponsored studies in the 1990s that sought to develop a non-nuclear penetrating warhead for the Trident SLBM. These studies also focused on questions about whether a reentry vehicle from a ballistic missile could penetrate a hardened target, using only its speed and angle of reentry, without a nuclear explosion. Both the Navy and the Air Force recognized that, without a nuclear explosion, the reentry vehicle from a ballistic missile would have to be far more accurate than those deployed in the 1990s (and still deployed today) to attack and destroy a buried target.

During the George W. Bush Administration, the Air Force and the Navy both pursued programs that would provide a prompt global strike capability. However, in FY2008, Congress eliminated funding for the Navy and Air Force programs, creating, instead, a combined, defense-wide Conventional Prompt Global Strike program (CPGS) that would pursue research and development into technologies that might contribute to the PGS mission. The program was to fund the design, development, and acquisition of guidance systems, boosters, mission planning capabilities, mission enabling capabilities, reentry systems, and payload delivery vehicles (PDVs).<sup>38</sup> Details on funding for this account are described below.

## Air Force Programs

### The FALCON Study

In 2003, the Air Force and DARPA (the Defense Advanced Research Projects Agency) initiated a program, known as FALCON (force application and launch from continental United States) that was designed to develop both a launch vehicle similar to a ballistic missile and a hypersonic

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<sup>36</sup> U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *Defense Budget Overview*, Washington, DC, February 2020, p. 1-2.

<sup>37</sup> Grossman, Elaine M. “Pentagon Eyes Bunker-Busting Conventional Ballistic Missile for Subs,” *Inside the Pentagon*, June 27, 2002, p. 1.

<sup>38</sup> FY 2011 RDT&E Budget Item Justification, PE 0604165D8Z.

reentry vehicle, known as the common aero vehicle (CAV) that, together, would provide the United States with the ability to meet the requirements of the prompt global strike mission.

The FALCON study outlined many of the requirements that would become part of the framework for the conventional prompt global strike mission. For example, it indicated that the proposed CAV, when launched by a modified ICBM or other launch vehicle, should be able to travel at five times the speed of sound (Mach 5) so that it could deliver a substantial payload from the continental United States to anywhere on Earth in less than two hours.<sup>39</sup> The study identified a number of objectives for the CAV system that would allow it to achieve these goals. It stated that the CAV and its delivery vehicle should achieve alert status, which would make it ready to launch, in under 24 hours and should then be able to launch from this alert status in less than 2 hours, once it had received an execution order. The study indicated that CAV should then be able to reach its target within 1 hour of its launch.<sup>40</sup> These characteristics would provide it with the capabilities needed to attack time-sensitive targets.<sup>41</sup>

To meet the “global” portion of the PGS mission, the study indicated that the CAV should not only have the range to “strike throughout the depth of an adversary’s territory,” it should also have a cross-range capability of 3,000 nautical miles. The cross-range measures the ability of the CAV to maneuver and vary from a standard ballistic trajectory after its release from its launch vehicle. This ability to maneuver would allow the CAV to adjust to new information so that it could attack mobile targets, if timely and accurate information became available and was communicated to the CAV during its flight. It would also provide the CAV with a high degree of accuracy, allowing it to deliver its weapons within a planned 3 meters of the intended target. The CAV would also have to be linked to “complete, timely intelligence, surveillance, and reconnaissance information.”

To minimize the risk of ambiguity or misinterpretation, where a nation observing the launch might conclude it was under nuclear attack, the Air Force proposed a plan to segregate the missiles armed with conventional warheads and deploy them far from bases with nuclear warheads. The missiles could be deployed “on mobile launchers or in semi-buried silos or berms on each coast, ready to launch on short notice.”<sup>42</sup> The two potential bases noted in the study were Vandenberg Air Force Base on the West Coast and Cape Canaveral on the East Coast.

Analysts identified a number of interrelated capabilities that the United States would need to be able to deliver weapons to targets across the globe within hours of a decision to launch. The United States would need the intelligence, surveillance, and reconnaissance (ISR) capability that would allow it to identify a target precisely and quickly. It would also need the command and control capability to review the targets, plan the attack, target the delivery vehicles, and order the launch within a short amount of time. Finally, it would need the continuing reconnaissance capability to verify that the intended target remained available and that the weapon reached and destroyed that target. The requirements would exist for both land-based and sea-based missiles.

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<sup>39</sup> DARPA, “FALCON (Force Application and Launch from CONUS Technology Demonstration Program,” Fact Sheet, November 2003. See, also, Pincus, Walter, “Pentagon has Far-Reaching Defense Spacecraft in the works. Bush Administration Looking to Space to Fight Threats,” *Washington Post*, March 16, 2005, p. 3.

<sup>40</sup> Report to Congress on the “Concept of Operations” for the Common Aero Vehicle, Submitted in response to Congressional Reporting Requirements, by Peter B. Teets, Under Secretary of the Air Force, February 24, 2004. p. 2.

<sup>41</sup> This implies that the U.S. command and control system would have the capability to identify potential targets, plan the mission, and prepare to launch the CAV within this time frame. These capabilities would be needed for the PGS mission, regardless of the munitions package on the ballistic missile.

<sup>42</sup> Air Force Space Command, *Common Aero Vehicle White Paper*.

As is noted below, the Falcon study, and the proposed CAV hypersonic vehicle, became the foundation for the Hypersonic Technology Vehicle (HTV). While this vehicle served, initially, as the leading contender for a hypersonic glider for the CPGS mission, it was sidelined after two failed tests in the 2010 and 2011. Nevertheless, the Air Force has continued to pursue the development of a vehicle similar to the HTV, now known as the Tactical Boost Glide (TBG) system, which would be launched on a modified version of the Army's Tactical Missile System (ATacMS).<sup>43</sup> This will also serve as the glide vehicle launched on the Air Force air-launched, rapid-response weapon (ARRW), which is described in more detail below.

## **Reentry Vehicle Research and Warhead Options**

As was noted above, the Pentagon's Defense Science Board (DSB), in a study published in early 2004, supported the idea of using long-range ballistic missiles for the prompt global strike mission because these missiles would have the required "responsiveness, range, speed, precision, lethality, and freedom of maneuver" to attack targets anywhere in the world within an hour of their launch.<sup>44</sup> Moreover, the study went on to note that existing U.S. land-based ballistic missiles could be converted to carry conventional warheads. According to the DSB study, modified Minuteman II missiles might each be able to carry a single warhead that weighed between 500 and 1,000 pounds; a modified Peacekeeper could possibly carry between 6,000 and 8,000 pounds of payload, which would allow for multiple warheads or reentry vehicles.<sup>45</sup> According to some estimates, these missiles could even destroy some targets without an explosive warhead, using the "sheer force of impact of a reentry vehicle moving at 14,000 feet per second."<sup>46</sup> According to the DSB study, Peacekeeper missiles could also carry a single reentry body that had been modified to improve accuracy by allowing for the maneuverability of the warhead.

In addition, as was noted above, the United States could use a hypersonic glide vehicle as the reentry body on a long-range ballistic missile. According to the Falcon Study, the CAV would have been an unpowered, maneuverable hypersonic glide vehicle capable of carrying approximately 1,000 pounds in munitions or other payload.<sup>47</sup> This vehicle would have had a cone-shaped winged body that, after launch aboard a booster derived from a ballistic missile, would fly within the atmosphere at hypersonic speeds and maneuver to its target. As is noted below, DOD funded this program, beginning in 2008, through the defense-wide Conventional Prompt Global Strike (CPGS) program.

Initially, the Air Force considered two types of warheads for the CPGS mission.<sup>48</sup> One of these would contain kinetic energy projectiles, like the flechettes described below (see "Conventional Trident Modification"), that would be fused to disperse over a wide area after release from the payload delivery vehicle. The delivery body could also carry an explosive warhead to enhance its capability to penetrate and destroy hardened and buried targets. These munitions could also be delivered by a hypersonic glide vehicle should such a system become operational. However, if the

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<sup>43</sup> Steve Trimble and Guy Norris, "Sandia's Swoosh Could Lead To First-gen Hypersonic Production Line," *Aviation Week*, October 11, 2018, <http://aviationweek.com/air-dominance/sandia-s-swoosh-could-lead-first-gen-hypersonic-production-line>.

<sup>44</sup> U.S. Department of Defense, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, *Report of the Defense Science Board Task Force on Future Strategic Strike Forces*, February 2004, p. 5-1.

<sup>45</sup> *Report of the Defense Science Board Task Force on Future Strategic Strike Forces*, February 2004, p. 5-3.

<sup>46</sup> Eric Schmitt, "U.S. Considers Conventional Warheads on Nuclear Missiles," *New York Times*, February 24, 2003.

<sup>47</sup> In 2006, the Bush Administration redesignated the CAV as the hypersonic technology vehicle, in response to the restrictions in the FY2005 Defense Appropriations Act.

<sup>48</sup> Major Jason E. Seyer, USAF, "Adding the Conventional Strike Missile to the U.S.'s Deterrence Toolkit," *High Frontier*, February 2009, p. 32.

United States determined that it needed a conventional PGS capability in the near term, before the boost-glide technology was ready for deployment, these munitions might have been deployed in existing reentry vehicles that follow a ballistic trajectory to their targets, like those currently deployed on U.S. nuclear-armed missiles.

## **Missile Options**

In 2004, the Air Force indicated that it could modify both Minuteman II missiles and Peacekeeper (MX) missiles to carry conventional warheads. The Minuteman II missile was first deployed in 1965 and was retired in the early 1990s. The Air Force deployed 450 of these missiles. Each carried a single nuclear warhead and had a range of over 7,000 miles. The Air Force has already modified some of these missiles, using some as target vehicles in tests of missile defense technologies and a few in a space-launch configuration. The Peacekeeper missile was first deployed in 1986. The Air Force deployed 50 of these missiles; each carried 10 warheads and had a range greater than 6,000 miles. The Air Force deactivated these missiles between 2002 and 2005. It has now begun to modify these missiles and plans to use them not only for the PGS mission, but also to launch satellites.

The Air Force renamed the modified Minuteman and Peacekeeper missiles, referring to them as Minotaur missiles. The Minotaur IV missile would use three stages from the Peacekeeper missile and a new fourth stage developed by Orbital Sciences Corporation. The Minotaur IV missile could serve as the boost vehicle for a land-based CPGS mission. When it began to consider the use of these missiles for the PGS mission, the Air Force stated that the modifications could be made at a relatively low cost and low level of technical risk because they would use the missiles' existing rocket motors. The avionics and guidance systems could rely, primarily, on existing technologies, with some modifications to allow the upper stages of the missiles and their reentry vehicles to maneuver for improved accuracy. The Air Force also indicated that a modified Peacekeeper missile would be able to carry much larger payloads than the Trident missile.<sup>49</sup>

The Air Force began an Analysis of Alternatives (AOA) study in 2006 to review technologies and programs that could meet the requirements of the prompt global strike mission. Reports indicate that the Navy and Air Force collaborated on the study, exchanging information on "service-specific" platforms, and considering a range of alternative platforms, across service lines, for the long-term PGS option.<sup>50</sup> These include a long-range land-based option, a shorter-range forward deployed land-based missile, a sea-based option, and an air-breathing option. The Air Force completed this study in 2008.<sup>51</sup>

## **The Conventional Strike Missile**

As the AOA drew to a close in 2008, the Air Force began to pursue the development of a system known as the conventional strike missile (CSM). It initially expected this missile to serve as a mid-term follow-on to the conventional Trident modification (CTM) program,<sup>52</sup> but after Congress refused to fund development of the CTM, the CSM became the earlier option for the

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<sup>49</sup> Michael Sirak, "Air Force Envisions Mid-Term, Prompt Global Strike Missile," *Defense Daily*, July 7, 2006.

<sup>50</sup> Carlos Munez, "Services Collaborate on Long-Term Prompt Global Strike Study," *Inside the Navy*, September 10, 2007.

<sup>51</sup> Emelie Rutherford, "AoA for Prompt Global Strike to go to JROC this Summer, Chilton Says," *Defense Daily*, March 5, 2008.

<sup>52</sup> Elaine M. Grossman, "'Conventional Strike Missile' Proposed as Midterm Global Option," *Inside Defense*, April 6, 2006.

PGS mission. Reports indicate that General Kevin Chilton, then the commander of STRATCOM, assigned the Air Force the lead role in developing the long-range missile capability for PGS in mid-2008.<sup>53</sup> According to DOD, the CSM was, at that time, the “lead design to demonstrate a possible materiel solution for the CPGS warfighting capability gap.”<sup>54</sup>

According to DOD, the CSM would have been a land-based system that used boost-glide technologies to deliver conventional payloads at near-global ranges, and to provide effects on target within minutes to hours of launch.<sup>55</sup> The CSM would not follow the standard ballistic trajectory of nuclear-armed ballistic missiles. Its booster would launch with a lower-profile, or depressed, trajectory. The payload delivery vehicle (PDV), after separating from the launch vehicle, could maneuver to its target. This would not only provide it with high accuracy, it would be able to maneuver to avoid overflight of third-party countries.<sup>56</sup> With these capabilities, the CSM might mitigate some of the concerns about nuclear ambiguity raised by Congress during its review of the CTM program.

According to Air Force plans, the CSM would have combined the Minotaur IV launch vehicle described above with a hypersonic payload delivery vehicle (PDV).<sup>57</sup> The first PDV would have been a weaponized version of the DARPA/Air Force HTV-2 vehicle. As an alternative, it could have been based on the Army advanced hypersonic weapon (AHW) that is described below.<sup>58</sup> Press reports indicate that General Chilton initially hoped that the CSM would reach an initial operational capability, with one missile on alert and two spares, by 2012. He later indicated that the missile might be ready for deployment in 2015.<sup>59</sup> These dates slipped, however, and, according to DOD officials, the program did not have an official deployment date because DOD had not concluded the research, development, and testing programs for the possible reentry bodies. DOD was not prepared to decide which technology would be deployed until the reentry bodies had been tested in five demonstration flights. This has not yet happened, and may not happen until later in the decade.<sup>60</sup>

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<sup>53</sup> Elaine M. Grossman, “Chilton Shifts Prompt Strike Priority to the Air Force,” *Global Security Newswire*, September 3, 2008.

<sup>54</sup> U.S. Department of Defense, *Fiscal Year 2011 Budget Estimates, Research Development, Test and Evaluation. Defense Wide*, Washington, DC, February 2010, p. 257, [http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2011/budget\\_justification/pdfs/03\\_RDT\\_and\\_E/OSD%20RDTE\\_PB\\_2011\\_Volume%203B.pdf](http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2011/budget_justification/pdfs/03_RDT_and_E/OSD%20RDTE_PB_2011_Volume%203B.pdf).

<sup>55</sup> Major Jason E. Seyer, “Adding the Conventional Strike Missile to the US’s Deterrence Toolkit,” *High Frontier*, February 2009.

<sup>56</sup> Major Jason E. Seyer, “Adding the Conventional Strike Missile to the US’s Deterrence Toolkit,” *High Frontier*, February 2009.

<sup>57</sup> Grossman, Elaine M. “U.S. Military Eyes Fielding ‘Prompt Global Strike’ Weapon by 2015,” *Global Security Newswire*, July 1, 2009.

<sup>58</sup> According to DOD, “the Army Hypersonic Glide Body (HGB) design provides an alternative risk reduction path within the Air Force CSM concept.” See U.S. Department of Defense, *Fiscal Year 2011 Budget Estimates, Research Development, Test and Evaluation. Defense Wide*, Washington, DC, February 2010, p. 257, [http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2011/budget\\_justification/pdfs/03\\_RDT\\_and\\_E/OSD%20RDTE\\_PB\\_2011\\_Volume%203B.pdf](http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2011/budget_justification/pdfs/03_RDT_and_E/OSD%20RDTE_PB_2011_Volume%203B.pdf).

<sup>59</sup> Elaine M. Grossman, “U.S. Military Eyes Fielding ‘Prompt Global Strike’ Weapon by 2015,” *Global Security Newswire*, July 1, 2009.

<sup>60</sup> Elaine M. Grossman, “Cost to Test Global-Strike Missile could Reach \$500 Million,” *Global Security Newswire*, March 15, 2010.

## Hypersonic Test Vehicle (HTV-2)

DARPA developed the Hypersonic Test Vehicle as a part of the Falcon program described above. Unlike the CAV, which would have been a spherical hypersonic glider, the HTV-2 was shaped like a wedge. DARPA indicated that the goal for the HTV-2 program was to develop a vehicle that could launch into the Earth's upper atmosphere and descend across the Pacific Ocean with speeds of more than 13,000 miles per hour. It hoped to design it to travel from Vandenberg Air Force Base to a target near Kwajalein Atoll in the Pacific Ocean in 30 minutes. Lockheed Martin Corporation developed the HTV-2, using many of the concepts and technologies developed for the E2 warhead, described below.<sup>61</sup> DARPA planned to acquire and test two vehicles. The Air Force also contracted with Lockheed Martin to produce a third vehicle, which the Air Force planned to use as the PDV in a test of the CSM's ability to deliver a weapon to the target.

