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Defense Primer: LGM-35A Sentinel Intercontinental Ballistic Missile

The LGM-35A Sentinel is an intercontinental ballistic missile (ICBM) system that is expected to replace the Minuteman III (MMIII) ICBM in the U.S. nuclear force structure. MMIII has served as the ground-based leg of the U.S. nuclear triad—land-based ICBMs, submarine-launched ballistic missiles, and nuclear-capable bombers—part of the U.S. nuclear deterrent since 1970.

The Sentinel program encompasses the missile and its associated infrastructure, including silos, communication equipment, and facilities for launch control, maintenance, and weapons storage. The Department of Energy’s National Nuclear Security Administration (NNSA) is also developing a W87-1 warhead for the missile.

The Biden Administration endorsed the program in its 2022 Nuclear Posture Review (NPR), which says Sentinel will replace the MMIII missiles “one-for-one to maintain 400 ICBMs on alert.” Since the FY2017 NDAA, Congress has required that no less than 400 on-alert U.S. ICBMs be deployed. The Administration included \$3.7 billion for the program in its FY2025 Department of Defense (DOD) budget request. The NNSA FY2025 budget request included \$1.1 billion for the W87-1 program.

What Is an ICBM?

The United States began deploying nuclear-armed ICBMs in 1959, and has maintained these systems “on alert,” or able to launch promptly, since that time. The Air Force has tested MMIII missiles to a range greater than 6,000 miles, or 5,000 nautical miles. Although some countries use road or rail mobile launchers for their ICBMs, the United States bases its ICBMs in hardened concrete silos, known as launch facilities, located in North Dakota, Montana, Wyoming, Colorado, and Nebraska.

An ICBM can reach targets around the globe in approximately 30 minutes after launch. During the first three minutes, three solid fuel rocket motors power the missile’s flight. After the powered portion of flight, the missile follows a parabolic trajectory toward its target. It releases its warhead during the mid-course portion of its flight, and the warhead continues to the target.

Once the President authorizes the launch of any U.S. nuclear-armed 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 can return to their bases after launch, without releasing their weapons, although the weapons cannot be recalled after their release from the bomber.

The Transition from Minuteman III

The U.S. Air Force first deployed Minuteman ICBMs in the 1960s. MMIII, the first of the class to carry multiple warheads, entered the force in the early 1970s. The Air Force has replaced and updated many of the component systems on the missile—a process known as life-extension—several times over the past 50 years. The most recent life-extension program included, among other things, a replacement booster and a new missile guidance computer. The Air Force has noted that both of these components may face reliability concerns as they reach the end of their intended lifespans over the next decade. After conducting a comprehensive Analysis of Alternatives in 2014, the Air Force determined that it would replace MMIII with a new missile system. The Air Force argued that when compared with a life-extended MMIII, the new missile 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.

Air Force officials have stated that the Sentinel would have numerous advantages to MMIII. These include the following:

- The use of a modular design and open architecture that would reduce cost and provide flexibility for improvements throughout the life of the weapon system. Open systems architectures would allow the Air Force to control the intellectual property of the system, including the system’s source code, enabling the Air Force to complete future upgrades and improvements. The modular design, in turn, would also allow maintenance in ways that mitigate security risks and potentially enabled a reduction in the number of required security forces.
- The increased throw weight of the Sentinel compared to the MMIII, due to the use of much lighter composite material, would allow the new missile to carry different payloads. As adversaries develop ballistic missile defenses in the future, the increased throw weight, which is a measure of the weight of the payload that the missile can deliver to a particular range, could potentially allow the Air Force to develop countermeasures that would help the missile overcome the defenses.

The Air Force planned for the Sentinel (originally Ground Based Strategic Deterrent, or GBSD) to begin replacing MMIII in 2029 and to complete the deployment in 2036.

Program Status

The Air Force plans to procure 634 missiles, plus an additional 25 missiles to support development and testing, to enable the deployment of a force of 400 missiles by FY2036 through at least FY2075. As of early 2024, the missile's forward and aft sections, as well as its rocket motor, have been undergoing testing, according to Northrop Grumman, the Sentinel's lead defense contractor.

According to the Air Force, the program also involves the modernization of "450 silos and more than 600 facilities across almost 40,000 square miles over 6 states, 3 operational wings and a test location." To provide program coordination, the Air Force recently stood up an ICBM Modernization Directorate in the Air Force Global Strike Command, as directed by the FY2023 NDAA.

