

W80-4 and W87-1 Warheads

These warheads are being developed in cooperation with the Department of Defense (DOD) and will serve the nation into the second half of this century.

Modernizing the Stockpile

Lawrence Livermore National Laboratory (LLNL) is the lead design agency for the nuclear explosive package in two separate programs: the W80-4 Life Extension Program (LEP) and the W87-1 Modification Program.

The W80-4 replaces the W80-1 warhead, currently employed in the U. S. Air Force's Air-Launched Cruise Missile (ALCM). The Long-Range Standoff missile will replace the aging ALCM.

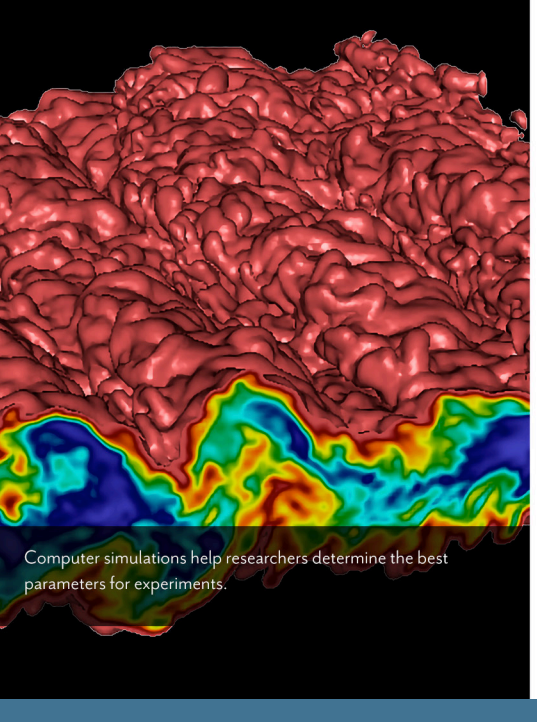
The W87-1 Modification Program will replace aging W78 warheads (more than 50 years old when due for replacement) in the stockpile and, together with the W87-0, underpin the nuclear triad. The W87-1 will be fielded in the Air Force's Ground-Based Strategic Deterrent missile, slated to replace the aging Minuteman III Intercontinental Ballistic Missile system.

The W80-4 will be the first warhead designed for use with a new missile since nuclear testing ended in 1992. The W87-1 is the first modern warheads to have all of its components manufactured in the modern National Nuclear Security Administration (NNSA) complex. These designs are based on well-tested nuclear components and will not require new underground nuclear tests to certify the warheads. Certification will rely on improved understanding and the highly capable tool set developed by the science-based Stockpile Stewardship Program (see Scientific Underpinnings on back).

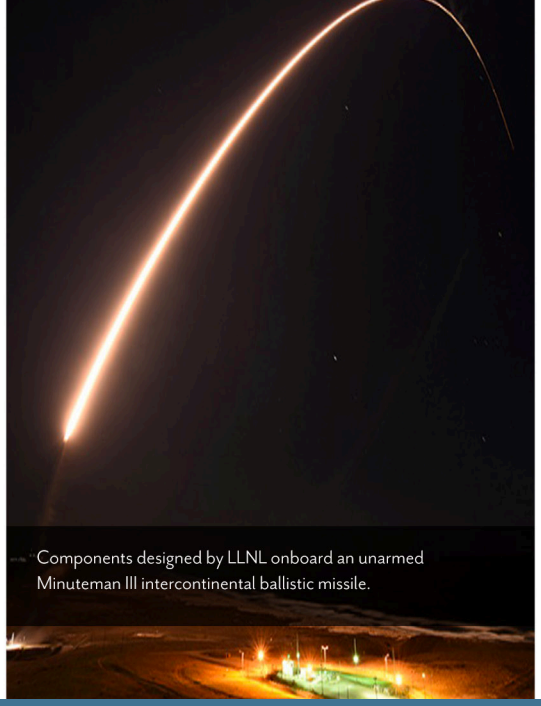
Accomplishments

The W80-4 LEP continues Phase 6.3 development engineering efforts, started in 2019, to perform design development and testing that enables design and specification release of the W80-4 warhead to the production agencies. The W87-1 Modification Program, restarted in January 2019, is in Phase 6.2: feasibility study and design options. LLNL is committed to completing the W80-4 LEP and W87-1 Modification Program in support of DOD's nuclear modernization programs. Both the W80-4 and W87-1 teams are making significant progress:

