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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—since 1970. (See CRS In Focus IF10519, *Defense Primer: Strategic Nuclear Forces*.) The Biden Administration included \$3.7 billion for the Sentinel in its FY2025 Department of Defense (DOD) budget request, and \$1.1 billion in the Department of Energy’s National Nuclear Security Administration (NNSA) budget request for the W87-1 nuclear warhead that is being developed for the missile. In 2024, DOD conducted a congressionally mandated review of the Sentinel program following an increase in cost projections.

### What Is an ICBM?

A U.S. 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. The missile releases its warhead during the mid-course portion of its flight, and the warhead continues to the target.

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. The United States bases its ICBMs solely in hardened concrete silos, known as launch facilities, located in North Dakota, Montana, Wyoming, Colorado, and Nebraska. Russia and China use both silos and road-mobile launchers for their ICBMs.

Once the President authorizes the launch of any U.S. ICBM, the missile 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, without releasing their weapons, although their weapons also cannot be recalled after their release.

### The Transition from Minuteman III

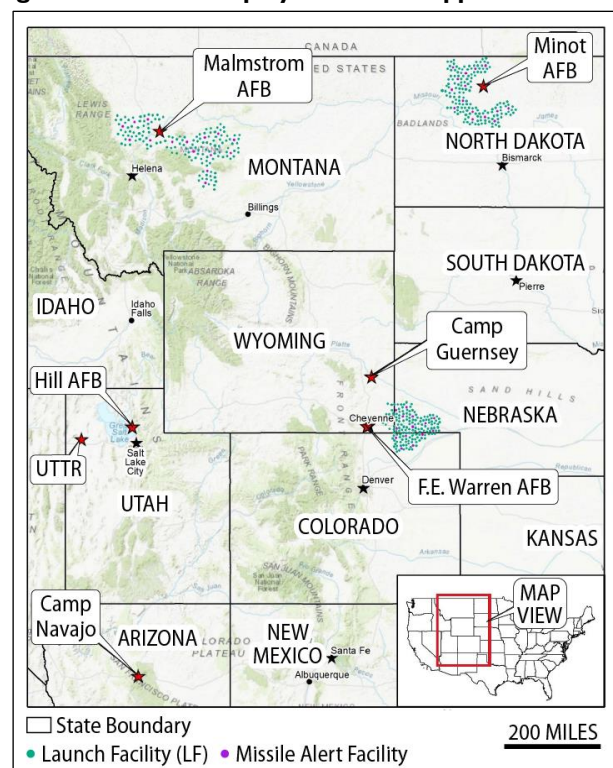
The U.S. Air Force first deployed Minuteman ICBMs in the 1960s. MMIII, which is currently deployed in a single-warhead configuration, entered the force in 1970. The Air Force has replaced and updated many of the component systems on the missile—a process known as life-extension—several times over the past 50 years. The Air Force has stated that some of these components may face reliability concerns as they reach the end of their intended lifespans. After conducting an Analysis of Alternatives in

2014, the Air Force decided to replace MMIII with a new missile system (originally Ground Based Strategic Deterrent) that would serve through 2075. The Air Force argued that when compared with a life-extended MMIII, the new ICBM would meet current and expected threats, maintain the industrial base, produce a modular weapon system, and reduce life cycle cost. The Air Force and Northrop Grumman, the Sentinel’s lead defense contractor, planned for the Sentinel to begin replacing MMIII in 2029.

### Program Status

The Air Force plans to procure 634 Sentinel missiles, plus an additional 25 missiles to support development and testing, to enable the deployment of 400 missiles. According to the Air Force, the program also includes modernizing “450 silos and more than 600 facilities across almost 40,000 square miles” (see **Figure 1**). To facilitate the MMIII to Sentinel transition, the Air Force stood up an ICBM Modernization Directorate in the Air Force Global Strike Command, as directed by Section 1638 of the FY2023 NDAA (P.L. 117-263).

**Figure 1. Sentinel Deployment and Support Locations**



Source: Air Force Global Strike Command, 2023.

In January 2024, the Air Force informed Congress that the Sentinel program exceeded its initial cost projections, positing at least a 37% increase (from \$118 million initial baseline cost to \$162 million in 2020 dollars) in the cost per unit. This cost increase is known as a “critical” breach per the Nunn-McCurdy Act (Title 10 *U.S. Code* §§4371-4377), which requires the Secretary of Defense to 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 attributed program cost increases primarily to Sentinel-supporting infrastructure updates, including launch control facilities and below-ground communications cabling. A June 2024 Government Accountability Office report also warned of potential risks to cost and schedule involving immature technologies, cybersecurity, staffing, and supply chain challenges.

