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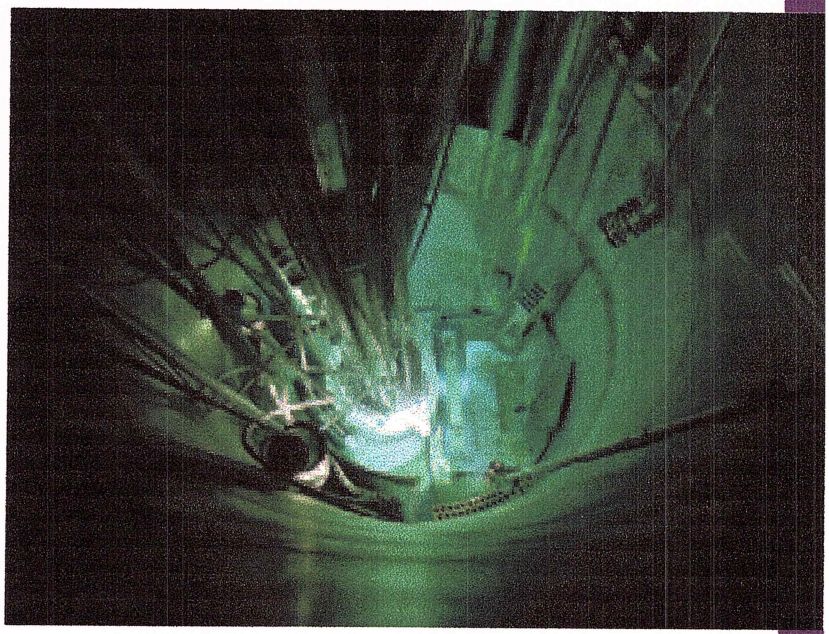
We are using a new ion beam analysis facility to measure—nondestructively and in depth—the constituents of neutron generator targets and sources. This facility, coupled with new plasma diagnostics and shock-physics capabilities, serves the neutron-generator program.

The Annular Core Research Reactor was modified to provide hostile environment testing for weapon components. The reactor was reconfigured for pulse operation with experiments located in the center of the reactor.

We completed the most detailed validation experiments ever performed on a nuclear weapon reentry body. These experiments successfully identified modes of vibration and discovered significant variability from unit to unit. The data will be critical to the validation of high-fidelity models for the nonlinear behavior of real weapon structures.

The W76 joint test assembly (JTA) telemetry system was employed in a reentry body, which was launched from a submarine, resulting in a successfully scored weapon-system test. The test validated advancements in radiation hardening, as well as the efficacy of Sandia's design methodology. An important first for this design was the digitization and transmission of neutron and firing-system waveforms. This system is significantly more complex, having 10 times the data rate of the original, yet the production costs are significantly less.

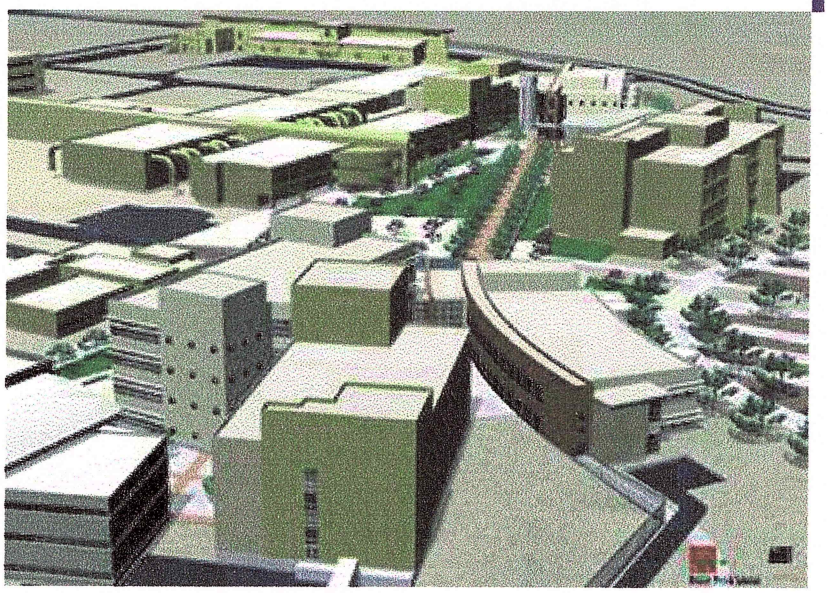


Inside Sandia's Annular Core Research Reactor.

