W80-4 LRSO Missile Warhead

The warhead is being developed in partnership with the DOD and will serve the nation into the second half of this century.

Description

As part of the effort to keep the nuclear arsenal safe, secure, and effective, the U.S. Air Force is developing a nuclear-capable Long-Range Standoff (LRSO) cruise missile. The LRSO is designed to replace the aging AGM-86 Air-Launched Cruise Missile, operational since 1982. The U.S. is extending the lifetime of its warhead, the W80-1, through the W80-4 Life Extension Program (LEP). The W80-1 will be refurbished and adapted to the new LRSO missile as the W80-4. As the lead design agency for its nuclear explosive package, Lawrence Livermore, working jointly with Sandia National Laboratories, is developing options for the W80-4 that include improvements in security, safety, and operational logistics.

Significance

The W80-4 will be the first warhead designed for use with a new missile since nuclear testing ended in 1992. The integration and certification must be accomplished without additional explosive nuclear testing. Certification will rely on improved understanding and the rich, highly capable toolset developed by the science-based Stockpile Stewardship Program. These tools include high-performance computing and codes and experimental facilities such as the Contained Firing Facility and environmental test facilities at Site 300 (for hydrodynamic and engineering testing) and the National Ignition Facility (for high-energy-density physics experiments).

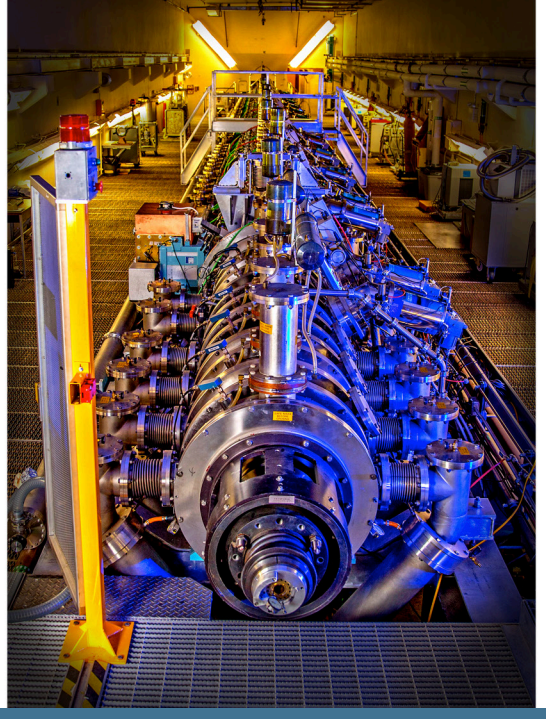
Accomplishments

In 2015, the W80-4 LEP entered into Phase 6.2—feasibility study and down-select—to establish program planning, mature technical requirements, and propose a full suite of design options. In October 2017, the program entered Phase 6.2A—design definition and cost study—to establish detailed cost estimates for all options and a baseline from which the core cost estimate and detailed schedule are generated, with appropriate risk mitigation. The W80-4 team is making significant progress:

- An effective team that includes the National Nuclear Security Administration and the U.S. Air Force is in place; coordination is robust.
- An extensive range of full-system tests, together with hundreds of small-scale tests, are in progress to provide confidence in the performance of W80-4 LEP design options that include additively manufactured components.
- LLNL leads DOE's effort to develop and qualify the insensitive high explosive formulated using newly produced constituents. Manufacturing of production-scale quantities of the new explosives is underway and on schedule.
- Ongoing revitalization at the LLNL main site as well as the Site 300 Experimental Test Site ensures the facilities and infrastructure are ready to execute the LEP.
- The next-generation supercomputer, Sierra, with a peak speed of 125-petaFLOP/ second, is now sited at Livermore and will play a central role in assessing W80-4 performance and LEP certification.
- Material characterization experiments conducted at the National Ignition Facility (NIF) are strengthening the technical foundation and informing LEP options.

The Future

The W80-4 program anticipates entering into Phase 6.3, development engineering, in fall 2018. The full-scale engineering development phase will test and ensure the warhead meets military requirements. The next phases in the effort are (Phase 6.4) production engineering, (Phase 6.5) first production, and (Phase 6.6) full-scale production. The LEP will implement the design option ultimately down-selected by the Nuclear Weapons Council.



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 the W80-4 warhead. Prior to the Stockpile Stewardship Program, the nation benefited from nuclear test results to validate and adjust computational models of warhead performance and safety. The science-based Stockpile Stewardship Program provides improved knowledge of the underlying physics and engineering through improved understanding validated by modern experiments. Certification of the life-extended warhead will be informed by extensive component testing, high-fidelity and predictive warhead simulations that model the integration of a life-extended warhead into a new missile, and high-fidelity flight tests. A few key facts about the program are listed below:

- The Stockpile Stewardship Program resolved the long-standing energy balance anomaly, removing a major source of disagreement between simulations and test data on past nuclear events.
- Data on material equations of state—how materials behave at extreme pressures and temperatures—have advanced and evolved our understanding, making possible greater predictive modeling not available during the nuclear testing era.
- High-performance computing advances are enabling a shift from 2D to 3D modeling, with a special focus on uncertainty quantification, alleviating 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, are providing data important to informing confidence in the weapon's performance models.
- Predictive warhead lifetime models are being developed to ensure confidence in extending warhead lifetimes, as are non-destructive evaluation tools to assess component health and preserve assets.
- Significant advancements in manufacturing are improving the quality of replacement components.
- The warhead 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, will ensure warhead safety and reliability.

Key Focus Areas

- Maintaining effective interagency and defense-contractor–vendor communications and coordination
- Developing and maturing technologies including advanced manufacturing technologies
- Monitoring Phase 6.2A deliverables and time lines
- Program execution according to NNSA's product realization requirements
- Reconstituting insensitive main-charge explosives to match legacy materials no longer produced
- Preparing new booster explosives with greatly improved safety performance
- Developing the staff and tools required for program execution using Earned Value Management techniques

Principal Sponsorship

- DOE, NNSA, NA-10 Defense Programs

LLNL-MI-757417
This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.
August 29, 2018