



Sandia Lab News
February • 2007

Labs Accomplishments 2007

 Sandia National Laboratories



Among Sandia's top achievements in 2006 was being named to lead and coordinate the efforts of institutions working toward a permanent repository for radioactive waste at Yucca Mountain, Nev. The goal is to deliver to the Nuclear Regulatory Commission by June 2008 a defensible

license application demonstrating that Yucca Mountain will meet all federal requirements as the nation's repository for high-level radioactive wastes. A viable repository for high-level waste is a priority in US nuclear energy policy. More on page 9.

To all Sandians:

Welcome to this year's edition of the *Lab News Labs Accomplishments*.

This publication is one important way many of the Labs' technical and operational achievements are noted. Once again our accomplishments are top-notch, and they speak to the high caliber of our people and partners.



Tom Hunter

It has been my privilege to lead this laboratory this past year, which included an opportunity for the management team to reexamine and rearticulate our intent as we move forward. The resulting Strategic Plan describes our capabilities at the highest level. I do hope you have had a chance to read it.

The 164 individual achievements noted in this document give us a sense of our capabilities from another perspective; collectively, these *Labs Accomplishments* tell us what we have done and what we can do when we apply our minds and our efforts to today's biggest national security problems.

Seeing these accomplishments collected in one place is a reminder to all of us that achievement of our strategic intent comes both from careful execution of our plan and from the drive that is inside each of us to fulfill the promise of our mission statement: to provide an "exceptional service in the national interest." Thank you for all you do.

Tom Hunter, Sandia Laboratories Director



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Cover photographs by Randy Montoya

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This year's *Labs Accomplishments* publication recognizes some of Sandia's best work during 2006, as submitted by center offices and selected by the division offices. Each citation is followed by the center numbers of centers that contributed most directly to the effort described.

This year's publication includes an acronym after each accomplishment that indicates which of Sandia's strategic management units (SMUs) or strategic management groups (SMGs) the work most directly supported. The SMG/SMU acronyms are:

- NW: Nuclear Weapons SMG & SMU
- ITS: Integrated Technologies & Systems SMG
- DS&A: Defense Systems & Assessments SMU
- HS&D: Homeland Security & Defense SMU
- ER&N: Energy, Resources, & Nonproliferation SMU
- ST&E: Science, Technology, & Engineering SMU
- IES: Integrated Enabling Services SMU



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Sandia National Laboratories

Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a subsidiary of Lockheed Martin Corporation and a prime contractor to the US Department of Energy's National Nuclear Security Administration.

Nuclear weapons

Power Sources Group 2520 submitted a new thermal battery for the **W76-1 Lifetime Extension Program** on schedule and within budget. This is the **first new thermal battery designed** by Sandia in nearly two decades. The design incorporates new electrochemistry using an advanced cobalt disulfide cathode material and a low-melting-point ternary-salt electrolyte in order to meet tightly constrained, multiple voltage requirements over an extended performance period. Final development and production activities were completed in less than two years, including recovery from a late-stage supplier change. (2500, 12300, 1800, EaglePicher Technologies) NW



Thermal batteries, diamond stamped July 2006

An 18-month New Mexico/California **design competition for a Reliable Replacement Warhead (RRW)** culminated in August 2006 with delivery of the final design data packages. This aggressive development yielded designs to the customer in only nine months that are certifiable without the need for underground testing while providing significant improvements in weapon safety, security, and manufacturability. **Transformation of both the complex and stockpile** are enabled with these designs. The teams made their final presentations in September 2006 and are ready to begin development on the preferred design. (240, 1400, 1500, 2100, 2400, 2500, 2600, 2700, 2900, 5300, 8200, 12300) NW

The New Mexico Reliable Replacement Warhead team produced high-fidelity designs using a **classified model-based collaborative environment**. Design iterations were done in days rather than weeks or months. Sandia managed the Pro/E models and direct classified network access was provided to both design teams. This supported real-time control of component volume and mass properties requirements. Hydrotest hardware was built directly from solid models in a digital environment, which is now being used to guide transformation of nuclear weapons complex work processes and infrastructure. (2900, LANL, production agencies) NW

The Manufacturing Science and Technology Center provided key support for a recent Los Alamos National Laboratory **hydrodynamic explosive test** to evaluate the New Mexico Reliable Replacement Warhead (RRW) design. The Sandia team solved a critical test hardware design problem with a creative approach to building a near-net-shape part with a design that provided the strength required for proper machining and performance. The successful hydrotest provided additional confidence in the RRW-NM design. (2400) NW



The expanding fireball from a Sept. 6, 2006, Reliable Replacement Warhead hydrotest at Los Alamos National Laboratory's Dual Axis Radiographic Hydrotest (DARHT) facility is shown a fraction of a second after detonation. Center 2400 personnel built critical components used in the test.

Sandia was chosen by NNSA's Deputy Administrator for Defense Programs as the **lead for technical services for system integration within the nuclear weapons complex**. Under the guidance of the Principal Assistant Deputy Administrator for Operations, Sandia will provide technical services for federal program managers in planning, research, analyses and studies, integrated schedule management, and maintenance and improvement of federally directed requirements processes. Systems Integration Technical Support Center 500 has been established to focus efforts on key topics such as program integration and planning, analyses supporting Complex 2030, and future stockpile planning. NW

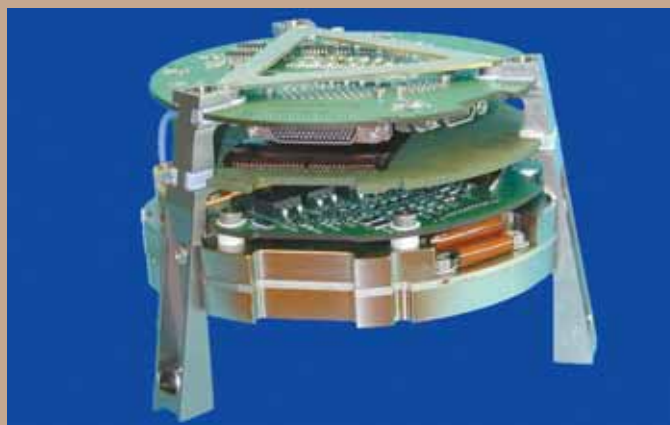
The Qualification Alternatives to the Sandia Pulsed Reactor (QASPR) project accomplished key testing and modeling milestones in FY06. In 132 days of testing, more than **3,900 transistors were characterized at SPR** prior to its shutdown. The testing included unique collection of data at low temperature (20 K) to aid in the understanding of neutron damage to electronics. The development and demonstration of two-dimensional computational modeling of a silicon bipolar junction transistor's response to

neutron damage was a critical step to developing a predictive capability. (1100, 1300, 1400, 1700, 2100, 6700, NNSA Sandia Site Office) NW