Engineers from Sandia and Lawrence Livermore national laboratories have begun a significant effort to develop a radically new W87 JTA telemetry system that will meet all of the needs of the Weapons Evaluation Groups, the Nuclear Design Lab, and the U.S. Air Force in a single instrumented reentry vehicle. The new system will acquire and transmit real-time test data from a test vehicle that will closely represent all aspects of a real nuclear weapon, including high-explosive initiation. This endeavor will enable the use of a single vehicle to meet the needs of multiple customers, thus achieving cost savings and more flexibility in the nuclear weapons flight test program.

A Sandia team in collaboration with Lawrence Livermore National Laboratory and Lockheed Martin Corporation designed and successfully flight-tested a warhead concept under the Submarine-launched Warhead Protection Program (SWPP). Warheads currently deployed by the U.S. Navy were designed and certified prior to cessation of underground nuclear testing and the closure of major NNSA weapon component facilities. The SWPP project investigated future options and exposed new staff to this important national security mission.

Submarine launch of the Tomahawk Cruise Missile.



Artist's rendering of the Microsystems and Engineering Sciences Applications (MESA) complex. MESA is the largest construction project in Sandia's history.

Microelectronics Development Laboratory.

• We continued developing future firing and fuzing systems that contain a wide range of new technologies. These technologies included the use of micro-machine and LIGA stronglinks (LIGA is a German acronym for a three-stage production process for fabricating microscopic parts), optical firing sets, and optical charging and triggering of capacitors. Through the use of simulation and rapid-prototyping tools and techniques, we were able to go from paper designs to hardware in less than a year. In addition, these tools allowed us to evaluate and solve a variety of design and manufacturing issues before prototypes were fabricated.

• Sandia has been a world leader in developing sensors that can "see, hear, and feel" substances or events thousands of times more sensitively than humans can. We continue to work on miniaturized sensors that monitor the health of nuclear weapons. The U.S. Navy W76-0/Mk4 Joint Test Assembly (JTA) redesign achieved production unit status, following a successful development flight test. The redesign replaced aging technology components in the existing 20-year-old JTA, which is used to test the continued conformance of a denuclearized version of the warhead. The new JTA collects significantly more state-of-health and critical performance data from onboard the reentry vehicle. This work has far-ranging applications in other missions, as described elsewhere in this publication.

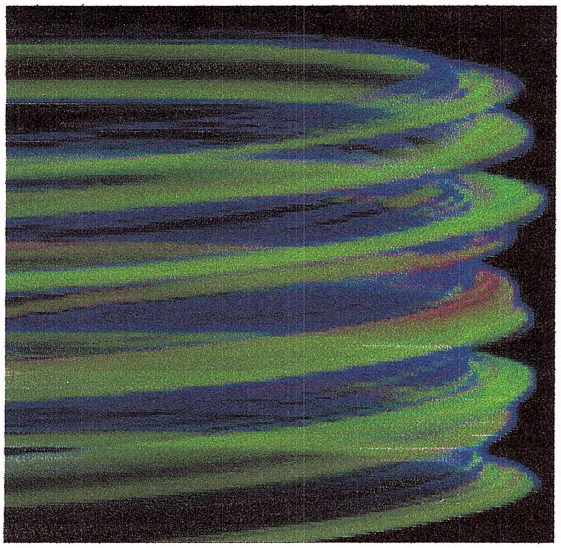
• For training, we completed a system that the U.S. Air Force will use to practice loading and handling operations. The Warhead Simulator Package is a key component of the trainer, which simulates the electrical functionality of a real War Reserve nuclear weapon. The new trainer provides a significant improvement by allowing military personnel to realistically practice performing lock/unlock and prelaunch arming/safing operations without using a real nuclear weapon.

Stockpile Life Extension Programs

• The W76 Trident and W80 cruise missile Stockpile Life Extension Programs (SLEPs) challenge Sandia to achieve technical innovations and employ new modeling and simulation tools. Sandia is developing new designs for the electrical systems, neutron generators, gas-transfer systems, and several new structural components. We also must achieve significant improvements in surety. Sandia designs and validates new War Reserve quality components that employ technologies often many generations ahead of the previous ones. These new technologies are far more reliable and many times lighter and smaller.

- We used the SALINAS massively parallel 3-D structural dynamics code and completed critical simulations of the W76 system's response to hostile radiation environments. Sensitivity and optimization analyses were performed on the firing and fuzing model using Sandia's DAKOTA software package. The CUBIT advanced meshing software generated a high-fidelity model for timing and scaling studies. This comprehensive system response simulation was an important milestone in the ASCI program.

