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Defense Primer: Ground Based Strategic Deterrent (GBSD) Capabilities

Figure 1. Notional GBSD Launch

Source: https://www.northropgrumman.com/GBSD/.

On September 8, 2020, the United States Air Force awarded Northrop Grumman Corporation a $13.3 billion contract to develop a new nuclear missile, the Ground Based Strategic Deterrent (GBSD), intended to replace the 50-year old Minuteman III (MMIII) Intercontinental Ballistic Missile (ICBM). (For details on the U.S. nuclear force structure, see CRS Report RL33640, *U.S. Strategic Nuclear Forces: Background, Developments, and Issues*, by Amy F. Woolf.) MMIII has been deployed as the ground-based leg of the U.S. nuclear forces structure (the "Triad") since 1970. The Air Force expects GBSD to begin replacing MMIII in 2029. As the missile moves toward production and deployment, issues for Congress include whether to authorize and appropriate funding for this program and, if so, to provide oversight as the program progresses and is implemented.

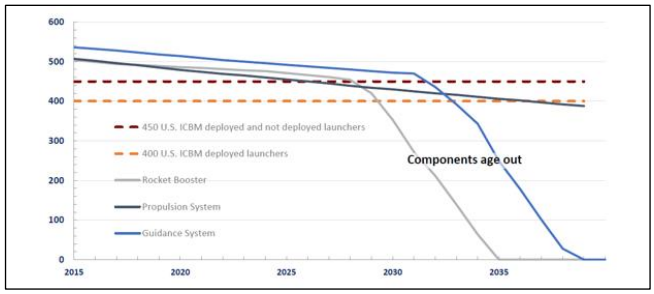
What Is an ICBM?

According to the Department of Defense (DOD), an ICBM is a missile that has a minimum range of 5,500 km, or roughly 3,400 miles. Although some countries use road or rail mobile launchers for their ICBMs, U.S. ICBMs are silo based; they are buried in protective launch facilities in North Dakota, Montana, Wyoming, Colorado, and Nebraska. An ICBM can hit its target on another continent in approximately 30 minutes. During the first three minutes, the missiles flight is powered by its three-stage solid fuel motors. After the powered portion of flight, it follows a ballistic trajectory toward its target, on a parabolic trajectory. Once the President authorizes the launch of a missile, it cannot be recalled or destroyed in flight. The same is true for nuclear missiles launched from U.S. submarines. In contrast, U.S. bombers could return to their bases after launch, without releasing their weapons, although the weapons could not be recalled after their release from the bomber.

Status of Minuteman III

MMIII first entered service around 1970 and has undergone several life extension programs over the past 50 years, the most recent of which occurred in the late 2000s and included a replacement booster and missile guidance computer. In the next decade, both of these components may face reliability concerns as they reach the end of their intended lifespan, known as aging out, as indicated in **Figure 2**. A 2016 Pentagon study recommended replacing MMIII rather than conducting another life extension. The study concluded that the replacement system (GBSD) would meet current and expected threats, maintain the industrial base, insert more reliable technology, produce a modular weapon system concept, and reduce life cycle cost.

Figure 2. Projected Decrease in Operational Minuteman III Missiles



Source: Mark Gunzinger, Carl Rehberg, and Gillian Evans, Sustaining the U.S. Nuclear Deterrent: The LRSO and GBSD, Center for Strategic and Budgetary Assessments.

Capabilities of GBSD

Modularity: What Is It and Why Is It Important in Lowering Lifecycle Costs?

In contrast with MMIII missiles, the GBSD employs a modular design and open architecture, allowing for the replacement of aging and outdated components. According to the Air Force, this modular approach would reduce the lifecycle cost of GBSD and provide flexibility for improvements throughout the life of the weapon system. Unlike in many current DOD systems, open systems architectures allow the Air Force to control the intellectual property of the system, including the system's source code. This allows multiple vendors, in addition to the contract winner Northrop Grumman, to compete for and complete future upgrades and improvements to the system. These types of upgrades might become important as technology evolves and could allow for improvements in the safety and reliability of the missile system. They could include better guidance systems or new types of countermeasures that might allow the missile to penetrate an adversary's ballistic missile defensive systems.