After 5½ years dormancy, the **Sandia Pulsed Reactor (SPR-III)** was removed from an in-ground storage vault, reassembled in the SPR Kiva, and activated as a nuclear facility in the beginning of FY06, with the first programmatic operation taking place on Jan. 18, 2006. The reactor operated safely for 159 days and conducted 563 operations before being shut down Sept. 30, 2006, per the Secretary of Energy's directive. This complex experiment campaign supported critical survivability **qualification testing for the W76-1 Lifetime Extension Program** and the Qualification Alternatives to the Sandia Pulsed Reactor (QASPR) project. (1300, 10300, 4200) NW

The hostile-environment **qualification of the replacement W78 neutron generator** was supported by key calculations performed using the Red Storm supercomputer. These calculations involved radiation transport analysis with Sandia's Integrated TIGER Series (ITS) code. On Red Storm, these calculations ran 14 times faster than on the retired ASCI Red supercomputer, allowing for more timely design and qualification decisions for this stockpile component. (1300, 1400) NW

As part of Phase 6.4 Production Engineering efforts, the W76-1/Mk4A Lifetime Extension Program matured the design definition and achieved successful **component producibility reviews**. System and arming, fuzing, and firing (AF&F) qualification activities included successful testing as well as significant progress in modeling and simulation of system performance in normal, abnormal, and hostile environments. The project **flew four test bodies on FCET-35**, the submarine-launched ballistic missile Follow-On Commander's Evaluation Test. These major milestones are critical to the overall W76-1 project and helped to build significant confidence with our customers. (2100, 1500, 1600, 1700, 1800, 2500, 2600, 2900, 8200, 5300, 12300) NW



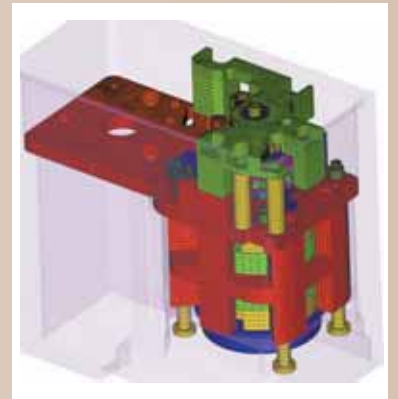
The W76-1/Mk4A arming fuzing subsystem (AFS) flew on the submarine-launched ballistic missile Follow-On Commander's Evaluation Test (FCET-35). This critical program milestone proved the AFS integrates into the arming, fuzing, and firing subsystem, interfaces with other Sandia-designed subsystems and the D5 missile, and accurately fuzes in a flight environment. FCET-35 was the first flight test of the Permafrost application-specific integrated circuit (ASIC) designed and fabricated at Sandia. This allowed the AFS team to continue preproduction activities at the Kansas City Plant and remain on schedule and under cost targets. (5300, 2100, 1700, many others) NW

Sandia met first production unit and product qualification deliverables for the **W76-1 intent stronglink, trajectory stronglink, and launch accelerometer**. These components are complex electromechanical subsystems that are key elements in the normal and abnormal nuclear safety capability of the W76-1 arming, fuzing, and firing systems. (2600, 1500, 1700, 1800, 2100, 2900, 12300, Kansas City Plant) NW

New materials sets and designs were developed for **header applications for an intent stronglink**. Glass ceramic-to-metal sealing technologies and header designs that are hermetic during exposures to 500 psi (3.4 MPa) and 1,292 degrees F (700°C) were prototyped using single-pin seal tests. The successful design depended on materials compatibility, minimization of residual stresses, and meeting electrical performance requirements. The design and materials sets are compatible with manufacturing constraints and capabilities, enabling the development of new more **producible and reliable designs for weapon components**. (1500, 1800, 2400, 2600) NW

The W76-1 intent stronglink (ISL) previously demonstrated the potential to unlock when the W76-1 was dropped, raising a nuclear safety issue. **Tests at various drop heights** demonstrated

dynamic characteristics of the ISL that were highly chaotic and unpredictable. A team of systems and components engineers, analysts, and experimentalists was tasked with resolving the problem. Using experimentally validated computer simulations, advanced statistical methods, and a new energy-based method for synthesizing input shocks, handling gear was designed that allowed "remain-locked" reliability predictions to reach levels greater than 99.99 percent. (1500, 2600, 2100) NW



Structural finite-element model of the W76-1 intent stronglink

Engineering modeling and simulation analysis played an important role in the **redesign of the B61 spin rocket motor (SRM)**. A team from Centers 1500 and 2500 provided timely engineering analysis to assess design requirements associated with the SRM, as well as recommendations to improve various aspects of the design. Sandia's expertise in reactive materials, compressible fluid flow, material thermal response, and stress analysis, and the availability of multiphysics modeling and simulation capabilities, were critical to understanding the fundamental physics and providing timely recommendations for redesign. (1500, 2500, 2100) NW

In support of NNSA's Pantex Throughput Improvement Plan, Sandia teamed with Pantex and Lawrence Livermore and Los Alamos national laboratories to ensure **safe, secure, and effective operations at Pantex**. Sandia led a value-stream analysis with anticipated improvements in efficiency of 30-50 percent for Pantex weapon operations (assembly, disassembly, dismantlement), streamlined requirements for dismantlement and inspection operations, helped achieve SS-21 (Seamless Safety for the 21st Century) safety authorizations for the W87 and B61, led an effort to expand the use of electrostatic dissipative flooring, and helped meet critical special tooling needs. (200, 2100, 8200) NW

(Continued on next page)

Nuclear weapons

(Continued from preceding page)

As the culmination of three years of effort, the Nuclear Weapons Strategic Management Unit (NWSMU) earned a quality management system registration from the International Organization for Standardization. **ISO 9001 registration** was presented after the ISO organization, which has representation in more than 90 nations, determined the quality system of the NWSMU, including its manufacturing science and technology and neutron generator production activities, meets international standards. The NWSMU management information system was identified as a best practice during the pre-audit. (200) NW

Six W76-1 thermal qualification tests were performed in FY06, five in the newly commissioned Thermal Test Complex. Keys to the tests were an integrated test/modeling and simulation approach, extensive instrumentation and diagnostics on test articles, uncertainty quantification of measurements and simulations, and tight integration with customer requirements. **Environmental fire conditions** created during these tests included the use of high-intensity radiant heat quartz lamps to simulate mock fires, weapon exposure to a real propellant fire, and a first-of-a-kind wind-driven jet fuel fire test. (1500) NW