DOD is also reviewing the program’s potential schedule changes. As of 2024, the missile’s forward and aft sections, its rocket motor, and its shroud have been undergoing testing. The Sentinel’s first developmental flight test has been delayed from 2023 to 2026, reportedly due to “increased lead times for guidance computer components.”

On July 8, 2024, DOD announced that the Nunn-McCurdy review was completed and the Sentinel program “met the statutory criteria to continue.” According to DOD officials, the review pointed to a further increase in costs as well as schedule delays; the Air Force is restructuring the program.

### Warheads

The Air Force plans to initially deploy the Sentinel with the W87-0 nuclear 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.” In April 2024 congressional testimony, NNSA Administrator Jill Hruby described NNSA concerns about the potential impact of Sentinel flight testing delays on W87-1 development and production. The W87-1 is the “first newly manufactured nuclear warhead in three decades,” according to its design agency, Lawrence Livermore National Laboratory. NNSA is also establishing production capacity to meet the requirement of Section 3120 of the 2019 National Defense Authorization Act (NDAA) (P.L. 115-232) to produce 80 plutonium pits by 2030; NNSA announced the qualification of the first war reserve pit for the W87-1 warhead in October 2024.

Lockheed Martin is developing the Mk21A reentry vehicle for the W87-1; this reentry vehicle was tested in June 2024. The Air Force plans to procure 426 Mk21A units.

## Considerations for Congress

### ICBM Force Necessity

Some analysts have suggested that the United States reduce or eliminate its ICBMs because they increase the risk of accidental war. Advocates of retaining ICBMs have argued that these missiles are the most “responsive” leg of the U.S. nuclear triad. The 2022 Nuclear Posture Review (NPR), a Biden Administration review of U.S. nuclear policy, echoed

past NPRs in stating that the three triad legs are “complementary,” with each one “offering unique attributes.”

### MMIII Life-Extension

Some Members of Congress have questioned the need to fund and deploy new ICBMs; others have also suggested that the Air Force again consider MMIII life extension. 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 all legs of the U.S. nuclear triad. In 2021, DOD commissioned an independent study on future ICBM options from the Carnegie Endowment for International Peace. This study recommended a further assessment of MMIII life-extension. However, the 2022 NPR endorsed Sentinel and said that any alternative would “would increase risk and cost.” Air Force officials stated in January 2024 that they do not see a “viable” long-term MMIII life-extension, though they are “committed” to doing “everything [they] can to keep it in the field.”

### Sentinel Costs and Schedule

Some Members of Congress have been concerned about growing DOD programmatic costs and schedule delays in the Sentinel program. Still other Members of Congress have raised concerns about growing NNSA costs and potential schedule delays related to the W87-1 warhead and plutonium pit production.

### Risk of Sentinel Delays

Some Members of Congress have expressed concern about the potential risks associated with transition from the MMIII to the Sentinel. Since the FY2017 NDAA (§1667 of P.L. 114-328), Congress has required that the Air Force deploy no fewer than 400 on-alert U.S. ICBMs. The 2022 NPR stated that Sentinel would replace the MMIII missiles “one-for-one to maintain 400 ICBMs on alert.” In Section 1650 of the FY2024 NDAA (P.L. 118-31), Congress directed the Air Force to “develop a plan to decrease the amount of time required to upload additional warheads to the [ICBM] force” that includes an assessment of the “feasibility and advisability of initiating immediate deployment of W78 warheads to a single wing of the [MMIII ICBM] force as a hedge against delay” of Sentinel ICBM deployment.

The 2023 report of the Congressional Commission on the Strategic Posture of the United States proposed considering such upload, within arms control limits, to field “the same number of warheads” “if the number of available [ICBMs] is reduced.” The commission report also proposed that the Air Force consider deploying Sentinel with multiple warheads or with “some portion of the future ICBM force” in a road-mobile configuration to account for evolving nuclear threats to the United States from Russia and China.

*This In Focus was originally authored by Amy F. Woolf, Specialist in Nuclear Weapons Policy.*

**Anya L. Fink**, Analyst in U.S. Defense Policy

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