In FY2008, when Congress established the defense-wide conventional prompt global strike program with a budget of \$100 million, DOD allocated \$56 million to hypersonic glide experiments and concept demonstration development. This is the portion of the budget that supported the development and testing of the HTV-2. This program area received an additional \$42 million in FY2009 and \$90 million in FY2010. The Obama Administration requested an additional \$136.5 million for this program area in FY2011. According to DOD's budget request, it planned to use these funds to conduct the HTV-2 flight experiments, finalize design concept for the CSM payload delivery vehicle, complete qualification of a Minotaur launch vehicle for a CPGS mission, and mature/demonstrate technologies associated with the high speed demonstration of conventional munitions. DOD also indicated that it would use funding in this program area to procure the PDV warhead and booster that the Air Force would use in the planned CSM "weaponized" flight test.<sup>62</sup>

On April 22, 2010, DOD conducted its first test of the HTV-2 vehicle, launching it from Vandenberg Air Force Base in California. It launched the HTV-2 on a Minotaur IV rocket, in its "lite" configuration, with only the three Peacekeeper stages, and without the new fourth stage. This reduced the range of the missile in response to test mission limitations.<sup>63</sup> According to DARPA, its preliminary results show that the HTV-2 achieved controlled flight in the atmosphere before telemetry was lost nine minutes after liftoff.<sup>64</sup> Media reports deemed the launch to be a partial success, noting that the boost mechanism performed a successful launch. The detachment was also successful, though the glider itself failed to fly the full time of 30 minutes and total distance of 4,100 nautical miles. According to press reports, DARPA was able to gather "a significant amount of data" during the test.<sup>65</sup> DOD reviewed the results of the April 2010 test, in an effort to determine what caused the vehicle to fail during its flight.<sup>66</sup> It also conducted a

<sup>61</sup> Defense Advanced Research Projects Agency (DARPA), *Falcon Hypersonic Technology Vehicle 2 (HTV-2)*, Fact Sheet, Washington, DC, April 15, 2010.

<sup>62</sup> U.S. Department of Defense, *Fiscal Year 2011 Budget Estimates, Research Development, Test and Evaluation*. *Defense Wide*, Washington, DC, February 2010, p. 261, [http://comptroller.defense.gov/Portals/45/Documents/deffbudget/fy2011/budget\\_justification/pdfs/03\\_RDT\\_and\\_E/OSD%20RDTE\\_PB\\_2011\\_Volume%203B.pdf](http://comptroller.defense.gov/Portals/45/Documents/deffbudget/fy2011/budget_justification/pdfs/03_RDT_and_E/OSD%20RDTE_PB_2011_Volume%203B.pdf).

<sup>63</sup> "Minotaur IV/HTV-2 Lifts Off," *Targeted News Service*, May 20, 2010.

<sup>64</sup> Defense Advanced Projects Agency (DARPA), *Falcon HTV-2 Launch Test Hypersonic Vehicle Flight Capabilities*, Fact Sheet, Washington, DC, April 23, 2010.

<sup>65</sup> Elaine M. Grossman, "Pentagon Nears Finding on Hypersonic Glider Test Failure," *Global Security Newswire*, August 19, 2010.

<sup>66</sup> Elaine M. Grossman, "Pentagon Nears Finding on Hypersonic Glider Test Failure," *Global Security Newswire*, August 19, 2010.

number of wind tunnel tests and computer simulations to optimize the vehicle design and flight trajectory before the second test.

DOD conducted a second test of the HTV-2 vehicle on August 10, 2011. According to DARPA, the Minotaur missile successfully boosted the HTV-2 vehicle onto the desired trajectory and the HTV-2 vehicle successfully separated from the booster and transitioned to its “Mach 20 aerodynamic flight.” However, the HTV-2 then “experienced a flight anomaly post perigee.” This prompted the system to make a “controlled descent and splash down in the ocean.”<sup>67</sup> In other words, DARPA lost contact with the HTV-2 vehicle after it began its independent flight along its glide trajectory, and the vehicle crashed into the ocean. DARPA said that the test had important successes, with the launching, separation, and initial trajectory of the vehicle, and that it collected significant data during the flight. However, it had not yet determined how to control the aerodynamic portion of the flight, after the HTV-2 separated from its booster.<sup>68</sup>

According to DOD, in FY2011, it completed a finalized the design concept for the CSM payload delivery vehicle and qualified the Minotaur launch vehicle for a CPGS mission analysis of launch system infrastructure requirements utilizing other ballistic missile propulsion programs. However, the combination of the poor test record and tight budget environment undermined the future of this program. DOD allocated \$51.8 million to this program area in FY2012 and requested an additional \$49.5 million for FY2013. Congress added funding to the CPGS program area in FY2013; after sequestration, the budget totaled \$176.4 million. However, only \$23 million of this was allocated to the HTV-2 program. Further, in its FY2014, FY2015, FY2016, and FY2017 budget requests, DOD sought only \$2 million for this program area. The FY2018 budget request included only \$1 million. According to the budget documents, these funds will allow DOD to conduct studies to evaluate system alternatives, and to continue aerodynamic and weapon risk reduction and technology maturation efforts through ground and wind tunnel tests. DOD does not, however, plan to conduct any additional flight tests of the HTV-2 vehicle.

## **ArcLight**

DARPA also, for a time, sought to design a new system, known as ArcLight, to serve as an alternative delivery vehicle for the PGS mission. The ArcLight program would use “a high-tech missile based on the current standard missile 3 booster with a hypersonic glider that can reach more than 2,300 miles to its target.”<sup>69</sup> DOD budget documents from prior years indicate that the ArcLight missile would have a range of around 2,000 nautical miles and might carry a 100-200 pound payload. The vehicle would have been launched from the Navy’s Mark 41 vertical launch system, on both submarines and surface ships. It would have a shorter range than either the Trident missile or the Air Force CSM. As a result, it would require forward positioning of Navy assets. DOD requested \$2 million for the ArcLight program in FY2010 and \$5 million in FY2011. However, it seems to have terminated the program and did not request any additional funding in FY2012 or subsequent years. As is noted below, however, the Air Force has recently funded a number of programs that may provide it with bomber-delivered, intermediate-range boost-glide capabilities.

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<sup>67</sup> Defense Advanced Research Projects Agency, *DARPA Hypersonic Vehicle Splash Down Confirmed*, Washington, DC, August 14, 2011, [http://www.darpa.mil/NewsEvents/Releases/2011/2011/09/11\\_DARPA\\_HYPERSONIC\\_VEHICLE\\_SPLASH\\_DOWN\\_CONFIRMED.aspx](http://www.darpa.mil/NewsEvents/Releases/2011/2011/09/11_DARPA_HYPERSONIC_VEHICLE_SPLASH_DOWN_CONFIRMED.aspx).

<sup>68</sup> Thom Shanker, “Brief Test of Military Aircraft Said To Yield Much Data,” *New York Times*, August 12, 2011.

<sup>69</sup> Craig Hooper, “New Navy Missile Could Hit Global Targets,” *Military.com*, July 8, 2010.

## Army Advanced Hypersonic Weapon

The Army also developed a hypersonic glide vehicle, known as the advanced hypersonic weapon (AHW). Like the HTV-2, the AHW would use a hypersonic glider to deliver a conventional payload, but could be deployed on a booster with a shorter range than the HTV-2 and, therefore, would need to be deployed forward, on land or at sea. It would be based on a conical design, rather than the wedged-shape design of the HTV-2. Upon nearing a target, the weapon would be able to maneuver and home in on target using a precision guidance system.

Congress appropriated \$1.5 million for the Army's advanced hypersonic weapon in FY2006, and added \$8.9 million in FY2007.<sup>70</sup> DOD allocated \$29 million of the combined fund for CPGS to the Army's program in FY2008, \$13.9 million in FY2009, \$46.9 million in FY2010, and \$69 million for FY2011. Congress appropriated \$91 million for this alternative in FY2012, and DOD requested an additional \$42 million for FY2013. As was noted above, Congress increased CPGS funding in FY2013, and, after sequestration, the AHW portion of the budget received \$147.8 million. Congress appropriated an additional \$55 million for the AHW in FY2014, \$90 million in FY2015, and \$86 million in FY2016. The FY2016 budget documents also indicated that DOD expected funding to increase steadily in the next five years. Following this plan, DOD requested \$174 million for the AHW, now known as the Alternate Re-Entry System, in FY2017, \$197.4 million in FY2018, and \$263.4 million for FY2019.<sup>71</sup>

The Army conducted a successful flight test of the AHW on November 17, 2011.<sup>72</sup> The system launched from the Pacific Missile Range Facility in Hawaii, and used the strategic targets system (STARS) booster stack, which is derived from the Navy's Polaris ballistic missile. According to press reports, the vehicle traveled 2,400 miles, from the Pacific Missile Range Facility in Hawaii to Kwajalein Atoll. The test collected data on hypersonic boost-glide technologies and test range performance. The mission also tested the thermal protection technologies for the vehicle, an area where concerns exist because of the high temperatures generated during flight.

DOD initially indicated that the AHW program was a "risk mitigation effort in support of the Air Force CPGS project" and was intended to "develop and demonstrate the capability of an alternative payload delivery vehicle (APDV) through a two-flight test schedule." However, after the HTV-2 experienced difficulties in both its flight tests, and the AHW succeeded in its first test, this system appeared to be the leading contender for the hypersonic glider portion of a boost-glide conventional prompt strike system.

DOD conducted a second flight test of AHW system on August 25, 2014.<sup>73</sup> During this test, DOD launched the vehicle from the Kodiak Launch Complex off Alaska and planned to fly it to the test range at Kwajalein Atoll in the South Pacific.<sup>74</sup> However, controllers destroyed the weapon four seconds after launch after detecting problems with the STARS booster. With this failure early in the flight, the test provided no information about AHW glider and did nothing to advance the

<sup>70</sup> Elaine M. Grossman, "Army Eyes Advanced Hypersonic Weapon," *Inside Defense*, January 5, 2007.

<sup>71</sup> The FY2019 budget documents list the request of \$263.414 million in PE164: Hypersonic Glide Experiment and Concepts Demonstration Support, which had supported the HTV-2 program and had been reduced to only \$1 million in FY2018. However, in the program description narrative, the documents indicate that "all of FY2019 funding will be allotted to P166, Alternate Re-Entry System/Warhead Engineering," which supports the AHW program.

<sup>72</sup> Ann Roosevelt, "First Test Flight Successful for Advanced Hypersonic Weapon Vehicle," *Defense Daily*, November 18, 2011, p. 6.

<sup>73</sup> Colin Clark, "Hypersonic Weapons Face Major Milestone in August Test," *Breaking Defense*, March 18, 2014.

<sup>74</sup> Bill Gertz, "Army Hypersonic Missile Fails in Second Test," *Washington Free Beacon*, August 25, 2014.

program.<sup>75</sup> Reports indicate that the Army has determined that failure was caused by an “external thermal protective cover designed to regulate motor temperature,” which “interfered with the launch vehicle steering assembly.”<sup>76</sup> Neither the booster nor the hypersonic vehicle contributed to the test’s failure.

DOD scheduled a third flight experiment, using a “scaled” version of the Advanced Hypersonic Weapon, for 2017. Although the test was conducted from land in Hawaii, the scaled version of the vehicle was sized to fit on a submarine-launched ballistic missile. As is noted below, this test was conducted, successfully, in late October, 2017.

In 2018, the Pentagon indicated that the Army, Navy, and Air Force would work together to develop and deploy the AHW as a common hypersonic glide vehicle by the early 2020s.<sup>77</sup> This vehicle is now known as the Common Hypersonic Glide Body, or C-HGB. The Navy will deploy it as a part of its submarine-launched Conventional Prompt Strike (CPS) program, and the Army will deploy it on the Long Range Hypersonic Weapon (LRHW) system. The Air Force had planned to deploy this glide vehicle on a system known as the Hypersonic Conventional Strike Weapon (HCSW/Hacksaw), but eliminated funding for this program in its FY2021 budget request.<sup>78</sup> The Air Force is, instead, focusing its hypersonics program on the ARRW system, which will carry the tactical boost glide reentry vehicle (TBG) derived from the HTV-2 program.

## Navy Programs

### Reentry Vehicle Research

In FY2003, the Navy requested funding for research on a new type of guided reentry vehicle that could significantly improve the accuracy of the Trident II (D-5) missiles. This program, known as the enhanced effectiveness (E2) initiative, included an initial funding request of \$30 million, a three-year study, and a full-scale flight test in early 2007.<sup>79</sup> Congress rejected the initial funding request in FY2003 and FY2004, but Lockheed Martin Corporation, the contractor pursuing the study, continued with a low level of research into this system.

The E2 reentry vehicle would have integrated the existing inertial measurement unit (IMU) guidance system (the system currently used to guide long-range ballistic missiles) with global positioning system (GPS) technologies so that the reentry vehicle could receive guidance updates during its flight.<sup>80</sup> A standard MK4 reentry vehicle, which is the reentry vehicle deployed on

<sup>75</sup> Andrea Shalal and David Alexander, “Experimental U.S. Hypersonic Weapon Destroyed Seconds After Launch,” *Reuters*, August 25, 2014.

<sup>76</sup> Jason Sherman, “DOD Plans FY-17 ‘Flight Experiment’ Of Hypersonic Weapon,” *Inside Defense*, February 5, 2015.

<sup>77</sup> According to press reports, the Navy is designing the common glide vehicle. The Army will develop the prototypes for flight testing and Sandia National Laboratories, the designer of the original concept, then will build the common glide vehicles. See Steve Trimble and Guy Norris, “Sandia’s Swerve Could Lead To First-gen Hypersonic Production Line,” *Aviation Week*, October 11, 2018, <http://aviationweek.com/air-dominance/sandia-s-swerve-could-lead-first-gen-hypersonic-production-line>.

<sup>78</sup> The HCSW would have been a solid-rocket-powered, air-launched, GPS-guided system. It was expected to reach initial operational capability on existing combat aircraft in FY2022. See Guy Norris, “B-52 Readied for Intense Hypersonic Weapons Test and Deployment Role,” *Aviation Week and Space Technology*, August 29, 2018.

<sup>79</sup> Norris, Robert S. and Hans M. Kristensen. “U.S. Nuclear Forces 2005,” *Bulletin of the Atomic Scientists*, January/February 2005, pp. 73-75.

<sup>80</sup> According to the Defense Science Board Task Force on Future Strategic Strike Forces, the IMU would guide the missile in its early phases, but the reentry body would receive a GPS update during its exoatmospheric flight; it would then use the IMU and control flaps to steer the warhead with GPS-like accuracy during atmospheric reentry. See U.S.

many Trident SLBMs, would be modified with a flap-based steering system, allowing it to maneuver when approaching its target to improve its accuracy and increase its angle of penetration. This steering system, which the Navy referred to as a “backpack extension,” would increase the size of the reentry vehicle, making it comparable in size to the MK5 reentry vehicle that is also deployed on Trident missiles. The E2 warhead could possibly have provided Trident missiles with the accuracy to strike within 10 meters of their intended, stationary targets. This accuracy would improve the lethality of the nuclear warheads, but it would also permit the missiles to destroy some types of targets with conventional warheads.<sup>81</sup>

Lockheed Martin flew these reentry vehicles in test flights of Trident missiles.<sup>82</sup> In a test conducted in 2002, it demonstrated that the new reentry vehicle could steer toward a target and strike with improved accuracy. In a test conducted in early 2005, a modified version of its reentry vehicle demonstrated that it could not only steer toward a target with improved accuracy, but also slow down and “control the impact conditions,” capabilities that would be needed for the delivery of some types of conventional warheads to their targets. Lockheed estimated that, if the program received funding from Congress beginning in FY2006, its reentry vehicle could enter production in FY2010 and achieve an initial operational capability in 2011. The Navy, however, did not seek funding for this program in FY2004, FY2005, or FY2006.

The Lockheed Martin reentry vehicle became a part of the plan to deploy conventional warheads on Trident submarine-launched ballistic missiles, and was included in the Navy’s budget request for FY2007 and FY2008. The budget request for FY2008 indicated that most of the work needed to design and develop the reentry vehicle for the conventional Trident could have been completed in FY2008, with an additional \$20 million request planned for FY2009.<sup>83</sup> The FY2008 funding would have supported, among other things, efforts to finalize the guidance and flap system on the maneuvering body extension of the reentry body, design an interface between the new guidance system and the missile system flight controls, begin development of a conventional payload that could fit within the reentry body, and initiate efforts to modify existing facilities so that they could test the conventional Trident modification (CTM) designs. Congress, however, rejected these funding requests amid concerns about the rationale for the program and the potential for misunderstanding if the weapons were used in a conflict.

If it had received the requested funding in FY2008, and proceeded with the expected work plan, the Navy planned to conduct system development and demonstration activities in FY2008 and FY2009, and planned to begin production and deployment in FY2010. With this timeline, the system would have reached its full operational capability by the end of 2012. However, as is noted below, Congress rejected the Navy’s funding request for FY2008 and restructured the PGS program.