W76-1 re-entry body qualification test in wind-driven pool fire

A multi-site team led by Center 2400 completed a successful **first-ever qualification of the Laser Engineered Net Shaping™ (LENS®)** process for a weapon component. LENS, developed and licensed by Sandia, builds and repairs components directly from a computer model using metal powder and a laser. This NNSA Office of Stockpile Technology-sponsored project also evaluated mechanical properties, machinability, hydrogen compatibility, and corrosion resistance of LENS parts. (2400, 8000, Kansas City Plant, Savannah River National Laboratory, Y-12 National Security Complex) NW

The Concurrent Design & Manufacturing (CDM) program completed development and qualification of **38 custom-made high-reliability components for the W76-1** Lifetime Extension Program (LEP). Twenty-five of these components were newly developed for the W76-1 LEP, and 13 were previously designed for use in other weapon systems. During FY06, CDM completed the qualification evaluation lots for 17 separate components. As of the end of the fiscal year, all 38 components were fully qualified for use in the W76-1 warhead, joint test assemblies, and trainers. (2600, 1700, 2500, 2100) NW

The Nuclear Weapons Strategic Management Unit created a process that enhanced the ability to deliver on time the **Performance Evaluation Assurance Report** to the NNSA's Sandia Site Office. Improvements in project management and data collection were accomplished using the Lockheed Martin Lean Six Sigma tools for establishing a better way of conducting business. The results provided a timely and thorough descriptive evidentiary summary of all nuclear weapon related work at Sandia as defined in the NNSA Performance Evaluation Plan for FY06. (200) NW

Impact Fuzing and Firing Dept. 2626 received a **qualification evaluation release for a Terminal Protection Device (TPD)** authorizing product builds to support the W76-1/MK4A Lifetime Extension Program. The TPD is an electromagnetic radiation filter designed to protect the arming, fuzing, and firing system electronics from damage due to system-generated electromagnetic pulsed voltages and currents. The product began entering the W76-1 cycle beginning in November 2006, with production at the Honeywell/Kansas City Plant to continue for several years. (2600) NW

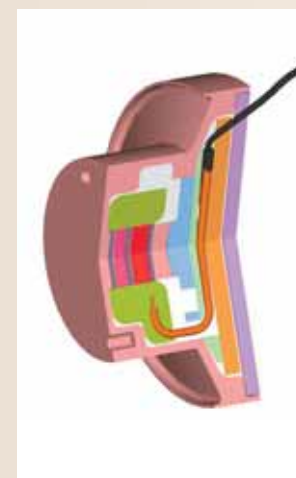
Expansion of the Code Management System's (CMS) capabilities has been completed and the system is now fully implemented by all military users. On Sept. 29, 2006, the software, training products, technical publications, and training were completed for the US Strategic Com-

mand/Air Combat Command/Navy Depot application of CMS. CMS now supports the W80-0 and the code enabling switch in addition to the B61-3,4,7,10,11; W80-1; B83-0,1; and W84-0 warheads previously supported. Thirteen months of development culminated in the completion of this NNSA Level 2 Milestone ahead of schedule. (1700, 1800, 2000, 2100, 2400, 2900, 4200, 5600, 5900, 6300, 12300) NW

The W76-1 Impact Fuze Product Realization Team (PRT) obtained an acceptable qualification evaluation release. This allows the Kansas City Plant to **proceed with production**. The PRT was challenged with reclaiming 30-year-old impact fuzes from W76-0 arming, fuzing, and firing systems and converting them to W76-1 impact fuzes. This involved harvesting W76-0 impact fuzes while maintaining interface compatibility, verifying functional performance following stockpile exposures, physically modifying the hardware to meet the W76-1 configuration, and proving the refurbished units met functional performance requirements. (2600, 2900) NW



Refurbished W76-1 impact fuze with coaxial cable



Impact fuze cross section

In August the standard approach for verifying a key parameter for War Reserve neutron generator targets became temporarily unavailable. A team was assembled to **formally qualify ion beam analysis (IBA) as an alternative test method**. IBA qualification was accomplished in three weeks, far less time than is normally required. Subsequently, 110 targets were qualified using IBA during the shutdown of the primary test method, allowing neutron tube and neutron generator products to continue to flow and be delivered on time. (2700, 1100, 12300) NW

The Neutron Generator Data Analysis System (NGDAS) realizes a 99 percent reduction in the time required to correlate design, manufacturing, and processing data with **neutron generator test and yield**. NGDAS integrates the data from the unclassified Oracle manufacturing system with the classified Product Tester System in a classified data warehouse. The system has been developed to dynamically accommodate ever-changing data-collection requirements while providing access to an infinite number of data combinations to meet the ad hoc data analysis needs of the various engineering disciplines (process, product, design, etc.). NGDAS received a **2005 Defense Programs Award of Excellence** for impact to the Stockpile Services Program. (2700, 4500, 6200) NW

QC Inspection Services Inc. successfully **integrated with the Responsive Neutron Generator Product Deployment Materials Value Stream** in 2006. The partnership facilitates incoming materials acceptance and aids in meeting center cost and schedule goals. This nationally accredited supplier completes inspections per Sandia inspection plans and uploads results from its site in Burnsville, Minn., to the Purchased Material Acceptance Application, an Oracle-based system used to manage acceptance. This resulted in real-time data at Sandia, a 32 percent decrease in cycle time, and an inspection cost reduction of \$500,000. (2700, 12300) NW

In September Neutron Generator Production was **awarded a Public Sector Shingo Prize**. The Shingo Prize is considered the "Nobel Prize of manufacturing" and is awarded to companies that have demonstrated application of lean principles to obtain world-class results and provide the best value to customers. By applying lean

concepts, Neutron Generator Production increased capacity by 67 percent, reduced inventory by 55 percent, realized cycle-time reductions of up to 75 percent, and accepted three new mission assignments without increases in budget or staff. (2700) NW

A joint Sandia/Kansas City Plant (KCP) team developed **major improvements in the Engineering Authorization (EA) release process**. EAs are the official agreements between the design agencies (such as Sandia) and a production agency (KCP) that authorize a product to be produced. After process improvements were implemented, 93.5 percent of EAs were released in less than 24 hours, and 99.8 percent of EAs were completed within 4.3 days — significant improvements over the previous average release time of 45 days. (2900, 8900, KCP) NW