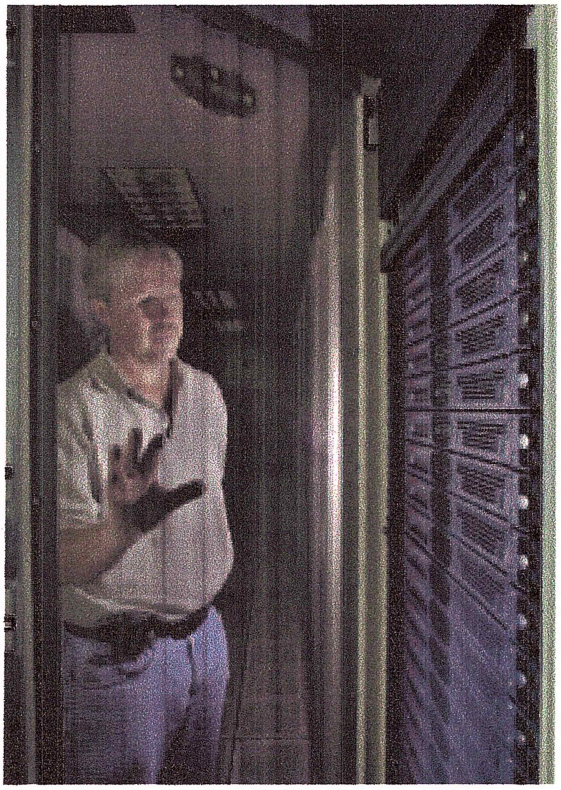
- We made significant advances in the parallel performance and physical fidelity of our suite of electromagnetics and plasma physics computational tools, named EMPHASIS. We used EMPHASIS to qualify systems in intense electromagnetic and X-ray environments, to design high-frequency electronics, and to model pulsed-power components.



This three-dimensional ALEGRA simulation is used to study the complexity associated with Z-pinch experiments.

- We used a microstructure model that can predict the accurate stress and failure response for component designs and manufacturing processes to optimize die design in a weapons component forging process. The model will lower the size and weight of automotive components, thus saving fuel and reducing emissions. Sandia was given an R&D 100 Award for the model.

- We adapted the Lightscape™ architectural lighting simulation to accurately model radiation transport in Sandia's Z accelerator, the world's most powerful electrical device and radiation source. Complementary research uses Sandia-developed software to find the optimal geometry for inertial confinement fusion components.



Carl Leishman examines one of many racks of computers that collectively form the basis of Sandia's Cplant system, the largest Linux cluster in the world.

- Sandia's Cplant team developed a flexible architecture for continued computing expansion and a testing strategy to ensure a quality environment for the users. Cplant is now a tri-lab computing resource, extending its access to sister labs and to the open community. Cplant, short for Computational plant, is now the largest Linux cluster in the world with nearly 2,000 Compaq Alpha nodes.

FACILITIES TO ADVANCE OUR MISSIONS

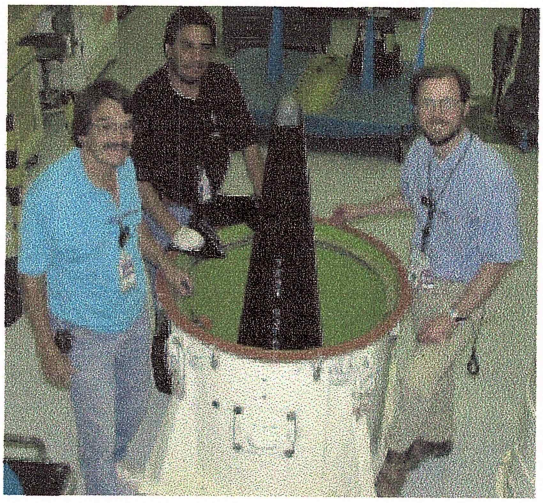
This year we dedicated the Processing and Environmental Technology Laboratory (PETL), a $46 million facility that brings together our materials science work. Materials science—the study of materials and the creation of new materials—is a longstanding Sandia strength. This state-of-the-art facility will advance our research and attract new scientists and new programs. Exciting new research and development of ceramics, composites, superconductors, and new supermaterials will occur here.

NUCLEAR DETERRENT REMAINS STRONG

Sandia is first and foremost a steward of our nation's nuclear weapons stockpile. A failsafe nuclear deterrent has long been vital to minimizing our nation's vulnerability to attack, and Sandia is central to keeping the deterrent ever ready.

Certifying and preserving the nuclear weapon stockpile remain our primary missions, and they continue to evolve due to changing defense strategies and the increasing worldwide proliferation of nuclear and other weapons of mass destruction in a post-Cold-War political environment.