- Between the two programs, more than 200 team members work with production agencies, NNSA, and the U.S. Air Force to design hardware, transfer technology, address manufacturing issues, deliver hardware, and execute vital system assessments.
- For the W80-4 LEP, an extensive range of full-system tests and hundreds of small-scale tests provide confidence in the performance of design options that include advanced manufactured components.
- The W87-1 Modification Program is currently conducting Phase 6.2—feasibility study and down select—with the goal of entering Phase 6.2A—design definition and cost study—in the third quarter of FY2021.
- LLNL leads the Department of Energy's effort to develop and qualify the insensitive high explosives (IHEs) formulated using newly produced compounds. Manufacturing production-scale quantities of the new explosives is underway.
- Ongoing revitalization at LLNL's main site and experimental test site ensures the readiness of facilities and infrastructure to execute both programs.
- The next-generation supercomputer, Sierra, with a peak speed of 125-petaflops, is now sited at Livermore and plays a central role in assessing W80-4 and W87-1 performance and certification.
- Material characterization experiments conducted at the National Ignition Facility (NIF) strengthen the technical foundation and inform program options.



Computer simulations help researchers determine the best parameters for experiments.



Components designed by LLNL onboard an unarmed Minuteman III intercontinental ballistic missile.



LLNL staff pictured with a W80-4 nuclear explosives package engineering test.

Scientific Underpinnings

The science-based Stockpile Stewardship Program, established in 1994 as a response to the end of explosive nuclear testing, provides advanced tools for developing and certifying warheads. Prior to the program, the nation benefited from underground nuclear testing to calibrate and adjust computational models of warhead performance and safety. The program improves knowledge of the underlying physics and engineering through understanding validated by modern experiments. Certification of the warheads will be informed by extensive component testing, high-fidelity and predictive warhead simulations that model the integration of a warhead on a new delivery platform, and high-fidelity flight tests. A few key program facts:

- The program resolved the long-standing energy balance anomaly, removing a major source of disagreement between simulations and test data on past nuclear events.
- Understanding data on material equations of state—how materials behave at extreme pressures and temperatures—enables greater predictive modeling not available during the nuclear testing era.
- High-performance computing advances have fostered a shift from 2D to 3D modeling with a special focus on quantifying uncertainty, which alleviates the need to rely on approximations that were required during the nuclear test era.
- Modern hydrodynamic testing and diagnostics at the Contained Firing Facility and high-energy-density experiments on platforms such as NIF provide data important to informing confidence in weapon performance models.
- Predictive warhead lifetime models are being developed to ensure confidence in warhead lifetimes, as are nondestructive evaluation tools to assess component health and preserve assets.
- Significant advancements in manufacturing are improving the quality of replacement components.
- The warheads will be certified to meet requirements in both normal and abnormal environments. Computational engineering models, validated using data from missile flight tests and engineering tests, ensure warhead safety and reliability.

The Future

The W80-4 LEP's next stage will be Phase 6.4—production engineering. The follow-on phases are Phase 6.5—first production, and Phase 6.6—full-scale production. For the W87-1, the team will establish a baseline cost for the W87-1 during the next step, Phase 6.2A—design definition and cost study.

Program execution will focus on meeting NNSA's product realization requirements, including its deliverables and timeline. Improved manufacturing efficiencies, the use of insensitive high explosives, and new technologies such as advanced manufacturing will all play a role in meeting these requirements.

Addressing future scenarios of warhead survivability will require exascale-class computers such as LLNL's El Capitan, projected to be the world's most powerful supercomputer when it is fully deployed in 2023. El Capitan will provide routine 3D studies of critical warhead requirements, ensuring the NNSA laboratories can meet their primary mission of keeping the nation's nuclear stockpile safe, secure, and effective.

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