DOD allocated a portion of the combined funding for the PGS mission to this program area in FY2009. In documents submitted with its FY2009 budget request, the Navy sought funding for a

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Department of Defense. *Report of the Defense Science Board Task Force on Future Strategic Strike Forces*. February 2004. pp. 5-7.

<sup>81</sup> Grossman, Elaine M., “Pentagon Eyes Bunker-Busting Conventional Ballistic Missile for Subs,” *Inside the Pentagon*, June 27, 2002. p. 1. See also, Robert S. Norris and Hans M. Kristensen, “U.S. Nuclear Forces 2005,” *Bulletin of the Atomic Scientists*, January/February 2005, pp. 73-75.

<sup>82</sup> Krivich, David, Director, SMP Advanced Programs and Business Development, Lockheed Martin Space Systems Company, *Update on Precision Conventional Ballistic Missile Global Strike Capabilities*, Briefing to the Defense Science Board Task Force on Nuclear Capabilities, July 22, 2005.

<sup>83</sup> Department of the Navy, Fiscal Year 2008/2009 Budget Estimates, Justification of Estimates, February 2007, Research, Development, Test, and Evaluation, Navy Budget Activity 4.

2009 flight experiment “using a Life Extension Test Bed (LETB-2) reentry body on a currently planned Trident D-5 missile test.”<sup>84</sup> The LETB-2 is essentially the same as the maneuvering reentry body, described above, that evolved from the E2 reentry vehicle program. Even though the test bed would fly on a Trident missile test, the Navy contended that the technology would be applicable to any conventional ballistic missile, and, therefore, was not prohibited by the FY2008 legislation. Moreover, according to some reports, the test was funded separately, outside the combined conventional prompt global strike (CPGS) account.<sup>85</sup> DOD indicated that during FY2012, it would continue to adapt the LETB reentry bodies as a part of its test-range development plans.

The Navy also requested, in its FY2009 budget, funding for a reentry body for a conventional ballistic missiles. This program, known as the Medium Lift Reentry Body, would be too large to fit on a Trident missile but could carry the warhead on the intermediate-range submarine-launched ballistic missile (described below). It would carry a tungsten-rod (“flechette”) warhead, which would be designed to destroy area targets such as airfields and military bases.

### **Conventional Trident Modification**

The Navy began to speak publicly about its plans for the conventional Trident modification (CTM) in early March 2006. Under this concept, the Navy planned to deploy each of its 12 Trident submarines on patrol (two would be in overhaul at any given time) with two missiles equipped to carry four conventional warheads each. The remaining 22 missiles on each submarine would continue to carry nuclear warheads, and the submarines would continue to patrol in areas that would allow them to reach targets specified in the nuclear war plan, although the patrol areas could be adjusted to accommodate targeting requirements for the CTM. Only four submarines would be within range of their targets, with two in the Pacific Ocean and two in the Atlantic Ocean. Consequently, only eight conventional missiles would be available for use at any time, and only one or two of the submarines would likely be within range of the targets specified for attack with conventional ballistic missiles.<sup>86</sup>

The Navy considered two types of warheads for the CTM program in the near term. One warhead would be designed to destroy or disable area targets like airfields or buildings, using a reentry vehicle loaded with tungsten rods—known as *flechettes*—that would rain down on the target and destroy everything within an area of up to 3,000 square feet. The other might be able to destroy hardened targets, like underground bunkers or reinforced structures, if it were accurate enough to strike very close to the target. Each would be deployed within the reentry body developed and tested under the E2 program. The Navy also explored, for possible future deployment, technologies that might be able to penetrate to destroy hardened, buried targets.

The Navy argued that these warheads would have provided the Navy with the ability to contribute to the prompt global strike mission in the near term, a goal that was identified in the 2006 QDR. The report indicated that the Navy would seek to deploy an “initial capability to deliver precision-guided conventional warheads using long-range Trident” missiles within two years,<sup>87</sup> although many expected it to take four years to field the full complement of 96 warheads. The capability, even when fully deployed, would be limited by the small number of available warheads. Hence, it

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<sup>84</sup> Elaine M. Grossman, “Controversial Missile Idea Lingers,” *Global Security Newswire*, March 20, 2008.

<sup>85</sup> Elaine M. Grossman, “U.S. Navy Plans August Test for Conventional Trident-Related Technology,” *Global Security Newswire*, May 21, 2009.

<sup>86</sup> *Ibid.*

<sup>87</sup> U.S. Department of Defense, Quadrennial Defense Review Report, February 6, 2006, p. 50.

seems likely that the Pentagon would have planned to use these missiles only in limited circumstances to meet specific goals.

The budget the Navy prepared for FY2007 included a total of \$503 million over five years, with \$127 million for FY2007, \$225 million for FY2008, \$118 million for FY2009, and \$33 million for FY2010.<sup>88</sup> As noted below, Congress denied the funding request in FY2007. The Pentagon requested a total of \$175.4 million for FY2008, but Congress did not approve the specific funding again. Instead, as is noted in more detail below, it provided research and development funding for a more general category of “prompt global strike” initiatives.

## **Submarine-Launched Conventional Prompt Strike**

The Navy first studied the possible development and deployment of a submarine-launched intermediate-range ballistic missile (SLIRBM) in the early 2000s. It requested industry participation in the study in mid-2003, and planned to conduct two static test-firings of a prototype rocket engine in 2005.<sup>89</sup> According to the Defense Science Board Task Force, this missile might have delivered a 2,000-pound payload over a 1,500-mile range,<sup>90</sup> with an accuracy of less than 5 meters. This would allow the missile to reach its target in less than 15 minutes.<sup>91</sup> Reports of the initial studies into this concept indicated that this proposed missile could carry either nuclear or conventional warheads, allowing it to contribute to the missions requiring prompt, long-range strike capabilities.<sup>92</sup> These missiles could also be deployed on nuclear-capable Trident submarines, with 2 or 3 missiles deployed in up to 22 of the submarine’s launch tubes, for a total of 66 missiles per submarine. However, as the concept emerged, it became evident that the missiles would have been deployed, with perhaps 2 per launch tube, in the four Ohio-class submarines that have already been converted to carry conventional cruise missiles and other non-nuclear weaponry.

Congress appropriated \$10 million for the SLIRBM in FY2005 and \$7.2 million in FY2006. In the House, the Defense Appropriations Subcommittee added \$2 million for this effort in FY2007, but the conference committee provided only \$1.3 million. The Pentagon did not request any additional funding for this program for FY2008, but it did indicate that prior-years’ funding would be used to continue funding efforts that will demonstrate the affordability and feasibility of this concept.

The Pentagon remained interested in this concept in 2008 and considered allocating \$120 million in FY2008 and \$140 million in FY2009 to pursue a medium-range “Submarine-launched Global Strike Missile” with a range of 2,000-3,000 nautical miles.<sup>93</sup> However, as is noted below, Congress eliminated Navy funding for conventional prompt global strike programs in FY2008 and combined all DOD funding in a single defense-wide account. This account did not provide

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<sup>88</sup> Grossman, Elaine, “Pentagon Wants Early Start on Conventional Missiles for Subs.” *InsideDefense.Com*, January 20, 2006. See also, Grossman, “Facing Doubts, Pentagon Readies Pitch for New Sub-launched Missile.” *Inside the Pentagon*. March 9, 2006.

<sup>89</sup> Norris, Robert S. and Hans M. Kristensen, “U.S. Nuclear Forces 2005,” *Bulletin of the Atomic Scientists*, January/February 2005, pp. 73-75.

<sup>90</sup> A Trident II (D-5) missile can deliver its warheads over a range of 4,000 miles.

<sup>91</sup> *Report of the Defense Science Board Task Force on Future Strategic Strike Forces*, February 2004, pp. 5-12.

<sup>92</sup> Koch, Andrew. “U.S. Considers Major Changes to Strategic Weapons,” *Jane’s Defence Weekly*, September 27, 2003.

<sup>93</sup> Grossman, Elaine, M., “Midrange Missile May be Backup to Modified Trident,” *Global Security Newswire*, September 21, 2007.

any funds to this missile, and the Navy did not request any additional funds in its budget in subsequent years.

The Pentagon reasserted its interest in deploying a prompt strike capability on submarines in January 2012, in its report on defense budget priorities and choices. It noted that, as a part of the U.S. effort to “rebalance” U.S. forces toward the Asia-Pacific and Middle East regions, the United States would need to invest in capabilities “required to maintain our military’s continued freedom of action in the face of new technologies designed to frustrate access advantages.” The list of such technologies included the “design of a conventional prompt strike option from submarines.”<sup>94</sup> In his briefing after the release of this document, Secretary of Defense Leon Panetta linked this effort with a program to provide the Virginia-class attack submarines with the capability to carry more conventional cruise missiles. The same mid-body launch tubes, known as the Virginia payload module, that might carry more cruise missiles might also carry conventional boost-glide systems.<sup>95</sup>

During the Obama Administration, DOD did not specify whether it would deploy a PGS system on land or at sea. It did, however, leave open the option of deploying the systems at sea, so that it could pursue technologies that would reduce the cost and risk of the program, as it developed both the booster and the hypersonic glider technologies, even if they came with a reduced range. Moreover, unlike with the conventional Trident program, with an intermediate-range PGS system, DOD would not install conventional warheads on missiles that had been equipped with nuclear warheads. In addition, the boosters would travel on a flatter trajectory, and would likely have a different launch profile and a different number of stages, than the existing Trident missiles. According to General Martin Dempsey, the former Chairman of the Joint Chiefs of Staff, these differences in technology would likely mitigate the risk of an adversary observing the launch and concluding, incorrectly, that the United States had launched an attack with a nuclear-armed missile.<sup>96</sup>

DOD has moved forward with the sea-based option for the conventional prompt strike mission. In its FY2015 budget request, DOD noted that, during FY2013, it began to review a new series of demonstrations within the Alternate Re-Entry System program area by the Navy’s strategic systems program. It also stated that it would begin critical design reviews and begin to assemble a vehicle for a Navy flight test in FY2015. The FY2014 budget documents noted that a flight test of a Navy variant of a conventional prompt strike system, which could be a reference to the intermediate-range option deployed on Virginia-class submarines, might occur before the end of 2016, but this was delayed until October 2017, when DOD conducted a successful test of a booster and glider that could be deployed on a submarine.

The October 30 test, identified as Flight Experiment 1, flew more than 2,000 nautical miles from Hawaii to the Marshall Islands. Although the flight was launched from land, the test was executed by the Navy’s Strategic Systems Programs office. The Pentagon estimated that the test cost \$160 million, and, while DOD did not identify the specific objectives or results of the test, Vice Admiral Terry Benedict, head of the Navy’s Strategic System Programs office, declared the event a “success.”<sup>97</sup> In addition, in a speech a few days after the test, Admiral Benedict indicated that

<sup>94</sup> U.S. Department of Defense, *Defense Budget Priorities and Choices*, Washington, DC, January 2012, p. 5, [http://archive.defense.gov/news/Defense\\_Budget\\_Priorities.pdf](http://archive.defense.gov/news/Defense_Budget_Priorities.pdf).

<sup>95</sup> Christopher P. Caves, “Subs May Serve Attack, Guided Missile Functions,” *Navy Times*, October 15, 2011, <http://www.navytimes.com/news/2011/10/navy-dual-use-submarines-attack-guided-missile-101511w/>.

<sup>96</sup> U.S. Department of Defense, *Major Budget Decisions Briefing From the Pentagon*, Washington, DC, January 26, 2012, <http://archive.defense.gov/transcripts/transcript.aspx?transcriptid=4962>.

<sup>97</sup> Jason Sherman, “DOD flies experimental hypersonic payload; claims success,” *Inside Defense*, November 2, 2017.

the Navy could eventually deploy the conventional strike system on either Ohio class ballistic missile submarines that have been converted to launch cruise missiles (known as SSGNs) or Virginia class attack submarines equipped with the Virginia payload module.<sup>98</sup>

The DOD budget request for FY2019 indicated that the Navy would conduct a second flight test by the end of FY2020. The budget request also contained no funds for the OSD-wide account for Prompt Global Strike Capability Development after FY2019, indicating that “Conventional Prompt Strike program and funding transfers to the Navy” starting in FY2020. Moreover, funding for the program has increased significantly, from a request for \$278 million in FY2019 to a request for \$1.1 billion in FY2021 and an expected \$5.3 billion between FY2021 and FY2025.

## Legislative Activity

Congress first considered the Administration’s plans to develop conventional warheads for possible deployment on long-range ballistic missiles in FY2003. Since then, it has demonstrated some support for and some skepticism about the plans.

### FY2003 and FY2004

As was noted above, the Navy requested \$30 million for its E2 program in FY2003 and FY2004. In each case, this was to be the initial year of funding in a three-year study. Congress refused the Navy’s request in both years.

The Bush Administration requested \$12.2 million in research and development funding for the common aero vehicle (CAV) program in FY2004. The House, in its version of H.R. 1588, the FY2004 National Defense Authorization Act, nearly doubled the authorized funding to \$24.2 million. The Senate provided the requested amount, and the conference committee split the difference, authorizing \$17.025 million. Although Congress supported the Administration’s request for funding, the House had shown concerns about the possibility that U.S. launches of ballistic missiles armed with conventional warheads could be misinterpreted as nonconventional launches by nations who might monitor U.S. military activity—a concern, particularly, to Russia and China. Hence, the House required that the Air Force submit a report on the concept of operations for the CAV that would address questions about the potential for misinterpretation of the launches. This reporting requirement remained in the final version of the National Defense Authorization Act for Fiscal Year 2004 (P.L. 108-136).

The National Defense Authorization Act for Fiscal Year 2004 (P.L. 108-136, §1032) also contains a requirement for an annual report describing “an integrated plan for developing, deploying, and sustaining a prompt global strike capability.” Congress mandated that the plan should include information on, among other things, the types of targets for long-range strike assets, the capabilities desired for these assets, an assessment of the command and control, intelligence, and surveillance capabilities necessary to support the PGS mission, integration with tactical missions, and cost and schedule for achieving the mission. In the conference report (H.Rept. 108-354), Congress noted that its interest in these issues derived from the 2001 Nuclear Posture Review and its focus on integrating nuclear and conventional strike capabilities to reduce reliance on nuclear weapons. It indicated that it saw a need for further analysis of future system requirements, along with a comprehensive effort to link planning and programs in a PGS roadmap to achieve a

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<https://insidedefense.com/inside-army/dod-flies-experimental-hypersonic-payload-claims-success>.

<sup>98</sup> Jason Sherman and Lee Hudson, “Navy reveals plans to put hypersonic strike weapons on submarines,” *Inside Defense*, November 3, 2017, <https://insidedefense.com/inside-navy/navy-reveals-plans-put-hypersonic-strike-weapons-submarines>.

coherent force structure. Hence, although the Air Force considered the NPR objective of integrating nuclear and conventional strike forces as a separate mission and separate concept from PGS, Congress, initially at least, blended both into the request for a new report.

The Air Force submitted its report on the CAV concept of operations to Congress in February 2004. This report offered several suggestions for measures the United States could take to reduce the possibility of misinterpretation if the United States were to deploy, and employ, ballistic missiles with conventional warheads. Many of the measures discussed in this report are summarized below, under “Issues for Congress.”

## **FY2005**

The Bush Administration requested \$16.4 million for research and development on the CAV in FY2005. Congress again increased this funding level, appropriating \$21.6 million for the development of the CAV. However, in July 2004, with passage of the FY2005 Defense Appropriations Act (H.R. 4613, P.L. 108-287), Congress repeated its concerns about the potential for misinterpretation. In the report on the Defense appropriations bill, Congress questioned whether there were safeguards in place to guarantee that other nuclear weapons states did not misinterpret the intent or use of ballistic missiles armed with CAV. In response to these concerns, the report stated that funds provided for CAV could only be used for non-weapons-related research on hypersonic technologies, including studies into microsatellites or other satellite launch requirements. Congress specified that the funds could not be used to “develop, integrate, or test a CAV variant that includes any nuclear or conventional weapons.” Congress also indicated that the funds could not be used to “develop, integrate, or test a CAV for launch on any ICBM or SLBM.” Congress would consider expanding the scope of this program in future years if safeguards negotiated among international partners were put into place.<sup>99</sup>

## **FY2006 and FY2007**

The Bush Administration requested \$27.2 million for CAV in FY2006. In response to the restrictions in the FY2005 Defense Appropriations Act, it restructured the program, and redesignated the CAV as the hypersonic technology vehicle. This new program excluded any development of weapons capabilities for the CAV. Congress approved the requested funding in the FY2006 Defense Appropriations Act and did not impose any new restrictions. The Bush Administration requested, and Congress appropriated, an additional \$33.4 million for CAV in its FY2007 budget. Congress also appropriated \$12 million for the Air Force conventional ballistic missile (CBM) program, which was exploring the possible use of a modified Minuteman missile as a mid-term option for the PGS mission.