Seventy-seven Man Portable Air Defense System (MANPADS) missiles were fired at the Tonopah Test Range in support of development of **next-generation missile warning systems**. The customer for this data was the Air Force Air Mobility Command, but the event was monitored by the Department of Homeland Security and allied participants from Canada, the UK, Australia, and New Zealand. The shoulder-fired missiles included both foreign and domestic assets. Ultraviolet, infrared, visible-spectrum, and acoustic signatures were obtained from the firings. Tonopah Test Range Dept. 2915 provided operational support. (2900) NW

MESA Microsystems Laboratory



The MESA (Microsystems and Engineering Science Applications) project achieved major milestones, including the **startup of the MicroFabrication Facility and new Microsystems Laboratory** that house 274 people from seven Sandia organizations. Overall the MESA project is ahead of schedule and on budget. The MicroFab is a 90,000-square-foot industrial facility that includes an ISO Class 4 clean room, 120 new semiconductor tools, and approximately 60 relocated tools from the Compound Semiconductor Research Lab. When complete, the MicroFab and MicroLab will replace the 50-year-old CSRL (Bldg. 893). NW (Photo by Bill Doty)

(Continued on next page)

Sandia, funded by the Defense Threat Reduction Agency to work with Lawrence Livermore National Laboratory and Holloman Air Force Base, executed two sled tests on the Holloman sled track. Two 5,000-lb-class heavy penetrators were instrumented to collect accelerometer and strain-gauge data. The tests provided penetrator researchers with information about nonmonolithic target setup and demonstrated the survivability of the Sandia-designed penetrator. The tests were completed within an aggressive schedule of 4½ months. (8200, 5400, 2600, 8700) DS&A



Nuclear weapons

(Continued from preceding page)

Critical Information Systems Dept. 6453 delivered a significant **upgrade to the NNSA's Office of Secure Transportation** in support of its mission. In September the department teamed with Communication Systems Dept. 6452, Cryptography and Information System Surety Dept. 5614, and Honeywell FM&T to deliver the upgrade to the Transportation Command and Control System. The delivery was the culmination of a four-year effort. The installation replaced outdated technology and was completed in three days while simultaneous hardware replacements were coordinated in five different locations around the country, including three at Kirtland Air Force Base. (6400, 5600, Honeywell FM&T) NW



ARG responders during exercise

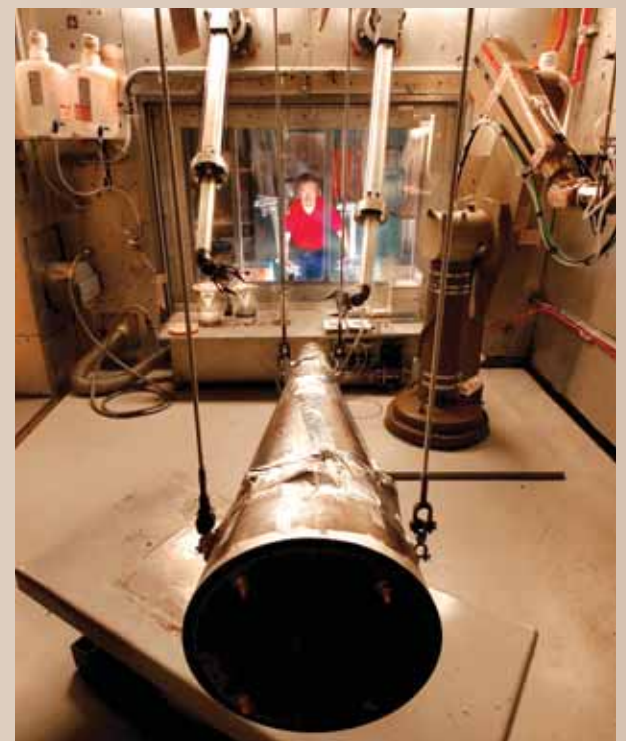
Last June the DOE/NNSA Accident Response Group (ARG), including ten Sandians, helped stage and **participated in a three-day demonstration and exercise** at F.E. Warren Air Force Base in Cheyenne, Wyo. The joint NNSA/DoD exercise for the NATO-Russian Council simulated an accident with a US Air Force payload-transporter van carrying a nuclear re-entry system. As part of the exercise the ARG gained entry to the van using a liquid-abrasive cutter, X-rayed the warhead, and performed final packaging. (12300) NW

Transition from the Peacekeeper missile, on which the Mk21/W87 re-entry vehicle was deployed, to Minuteman III required the DoD to modify its missile system to be compatible with the W87, and that Sandia and Lawrence Livermore National Laboratory (LLNL) qualify the warhead for the new application. Sandia and LLNL completed evaluations and tests to demonstrate that interfaces and environments were compatible, nuclear

safety requirements were met, and proper functional operation in flight tests was achieved. A major assembly release was approved in June, and the first Mk21/W87 was deployed on the Minuteman III in October. (8200, 8700, 1500, 2600, 2700, 2900) NW

Hostile shock testing of the W76-1 was completed at **Sandia's Light Initiated High Explosives (LIHE) facility**. Lateral and aft shock impulse tests of the W76-1/MK4A system were conducted to simulate exo-atmospheric cold X-ray-induced blow-off impulse during a hostile encounter. Structural dynamics response data obtained from the tests was used for **model validation of the Salinas structural dynamics computational model**. This was the first weapon system qualification test completed at the recently renovated LIHE facility since it was mothballed in 1992. (2100, 1500, 2500) NW

What happens to nuclear weapons in transit if the truck carrying them is in a severe accident? Nothing unsafe. That was the conclusion of a recent **study supporting safety basis reauthorization for NNSA's Office of Secure Transportation** over-the-road operations. The tri-lab team, led by Surety Assessment Center 12300 and managed by Security Systems and Technology Center 6400, used large-scale testing, modeling and simulation, analysis, and engineering judgment to evaluate weapon response outcomes for hundreds of thousands of accident scenarios. Over-the-road operations will be reauthorized until 2011. (12300, 6400) NW



Hostile shock testing of the W76-1 in Sandia's LIHE facility (Photo by Randy Montoya)



SafeGuard Transporter

Defense systems and assessments

The Thermal Spray Research Laboratory, in collaboration with Organic Materials Dept. 1821, has completed a process maturation effort for **protective coating technology** applied to electronics components critical to the security and defense of the United States. The effort has involved development and qualification of materials and processes, as well as writing of specifications, for industrial application of the technology. Technology transfer to outside vendors is underway. The work was jointly sponsored by the US Air Force and DoD. (1800, 2400) DS&A