Sandia's Lab Director C. Paul Robinson recently conveyed to the Secretaries of Energy and Defense his eighth annual assessment of, and confidence in, the continued safety and reliability of the U.S. nuclear weapon stockpile. The two secretaries integrate assessments from several sources into an annual stockpile certification statement to the President. Our technical staff support these actions with thorough work throughout the year to maintain the stockpile and to assess its continued capability. Sandia's work has earned an Outstanding rating from DOE for many years in its annual assessment of national laboratories. Further confirmation of this outstanding performance is provided in the following subsections which summarize key elements of Sandia's Stockpile Stewardship efforts.



Members of the W76-1 Stockpile Life Extension Program staff responsible for assembling flight test units include (from left) Reyes Chavez, Jimmy Aldaz, and Shawn Kerr.

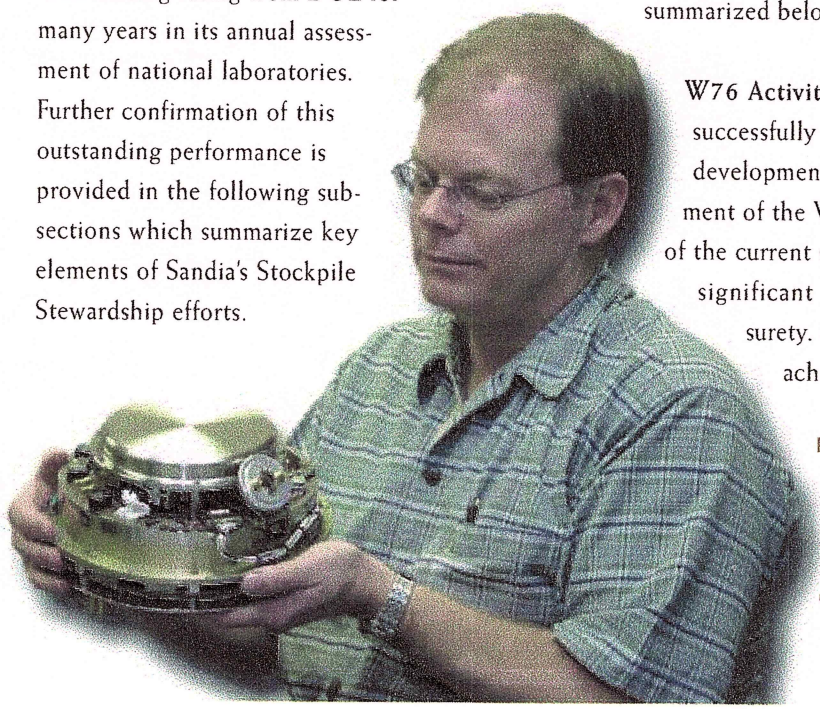
REFURBISHING AND SUSTAINING WEAPON SYSTEMS

The W76, W80 and W87 Stockpile Life Extension Programs (SLEPs) challenge Sandia to achieve technical innovations and employ new modeling, simulation, and testing tools and capabilities. Sandia is developing new designs for the electrical systems, neutron generators, gas-transfer systems, and several new structural components. We also are working constantly to maximize nuclear surety systems. Sandia designs and validates new War Reserve (WR) quality components that employ technologies that are highly reliable.

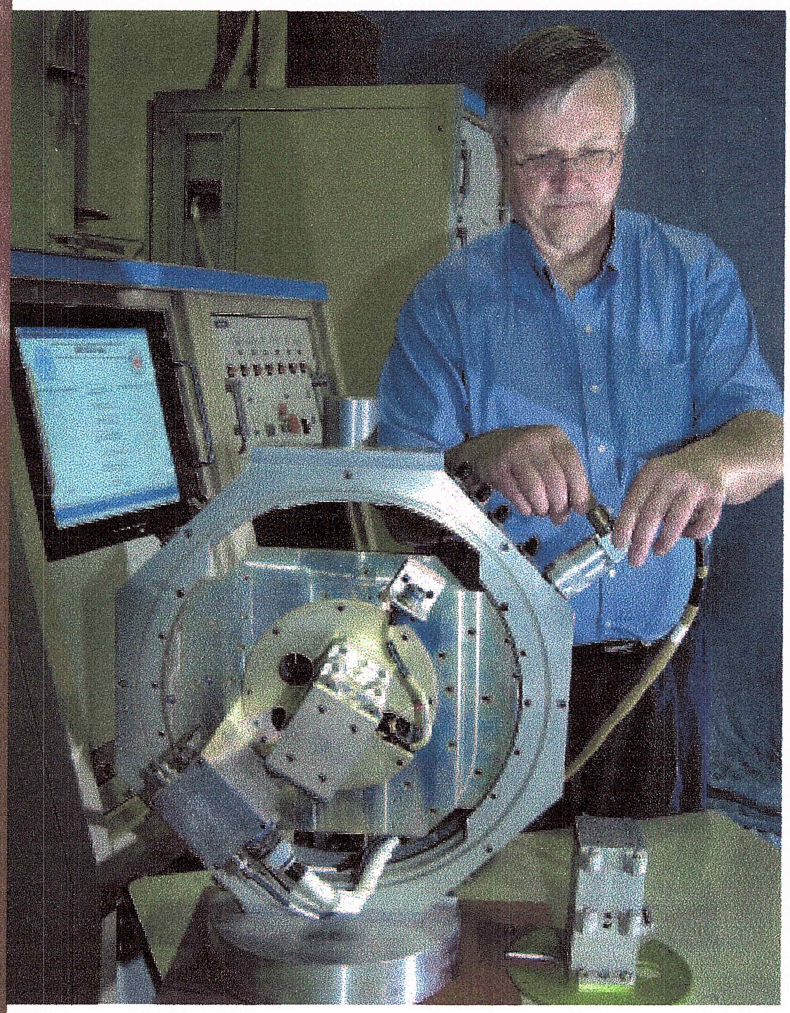
Additionally, as part of our annual certification process, we are continually evaluating component, subsystem and system performance, and where potential issues are uncovered, we are moving rapidly to address the problems.