The budget projections in the FY2006 budget request demonstrated how costs could have increased if the Air Force continued to pursue the CAV program. The budget requests were projected to be between \$31 million and \$39 million each year for the next three years, but they were then projected to rise to \$92 million in FY2010 and \$94 million in FY2011. This sharp increase reflected an expected change in the program from research and development to production and deployment at the end of the decade. This change would require that the Air Force address and resolve congressional concerns about the potential for misunderstandings with the launch of ballistic missiles armed with conventional warheads.

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<sup>99</sup> U.S. Congress, House, *Making Appropriations for the Department of Defense for the Fiscal Year Ending September 30, 2005, and For Other Purposes*, Conference Report to Accompany H.R. 4613, H.Rept. 108-622, p. 240.

The budget projection for the CAV also indicated that the CAV would not have provided a near-term solution to the PGS mission needs. It would not have been available until the middle of the next decade, even though, as was evident in the 2006 QDR, the Pentagon was interested in meeting the needs of the PGS mission in the near term. This resulted in a growing interest in the Navy's CTM program.

The Navy's FY2007 budget included \$127 million for the conventional Trident modification. The request separated into three categories. The budget included \$38 million for the CTM within the much larger (\$957.6 million) budget for Trident II missile modifications; \$12 million for strategic missile systems equipment to support the CTM; and \$77 million for the development of an advanced strike capability that would demonstrate the feasibility of the CTM concept.

Neither the House nor the Senate Armed Services committees authorized the Administration's request in their versions of the FY2007 Defense authorization bills (S. 2766 and S.Rept. 109-254; H.R. 5122 and H.Rept. 109-452). Both committees noted their concerns about the possibility that nations, such as Russia, might misunderstand the launch of a conventional Trident missile and determine that they were under attack from U.S. nuclear weapons. Both committees requested reports from the Administration that would address a range of issues raised by this prospective program. The Senate Armed Services Committee withheld \$95 million of the Administration's request, pending completion of the report. It authorized the use of \$20 million for the preparation of the report and \$32 million for research and development on technologies that would support the Trident modification. It specified that the money could not be used on the CTM program itself. The full Senate accepted the committee's position. The House Armed Services Committee eliminated the \$38 million for CTM in the Trident II modification budget and the \$12 million for strategic missile systems equipment. It also reduced by \$47 million the Navy's request for funding for the CTM program, leaving \$30 million for this effort.

The conference committee, in its report (H.Rept. 109-702, §219), adopted the reporting requirements included in the Senate bill, but, instead of fencing the funding pending completion of the report, accepted the House's reduction in CTM funding. Therefore, as was the case in the House bill, the conference report included only \$30 million for research and development into an advanced strike capability that would support the CTM concept.

The House and Senate appropriations bills also rejected the Administration's request for funding for the CTM program. Following the HASC, the Defense Appropriations subcommittee in the House eliminated all but \$30 million in research and development funding. It also raised questions about the feasibility of the proposed schedule for the program and questioned whether the decision to move forward immediately would prejudice the outcome of the PGS AOA study. In the Senate, the Defense Appropriations Subcommittee eliminated all funding for the CTM program, and provided \$5 million for the National Academy of Sciences to analyze the mission requirement and recommend alternatives. The conference report on the Defense Appropriations Act (H.Rept. 109-676) retained the Senate provision that funded \$5 million for a report from the National Academy of Sciences. It also included \$20 million in Research, Development, Test and Evaluation funds for research that would focus on those "developmental items which are common to all the global strike alternatives."

## **FY2008**

The President's budget request for FY2008 included continued funding of \$32.8 million for the CAV. Congress did not approve this request, but in both the authorization and appropriations bills, transferred this funding to a new, integrated account for Prompt Global Strike Research. Congress also eliminated separate funding of \$50 million for other elements of the FALCON program,

rolling them into the new account as well. As is discussed in more detail below, the total funding for this new account was set at \$100 million for FY2008, less than half of the requested funding for all the programs that were combined in the new account. The Pentagon has objected to this transfer, noting that the elimination of the specific line items and the overall reduction in funding would lead to the termination of the FALCON program and the cancellation of several planned flight tests for the CAV. Although the Pentagon eventually accepted the idea of a combined program for PGS research, it suggested that the total budget be set at \$208 million, an amount equal to the total proposed for the combined programs, so that each could continue to receive the required level of investment.<sup>100</sup> Congress did not accept this appeal, and the conference reports on both the authorization (H.R. 1585, H.Rept. 110-477) and appropriations (P.L. 110-116, H.Rept. 110-434) bills limited the funding to \$100 million.

The President's budget for FY2008 also included a total of \$175.4 million for the CTM program. This request included \$36 million, within the much larger budget of just over \$1 billion for Trident II modifications, to begin modifying the Trident II missiles to carry conventional warheads. Congress had denied all funding for this purpose in FY2007. It also included \$13 million in strategic systems missile equipment, which would be used to begin modifying Trident submarines to carry the conventional missile. Congress had also denied this funding in FY2007. Finally, the budget included \$126.4 million to develop advanced strike capabilities under the "Hard and Deeply Buried Target Defeat System Program" area. This funding is allocated to continue research and development into reentry vehicle technologies for the conventional Trident modification. Congress had appropriated only \$20 million for this effort in FY2007, even though the budget had requested \$77 million.

The House Armed Services Committee, in its version of the FY2008 Defense authorization bill (H.R. 1585, H.Rept. 110-146), supported continued research, development, testing, and evaluation of the conventional Trident concept, but prevented funds from being obligated or expended for the operational deployment of the system. Specifically, it approved the request for \$126.4 million for continued research and development on the reentry vehicle, and authorized \$16 million for procurement, but reduced the budget request by \$33 million, withholding all funds for long-lead procurement. The Strategic Forces Subcommittee noted that it supported, in general, the pursuit of technologies for the prompt global strike mission, but also noted that questions remained about the concept of operations and the possibility for misunderstandings. Hence, it sought to slow the program until the National Academy of Sciences completed its report.

The Senate Armed Services Committee, in its version of the FY2008 Defense authorization bill (S. 1547, S.Rept. 110-77), recommended that no funding be provided specifically for the CTM program, and that all \$208 million in PGS funding be transferred to PE 65104D8Z, to support common prompt global strike concepts. The committee specifically indicated that this program element should support a "coordinated look at a variety of kinetic non-nuclear concepts, as necessary, to address the feasibility of a prompt global strike." In its report, it noted that the services were exploring several potential options for the PGS mission, and that research funded through this program element could support, "in a coordinated fashion," technologies that could be common to several of these concepts. The committee also indicated that it believed any resulting PGS capability should be clearly and unambiguously non-nuclear.

The conference committee adopted the Senate's approach to combining the funding in a single account, but, as the Appropriations Committee had done, limited the funding to \$100 million (H.Rept. 110-477). The conference report also required that the Under Secretary of Defense for

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<sup>100</sup> Department of Defense Budget Appeal, FY2008 Defense Appropriations Bill, October 15, 2007.

Acquisition, Technology, and Logistics submit a plan describing how DOD would obligate the FY2008 funds (H.Rept. 110-477, §243). This funding profile indicates that Congress did not reject the Prompt Global Strike concept completely, even though it had not accepted the Administration's sense of urgency or its certainty in the need for the CTM program in the near term.

The House and Senate Appropriations Committees followed the "combined funding" model established by the SASC. The House Appropriations Committee eliminated the specific funding for the CTM, directed DOD to create a "prompt global strike program element within the Research, Development, Test, and Evaluation, Defense-Wide appropriation," and moved \$100 million into this new account to "further the Department's prompt global strike initiative" without "limiting the Nation to a single option" at this point in time. Some of these funds could be used to support research and development on the CTM concept. The committee also mandated that DOD submit a report "that discusses the technology thrusts and investment objectives and outlines the allocation of funding towards achieving these objectives." The Senate Appropriations Committee, in its version of the bill (H.R. 3222, S.Rept. 110-155) provided \$125 million for the Research, Development, Test and Evaluation, Defense-Wide account for prompt global strike mission. It noted that these funds should be used "for engineering and development of alternatives to the conventional TRIDENT missile program." The final version of the FY2008 appropriations bill limited the funding to \$100 million (P.L. 110-181, H.Rept. 110-477).

## **FY2009**

The Pentagon requested \$117.6 million for the prompt global strike program element established in the FY2008 Defense authorization and appropriations processes. It also submitted a report to Congress, as required by the FY2008 Defense authorization bill (P.L. 110-181, H.Rept. 110-477, §243), that outlined its plans for dividing up the FY2008 and FY2009 funding under the PGS program element. In this report, DOD planned to spend \$58 million in FY2008 and \$70 million in FY2009 on tests of the hypersonic glide vehicle emerging from the Air Force/DARPA program. It also allotted \$30 million in FY2008 and \$40 million in FY2009 for alternative reentry systems development, a reference to the Medium-Lift Reentry Body that could be deployed on a new sea-based ballistic missile. Further, the report indicated that DOD would spend \$6 million in FY2008 and \$3 million in FY2009 on the LETB-2 demonstration described above.

The House Armed Services Committee, following the lead of the Strategic Forces Subcommittee, approved this request. The Senate Armed Services Committee, however, added \$30 million to this amount, for a total of \$147.6 million, in its version of the FY2009 Defense authorization bill (S. 3001). It indicated that these added funds, plus an additional \$15 million in the budget request, were to be allocated to R&D on the Army program developing an advanced hypersonic glide vehicle—this program had not been included in the original budget request. However, in the final version of the FY2009 Defense authorization bill, Congress provided the requested amount of \$117.6 million for the PGS account.

The Defense Subcommittee of the Senate Appropriations Committee deleted \$43 million from the PGS account, leaving \$74.6 million. It removed the \$40 million planned for work on the medium lift reentry body and the \$3 million allocated to the LETB-2 test bed program. In other words, it rejected DOD's plans to continue developing reentry technologies that could be deployed on either the Trident missile or a new sea-based conventional ballistic missile. The final version of the Defense appropriations bill, which was included in a larger consolidated appropriations bill, included this reduction in funding. Further, the legislation specified that "not less than one-

fourth” of the funds provided, or \$19 million, must be “available” for the advanced hypersonic weapon under development by the Army.<sup>101</sup>

## **FY2010**

The Department of Defense requested \$166.9 million for the defense-wide conventional prompt global strike program element. This request included \$91.5 million for the DARPA/Air Force hypersonic test vehicle, which the budget indicated would support efforts to continue hypersonic technology development, to integrate the HTV-2 vehicles with Minotaur IV lite launch vehicles, and to assess the progress of thermal and aerodynamic protection to the vehicles. The budget request also included \$46.9 million for the Army’s AHW program. The budget documents indicated that this funding would support a first flight of the AHW in FY2011. Congress authorized and appropriated the requested funds for FY2010.

## **FY2011**

The Department of Defense requested \$239.9 million for the combined Conventional Prompt Global Strike program area in FY2011. The budget documents indicate that the Air Force Conventional Strike Missile was still the leading design to fulfill the PGS mission, and the Army AHW was deemed the alternative risk reduction plan to the CSM. The FY2011 budget allocated \$136.6 million to hypersonic glide experiments; this would support the continued development of a payload delivery vehicle (PDV) for the conventional strike missile and development of the Minotaur IV rocket booster. It would also support the integration of the HTV-2 delivery vehicle and Minotaur IV missile, with two test flights of this CSM design expected in FY2011. The budget also allocated \$69 million to the Alternate Re-Entry System; this supports the development of the hypersonic glide body (HGB) or the Army advanced hypersonic weapon. The budget request would support one test flight of this technology in FY2011. The PGS fund also allocated \$24 million to Test Range Development and \$10.3 million to administrative and study costs, including the application of the Prompt Global Strike Analysis of Alternatives results.

Both the House and the Senate approved this request in their versions of the FY2011 Defense authorization bill. The Senate Defense Appropriations Subcommittee, in its report on the FY2011 Defense appropriations bill, recommended full funding for the FY2011 request; however, it directed that DOD could not obligate more than \$189 million until it provided Congress with details how it planned to restructure the program in light of the disappointing flight test results for the HTV-2 vehicle.<sup>102</sup> Congress, however, never completed work on the FY2011 budget request, passing, instead, a continuing resolution through March 4, 2011. This bill held funding for most government programs at the FY2010 level.

## **FY2012**

The Department of Defense has requested \$204.8 million for conventional prompt global strike programs in FY2012. Although the original budget documents indicated that all of this funding is allocated to hypersonic glide experiments and concept demonstration, this was an error and some of the funding is alternative concepts and range support. According to the amended budget request, \$132 million is allocated to hypersonic glide experiments and concept demonstration,

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<sup>101</sup> Elaine M. Grossman, “Strategic Arms Funds Tilt Conventional in 2009,” *Global Security Newswire*, November 7, 2008.

<sup>102</sup> U.S. Congress, Senate Committee on Appropriations, Subcommittee on Defense, *Defense Department Appropriations Bill, 2011*, Report, 111<sup>th</sup> Cong., 2<sup>nd</sup> sess., September 15, 2010, S.Rept. 111-295 (Washington: GPO, 2010), p. 177.

while \$51 million is allocated to the alternate payload delivery vehicle options, \$12 million is allocated to range support and \$10 million for long-range studies. The budget request indicates that the funding in FY2012 will be used to procure the PDV—the “weaponized” version of the DARPA/Air Force HTV-2 vehicle—the warhead, and the booster to support the planned “weaponized” test of the Air Force conventional strike missile.

When considering the Administration’s request for the CPGS program, the House Armed Services Committee, in its version of the FY2012 Defense Authorization Bill, approved \$179.8 million for this program. In its report, the committee noted that the HTV-2 vehicle had not succeeded in its 2010 test flight, and that it was concerned about DOD’s intent to pursue a weaponized missile system, or any material development decision, before it had demonstrated that the technology is feasible. Moreover, the committee questioned DOD’s narrow focus on the Air Force CSM with the HTV-2 payload as the solution to the CPGS problem. It noted that DOD had provided briefings about “other potential conventional long-range strike capabilities that may be lower cost, carry less technical risk, and provide a capability sooner than CSM.”<sup>103</sup> As a result, the committee encouraged DOD to pursue “a broader examination of the tradespace of CPGS capabilities and concepts to meet warfighter requirements.” The Senate Armed Services Committee, in its version of the FY2012 Defense Authorization Bill, approved the Administration’s request for \$204.8 million for CPGS. The conference committee, however, adopted the House position, and authorized \$179.8 million the CPGS program. It also altered the allotments within the budget, providing \$61.8 million for hypersonic glide experiment and concepts development, the portion of the budget that supports the HTV-2, and \$91 million for the Alternate Re-Entry System, which supports the Army’s AHW program.

The House Appropriations Committee voted for a deep reduction in CPGS funding for FY2012, approving only \$104.8 million for the program. The committee’s report did not offer an explanation for the \$100 million reduction. The Senate Appropriations Committee appropriated the requested \$204.8 million. In the consolidated appropriations Act (H.R. 2055) for FY2012, Congress matched the Defense Authorization Act and appropriated \$179.8 million for CPGS. The conference report noted that the reduction of \$25 million was based on delays in the program caused by two failed HTV-2 flight tests. As a result, the conferees directed that the reduction in funding should not come from the AHW vehicle, which had a successful flight test in late 2011.

## **FY2013**

The Pentagon budget request for FY2013 included \$110.383 million for the CPGS program. Within this total, DOD requested \$49.5 million for hypersonic glide experiment and concepts development, \$42 million for the Alternate Re-Entry System, \$11 million for test range development, and \$7.9 million for studies. The House and Senate Armed Services Committees both approved this amount in their versions of the FY2013 Defense Authorization Bills (H.R. 4310 and S. 3254); this amount was included in the final version of the FY2013 Defense Authorization Act (P.L. 112-239). The House Armed Services Committee, in its report accompanying the bill (H.Rept. 112-479), also directed the Secretary of Defense to provide a report “detailing how the Department plans to use competition and integrate verification and transparency measures as it develops and deploys CPGS capabilities.”

The Senate Appropriations Committee, in its version of the FY2013 Defense Appropriations Bill, increased funding for the CPGS program from the requested \$110.383 million to \$200.383 million. In its report, the committee noted that the recommended an increase of \$90 million so

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<sup>103</sup> U.S. Congress, House Committee on Armed Services, *National Defense Authorization Act for Fiscal Year 2012*, 112<sup>th</sup> Cong., 1<sup>st</sup> sess., May 17, 2011, H.Rept. 112-78. p. 69.

that the Army could continue planning for and completing a second, longer-range flight test of AHW. Congress included this amount in the Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6), although, after sequestration, the final amount appropriated for FY2013 equaled \$176.4 million. Within this total, \$147.8 million was allocated to the Alternate Re-Entry System, or AHW, and only \$23 million was allocated to the HTV-2 hypersonic glide experiment and concepts development area.