The Defense Systems & Assessments Special Operations Initiative continues to make strategic contributions to and establish **Sandia's presence in the US special operations community**. Robert Spulak (5042) is an associate fellow of the Joint Special Operations University, which recently taught a two-week Special Operations Combating Terrorism course as part of the Regional Defense Counterterrorism Program. This DoD program educates and trains foreign counterterrorism operators and officials to enhance partner-nation capabilities. Robert taught the **class on weapons of mass destruction and terrorism** to 24 students from 17 countries, including Afghanistan, Oman, Philippines, Thailand, Niger, Ukraine, and Kazakhstan. (5000) DS&A

The fourth Global Burst Detector (GBD) for the Block IIF generation of Global Positioning Satellites (GPS) was delivered in April. The GBD is the NUDET (NUclear DETonation) detection flight payload funded by NNSA. The GBD delivery included the second **Enhanced Optical Sensor (BDYE) flight system**

designed and built by Sandia. The BDYE sensor provides a dramatic improvement in capability to detect and identify atmospheric nuclear detonations. The sensor reduces weight, size, and power requirements by a factor of 1,000 while providing improved performance. (5700, 5500, 5300, 2400, 1800, 1700, DRS Technologies, Scramtom, Inc., Grinding and Dicing Services, Inc., IC Interconnect, Raytheon Vision Systems) DS&A



GPS Block IIF

The Advanced Concepts Group and Sandia's Information Systems Analysis Center sponsored a **workshop on effects-based electronic information operations**. About two dozen experts in information operations from the DoD and other national security agencies joined Sandia staff for the two-day event, during which they developed concepts for assessing effects-based information operations. (7000, 5600) DS&A

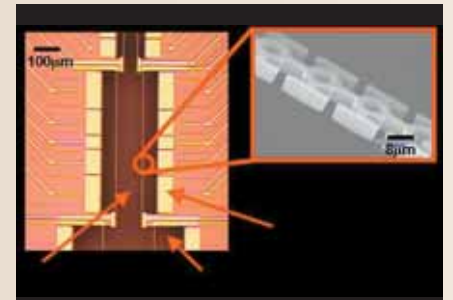
Sandia's Advanced Systems Program area achieved major milestones relating to the **mission, flight, and ground aspects of three major programs**. The efforts of approximately 300 FTEs (full-time equivalents) combined to provide system engineering, hardware, and software deliverables to the government customer, spacecraft contractor, and ground facilities. Advanced Systems projects continue to focus on accelerating the installation of state-of-the-art technology into high-payoff system applications to meet challenging national needs. (5700, 5500, 5300, and matrix partners) DS&A

Wi-Fi (802.11) technology was adapted for use as an **in-flight network for telemetry data**. The network reduces the required air-to-ground bandwidth by combining several spatially diverse data sources into a single stream. Networking also enables advanced sensors, directed satellite telemetry, and remote command and control. Two flight demonstrations for DoD programs were conducted from Sandia's Kauai Test Facility and the Kodiak Launch Complex. The missions demonstrated network communications throughout the duration of the flights. Additional improvements and flights are planned in FY07. (2600, 5400) DS&A

Sandia provided enabling theory, concepts, and designs for a project to develop an **Adaptive Thinking & Leadership (ATL) training system** for the US Army Special Forces. The training system is a game-based product developed to enrich classroom training. It is unique in that it hones **soldiers' skills in cultural awareness, communi-**

cation, mental agility, and negotiation rather than in tactical combat training. Sandia was awarded a certificate of appreciation for patriotic civilian service from the Army for this effort. (6300) DS&A

A National Security Agency Disruptive Technology Office ion trap foundry activity by MESA researchers has microfabricated **micrometer-scale linear Paul traps**. The ion trap chip consists of metallic electrodes on a silicon substrate and has been used by National Institute of Standards and Technology-Boulder researchers to trap crystals of magnesium ions, which can serve as quantum bits.



Optical and scanning electron micrograph images of Sandia microfabricated ion traps

This demonstration is a significant step toward making more complicated systems of integrated traps that can serve as the **basis of a quantum computer**, which would provide exponential speedup versus classical computation and have important applications such as cryptanalysis. (1700) DS&A

Cognitive and Exploratory Systems Dept. 6341 delivered CDMTS-AAR to the Navy Air Warfare Training Development program. CDMTS-AAR, a **software application to support debriefing and performance measurement** for simulation-based training, has been accepted by the MH-60R program for inclusion in tactical operational flight trainers currently under development. (6300) DS&A

(Continued on next page)

A first-ever **electromagnetic launch and successful operation of a War Reserve payload**, including energetics and fusing, was conducted at Sandia in October.

The 50-lb modified naval countermeasures cartridge was launched from a Bldg. 9930 firing site to a tactically effective altitude demonstrating compatibility with electromagnetic launch systems. The work is a joint development of Sandia, Lockheed Martin Maritime Systems & Sensors (Littoral Ships and Systems), and Lockheed Martin Sippican in the Shared Vision program for advanced naval countermeasure launch systems and capabilities. (5400) DS&A



Electromagnetic countermeasures launcher live fire test in October 2006

The Integrated Military Systems Development Center coordinated **four launches from the Kauai Test Facility**. Two of the launches, conducted in April, were in support of the Missile Defense Agency's Critical Measurements and Countermeasures Program. The missions tested critical system elements and system-level issues and provided data that contributed to the Ballistic Missile Defense System risk-reduction effort. Two additional target launches took place in November and June in support of the Navy's AEGIS Ballistic Missile Defense System. The **targets simulated rogue missiles** and were successfully intercepted by the Navy's Standard Missile-3 Interceptor. (5400, 2600) DS&A

Medium-range target launch on June 22, 2006



Defense systems and assessments

(Continued from preceding page)



Division 8000 is supporting the **Non-Line-Of-Sight Cannon (NLOS-C)** program, a part of the Army's Future Combat System, by collaborating with British Aerospace Systems and DoD laboratories for the development of laser ignition technology. Sandia is providing multidisciplinary solutions in a timely manner that has transformed an investigative project into a multiyear, multi-million-dollar program. (8200, 8300, 8700, 8900) DS&A

Sandia has developed a new family of flight computers called IMPACCT that addresses a national need for **economical computer solutions for high-consequence aerospace applications.**

IMPACCT embodies a flexible design concept that combines Sandia electromechanical sub-assemblies with commercial computer modules. Ongoing Sandia-sponsored graduate research at Kansas State University (KSU) has produced **student-inspired versions of IMPACCT.** Initial flight-testing occurred in FY06 and tests are planned on STARS Missile Defense flight tests in FY07. Four KSU students have obtained IMPACCT-related master's degrees and are helping sustain development and application efforts as Sandians. (5400, 5300) DS&A