Notable activities for critical weapon systems are summarized below.

W76 Activities: The W76-1 SLEP team successfully completed its second year of development engineering. The refurbishment of the W76 not only extends the life of the current system, but also incorporates significant improvements in weapon surety. Several significant milestones achieved this year include:



Rex Eastin displays a new telemetry subassembly for the W76-1 joint test assembly, JTA1. It is less than two-thirds the size of its predecessor. The compact design allows more data to be obtained from fewer test flights.



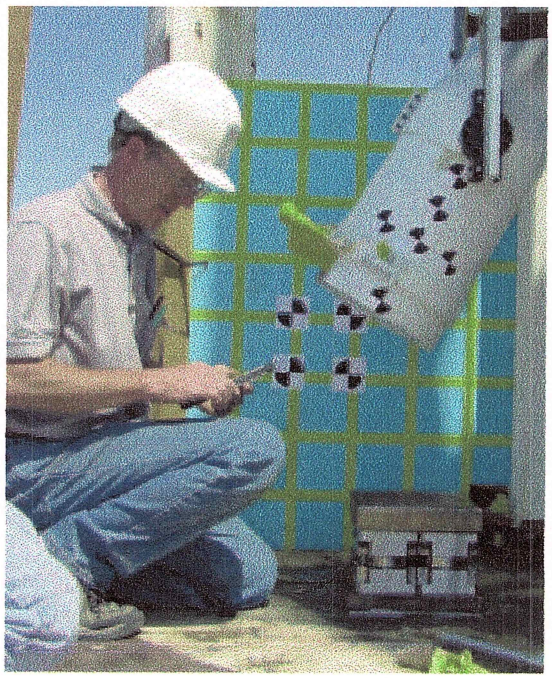
Richard Fitak runs tests with the W80 Command Disable System Tester that will be used at the Pantex Plant. Sandia engineers and technicians designed and built the tester.

- Critical reviews of requirements for the arming, fuzing, and firing subsystem and Joint Test Assembly conceptual designs were performed.
- Two reentry body validation tests were completed and our first Joint Ground Test in support of structural and thermal model validation and environmental specification was conducted.
- Our first flight test bodies were delivered in support of the Navy.
- A neutron generator was redesigned and qualified for the W76 warhead to provide additional surety in radiation environments.

This intensive two-year project successfully supported the stockpile needs without the benefit of underground tests. The W76 neutron generator is the first neutron generator developed and produced at Sandia and installed in the stockpile.

- The W76-1 Arming and Fuzing Subsystem (AFS) integrates radar, flight computer, and diagnostics in a single compact assembly. The design is meeting aggressive cost goals through use of commercial off-the-shelf parts, innovative packaging, and automated production processes. The project team has delivered the first two AFS flight test units on schedule.

W80 Activities: The W80-3 SLEP team successfully completed its second year of development engineering, including recovering from a five-month congressionally mandated work stoppage, and is rebaselining the project timeline and budget. The refurbishment not only extends the life of the current warhead, but also incorporates significant improvements in weapon surety. The W80-3 refurbishment also represents an in-depth collaboration with the Advanced Simulation and Computing (ASC) program to develop and



W80-3 system abnormal environment drop test was completed at Sandia's drop test facility.