## **FY2014**

The DOD budget request for FY2014 included \$65.4 million for “prompt global strike capability development.” Within this total, DOD allocated \$2 million to hypersonic glide experiment and concepts development, \$55 million to the Alternate Re-Entry System and warhead engineering, \$5 million to test range development, and \$3.4 million to studies.

A number of factors might account for both the reduction in the overall budget request and the striking shift away from the HTV-2 program area. First, the budget documents indicate that overall reductions in DOD spending have affected DOD’s ability to develop prompt global strike capabilities. Specifically, DOD states that “the level of resourcing ... reflects iterative reductions from efficiencies and budget reductions, which reduces the Department’s ability to develop flexible responsive solutions to emerging war fighter needs.”<sup>104</sup> The budget request also highlights a shift in defense priorities, noting that DOD now plans to focus, with higher priority, on “research and development of intermediate range concepts.”<sup>105</sup> This may be a reference to DOD’s interest, as noted in the January 2012 report on Defense Budget Priorities and Choices, in designing “a conventional prompt strike option from submarines.”<sup>106</sup> As was discussed above, this option could lead to the deployment of intermediate-range ballistic missiles on Virginia-class attack submarines.

Within the CPGS program, the shift in funding away from the hypersonic glide experiment and toward the Alternate Re-Entry System indicates that DOD plans to seek an alternative to the HTV-2 vehicle. Specifically, according to the budget documents, the Alternate Re-Entry System “sub-project will test and evaluate alternative booster and delivery vehicle options and will assess the feasibility of producing an affordable alternate solution to fill the CPGS capability gap.”<sup>107</sup>

Congress appropriated the requested funds, and maintained the requested division among program areas, in the FY2014 National Defense Authorization Act (P.L. 113-66). However, in its explanation of the bill, it requested that DOD submit a report addressing “the policy considerations concerning any potential ambiguity problems regarding the launch of a conventionally-armed missile from submarine platforms” and a description of the target sets that a submarine-launched missile could reach but that could not be reached by missiles from other platforms. It also requested that the report compare the costs of submarine-launched conventional missiles with the costs of those launched by other platforms. Congress included this provision

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<sup>104</sup> U.S. Department of Defense, *Fiscal Year (FY) 2014 President’s Budget Submission*, Research, Development, Test & Evaluation, Defense-Wide, Washington, DC, April 2013, pp. 3-581, [http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2014/budget\\_justification/pdf/03\\_RDT\\_and\\_E/DoD\\_Human\\_Resources\\_Activity\\_PB\\_2014.pdf](http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2014/budget_justification/pdf/03_RDT_and_E/DoD_Human_Resources_Activity_PB_2014.pdf).

<sup>105</sup> *Ibid.*, pp. 3-582.

<sup>106</sup> U.S. Department of Defense, *Defense Budget Priorities and Choices*, Washington, DC, January 2012, p. 5, [http://archive.defense.gov/news/Defense\\_Budget\\_Priorities.pdf](http://archive.defense.gov/news/Defense_Budget_Priorities.pdf).

<sup>107</sup> U.S. Department of Defense, *Fiscal Year (FY) 2014 President’s Budget Submission*, Research, Development, Test & Evaluation, Defense-Wide, Washington, DC, April 2013, pp. 3-590.

because DOD's renewed interest in the possible deployment of a sea-based CPGS capability restored concerns about possible ambiguity issues.

## **FY2015**

The DOD budget request for FY2015 includes \$70.8 million for Prompt Global Strike Capability Development. Within this total, DOD has allocated \$2 million to the HTV-2 program—the Hypersonic Glide Experiment and Conceptions Demonstration Support—line and \$65.2 million to the AHW—Alternate Re-Entry System/Warhead Engineering—line. The request also includes \$3.6 million for CPGS studies, but no additional funding for test range development. The House and Senate Armed Services Committees both approved this amount in their versions of the FY2015 National Defense Authorization Act, but Congress added \$25 million to the program's appropriation, for a total of \$95.6 million.

As in FY2014, the “level of resourcing” in the budget request reflects “reductions from efficiencies and budget reductions.” DOD notes that this “reduces the Department's ability to develop flexible responsive solutions” to meet CPGS requirements. At the same time, the FY2015 budget request follows the trend set in FY2013 and FY2014, with the reduced emphasis on the HTV-2 program and added funding flowing to the AHW glider program. Further, although this is not reflected in the budget request, during testimony, DOD officials have referred to the program as “conventional prompt strike,” dropping the emphasis on global. Taken together, these two changes demonstrate that DOD's focus may now be on developing an intermediate-range capability for the prompt strike mission.

## **FY2016**

The DOD budget request for FY2016 includes \$78.8 million for Prompt Global Strike Capability Development. Within this total, DOD has allocated \$2 million to the HTV-2 program—the Hypersonic Glide Experiment and Conceptions Demonstration Support—line and \$72.95 million to the AHW—Alternate Re-Entry System/Warhead Engineering—line. The request also includes \$2.9 million for CPGS studies and \$1 million for test range development. This request, along with the plans to move forward with the testing program for the AHW, further indicates that DOD has essentially concluded the HTV-2 program and is moving toward the development and deployment of a system using the AHW glider and an intermediate-range booster, possibly deployed at sea.

The House, in its version of the FY2016 National Defense Authorization Act (H.R. 1735), provided \$108.8 million for Prompt Global Strike Capability Development. It added \$15 million for Concept Development by the Army of a CPGS option and \$15 million for Concept Development by the Navy of a CPGS option. These additions were intended to support the program following testing complications in prior years. The House bill also contained a sense of the Congress statement noting that “the United States must continue to develop the conventional prompt global strike capability to strike high-value, time-sensitive, and defended targets from ranges outside of current conventional technology while addressing and preventing any risk of ambiguity.” It mandated that the Secretary of Defense submit a report by September 30, 2020, on the outcome of the military requirements process and Milestone A decision for at least one conventional prompt global strike weapons system.

The Senate, in its version of the NDAA (S. 1376), authorized \$88.8 million for this program area. In the report accompanying its bill (S.Rept. 114-49), the Senate Armed Services Committee noted that this funding was intended to support DOD's efforts to examine sea-based and ground-based concepts and to support the flight experiment scheduled for March 2017. The Senate bill also mandated that the Secretary of Defense make a Milestone A decision for the Conventional Prompt

Global Strike Weapons System no later than September 30, 2020, or eight months after the successful completion of a second intermediate-range flight test.

The conference report on H.R. 1735 adopts the Senate funding level, authorizing \$88.8 million for Prompt Global Strike Capability Development, with an added \$5 million allocated to Concept Development by the Navy and Concept Development by the Army. The report also adopts the House language with respect to requesting a report by September 30, 2020, on the outcome of the military requirements process and Milestone A decision for at least one conventional prompt global strike weapons system.

## **FY2017**

The DOD budget request for FY2017 included \$181.3 million for Prompt Global Strike Capability Development. Within this total, DOD allocated \$174 million to the AHW—Alternate Re-Entry System/Warhead Engineering—line. The request also included \$2 million for Hypersonic Glide Experiment and Concepts Demonstration Support, an activity that “supports both ground and flight tests” and provides data needed to support a potential acquisition program. The budget also includes \$3.3 million for CPGS studies and \$2 million for test range development. This request, along with the plans to move forward with the testing program for the AHW, further indicates that DOD is moving toward the development and deployment of a system using the AHW glider and an intermediate-range booster, possibly deployed at sea.

Congress approved the DOD request of \$181.3 million for Prompt Global Strike Capability Development in the National Defense Authorization Act for Fiscal Year 2017 (P.L. 114-328). It also mandated, in Section 1688, that the Secretary of Defense make a Milestone A decision for the program by September 30, 2020, or no later than eight months after the successful completion of the second intermediate-range flight test. The legislation also limits the funds available for the program to 75% of the authorized amount until Pentagon officials submit a report to Congress on whether there are warfighter requirements for a “limited operational conventional prompt strike capability” and whether the Pentagon’s plan and schedule for the CPGS program supports those requirements. These provisions reflect congressional concerns about the pace and direction of the CPGS program.

## **FY2018**

The DOD budget request for FY2018 included \$201.75 million for Prompt Global Strike Capability Development. Within this total, DOD allocated \$197.4 million to the AHW—Alternate Re-Entry System/Warhead Engineering—line. The request also includes \$1 million for Hypersonic Glide Experiment and Concepts Demonstration Support, an activity that “supports both ground and flight tests” and provides data needed to support a potential acquisition program. The budget also included \$3.3 million for CPGS studies. This request, along with the plans to move forward with the testing program for the AHW, further indicates that DOD is moving toward the development and deployment of a system using the AHW glider and an intermediate-range booster, possibly deployed at sea.

Congress approved the Administration’s request for \$201.75 million for Prompt Global Strike Capability Development in the FY2018 National Defense Authorization Act (P.L. 115-91). It also directed that the Secretary of Defense “plan to reach early operational capability for the conventional prompt strike weapon system by September 30, 2022.” The legislation also mandates that the Chairman of the Joint Chiefs of Staff submit a report to Congress that outlines “the estimated period for the delivery of a medium-range early operational capability, the required level of resources necessary to field a medium-range conventional prompt global strike weapon

within the United States (including the territories and possessions of the United States), or a similar sea-based system, and a detailed plan consistent with the urgency of the associated capability gap across multiple platforms.” The report should also provide a plan to address any “potential risks of ambiguity from the launch or employment of such a capability.”

In June 2018, the Pentagon submitted a reprogramming request to Congress that added \$159.5 million to the FY2018 budget for Prompt Global Strike Capability Development. According to the documents supporting the reprogramming request, \$40.0 million would increase production of the hypersonic glide vehicles and prototypes, possibly to five per year, to support the Navy’s CPS program; \$34.5 million would address the lack of autoclaves (high-temperature and pressure ovens) needed to produce the thermal protection systems for the CPS hypersonic glide vehicles; and \$20.0 million would improve the test and evaluation (T&E) infrastructure needed to support full-scale testing of the CPS system. The request also included \$65 million to support an accelerated demonstration of a new land-launched hypersonics capability. With this reprogramming request in place, funding for Prompt Global Strike Capability Development in FY2018 totaled \$374.9 million.<sup>108</sup>

## **FY2019**

The DOD budget request for FY2019 included \$278 million for the CPS program. This included \$263 million in defense-wide research and development account and \$15 million in Navy research and development accounts. Within the defense-wide account, DOD allocated the full \$263 million to the Alternate Re-Entry System/Warhead Engineering line. Moreover, as noted above, the defense-wide research and development account contains no funding for the program after FY2019, as the program is transitioning to the Navy’s research and development accounts in FY2020.

The budget documents indicated that, in FY2019, the program would focus on manufacturing and testing the booster and hypersonic glide body that will be used in the second Flight Experiment test and begin manufacturing and testing of the hypersonic glide body that will be used in the third test. It would also, among other tasks, “continue studies for future system development to examine cost, lethality, aerodynamic and thermal characteristics” and “conduct trade studies to evaluate system alternatives, affordability, and end-to-end system concepts.”

Congress, in the National Defense Authorization Act for FY2019 (P.L. 115-232), increased funding for Prompt Global Strike Capability Development to \$413.4 million, adding \$150 million to accelerate the program. This total represents an increase of 57% over the Administration’s request for FY2019, and an increase of 40% over the amount approved for FY2018 when the July 2018 reprogramming request is included in the total. Congress also increased funding for the program in the Department of Defense Appropriations Act, 2019 (P.L. 115-245), by \$186 million, to a total of \$466.9 million. The Senate Appropriations Committee had recommended an increase of \$345 million, to a total of \$615.9 million, within a total increase of \$928.6 million for the full scope of hypersonic programs. The committee noted in its report on the bill (S.Rept. 115-290) that DOD “is accelerating existing efforts in hypersonics to counter the progress made by near peer threats.” It indicated that the recommended increase in funding was to “to support hypersonics research and prototyping efforts.”

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<sup>108</sup> [https://comptroller.defense.gov/Portals/45/Documents/execution/reprogramming/fy2018/prior1415s/18-17\\_PA\\_June\\_2018\\_Omnibus.pdf](https://comptroller.defense.gov/Portals/45/Documents/execution/reprogramming/fy2018/prior1415s/18-17_PA_June_2018_Omnibus.pdf).

## **FY2020**

In FY2020, the Pentagon transferred DOD's Prompt Global Strike Capability Development program to the Navy, where the Conventional Prompt Strike (CPS) program is now funded through the Precision Strike Weapons Development Program. The Navy's budget request for CPS in FY2020 included \$593.1 million for this program, an increase of 27% over the \$466.9 million appropriated in FY2019. The budget documents indicate that the increase from FY2019 to FY2020 was "largely associated with the design, development, and experimentation of hypersonic subsystems including boosters, conventional warheads, thermal protection systems, guidance systems, payload modules, launch systems, fire control systems, support equipment, underwater launch facility updates, and hypersonic glide bodies." The documents also note that the Navy plans to conduct a second flight experiment in FY2020 and "to begin missile procurement to support prototyping activities and hypersonic glide bodies."

The House of Representatives, in its version of the FY2020 National Defense Authorization Act (H.R. 2500), reduced the request by \$80 million, noting that there was excess growth in the program. The House Appropriations Committee, in its version of the Department of Defense appropriations bill, 2020, also reduced the funding for the CPS program by \$183.7 million. The Senate Armed Services Committee, in its version of the FY2020 National Defense Authorization Act (S. 1790), funded the requested amount of \$593.1 million. Congress appropriated \$512.2 million for the Conventional Prompt Strike Program in FY2020, noting, as the House had done, that there was excess growth in the program.

## **FY2021**

The Navy has requested \$1.1 billion for the Conventional Prompt Strike program in FY2021, nearly doubling the amount appropriated for FY2020. According to the Navy's budget documents, the increase in funding for FY2021 "provides for platform integration and development efforts, procurement of prototype C-HGBs (common hypersonic glide bodies), [and] the increased development and procurement of missiles/missile body flight articles." The funding will also support additional launch testing and increased efforts associated "with the design, development, and experimentation of hypersonic subsystems." The documents indicate that the Navy still planned to conduct a second experimental flight test of the system in FY2020 and the first development flight test in FY2022. It expects to begin deployment of the system in FY2028.

Congress authorized \$1.03 billion for the Conventional Prompt Strike program in the National Defense Authorization Act for 2021 (H.R. 6395). It also included a requirement (§1671) for the Chairman of the Joint Chiefs of Staff, in coordination with the Undersecretary of Defense for Policy, to submit a report to Congress on strategic hypersonic weapons. The report should address a number of issues, including "a discussion of the authority and policy processes to use hypersonic weapons and" how such authorities would be delegated to the combatant commands or military chiefs; how DOD will address escalation risks associated with the use of hypersonic weapons, including an "analysis of the escalation risks posed by foreign hypersonic systems that are potentially nuclear and conventional dual-use capable weapons"; the potential targets for U.S. strategic hypersonic weapons; the process DOD would use to "establish targeting and release authority for conventional prompt strike hypersonic weapons"; and the required force structure and basing plans for U.S. strategic hypersonic weapons. The legislation also mandates that the Secretary of the Army and the Secretary of the Navy submit a report to Congress that outlines the total costs for their respective long-range hypersonic programs and the testing strategy and schedule for those programs.

## Issues for Congress

### Assessing the Rationale for CPGS

#### The Need for Prompt Response

The original prompt global strike mission requirements were based on the assumption that a future conflict would take place far from existing U.S. bases overseas, and possibly far from ocean areas where the United States had deployed most of its sea-based forces. It was also assumed that a future conflict could develop quickly, allowing too little time for the United States to move its forces into the region, either by acquiring basing rights on land or by moving sea-based forces closer to the theater of conflict. Further, the concern about hidden or relocatable targets reflected an assumption that targets could appear with little notice and remain vulnerable for a short period of time, factors that placed a premium on the ability to launch quickly and arrive on target quickly. The requirements also assumed that U.S. forces were likely to face an “anti-access” threat, or air defense capabilities that would impede operations by U.S. aircraft.

Many of these characteristics were present in Afghanistan in 2001, when the United States attacked al Qaeda training camps and the Taliban government after the September 11 terrorist attacks. The attacks on the United States came without warning, and, although the United States took several weeks to plan its response and acquire the needed intelligence information on target areas, speed was of the essence if the United States hoped to trap and destroy leaders at the training camps in Afghanistan. The United States had no military bases in the region and had to take the time to acquire basing rights in nearby nations and to move U.S. naval forces into the region. Further, the mountainous terrain offered the enemy areas where their leadership could hide and hope to evade attack.

However, these characteristics may not be present in most, or even many, future conflicts. Moreover, with the renewed focus, in the 2018 National Security Strategy and National Defense Strategy, on great power conflict, the United States may be less likely to face a sudden, unanticipated conflict, with no time to build up its forces and with the requirement to strike some targets within hours of the start of the conflict. And, as the threat environment has changed, the rationale for the deployment of prompt long-range strike and hypersonic weapons has also changed.