IMPACCT-2K flight computer for missile defense applications

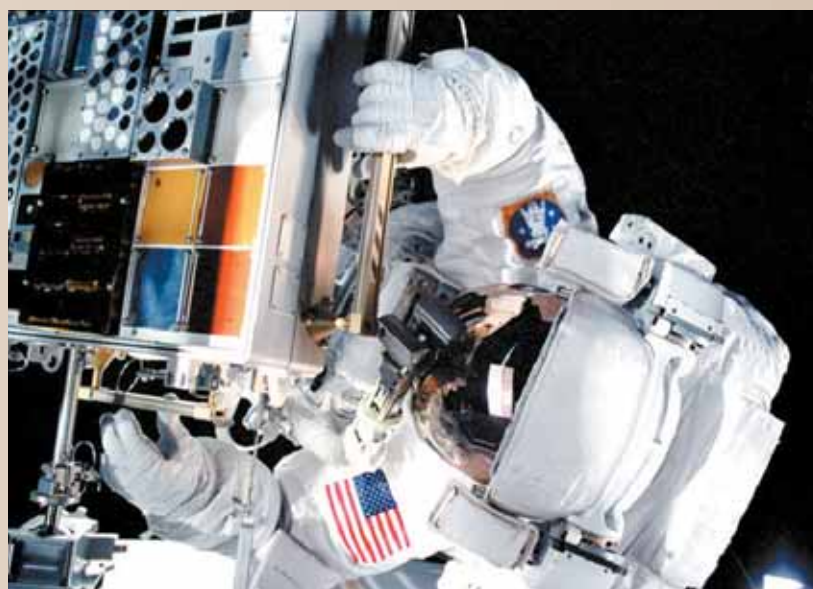
Sandia supported the Director of National Intelligence's postdoctoral research program, offering two-year fellowships to further postdoctoral **unclassified research in topics of interest to the intelligence community.** Sandians submitted 15 proposals to the broad area announcement call in February 2006, and as of October four of the projects were accepted. The program gives the postdocs and principal investigators the opportunity to learn firsthand the importance of science and technology to intelligence activities. (5900, 6300, 1700, 1400) DS&A

Ambassador John Negroponte, then-director of National Intelligence, presented the **National Intelligence Community Seal Medallion Award for Meritorious Service** to Charles Craft (5923). The Seal Medallion, the highest award given by the national intelligence community to contractor personnel, recognized Charles' expertise in analyzing and understanding foreign nuclear weapons programs and his contributions to US national security policy during his tenure as chairman of the Joint Atomic Energy Intelligence Committee (JAEIC) from May 1999 through October 2005. Charles continues to serve as the chairman of the JAEIC. (5900) DS&A

The Ground-Based Nuclear Explosion Monitoring Team configured, installed, and tested a new release of the **NNSA Knowledge Base** at the Air Force Technical Applications Center (AFTAC) in July. The Knowledge Base is designed to improve AFTAC's **subsurface nuclear explosion treaty monitoring capability** by providing detailed earth model information through various interfaces. Sandia recently worked closely with AFTAC to integrate the Sandia geophysical prediction software package into the National Data Center. The delivery process was modified to facilitate rapid, collaborative product development by NNSA laboratories and AFTAC researchers. (5500, 5700) DS&A

Development and application of the System-of-Systems Analysis Toolset (SoSAT), a modeling and simulation tool, achieved critical milestones in 2006. SoSAT is being used in support of the US Army's Future Combat Systems (FCS) to **assess and evaluate simulated combat missions** of FCS brigade combat teams (BCTs). FCS is designed to link soldiers to a wide range of weapons, sensors, and information systems to enable improved interoperability. The Army's Program Executive Office for Ground Combat Systems has adopted **SoSAT as the primary system-of-systems modeling and simulation tool** for evaluating modernization of current force BCTs. The initial release of SoSAT to the user community occurred in June. (6300, 1400) DS&A

A three-year effort to create **lightweight materials for space-based systems**, including piezoelectric polymer films for use as ultralight mirrors in space telescopes, has culminated in a collaborative effort with NASA Langley, Boeing, and others on a space-flight qualification experiment called **Materials International Space Station Experiment (MISSE).** MISSE consists of a large suitcase-type box holding materials samples and active measurement systems. MISSE 6 will launch in early 2007, orbit for two years attached to the outside of the International Space Station, and then return to earth for inspection. (5700) ITS



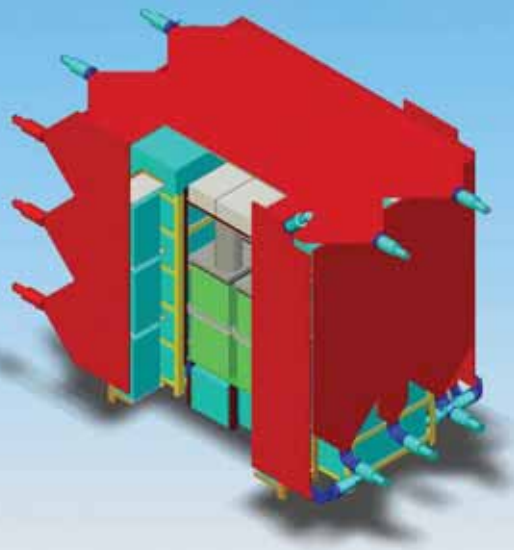
Astronaut space walk to place MISSE on the outside of the International Space Station (NASA photo)

The Structural Health Monitoring Program is improving health monitoring methods to keep pace with the growing size and complexity of aircraft structures. Conducted jointly with Boeing, the FAA, and several airlines, this effort produced a **microsensor for crack detection.** The sensor is permanently mounted in a distributed network to provide rapid, and potentially real-time, monitoring of critical regions of an aircraft. The certification effort produced the first allowable use of in-situ health monitoring sensors on commercial aircraft via inclusion in the Boeing Standard Practices Manual. (6400)

The Advanced Concepts Group hosted a workshop on **"War in 2035: The Role of Emerging Technologies."** The workshop was cosponsored by The Center for Strategic and Budgetary Assessments at the request of the Pentagon Office of Net Assessments. About a dozen invited experts on nanotechnology, bio- and neuro-technologies, and intelligent machines were joined by a handful of Sandians to discuss potential applications of these technologies in military conflict 30 years from now. They then discussed how these applications might significantly change warfare as we know it today. (7000) ITS