In January 2024, the Air Force reportedly informed Congress that the Sentinel program exceeded its initial cost projections, noting a 37% increase (from \$118 million initial baseline cost to \$162 million in 2020 dollars) in the cost per missile. This cost increase is known as a "critical" breach per the Nunn-McCurdy Act, which requires that the Secretary of Defense certify that the program is essential to national security, has no cheaper alternatives, and cannot be terminated. It also mandates that DOD develop and validate new cost estimates and program milestones and submit this information to Congress.

Air Force officials have also suggested that the program could be delayed by as much as two years and stated that cost and schedule challenges have arisen primarily from updates to the missile's supporting infrastructure, including silos, launch control facilities, and below-ground communications cabling, as well as from supply chain disruptions. A June 2023 GAO report also warned of potential risks to cost and schedule involving immature technologies, software development, and cybersecurity.

Warheads

The Sentinel will initially deploy with the W87-0 warheads currently mounted on the MMIII. NNSA is in the process of developing the W87-1 warhead, which, according to NNSA, "is slated to deploy between FY2031 and FY2032." This warhead is the "first newly manufactured nuclear warhead in three decades," according to its design agency Lawrence Livermore National Laboratory. NNSA is also in the process of establishing production capacity and recapitalizing infrastructure to meet the requirement of the 2019 NDAA to produce 80 plutonium pits by 2030, and anticipates the first certified pit for the W87-1 warhead in 2024. Lockheed Martin is developing the Mk21A reentry vehicle that will house the W87-1 atop the Sentinel.

The Air Force planned to deploy the Sentinel with one warhead per missile. However, with the greater throw weight available on the missile, the Air Force could, potentially, instead deploy two or three warheads in a multiple-independently targetable reentry vehicle (MIRV) configuration. A MIRV enables the delivery of multiple warheads deployed on one missile to different targets. Currently, the United States disperses single-warhead MMIIIs across the upper Midwest, which, according to DOD, reduces the value of each individual missile and complicates an adversary's ability to attack the entire force. Some argue that MIRVed ICBMs could enable the Air

Force to meet targeting requirements with a smaller number of deployed missiles.

Considerations for Congress

Some members of Congress have been concerned about the growing cost and delayed schedule of the program. In the past, some members of Congress have questioned the need to fund and deploy new ICBMs; others have also suggested that the Air Force consider, again, whether it could life-extend the MMIII. They, along with other commentators, have argued that a delay or cancellation of Sentinel could ease financial and other pressures caused by the simultaneous recapitalization of U.S. land-based, sea-based, and air-delivered nuclear weapons. In 2021, DOD commissioned an independent study on future ICBM options from the Carnegie Endowment for International Peace. It recommended further study of MMIII life-extension, specifically regarding technical and cost feasibility. However, the 2022 NPR said that any alternative to Sentinel replacing the MMIII would "would increase risk and cost." Air Force officials also stated in 2023 that they do not see a "viable" long-term life-extension for MMIII, though they are "committed" to doing "everything [they] can to keep it in the field."

In the past, some analysts have suggested that the United States reduce or eliminate its ICBMs because their vulnerability to attack could make them destabilizing in a crisis and could incentivize adversaries to attack the United States first. Alternatively, other commentators have asserted that every NPR since the end of the Cold War has endorsed the nuclear triad. The 2022 NPR stated that the three triad legs are "complementary," with each one "offering unique attributes."

The 2023 report of the Congressional Commission on the Strategic Posture of the United States, created by the FY2022 NDAA, proposed strategies to mitigate the risk of modernization delays of the U.S. nuclear triad. These included a proposal to upload additional warheads to part of the MMIII force if Sentinel deployment is delayed while some of the deployed MMIII age out, and a proposal to deploy the Sentinel in a MIRVed configuration. It noted, however, that these activities would need to be done in compliance with the New START Treaty, which sets warhead and launcher limits on U.S. and Russian strategic nuclear forces. To mitigate the dangers of growing Russian and Chinese nuclear threats, the commission also recommended the possible fielding of a portion of the "future ICBM force in a road-mobile configuration."

The FY2024 NDAA included a number of provisions and reporting requirements related to the Sentinel program. It directed the Air Force, in coordination with U.S. Strategic Command and others, to "develop a plan to decrease the amount of time required to upload additional warheads to the [ICBM] force in the event Presidential direction is given to exercise such a plan."

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