#### Evolving Rationale

When the Bush Administration first began to consider the deployment of long-range ballistic missiles with conventional warheads, some analysts argued that, with improvements in accuracy, conventional warheads could substitute for nuclear warheads in attacking some sites now targeted by nuclear weapons. This type of “substitution” would have allowed the United States to reduce its reliance on nuclear weapons and to reduce the number of nuclear weapons in its deployed forces. Critics of this rationale, however, noted that conventional weapons could not really substitute for nuclear weapons in U.S. deterrence strategy. Even if they had the accuracy and explosive power needed to destroy some types of targets, they could not threaten the scale of destruction and would not have the psychological effects of nuclear weapons. Most experts agree that these characteristics are necessary for the weapons to deter conflicts with other nuclear-armed nations.

As a result, most of the supporters of the prompt strike mission came to view these weapons as a “niche” capability that would expand U.S. conventional options and reduce the likelihood that the

President might need to use a nuclear weapon in the absence of a conventional alternative. With this rationale, the United States might only need a very small number of these weapons, for use against critical, high-value targets or as the “leading edge” of a broader military campaign. Moreover, the United States could plan for their use independent of its nuclear deterrent. The programs’ advocates noted that, in the absence of such a capability, in a circumstance when the United States believed it needed to strike promptly at long ranges at the beginning of a conflict, the President might have no choice other than to use a missile armed with a nuclear warhead. The CPGS capability would provide that choice. In the 2010 Nuclear Posture Review, the Obama Administration extended this logic to regional deterrence and the assurance of U.S. allies. If the United States had a wider range of credible conventional weapons that it could turn to when defending its allies and forces overseas, there could be fewer circumstances in which the United States might feel compelled to resort to nuclear weapons for regional deterrence. This would not only reduce the role of nuclear weapons in regional deterrence, it might also increase the credibility of the U.S. deterrent.

During the latter years of the Obama Administration and early in the Trump Administration, the United States expanded the scope of its research and development programs into hypersonic capabilities, and now seems interested in deploying hypersonic glide vehicles on more types of delivery systems. These changes are consistent with an expanded rationale for long-range conventional strike weapons, in general, and hypersonic weapons, in particular. As potential adversaries, such as Russia and China, have improved and expanded their defensive capabilities in ways that would complicate U.S. efforts to bring forces to bear during a conflict, the United States has sought to counter with prompt, accurate systems that could suppress those defenses by attacking them early in a conflict. Hypersonic weapons, with their speed, precision, and maneuverability, could contribute to this mission. In this role, prompt strike and hypersonic weapons would no longer serve as a “niche” or “leading edge” capability. According to Michael Griffin, the Under Secretary of Defense for Research and Engineering, these weapons would serve as tactical, rather than strategic assets, bringing capabilities such as “very quick response, high speed, highly maneuverable, difficult to find and track and kill” to theater conflicts or regional conflicts.<sup>109</sup>

As the CPGS program has evolved in the past 15 years, and as the United States has placed a higher priority on long-range strike and hypersonic weapons in recent years, analysts have questioned the shifting and expanding rationale for the programs. For example, some questioned whether the President would need more conventional options to avoid the use of nuclear weapons when responding to threats to U.S. or allied security. The President has never, in the past, been faced with the choice of using a nuclear weapon or no weapon at all. The President has always had a wide range of conventional options, even if the United States had to wait hours or days for the weapons to arrive on target.

Many analysts also argued that the deployment of CPGS might upset strategic stability and increase the likelihood of nuclear war. Although the U.S. President might choose to initiate a conflict or respond to a threat with a conventional attack, it is not clear that the adversary would know that the incoming weapons carried conventional warheads. Moreover, the United States would not be able to control the adversary’s reaction or the escalation of the conflict, particularly if the adversary possessed nuclear weapons. Hence, by making the start of the war “easier,” the

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<sup>109</sup> Aaron Mehta, “Three Thoughts on Hypersonic Weapons from the Pentagon’s Technology Chief,” *Defense News*, July 16, 2018, [https://www.defensenews.com/air/2018/07/16/3-thoughts-on-hypersonic-weapons-from-the-pentagons-technology-chief/?utm\\_source=Sailthru&utm\\_medium=email&utm\\_campaign=ebb%207/17/18&utm\\_term=Editorial%20-%20Early%20Bird%20Brief](https://www.defensenews.com/air/2018/07/16/3-thoughts-on-hypersonic-weapons-from-the-pentagons-technology-chief/?utm_source=Sailthru&utm_medium=email&utm_campaign=ebb%207/17/18&utm_term=Editorial%20-%20Early%20Bird%20Brief).

deployment of conventional warheads on long-range ballistic missiles might, in this view, actually make the eventual use of nuclear weapons more likely.

Some have also noted that this concern would be amplified if the United States were to deploy hypersonic weapons on a wider range of delivery vehicles and develop plans to use them in theater or regional conflicts. Even if the adversary recognized that the U.S. weapons did not carry nuclear warheads, the shortened time lines for attacks and responses could be destabilizing. Because the weapons could be launched and reach their targets quickly, they would shorten the amount of time available to an adversary both for detecting and responding to an attack. But pressure to respond promptly, possibly in response to ambiguous information and before countervailing capabilities were destroyed in an attack, could lead to inadvertent or unnecessary escalation during a crisis.

Russian officials have echoed these concerns about U.S. conventional prompt global strike capabilities and their implications for strategic stability.<sup>110</sup> They have argued that these weapons, even if armed with conventional warheads, could threaten critical targets in Russia and even threaten Russia's strategic nuclear forces if the United States deployed large numbers of missiles armed with highly accurate reentry vehicles. This might provide the United States with the capability to undermine Russia's nuclear deterrent, without resorting to the first use of nuclear weapons, and might actually increase the likelihood of a U.S. attack against Russia. Moreover, even if Russia were not the target of an attack with these missiles, it might not know whether the missile carried a nuclear warhead or a conventional warhead, or whether it was headed toward a target in Russia. Finally, some Russians have argued that the United States might replace the conventional warheads with nuclear warheads to exceed the limits in a treaty.<sup>111</sup>

## **The Potential for Misunderstanding a CPGS Missile Launch**

Some Members of Congress and many analysts outside government have focused much of their criticism of the PGS concept on the potential that other nations might detect the launch of a U.S. CPGS missile and conclude, mistakenly, that the United States had launched an attack with nuclear-armed missiles. Specifically, some argued that, if the United States were to launch these missiles during a conflict, nations with minimal satellite capabilities and launch notification systems (such as China) or degraded launch notification systems (such as Russia) could conclude that they were under attack with nuclear missiles.<sup>112</sup> Further, because many possible targets lie south of Russia and China, and the United States has historically planned to launch its ballistic missiles over the North Pole, a conventionally armed long-range ballistic missile might fly over these two nations to strike its targets. For many minutes during their flight patterns, these missiles might appear to be headed toward targets in these nations. The potential for misunderstanding is compounded by the short time of flight of these missiles, giving these nations little time to evaluate the event, assess the threat, and respond with their own forces. Under such circumstances, critics claim that these nations may conclude they have no other option than to respond with their own nuclear weapons.

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<sup>110</sup> Elaine M. Grossman, "Russian Experts Question Role of Conventional "Prompt Global Strike" Weapons," *Global Security Newswire*, April 7, 2009.

<sup>111</sup> For a detailed discussion of stability concerns associated with CPGS, and a review of Russian and Chinese objections to the program, see James M. Acton, *Silver Bullet? Asking the Right Questions About Conventional Prompt Global Strike* (Washington, DC: Carnegie Endowment for International Peace, 2013), pp. 111-126.

<sup>112</sup> For a description of ongoing problems with Russia's early warning system for ballistic missile attack, see Mosher, David E. et al., *Beyond the Nuclear Shadow: A Phased Approach for Improving Nuclear Safety and U.S.-Russian Relations*, RAND Corporation, 2003. p. 5.

As was noted above, Congress raised concerns about the potential for misunderstanding in several of its annual debates over the authorization and appropriations of funds for the CPGS mission. These concerns grew as the Department of Defense planned to move ahead with the conventional Trident modification (CTM). In response to these concerns, in the FY2007 Defense Appropriations Act (P.L. 109-289), Congress provided \$5 million for the National Academy of Sciences to analyze the mission requirement and recommend alternatives.

The National Academies published the report—*U.S. Conventional Prompt Global Strike: Issues for 2008 and Beyond*—in August 2008. This report recognized concerns about the potential for misunderstanding, but concluded that these concerns should not eliminate pursuit of the program. The study noted that the United States and Russia had monitored and tracked the launches of hundreds of ballistic missiles over the years, and they had demonstrated the capability to “acquire sufficient data to determine their trajectory and hence ... their target.”<sup>113</sup>

At the same time, however, the study noted that the risk of misunderstanding could increase if the United States used boost-glide technologies for the CPGS mission, because a nation’s ability to predict the target of such a system would be undermined by the fact that these systems could maneuver and change their direction after launch. Moreover, the study noted that the use of new, conventional-only launchers or delivery vehicles would not necessarily mitigate the risks because “there is simply no ‘bright line’ between nuclear and conventional systems when relatively long-range platforms are being considered.”<sup>114</sup>

## **Mitigating the Risks**

The National Academies study noted that concerns about the possible misinterpretation of a launch were, at the present time, limited to Russia, because no other nuclear weapons state had the ability to detect and track the launch of U.S. ballistic missiles.<sup>115</sup> As a result, the United States might be able to mitigate the risks of misunderstanding by altering the deployment and operating patterns of systems armed with conventional warheads, and by cooperating with Russia to demonstrate that these systems do not carry nuclear warheads.

For example, the Air Force indicated during its early studies that it could deploy long-range missiles armed with conventional warheads at bases, such as Vandenberg Air Force Base on the California coast, that did not house missiles armed with nuclear weapons and “have no nuclear capability or association,”<sup>116</sup> as they would lack the facilities and equipment needed to handle or store nuclear weapons. Further, their deployment with a hypersonic reentry body, rather than a standard postboost vehicle and warhead present on a nuclear-armed missile, would reinforce this designation.<sup>117</sup> The United States and Russia could also institute a number of cooperative measures, including military-to-military contacts, high-level political consultations, and ongoing discussions to keep Russia informed about U.S. plans for these missiles and to make them aware of the observable differences between conventional and nuclear-armed long-range ballistic missiles.<sup>118</sup> The United States could also provide Russia with prior notification of planned launches of ballistic missiles with conventional warheads, or the two nations could set up a

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<sup>113</sup> National Research Council of the National Academies, *U.S. Conventional Prompt Global Strike: Issues for 2008 and Beyond*, Washington, DC, August 2008, p. 72.

<sup>114</sup> *Ibid.*, p. 72.

<sup>115</sup> *Ibid.*, p. 75.

<sup>116</sup> Report to Congress on the “Concept of Operations” for the Common Aero Vehicle. Submitted in response to Congressional Reporting Requirements, by Peter B. Teets, Under Secretary of the Air Force. February 24, 2004. p. 4.

<sup>117</sup> Air Force Space Command, Common Aero Vehicle White Paper, p. 8.

<sup>118</sup> *Ibid.*, p. 7.

dedicated “hot line” for use after a launch. That way, the United States could inform Russia of the launch and assure it that the missile did not carry a nuclear warhead and was not headed for targets in Russia. Over time, these measures would not only provide information about the missiles and their missions, but might also build confidence and understanding between the parties. The increased level of cooperation, and possibly decreased level of suspicion, might then reduce the likelihood of misinterpretation if the United States were to launch ballistic missiles with conventional warheads.

The Air Force also indicated that the CSM, which would have used a conventional booster and a hypersonic payload delivery vehicle, would not follow the same trajectory as a nuclear-armed ballistic missile. Specifically, the Air Force planned to launch the CSM on a “depressed trajectory” that would achieve an altitude of only 500,000 feet. As a result, its flight would not resemble the trajectories that would be followed by nuclear-armed ballistic missiles on course for targets in Russia or China.<sup>119</sup>

DOD has indicated that the same would be true of a submarine-launched, intermediate-range boost-glide system. It would follow a shaped or depressed trajectory, and would not resemble the launch characteristics or trajectory of a nuclear-armed ballistic missile. Moreover, if the missile used a new booster, rather than one that had been deployed as a part of the U.S. nuclear force, the difference would likely be evident to Russia’s early warning systems.

## **Remaining Concerns**

Taken together, these types of measures might help reduce the risks of misunderstandings. But the accumulation of information during peacetime and frequent communications during crises may not be sufficient to address problems that could come up in an atmosphere of confusion and incomplete information during a conflict. Specifically, the argument in favor of using long-range ballistic missiles for the PGS mission assumes that the United States might have little warning before the start of a conflict and might need to launch its missiles promptly at that time. This scenario would allow little time for the United States to consult with other nations or inform them about its intentions. If other nations are caught by surprise and fear they might be under nuclear attack, they might also decide to respond promptly, before the United States had the opportunity to convince them that the missiles carried conventional warheads.

Even though routine data exchanges and on-site inspections may provide confidence in the absence of nuclear warheads on the missiles on a day-to-day basis in peacetime, they cannot provide assurances that the warheads could not be changed in a relatively short period of time or that the warheads were not actually changed in the days or weeks since the last inspection. In addition, changing the basing patterns or launch patterns of missiles to draw a sharper distinction between conventional and nuclear-armed missiles assumes both that other nations can observe the differences and that they believe the different appearances indicate different warheads. Finally, these measures would do nothing to alleviate concerns among nations that did not participate in the cooperative programs.

As a result, while the measures described above can reduce the possibility of misunderstandings, they probably cannot eliminate them. Moreover, they cannot address concerns, often expressed by officials in Russia and China, that the United States might use these weapons, along with other conventional strike systems and missile defenses, to acquire the ability to attack strategic or nuclear targets in these nations without resorting to the use of U.S. nuclear weapons.

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<sup>119</sup> Air Force Space Command, Common Aero Vehicle White Paper, p. 11.

## Reviewing the Alternatives

As the preceding discussion indicates, the United States has considered a number of alternatives for weapons systems that could contribute to the PGS mission. For a time, the Air Force CSM, armed with a payload delivery vehicle derived from either the DARPA/Air Force HTV-2 vehicle or the Army AHW vehicle, appeared to be the main contender for this mission. However, because the HTV-2 failed during two test flights and the AHW, which has tested successfully, may be better suited to an intermediate-range system, a submarine-launched missile armed with the AHW is now the planned platform for the Navy Conventional Prompt Strike program. At the same time, the Pentagon is pursuing a number of other options for precision conventional strike weapons, particularly if a system with shorter range or longer delivery times can meet some of the requirements. Cruise missiles and ballistic missiles with conventional warheads might meet some of the requirements. Moreover, as was noted above, the Army, Navy, and Air Force are now working together to develop and deploy hypersonic capabilities by the early 2020s.

## Land-Based Ballistic Missiles

Long-range land-based ballistic missiles armed with conventional warheads, even if they relied on standard ballistic missile reentry bodies instead of boost-glide technologies, would likely possess many of the operational strengths associated with nuclear-armed ballistic missiles. They might have extremely high rates of readiness and reliability, allowing military planners to expect more than 90% of the missiles to be available for use at any given time; they could likely respond promptly after a decision to launch; and, when armed with a hypersonic payload delivery vehicle, they would likely have a high degree of accuracy allowing for attacks across a wide range of targets. Consequently, these systems would “free the U.S. military from reliance on forward basing and enable it to react promptly and decisively to destabilizing or threatening actions by hostile countries and terrorist organizations.”<sup>120</sup> These weapons would probably address all the potential circumstances cited in requirements for the PGS mission.

However, as is noted above, many analysts have expressed concerns about the possibility that the launch of these missiles could generate misunderstandings within other nuclear-armed nations and undermine strategic stability because they would follow the same ballistic missile trajectories as U.S. nuclear-armed missiles. Even if the United States based and operated these missiles differently from nuclear-armed missiles and cooperated with other nations to demonstrate that these missiles did not carry nuclear warheads, other nations, such as Russia or China, could still question whether the missiles launched during a conflict carried conventional warheads or whether the United States had converted them back to carry nuclear warheads.

Medium- or intermediate-range ballistic missiles, possibly deployed outside the United States, could also provide a prompt, long-range strike capability for regional conflicts. This type of missile could carry either unguided warheads or a hypersonic glide vehicle like the AHW. Because an intermediate-range missile would be launched from outside the continental United States, its trajectory would not resemble that of a land-based ICBM, and, therefore, could address concerns about the misunderstandings and misperceptions.