Nonproliferation

A team of Sandia and Lawrence Livermore National Laboratory researchers **deployed an anti-neutrino detector at a commercial nuclear reactor.** The detector, which applies technology developed for fundamental physics research, measured the reactor power history and fuel evolution from outside the containment building. This monitoring technique could find application in reactor safeguards regimes, verifying reactor operator declarations and **reducing the need for expensive physical inspections.** Several safeguards agencies have expressed interest in the deployment results, as have many academic neutrino physicists. (8100, 6700, LLNL) ER&N



An effort to **engage Iraqi scientists and engineers** currently supports 13 projects on a variety of topics, including radiation safety, materials science, energy, public health, and agriculture. An additional 12 projects are funded under the Iraq Research and Development Initiative, a joint program of DOE, the Department of State, and the Civilian Research and Development Foundation. All projects employ Iraqi scientists and engineers in meaningful civilian work, and many contribute to ongoing efforts to **rebuild sectors of the Iraqi economy** and support US government priorities in Iraq. (6700) ER&N

Sandia and Mechtronic Solutions developed a **small gamma radiation spectrometer.** This sensor is part of a larger system and required teaming with two outside organizations. A fully functional prototype was developed, integrated, and field tested in four months. The sponsor levied stringent new requirements, ordered a limited production run, and shortened the delivery timeline. The team met this new challenge and delivered all units on schedule. (5900, 2400, Mechtronic Solutions) DS&A

Sandia completed US-funded **security improvements at Russian Federation Navy nuclear facilities** two years ahead of schedule. The program seeks to enhance protective measures for nuclear warheads at more than 30 sites. Security improvements include the installation of intrusion alarms, access control systems, search and scan systems, access delay systems, and communications and response force upgrades. Special emphasis is placed on sustainable, maintainable systems. (6700) ER&N



Sandia researchers built and tested a prototype neutron scatter camera for the detection of special nuclear material (SNM). The camera images high-energy radiation from SNM, allowing visualization of shielded or smuggled material. The prototype camera has demonstrated this capability with excellent angular resolution (approximately 10 degrees) and sensitivity in the energy range of unscattered fission neutrons (1 to 10 MeV). A full-scale version has the potential to pinpoint a source's location while simultaneously obtaining its spectra. (8100) HS&D

Homeland security and defense



Designed for setup in one day, the Rapidly Deployable Chemical Detection (RDCD) system was tested recently in a 10-game Oakland A's homestand in Oakland's McAfee Stadium. The system protects high-profile events by sensing more than 40 different chemicals using multiple overlapping detection technologies and live video. The RDCD platform will also readily accept detectors that sense other threats, such as radiological detectors. (8100) HS&D

Initially deployed to detect outdoor terrorist attacks involving biological weapons, the Department of Homeland Security's BioWatch program was expanded to **detect attacks in public facilities**. Sandia is working with a multilaboratory team, including Lawrence Livermore, Argonne, and Lawrence Berkeley national laboratories, to deploy BioWatch monitoring devices at high-profile facilities nationwide. Sandia has helped lead the development of methodologies and evaluation criteria for indoor BioWatch deployment. Working with federal, state, and local officials, Sandia has designed and deployed detection architectures in numerous facilities around the country. (8100, 1500, 8700) HS&D

A late-start Laboratory Directed Research & Development project examined **armoring approaches against common types of improvised explosive device (IED) attacks** on light military vehicles in Iraq. The Rapid Response Armor project included analysis and explosive testing of flyer plates against layered armor targets consisting of rolled homogeneous armor steel, conveyor-belt rubber, and sand. This information was of considerable interest to military labs; the US Army Tank Automotive Research, Development, and Engineering Center; the Army Tank Automotive Command; and the Army Research, Development, and Engineering Command. (5400) HS&D

Experimental work has demonstrated convincingly that trace chemical detection can be used to **detect a mass of bulk explosive material in a moving vehicle**. Detection of TNT has been demonstrated at distances up to 45 feet, vehicle speeds up to 50 mph, and under various wind and temperature conditions. This research indicates that it may be possible to detect a large vehicle bomb in a moving vehicle by making use of trace detection technology. (6400, 2500, 6300, 1500) HS&D

Department of Homeland Security Secretary Michael Chertoff **dedicated the National Infrastructure Simulation and Analysis Center (NISAC)** at Sandia. NISAC, a partnership between Los Alamos National Laboratory and Sandia, integrates the laboratories' expertise in modeling and simulation of complex systems to examine both **natural and man-made infrastructure national security issues**. During Hurricane Katrina NISAC was a helpful resource to the US Northern Command (NORTHCOM), which has military responsibility for homeland defense. (6300) HS&D



NISAC building, dedicated in 2006 by DHS Secretary Michael Chertoff (Photo by Randy Montoya)

Sandia provided technical leadership in cyber and physical security testing and evaluation for the Department of Homeland Security's Cargo Security Program. Its goal is to help Customs and Border Protection officials **secure US borders against cargo threats**. Sandia's accomplishments include improved security of commercial devices, develop-



Cargo ship carrying containers like those tested as part of DHS's Cargo Security Program

ment of a security requirements document, and creation of a highly successful cross-organizational team to meet customer needs. (5600, 8200, 6700, 6400, 5300, Space and Naval Warfare Systems Command, Johns Hopkins Applied Physics Lab, Lawrence Livermore National Laboratory, Pacific Northwest National Laboratory) HS&D

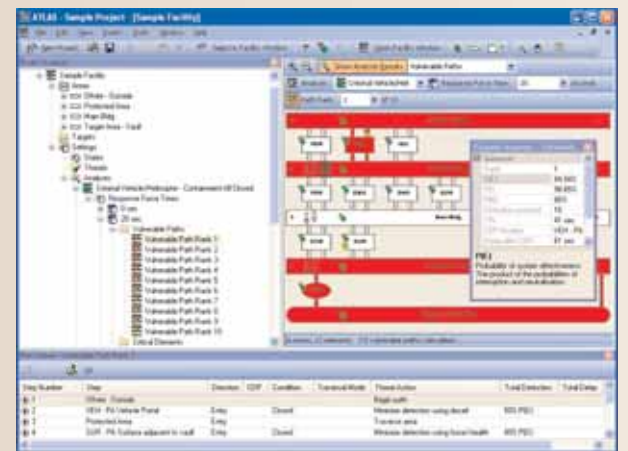


BROOM hand-held device for collecting samples

Sandia served as the security system integrator in a unique public-private partnership called LOGIIC: Linking the Oil and Gas Industry to Improve Cyber Security. Jointly funded by the Department of Homeland Security and industry, LOGIIC brought together 14 organizations to find ways to **reduce cyber vulnerabilities in process control systems**. The 12-month project identified new security sensors for process control networks and integrated them into a comprehensive, enterprise-scale monitoring solution for improved situational awareness. A Sandia-developed test environment was used to evaluate potential threats and demonstrate the LOGIIC monitoring system. (5600) HS&D

