U.S. Ballistic Missile Defense

Ballistic missile defense systems seek to defend a given area from attack by locating and tracking an incoming ballistic missile and then launching an interceptor to destroy the missile before it can reach its target. All U.S. interceptors are made up of a booster rocket and a kill vehicle. While most interceptors are "hit-to-kill," meaning the kill vehicle crashes into the incoming missile to destroy them, others use a blast fragmentation warhead that detonates an explosive charge and sprays shrapnel in the hopes of detonating the payload in the incoming missile. The United States employs missile defenses that launch both types of interceptors.

The U.S. Missile Defense Agency (MDA) has worked to develop and deploy a number of such systems to defend the homeland, allies and assets abroad. In this vein, the United States has developed three theater (regional) systems and one to protect the homeland, the Ground-Based Midcourse Defense (GMD) system.

Theater Ballistic Missile Defense systems target incoming short-, medium- and intermediate-range ballistic missiles. These systems include the land-based Patriot Advanced Capability (PAC-3) and Terminal High Altitude Area Defense (THAAD) systems deployed in Europe, the Middle East and Asia, and the sea-based Aegis system, although the Aegis Ashore can be deployed on land.

The GMD system aims to protect the U.S. homeland from a limited number of intermediate and long-range ballistic missiles by destroying the incoming warhead in its midcourse phase, outside of the Earth's atmosphere. It is designed to be effective against an accidental or rogue missile launch and not against the strategic deterrents of Russia and China. First deployed in 2004, this system currently comprises 44 ground-based interceptors at Fort Greely in Alaska and at Vandenberg Air Force Base in California, in addition to associated satellite and radar systems.

The Next Generation Interceptor program, currently being implemented, would produce 31 new interceptors to replace current interceptors in Fort Greely and Vandenberg Air Force Base for more advanced interceptor systems. These new interceptors are expected to cost $498 million each totaling $18 billion over the life of the program. They are currently planned to be fielded in 2027 or 2028.

The Pentagon is also spending $1.5 billion on a new missile and air shield for Guam in FY 2024. The existing system was announced to defend Guam against North Korean threats, but this new development is set to defend against Chinese threats. Guam is currently protected by the Army's THAAD ballistic missile defense system and the Navy's Aegis system.

The United States' deterrence strategy proclaims that offensive nuclear weapons deter nuclear weapon states, like Russia and China, and U.S. missile defenses are meant to protect against rogue state threats, like North Korea. Under the Trump administration, the United States shifted its strategy toward creating a layered missile defense system that plans to integrate the systems deployed abroad with those deployed at home. Although still not effective against large scale attacks, the adjustment was intended to increase protection in light of continued development of missile capabilities, including cruise and hypersonic weapons.

In October 2022, the Biden administration released its Missile Defense Review, which outlines integrated deterrence that incorporates diplomacy, missile defense, and nuclear capabilities. Nuclear weapons are stated to be the credible threat to deter attacks, while missile defense is deterrence by denial. This missile defense strategy prioritizes the modernization and expansion of the GMD system and strengthening regional defense and deterrence in cooperation with Allies.

How do these systems work?

While engaging hypersonic and cruise missiles requires defending areas, ballistic missile defense considers engaging threats during three stages: the boost phase, the midcourse phase and the terminal phase of flight.

Boost-phase defense encompasses engagements while the booster rocket is still accelerating. The midcourse defense layer can be divided into 1) the ascent phase, when the incoming missile is engaged prior to apogee; 2) the descent phase, when intercept occurs after apogee; 3) and finally, the terminal phase refers to engagements as and after warheads reenter the atmosphere and become subject to drag and reentry heating.

Engagements in the boost phase are ideal but very difficult because there is such a short time period to make a decision. Boost-phase engagements also require engagement by systems that are deployed near enemy territory, which can undermine the strategic deterrents of adversaries. Presently, the United States does not have this technology and it was found not to be "practical or feasible" by the National Academy of Sciences.

Terminal defense is dangerous because it is the last shot at interception. The PAC-3, THAAD and Aegis systems all target the terminal phase. In November 2020, the Aegis SM-3 Block IIA was tested against an ICBM-class target and deemed successful, although it was not conducted under real-world conditions.

The U.S. GMD system, as its name dictates, seeks to engage incoming missiles in the midcourse layer. It relies on an extensive network of ground- and space-based sensors and radars, which are deployed from Greenland to Japan, and from the Pacific Ocean to launch detection satellites orbiting the Earth.

Do these systems work?

Despite the assurances of MDA officials, presently, these defense systems have an uneven testing record. The Government Accountability Office found that the MDA failed to meet its planned testing goals in fiscal year (FY) 2019 due to significant development delays. The lack of testing is problematic as it results in less data to validate system capabilities. These failures are particularly concerning given the MDA's $199 billion in funding from 2002 to 2023 and requested $55 billion from FY 2024 through 2028. This is an increase of $8 billion from the requested $47 billion from FY 2019 through 2023.

In the tests that have occurred, the GMD system has an approximate 50% success rate in scripted tests and replacements for these weapons are years away. In October of 2019, the Pentagon terminated its Redesigned Kill Vehicle program, intended for deployment in 2023, to augment and replace the GMD's outdated and unreliable interceptors, due to technical design flaws. From the limited information publicly available, it is difficult to assess whether 50% can be considered successful, as valuable data can be derived from any test regardless of its success. What is clear, however, is that GMD is expensive and not, apparently, meeting its goals.

The MDA enacted $2.8 billion in FY 2023 and requested an additional $3.25 billion in FY 2024 for existing GMD and the development of the Next-Generation Interceptor. In the interim, Congress has asked MDA to field a separate interceptor by 2026.

There is a long list of expensive agency flops, including $2.2 billion for a failed sea-based radar, $5.3 billion on a scrapped chemical laser system, and $2.7 billion on an ineffective blimp-based radar system.

While the theater missile systems have a better testing record, they are not immune to reliability concerns. Up until 2006, THAAD had an exceedingly poor testing record of 2 out of 16, but since then, its testing record has improved to 16 out of 16. The Aegis continues to have a mixed record of 34 successes out of 43 attempts. The PAC-3's record is quite poor in the field, and the numbers from the Pentagon are highly disputed.

Threat to strategic stability and arms control

In theory, effective missile defense should increase homeland security. However, the system is only effective against small scale threats and provides essentially zero protection against attack by a larger adversary such as Russia. Furthermore, both Russia and China have cited U.S. missile defenses, and the lack of transparency around them, as justifications for building their own nuclear capabilities — an effort to blame the U.S. for an arms race they are running. Russia has also cited U.S. missile defense as a reason for its reluctance to engage in further arms control.

Specifically, Moscow and Beijing profess concern about the Aegis SM3-Block IIA, which the United States tested against an ICBM-class target in November 2020. The United States plans to deploy the system in Poland and complete construction on Aegis Ashore Poland in 2023, ostensibly to counter a future potential Iranian threat, and in the Asia pacific. Later in 2023, technical capability declaration is expected, meaning that all major components of the system are installed and ready to begin integration. However, Russia and China have responded with a wide array of new missile capabilities that are advertised as to defeat U.S. missile defense systems. Although the U.S. has extremely limited effective defense against Russian or Chinese strategic forces, the imagined threats to such capabilities are being used to fuel an arms race that could undermine the stability of nuclear deterrents.