If the missiles had a range of less than 5,500 kilometers, they would be inconsistent with the limits in the 1987 Intermediate-Range Nuclear Forces Treaty. However, the United States has

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<sup>120</sup> DARPA, “FALCON (Force Application and Launch from CONUS Technology Demonstration Program,” Fact Sheet, November 2003.

recently withdrawn from the INF Treaty in response to Russia's violation of the agreement.<sup>121</sup> Congress has supported the development of a new land-based intermediate-range missile as a part of the U.S. response to Russia's violation. The National Defense Authorization Act for FY2018 (P.L. 115-91) mandated that the DOD "establish a program of record to develop a conventional road-mobile ground-launched cruise missile system with a range of between 500 to 5,500 kilometers, including research and development activities with respect to such cruise missile system." As noted above, when DOD submitted a reprogramming request to Congress in July 2018, it included \$65 million to support an accelerated demonstration of a new land-launched hypersonic capability. It noted in the request that the funding for this program would total \$170 million in FY2018 and FY2019.

## **Submarine-Launched Ballistic Missiles**

As noted above, the United States considered deploying conventional warheads on long-range Trident ballistic missiles, carried by its Ohio-class submarines. Submarine-launched ballistic missiles armed with conventional warheads could have many of the same benefits as land-based missiles. As nuclear delivery vehicles, they have been deployed with the command and control systems needed to allow for prompt decisionmaking and prompt launch during a crisis. They have the range to reach targets around the world and they could have the accuracy, particularly if armed with hypersonic payload delivery vehicles, to attack a wide range of targets on short notice.

SLBMs armed with conventional warheads, however, would also raise many of the same questions about misunderstandings as land-based ballistic missiles, particularly if these warheads were deployed on the same submarines that currently carry nuclear warheads. The Navy could not employ many of the techniques identified by the Air Force to convince potential adversaries that the missiles carried conventional warheads. Even if the United States did deploy SLBMs with conventional warheads on submarines that did not carry nuclear warheads, it would be extremely difficult to demonstrate these differences and assure other nations of the segregated deployments in a submarine that is intended to be hidden and invulnerable when at sea. Further, according to some reports, Russia's ability to monitor U.S. SLBM launches might be even more degraded than its ability to monitor ICBM launches, so it might conclude that it is under nuclear attack if it observed an SLBM launch from a U.S. ballistic missile submarine.

On the other hand, because the submarines are mobile and the missiles are long-range, the United States could alter the patrol areas for Trident submarines so that, if they were to launch their conventional missiles, they could use trajectories that did not require them to fly over these nations on their way to their intended targets. Alternatively, the submarines could move prior to launching their missiles, to avoid overflight of Russia or China, but this presumes that the United States had the time to move its submarines to these new launch points prior to the start of the conflict, a possibility that is inconsistent with the PGS mission's assumption that the United States could need to launch its missiles promptly at the start of an unexpected conflict.

## **Long-Range Bombers**

U.S. bombers—B-52s, B-2s, and B-1s—have the range and payload needed to deliver weapons to targets across the globe. But, initially, they were not considered to be suited to the PGS mission

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<sup>121</sup> See CRS Insight IN10985, *U.S. Withdrawal from the INF Treaty*, by Amy F. Woolf. The United States first assessed that Russia had developed an INF-range ground launched cruise missile in 2013; Russia has denied the allegation. For details, see CRS Report R43832, *Russian Compliance with the Intermediate Range Nuclear Forces (INF) Treaty: Background and Issues for Congress*, by Amy F. Woolf.

because they could take hours or days to reach targets in remote areas, and they would require tanker support to refuel during their missions. The long flight time could contribute to crew fatigue, and air defenses could deny the bombers access to some critical target areas. The long flight time could also provide adversaries with warning of the impending attack.

Conventional cruise missiles, like the JAASM-ER (Joint Air-to-Surface Standoff Missile, extended range) delivered by B-52 bombers would allow the aircraft to stay out of the range of some air-defense systems, but they could still take too long to reach their targets to meet the objectives of the PGS mission. On the other hand, the long flight duration could give the United States time to review and resolve the situation without resorting to military attacks. Moreover, because accurate and timely intelligence reports are critical to the success of long-range strike missions, the United States could use the time during the bombers' flights to acquire and update information on the target of the attack.

The Air Force could also launch shorter-range missiles armed with hypersonic-glide vehicles from its bombers, both to improve the ability to penetrate air defenses and to reduce the amount of time needed to reach a target from a stand-off bomber.<sup>122</sup> The Air Force planned to deploy the first of these systems—known as the Hypersonic Conventional Strike Weapon (HCSW/Hacksaw)—by 2022, but it eliminated funding for this system in its FY2021 budget request. According to the Air Force, the HCSW would have been a solid-rocket-powered GPS-guided system that would employ a version of the AHW hypersonic glider and launch off a B-52 bomber. In April 2019, the Air Force had awarded a \$928 million contract to Lockheed Martin to design, develop, and test this system.<sup>123</sup>

The Air Force is also pursuing a program, known as the Tactical Boost Glide (TBG) system, employing a glider similar to the CAV/HTV-2 and launching on a modified version of the Army's Tactical Missile System (ATacMS). Moreover, in August 2018, the Air Force awarded a second contract to Lockheed Martin—valued at up to \$480 million—to develop a follow-on prototype for this type of hypersonic glider. This program, known as the air-launched, rapid-response weapon (ARRW), would enter the force later in the 2020s.

## **Tomahawk Cruise Missiles**

At the present time, the Navy has the capability to attack targets at ranges of around 1,500 nautical miles with sea-based cruise missiles. These Tomahawk missiles have been employed often in the conflicts in the past 20 years, providing the United States with the ability to reach targets without risking aircraft or their crews. The Navy has modified four of its Trident ballistic missile submarines so that they can carry cruise missiles. These submarines are equipped to carry up to 7 Tomahawk missiles each in up to 22 (out of 24) of their Trident launch tubes, for a total of 154 cruise missiles per submarine. But these missiles may be limited in their ability to contribute to the PGS mission. With a maximum speed of about 550 miles per hour and a range of 1,500 nautical miles, they can take two to three hours to reach their targets. Moreover, their reach is limited, even if the ships or submarines carrying the missiles are deployed in the region of the

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<sup>122</sup> For a description of these programs, and their funding profiles, see CRS Report R45811, *Hypersonic Weapons: Background and Issues for Congress*, by Kelley M. Saylor.

<sup>123</sup> Corey Dickstein, "Military Services to Work Together to Speed Hypersonic Weapon Development," *Stars and Stripes*, July 25, 2018, [https://www.stripes.com/news/military-services-to-work-together-to-speed-hypersonic-weapon-development-1.539431?utm\\_source=Sailthru&utm\\_medium=email&utm\\_campaign=ebb%2026.07.18&utm\\_term=Editorial%20-%20Early%20Bird%20Brief](https://www.stripes.com/news/military-services-to-work-together-to-speed-hypersonic-weapon-development-1.539431?utm_source=Sailthru&utm_medium=email&utm_campaign=ebb%2026.07.18&utm_term=Editorial%20-%20Early%20Bird%20Brief).

conflict. Consequently, the Navy has also explored alternatives that would allow it to reach its potential targets more quickly.

## **Hypersonic Cruise Missiles**

Since the mid-1990s, the Navy has explored several options for the development and deployment of an attack missile that could travel at speeds of Mach 3 to Mach 5.<sup>124</sup> These hypersonic missiles would allow the Navy to attack targets within 15 minutes from ships or submarines based within 500 to 600 nautical miles of their targets. Hence, they would provide the capability for prompt strikes within the theater of operations, but they would not have the range sought for the PGS mission. The United States would either need to keep its vessels on station near potential areas of conflict, which it already does in certain areas, or it would need days or weeks to move its ships or submarines into place.

## **Scramjet Technologies**

The Air Force, in collaboration with DARPA, NASA, and the Navy, is developing scramjet—supersonic combustion ramjet—technologies that may contribute to the long-range strike mission in the future. In this type of vehicle, the engine gets the oxygen it needs for combustion from the atmosphere passing through the vehicle, instead of from a tank onboard. This eliminates the need for heavy reservoir oxygen tanks, and makes the vehicle far smaller, lighter, and faster than a conventional rocket. According to NASA, a scramjet could, theoretically, travel at 15 times the speed of sound.<sup>125</sup> The scramjet would destroy targets by crashing into them at hypersonic speeds. However, the Air Force may also use the technology to create a payload delivery vehicle that might carry conventional munitions and be launched on a long-range missile.<sup>126</sup>

The Air Force has designed an experimental scramjet, the X-51 WaveRider, that it can release from an Air Force bomber. It conducted a flight test of this vehicle on May 26, 2010. In this test, the vehicle was released at an altitude of 50,000 feet, from under the wing of a B-52 bomber.<sup>127</sup> An Army tactical missile solid rocket booster accelerated the X-51 to a speed of approximately Mach 4.8, the speed required for the engine to ignite. The Air Force had intended for the scramjet to fly 300 seconds and reach speeds of 4,500 miles per hour, or six times the speed of sound.<sup>128</sup> However, the vehicle did not reach either of those thresholds before it began to slow down. Reports indicated that the engine was flying normally when the vehicle started having control problems and was eventually terminated.<sup>129</sup>

The Air Force conducted three additional tests of the X-51A WaveRider. In the 2011 test, a mechanical problem caused it to end its operations earlier than planned. In the 2012 test, the system lost control due to a “faulty control fin” seconds after it the rocket booster ignited.

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<sup>124</sup> For a summary of these programs see Statement of Ronald O’Rourke, Specialist in National Defense, Congressional Research Service, before the House Armed Services Committee, Subcommittee on Projection Forces, Hearing on Long-Range Strike Options, March 3, 2004. pp. 10-11.

<sup>125</sup> [http://www.nasa.gov/missions/research/f\\_scramjets.html](http://www.nasa.gov/missions/research/f_scramjets.html).

<sup>126</sup> Boeing, “Boeing X-51A WaveRider Breaks Record in 1<sup>st</sup> Flight,” Information Sheet, <http://www.boeing.mediaroom.com>, May 26, 2010.

<sup>127</sup> Boeing, “Boeing, Air Force Research Lab, Pratt & Whitney Rocketdyne to Conduct X-51A WaveRider Flight Test on May 25,” Information Sheet, <http://www.boeing.mediaroom.com>, May 20, 2010.

<sup>128</sup> *Ibid.*

<sup>129</sup> “Early Waverider Findings,” *Aviation Week and Space Technology*, June 7, 2010.

However, in a fourth and final test of the X-51A in May 2013, the WaveRider reached a speed of Mach 5.1 and an altitude of 80,000 feet during its 300-second test flight.

DARPA and the Air Force continue to pursue the development of scramjet technologies and air-breathing hypersonic capabilities. Air Force research funding has increased from a level of around \$80 million in FY2012 to a request for \$292 million in FY2018 and \$258 million in FY2019.<sup>130</sup> The research is focusing on the development of hypersonic cruise missiles that could be launched from fighters and bombers, including a program known as the hypersonic air-breathing weapon concept, and one known as tactical boost glide program.

This technology remains in its early stages, and could not contribute to the PGS mission for several years. However, because these vehicles would not leave the atmosphere or fly on a ballistic missile trajectory, they may address the nuclear ambiguity issues raised by long-range ballistic missiles in the CPGS program.

## Arms Control Issues

In April 2010, the United States and Russia signed a new strategic arms reduction treaty, known as New START.<sup>131</sup> During the negotiations on New START, Russia voiced concerns about U.S. plans to deploy conventional warheads on ballistic missiles that now carry nuclear warheads. As was noted above, Russia believes these weapons would undermine strategic stability and increase the risk of nuclear war. The Obama Administration responded to Russia's concerns by noting the United States did not plan to target its PGS systems against Russia and that the United States would not deploy enough of these weapons to threaten Russia's strategic deterrent. Nevertheless, the preamble to the treaty states that the parties are "mindful of the impact of conventionally armed ICBMs and SLBMs on strategic stability." However, according to the Obama Administration, neither this statement nor any other provisions in the treaty will "in any way limit or constrain research, development, testing, and evaluation (RDT&E) of any strategic concepts or systems, including prompt global strike capabilities."<sup>132</sup>

During the negotiations on New START, Russia initially sought to ban the deployment of conventional warheads on strategic ballistic missiles. The United States rejected this proposal because it would have interfered with ongoing U.S. plans and programs for the CPGS mission. As Rose Gottemoeller, the Assistant Secretary of State for Arms Control, Verification and Compliance, noted when she testified before the Senate Foreign Relations Committee, "We were firm during the negotiations that the treaty must allow for strategic missiles [of] conventional configuration."<sup>133</sup> At the same time, however, the United States agreed that ballistic missiles armed with conventional warheads that were otherwise consistent with the treaty's definition of strategic ballistic missiles would count against the treaty's limits on deployed delivery vehicles.

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<sup>130</sup> Vivienne Machi, "Future Weapons: Rivals Push Pentagon to Boost Funding for Hypersonics Research," *National Defense*, June 26, 2017.

<sup>131</sup> For details on the limits and restrictions in this Treaty see CRS Report R41219, *The New START Treaty: Central Limits and Key Provisions*, by Amy F. Woolf.

<sup>132</sup> U.S. Congress, Senate Committee on Foreign Relations, *Treaty With Russia on Measures for Further Reduction and Limitation of Strategic Offensive Arms (the New START Treaty)*, 111<sup>th</sup> Cong., 2<sup>nd</sup> sess., October 1, 2010, Exec Rpt. 111-6, p. 56. See, also, U.S. State Department, Bureau of Verification, Compliance, and Implementation, *Conventional Prompt Global Strike*, Fact Sheet, Washington, DC, April 8, 2010, <http://www.state.gov/t/vci/rls/139913.htm>.

<sup>133</sup> U.S. Congress, Senate Committee on Foreign Relations, *Treaty With Russia on Measures for Further Reduction and Limitation of Strategic Offensive Arms (the New START Treaty)*, 111<sup>th</sup> Cong., 2<sup>nd</sup> sess., October 1, 2010, Exec Rpt. 111-6, pp. 51-52.

The warheads deployed on these missiles would similarly count against the treaty's limits on deployed warheads.<sup>134</sup>

Hence, under New START, U.S. land-based ballistic missiles armed with conventional warheads would count under the limits in New START if, according to paragraph 6 of Part One of the Treaty Protocol, the missile "has a ballistic trajectory over most of its flight path" and a range greater than 5,500 kilometers. Submarine-launched ballistic missiles would meet this criteria if they traveled on a ballistic trajectory for most of their flight path and had a range greater than 600 kilometers. Obama Administration officials explained that the United States accepted this provision because it would be nearly impossible to distinguish between a missile armed with nuclear warheads and one armed with conventional warheads, and, therefore, extremely difficult to verify compliance with the treaty limits if the missiles with conventional warheads did not count.

Moreover, the Obama Administration insisted that, although the United States might have to reduce its number of nuclear warheads if it deployed conventional warheads on ballistic missiles that met this definition, the treaty's limits were high enough to "accommodate the level of CPGS deployments that is foreseeable over the lifetime of the treaty." In response to a question posed by the Senate Foreign Relations Committee, Secretary of Defense Gates stated that

as envisaged by our military planners, the number of such conventionally armed delivery vehicles and the warheads they carry would be very small when measured against the overall levels of strategic delivery systems and strategic warheads. Should we decide to deploy them, counting this small number of conventional strategic systems and their warheads toward the treaty limits will not prevent the United States from maintaining a robust nuclear deterrent.<sup>135</sup>

According to Obama Administration officials, the New START Treaty, would, therefore, count the warheads deployed on CPGS systems, like the Navy's conventional Trident modification, that delivered reentry vehicles along a ballistic missile trajectory. It would not, however, capture warheads deployed on boost-glide systems, like the Air Force's conventional strike missile, that launched along a depressed trajectory and used a hypersonic glide vehicle to deliver weapons to targets. In testimony before the Senate Foreign Relations Committee, Principal Deputy Under Secretary of Defense for Policy James Miller stated that because boost-glide systems fly on a non-ballistic trajectory, "we are confident that such non-nuclear systems," which do not otherwise meet the definitions for the New START Treaty, "would not be accountable as new kinds of strategic offensive arms for the purposes of the treaty."<sup>136</sup>

Under the definitions in New START, these types of systems would qualify as new kinds of strategic offensive arms. Article V of the treaty indicates that, "when a Party believes that a new kind of strategic offensive arm is emerging, that Party shall have the right to raise the question of such a strategic offensive arm for consideration in the Bilateral Consultative Commission." As a result, Russia would have the opportunity to question the United States on whether the boost-glide systems should count under the treaty. But the United States would not have to delay the development, testing, and deployment of these systems while the discussions proceeded and it would not have to defer their deployment if Russia did not agree with the U.S. conclusion that these systems did not count under New START. In the article-by-article analysis submitted with the New START Treaty, the State Department indicated that "the deploying Party would be

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<sup>134</sup> Ibid., p. 52.

<sup>135</sup> Ibid., p. 54.