Consequently, modularity may provide benefits in the maintenance of a weapon system because it would allow the Air Force to modify and possibly improve the initial design of the missile by upgrading and replacing smaller systems, of modules, without redesigning the entire weapon system. This could potentially be a more cost-effective way to support the missile's intended 50-year life cycle than the life extension programs that replaced aging parts in the MMII. Also, the Air Force would not have to go back and pay the original vendor to open software to add the new piece into the system architecture in the future.

Improved Security

The Air Force has noted that, with MMIII, most of the maintenance conducted on the warhead or the Missile Guidance Computer currently requires that the launcher closure door (the access door directly above the missile) be open. This introduces a security vulnerability by increasing the possibility of unauthorized observation or access. To counter this, during MMIII maintenance operations, the Air Force assigns additional Security Forces to the crew to help protect the warhead. With the modular design of GBSD, much of the maintenance can be conducted with the launcher closure door closed. The Air Force states that deploying the GBSD would mitigate the security risks during maintenance compared to the current MMIII.

Potential Manpower Savings

The three current MMIII bases in the Air Force (Minot AFB, Malmstrom AFB, and FE Warren AFB) require greater numbers of security forces personnel compared with other units in the Air Force. The GSBD's modularity that enables most maintenance to be done with the launcher closure door closed could also allow for a reduction in the number of Security Forces personnel required at the bases. In addition to fewer required Security Forces, the Air Force expects the maintenance needs of a new weapon system to be greatly reduced. Finally, although the final layout of how the system will be set up has not been publicized, there are indications to suggest that fewer Launch Control Centers (LCCs) will be required. Current requirements have 15 LCCs at each of the three missile bases for a total of 45 LCCs. Each LCCs is manned continuously by two missile combat crew members. If fewer LCCs are needed in GBSD, it could lead to the need for fewer missile operators. It is premature to estimate the potential total manpower savings, but it may be reasonable to assume there will be some.

Improved Throw Weight

The MMIII engines use heavy steel casings to house the missile propellant. These casings add to the weight of the missile and affect its flight range and payload capabilities. Modern rocket boosters, like the Navy's D5 Submarine Launched Ballistic Missile, use composite material to save weight and increase potential payload. GBSD's boosters use a composite material, making GBSD significantly lighter than the MMIII. Most notably, this will increase the missile's throw weight, which is a measure of the weight of the payload that the missile can deliver to a particular range. The Air Force asserts that the greater throw weight will allow GBSD to carry different payloads and give it more flexibility for future missions. Specifically, as adversaries develop ballistic missile defensive systems in the future, the increased throw weight could potentially allow the Air Force to develop countermeasures that would help the missile overcome the defenses.

At this time, the Air Force does not plan to deploy the GBSD with more than one warhead per missile. However, the added throw weight could preserve that option for the future. If it deployed multiple warheads on each missile, the Air Force might be able to deploy fewer missiles but still cover the same number of targets. Currently, the United States disperses single-warhead missiles across a large area of the upper Midwest, which both reduces the value of each individual missile and complicates an adversary's ability to attack the entire force. A smaller number of multiple warhead missiles could change this calculus but also might provide a less costly alternative for the GBSD force.

Considerations for Congress

There are objections to authorizing and funding the GBSD that come from both some Members of Congress and former defense officials who argue that nuclear weapons are outdated and ICBMs are destabilizing. Other critics note the costs of the "nuclear bow-wave" during the modernization scheduled over the next decade that a 2019 CBO study estimated to be $234 billion for just the three major programs: B-21 Bomber, submarine, and ICBM. Some argue that cutting down from a Triad to a Dyad may be the best way to help control costs while still maintaining a nuclear deterrent force. That would likely mean eliminating the ICBM leg and cancelling the GBSD program. The Air Force notes President Obama's 2010 Nuclear Posture Review, which stated, "Retaining all three Triad legs will best maintain strategic stability at reasonable cost, while hedging against potential technical problems or vulnerabilities." If Congress chooses to fund this program, potentially one of the biggest challenges would be to ensure the program stays on schedule and on budget.

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