<sup>136</sup> Ibid., p. 55.

obligated to *attempt* to resolve the issue within the framework of the BCC [emphasis added].” But, according to the State Department, “there is no requirement in the treaty for the deploying Party to delay deployment of the new system pending such resolution.”<sup>137</sup>

The New START Treaty would not affect either the Navy’s Conventional Prompt Strike concept or the Air Force Plans to deploy missile-launched hypersonic gliders on heavy bombers. The Navy program currently envisions deployed the hypersonic glider on an intermediate-range missile, and the Air Force program would use a booster and glider that had never carried nuclear warheads or been associated with treaty-accountable nuclear delivery vehicles. Moreover, under New START, the bombers count against the treaty limits as both one delivery vehicle and one warhead, regardless of the number or type of weapons on board.

## Potential Threats from Russia and China

There is growing concern in the Pentagon, Congress, and among some in the defense community about the efforts by potential U.S. adversaries, including Russia and China, to develop hypersonic boost-glide systems and, in some cases, hypersonic cruise missiles.<sup>138</sup> The Strategic Forces Subcommittee of the House Armed Services Committee addressed these programs in a hearing in late 2015. Further, a study published by the National Academy of Sciences in late 2016 highlighted the complexities that such programs create for U.S. defensive programs and the “gaps and seams” that exist in U.S. efforts to address the threat. The summary to the study stated that high-speed maneuvering weapons, such as hypersonic cruise missiles or boost-glide vehicles, “can combine speed and maneuverability between the air and space regimes to produce significant new offensive capability that could pose a complex defensive challenge.”<sup>139</sup>

According to Michael Griffin, the Under Secretary of Defense for Research and Engineering, the growing gap between U.S. and Chinese hypersonic weapons can create instability, because, without its own hypersonic weapons, the only response the United States would have if “the Chinese started throwing hypersonic missiles at American bases in the Pacific and sinking carrier strike groups,” would be “to let them have their way or go nuclear.”<sup>140</sup> In testimony before Congress, he noted that “we, today, do not have systems which can hold them at risk in a corresponding manner, and we don’t have defenses against those systems.” He also noted that this would place the United States at a disadvantage, and stated that “it is among my very highest priorities to erase that disadvantage, creating our own systems to hold them at risk and to provide defense.”<sup>141</sup>

<sup>137</sup> U.S. Department of State, *Article-by-Article Analysis of the New START Treaty Documents*, Washington, DC, May 5, 2010, <http://www.state.gov/t/avc/trty/141829.htm#text>.

<sup>138</sup> Bill Gertz, “Air Force: Hypersonic Missiles from China, Russia Pose Growing Danger to U.S.,” *Washington Free Beacon*, November 30, 2016. See, also James Acton, “The Arms Race Goes Hypersonic,” *Foreign Policy*, January 30, 2014.

<sup>139</sup> National Academy of Sciences, *High-Speed Maneuvering Weapons: A Threat to America's Global Vigilance, Reach, and Power*, Unclassified Summary, Washington, DC, November 2016, p. 4, <https://www.nap.edu/read/23667/chapter/1#ii>.

<sup>140</sup> Paul McCleary, “China Loves DoD Acquisition Culture, Says R&D Chief Griffin,” *Breaking Defense*, March 6, 2018. <https://breakingdefense.com/2018/03/china-loves-dod-acquisition-culture-says-r/>.

<sup>141</sup> Christian Davenport, “Why the Pentagon fears the U.S. is losing the hypersonic arms race with Russia and China,” *Washington Post*, June 8, 2018, [https://www.washingtonpost.com/business/economy/why-the-pentagon-fears-the-us-is-losing-the-hypersonic-arms-race-with-russia-and-china/2018/06/08/7c2c3b4c-57a7-11e8-b656-a5f8c2a9295d\\_story.html?mkt\\_tok=eyJpIjoiWTJJelkySXhaRFI5TkRNeSIsInQiOiJRazRKdXVNSnlSeU1DZlBBS1VXUG1WYXFSZEtlN1wvRDBxb1lSV1wvMUptOGV2WTlpeDVWR0g3ZUdHK0N3UDN1QUJzcXNvSG1oUHBlcHl](https://www.washingtonpost.com/business/economy/why-the-pentagon-fears-the-us-is-losing-the-hypersonic-arms-race-with-russia-and-china/2018/06/08/7c2c3b4c-57a7-11e8-b656-a5f8c2a9295d_story.html?mkt_tok=eyJpIjoiWTJJelkySXhaRFI5TkRNeSIsInQiOiJRazRKdXVNSnlSeU1DZlBBS1VXUG1WYXFSZEtlN1wvRDBxb1lSV1wvMUptOGV2WTlpeDVWR0g3ZUdHK0N3UDN1QUJzcXNvSG1oUHBlcHl)

Members of Congress and Pentagon officials have also highlighted that the United States does not have the capability to defend against these missiles.<sup>142</sup> Section 1687 of the Defense Authorization Bill for Fiscal Year 2017 (P.L. 114-328) designates the Director of the Missile Defense Agency as DOD's executive agent for the development of a U.S. capability "to counter hypersonic boost-glide vehicle capabilities and conventional prompt strike capabilities that may be employed against" the United States, its allies, and its forces overseas. It mandates that the director develop "architectures for a hypersonic defense capability" and develop a program of record for this capability by September 30, 2017. General Hyten has also noted that the Pentagon's FY2019 budget includes \$42 million for the Air Force and the Missile Defense Agency to work on a prototype for space-based sensors that could track hypersonic missiles after launch and assist in the defense against them.<sup>143</sup>

Concerns about Russian hypersonic weapons escalated in late December 2018, when Russia tested its new Avangard hypersonic glider. According to press reports, this nuclear-capable glider was launched from a site in southwestern Russia and flew 3,500 miles to a target on the Kamchatka Peninsula. The glider was launched on an older Russian SS-19 ballistic missile, which routinely carries up to six nuclear reentry vehicles, but may be able to carry three hypersonic gliders.<sup>144</sup> Russian sources noted, and U.S. press reports confirmed, that this new maneuverable delivery vehicle "is impossible to intercept with existing anti-missile defenses" because it does not follow a predictable trajectory.<sup>145</sup> On December 27, 2019, the Russian military announced that the Strategic Rocket Forces had activated two SS-19 missiles equipped with Avangard hypersonic glide vehicles.<sup>146</sup>

Experts have noted that the Avangard does not create a new threat to the United States or new issues for nuclear deterrence simply because it can maneuver past missile defenses. The United States does not yet have, and is not developing, missile defenses that could intercept existing Russian long-range ballistic missiles. Experts note that Russia began to develop the Avangard in the late 1980s, after the Reagan Administration announced that the United States would pursue the development of an expansive missile defense system, but this system, known as the Strategic Defense Initiative, was scaled back and eventually abandoned after the demise of the Soviet Union. Russia seems to have revived and accelerated the program in the 2000s, after the United

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<sup>142</sup> Barbara Starr, "US general warns of hypersonic weapons threat from Russia and China," *CNN*, March 27, 2017, <https://www.cnn.com/2018/03/27/politics/general-hyten-hypersonic-weapon-threat/index.html?sr=twCNN032718general-hyten-hypersonic-weapon-threat0600PMVODtop>.

<sup>143</sup> Rebecca Kheel, "Russia, China eclipse US in hypersonic missiles, prompting fears," *The Hill*, March 27, 2017, <http://thehill.com/policy/defense/380364-china-russia-eclipse-us-in-hypersonic-missiles-prompting-fears>.

<sup>144</sup> Paul Sonne and Anton Troianovski, "Russia is poised to add a new hypersonic nuclear-capable glider to its arsenal," *Washington Post*, December 26, 2018, [https://www.washingtonpost.com/world/europe/russia-is-poised-to-add-a-new-hypersonic-nuclear-warhead-to-its-arsenal/2018/12/26/e9b89374-0934-11e9-8942-0ef442e59094\\_story.html?mkt\\_tok=eyJpIjoiTnpFeVltRmhaV05rWTJRNCIsInQiOiJRd042Qk4wN2oyYzNoSnpgZW5VaHpoTXBtbEdnT1liakFSaFIYZGpuUDdPbTZrYzNSWW5JaXNuc0JtOE9OZ2hEUG4zTFE4cDIgbm5vVkJKUXpZlWY4MkhtUUVMYnJaU2VyRmFNOHICYUFpQ1wvTTNMTml1VWJKd0ZRRm9zRE9ZRDYifQ%3D%3D&noredirect=on&utm\\_term=.dc5a88155ecf](https://www.washingtonpost.com/world/europe/russia-is-poised-to-add-a-new-hypersonic-nuclear-warhead-to-its-arsenal/2018/12/26/e9b89374-0934-11e9-8942-0ef442e59094_story.html?mkt_tok=eyJpIjoiTnpFeVltRmhaV05rWTJRNCIsInQiOiJRd042Qk4wN2oyYzNoSnpgZW5VaHpoTXBtbEdnT1liakFSaFIYZGpuUDdPbTZrYzNSWW5JaXNuc0JtOE9OZ2hEUG4zTFE4cDIgbm5vVkJKUXpZlWY4MkhtUUVMYnJaU2VyRmFNOHICYUFpQ1wvTTNMTml1VWJKd0ZRRm9zRE9ZRDYifQ%3D%3D&noredirect=on&utm_term=.dc5a88155ecf).

<sup>145</sup> Aristos Georgiou, "Russia Successfully Tests Weapon That Travels 27 Times Speed of Sound and Renders Missile Defense Systems 'Useless'—Officials," *Newsweek*, December 28, 2018, [https://www.newsweek.com/russian-new-weapon-mach-27-avangard-hypersonic-glide-vehicle-intercontinental-1273729?utm\\_source=Twitter&utm\\_campaign=NewsweekTwitter&utm\\_medium=Social](https://www.newsweek.com/russian-new-weapon-mach-27-avangard-hypersonic-glide-vehicle-intercontinental-1273729?utm_source=Twitter&utm_campaign=NewsweekTwitter&utm_medium=Social).

<sup>146</sup> Julian E. Barnes and David E. Sanger, "Russia Deploys Hypersonic Weapon, Potentially Renewing Arms Race," *New York Times*, December 27, 2019, <https://www.nytimes.com/2019/12/27/us/politics/russia-hypersonic-weapon.html>.

States withdrew from the 1972 Anti-ballistic Missile (ABM) Treaty), again anticipating the U.S. development of widespread missile defenses.<sup>147</sup> Most existing U.S. missile defense interceptors are designed to counter medium- and intermediate-range ballistic missiles launched by adversaries in Asia or the Middle East and lack the capability to intercept Russia's long-range ballistic missiles. While the United States has deployed a few dozen interceptors that can target long-range missiles in Alaska and California, these lack both the technical sophistication and the overall numbers needed to intercept hundreds of sophisticated Russian missiles.

Some have also questioned the view that, without its own hypersonic capabilities, the United States might have to escalate to nuclear weapons in response to Chinese attacks with hypersonic weapons. This argument is similar to the argument made in support of the CPGS program in its early years—that without a prompt, global conventional capability, a U.S. President might be faced with the choice of launching a nuclear attack or no attack at all early in a conflict. But, as noted above, the United States deploys a number of different long-range strike capabilities, and a President would have a range of options, even if some lacked the promptness offered by ballistic missiles and hypersonic glide vehicles. Moreover, the Pentagon has justified the development of U.S. hypersonic weapons as a response to the need for prompt attack against a range of adversarial air defense and access denial capabilities. They are not seen as a response to an adversary's hypersonic weapons. Thus, the Pentagon has identified a requirement for these weapons that is independent of an adversary's possession of hypersonic weapons, and would have a range of capabilities available if it had to respond to an adversary's use of such weapons.

Moreover, although Under Secretary Griffin highlighted his concerns about the potential gap between U.S. and Chinese hypersonic programs in testimony early in 2018, he also noted, in a press interview in July 2018, that the United States has “been [and] will remain the world leader in this research area.” To maintain that edge, he noted that the United States would increase its investments in the research and prototyping for hypersonic weapons, so that it can mature its capabilities over the next decade.<sup>148</sup> Hence, although discussions about the threats from Russian and Chinese hypersonic weapons are often interpreted as a pending arms race in the deployment of these new technologies, they may be more appropriately understood as a competition in the development of new technologies.

## **Weighing the Benefits and Risks**

The Bush Administration and the Obama Administration both supported the deployment of systems that employ long-range booster rockets and hypersonic payload delivery systems to fulfill the requirements of the prompt global strike mission. Both Administrations have argued that these systems can provide the United States with the ability to attack anywhere in the world on short notice, in support of regional or national security goals. They have both noted that, by strengthening the U.S. ability to attack at long ranges with conventional weapons, these systems could help reduce the number of circumstances when the United States might have to consider using nuclear weapons to defend its interests. The Trump Administration continues to support the development and deployment of these systems, although it has not linked them to efforts to reduce U.S. reliance on nuclear weapons.

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<sup>147</sup> Pavel Podvig, “Avangard system is tested, said to be fully ready for deployment,” *Russian Forces Blog*, December 26, 2018, [http://russianforces.org/blog/2018/12/avangard\\_system\\_is\\_tested\\_said.shtml](http://russianforces.org/blog/2018/12/avangard_system_is_tested_said.shtml).

<sup>148</sup> Aaron Mehta, “Three Thoughts on Hypersonic Weapons from the Pentagon's Technology Chief,” *Defense News*, July 16, 2018, <https://www.defensenews.com/air/2018/07/16/3-thoughts-on-hypersonic-weapons-from-the-pentagons-technology-chief/>.

Critics, however, have argued that these weapons might provide the United States with more capability than it needs under most circumstances, while, at the same time, raising the possibility that their use might be misinterpreted—either as the launch of nuclear weapons or as the use of conventional weapons against nuclear targets. Moreover, as would be true for any weapon seeking to achieve this mission, the ability to attack targets across the globe on short notice depends on the U.S. ability to acquire precise information about the locations of potential targets and to translate that information into useful targeting data. If it takes longer for the United States to acquire and use that information than it would take for it to launch and deliver a ballistic missile, or, as has often been the case, if such precise information is unavailable, then the United States may not be able to benefit from the unique characteristics of long-range ballistic missiles. Bombers would take longer to reach their targets, but this added time might provide the United States with the opportunity to acquire the needed intelligence. A 2008 report by the Government Accountability Office (GAO) identified this particular problem, noting that many of the ongoing studies into global strike and prompt global strike have not addressed the need for critical enabling capabilities along with the weapons systems that would be used in the attacks.<sup>149</sup>

Moreover, during the Cold War, most analysts recognized that prompt, global attack capabilities could prove destabilizing in a crisis, when nations might have incomplete information about the nature of an attack and too little time to gather more information and plan an appropriate response. Faced with these circumstances, a nation who was not an intended target, such as Russia, might choose to respond quickly, rather than to wait for more information. The same could be true for the adversaries who are the intended targets of U.S. conventional prompt strike weapons. If the United States hoped to degrade or destroy an adversary's capabilities at the start of a conflict, before they could be used to degrade U.S. capabilities or attack U.S. forces, the other nation might choose to use these weapons even more quickly during a crisis, before it lost them to the U.S. attack.<sup>150</sup>

Some have argued that the possible crisis instabilities associated with long-range ballistic missiles should not eliminate them from consideration for the conventional prompt strike mission because the United States can work with Russia, China, and other nations to reduce the risks; also because no other weapons, at least in the short term, provide the United States with the ability to attack promptly anywhere on the globe at the start of an unexpected conflict. Yet the question of whether the United States should accept the risks associated with the potential for misunderstandings and crisis instabilities can be viewed with a broader perspective. How likely is the United States to face the need to attack quickly at great distances at the start of an unexpected conflict? How much would the United States lose if it had to wait a few hours or days to move its forces into the region (or to await the intelligence reports and precise targeting data needed for an attack)?

If the risks of waiting for bombers or sea-based weapons to arrive in the theater are high, then long-range ballistic missiles may be the preferred response, even with the risk that other nations might misunderstand U.S. intentions. On the other hand, if the risks of waiting for other forces to arrive in theater are deemed to be manageable, and the risks of potential misunderstandings and crisis instabilities associated with the launch of long-range ballistic missiles are thought to be high, then the United States can consider a broader range of alternative weapons systems to meet the needs of the PGS mission.

<sup>149</sup> U.S. Government Accountability Office, Military Transformation, "DOD Needs to Strengthen Implementation of its Global Strike Concept and Provide a Comprehensive Investment Approach for acquiring Needed Capabilities." GAO-08-325. April 2008. p. 5.

<sup>150</sup> James M. Acton, *Silver Bullet? Asking the Right Questions About Prompt Global Strike* (Washington, DC: Carnegie Endowment for International Peace, 2013), pp. 120-129.

This consideration may be part of the rationale for the recent interest in deploying hypersonic weapons on bombers and intermediate-range land-based missiles. These options would provide a prompt, precision response while lowering the risk of ambiguity or misperception that might exist with long-range missiles. However, even shorter-range prompt strike weapons can raise concerns about crisis stability, particularly if they can maneuver to avoid defenses and change direction to conceal their intended targets. A nation facing an attack with such weapons may believe it has to respond promptly, or even preemptively, during a crisis. If U.S. forces faced the same calculation, both parties could face the risk of a crisis escalating to conflict with little notice.

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