The Advanced Radar Systems project recently demonstrated the utility of **radar remote sensing in a proliferation detection scenario** involving material movement by truck and train. The demonstration was funded by DOE/NA-22 and featured both established radar technologies and technologies in development. (5300) HS&D

Sandia has team lead and system testing responsibilities for the Department of Homeland Security's Biological Warning and Incident Characterization (BWIC) system. BWIC will **help local agencies interpret and respond to a bioterrorism attack** by facilitating timely warning, attack assessment, communications, and effective response. The system is being piloted in five jurisdictions, with plans to deploy to tens of cities during the next four years. BWIC integrates monitoring and modeling capabilities from several national laboratories. (8100) HS&D

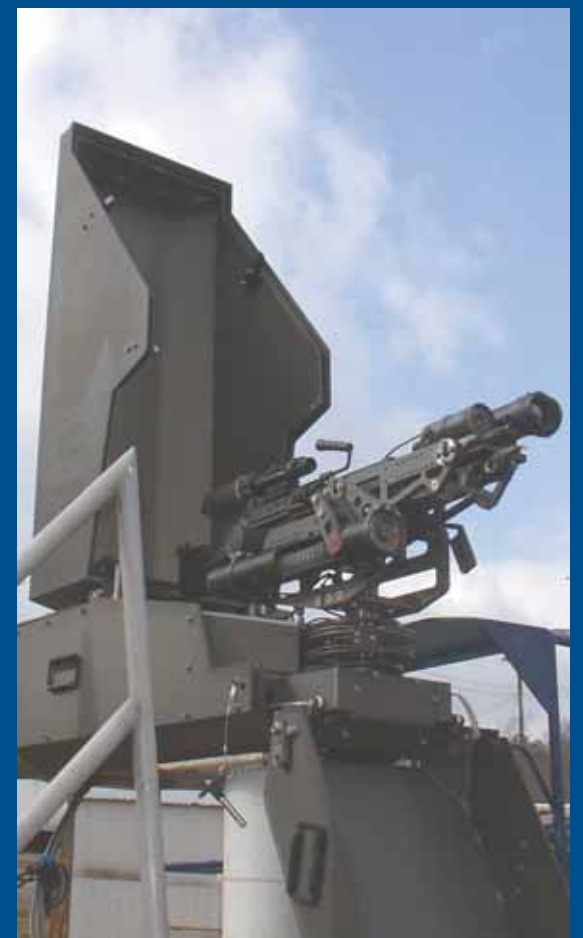


ATLAS 4.2 analyzing a potential vulnerability

DOE has secure facilities that protect nuclear assets from sabotage and theft. The Sandia-developed Adversary Time-Line Analysis System (ATLAS) is the **official tool used by all DOE vulnerability assessment analysts** to assess these facilities for vulnerability to intruders. ATLAS 4.2 was released in September, the culmination of six years of development. It provides users with a new user-friendly interface for modeling and analyzing productivity gains, as well as new capabilities to locate and address potential vulnerabilities. (6400) HS&D

Two projects were completed for the US Air Force at Whiteman Air Force Base, Mo., and in Guam. These involved installing systems to **support local force exercises** to develop tactics and formalize conduct of operations, and upgrading an installation using a remote ground satellite unit. (5400, 6400) HS&D

Remotely Operated Weapon System



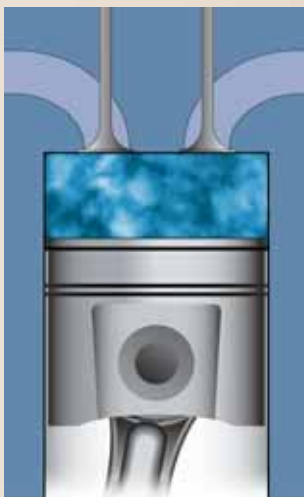
Sandia supported the development and installation of **remotely operated weapon systems (ROWS)** at the Y-12 National Security Complex. In addition to improving security, this deployment marked a dramatic transition point for the application of lethal technology at NNSA sites. The ROWS deployment at Y-12 was the first within the NNSA complex. It received an **NNSA Defense Programs Award of Excellence** in October. Two Sandians, Doug Smathers (5612) and Mike Williams (6431), were members of the award-winning Sandia/Y-12 team. (6400, 5600) HS&D

Energy and critical infrastructures

In January 2006 DOE's Office of Civilian Radioactive Waste Management asked Sandia to become the Lead Lab for Repository Systems. Sandia is making use of past experience with the Waste Isolation Pilot Plant and other projects to lead and coordinate the efforts of institutions working toward a **permanent repository for radioactive waste at Yucca Mountain, Nev.** The immediate goal: to deliver to the Nuclear Regulatory Commission by June 2008 a defensible license application demonstrating that Yucca Mountain will meet all federal requirements as the nation's repository for high-level radioactive wastes. (6700) ER&N

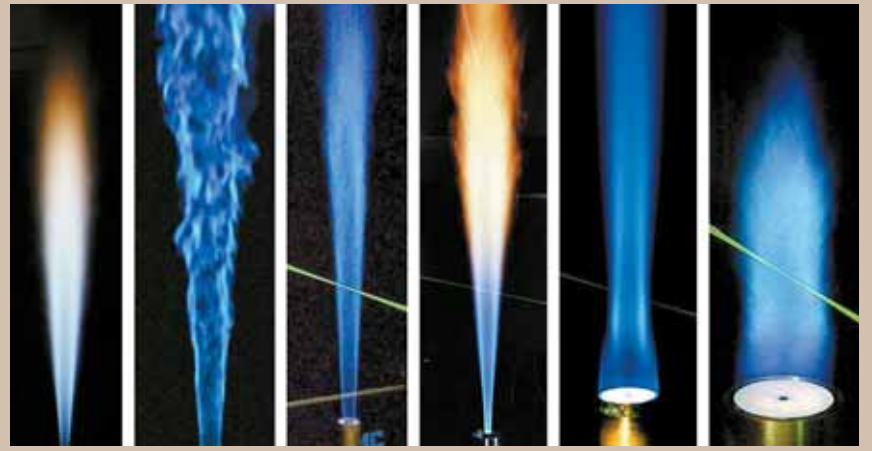
Sandia researchers conducted **spent fuel pool heat-up and propagation phenomena experiments** to study the nature of Zircaloy fires in boiling water reactor spent nuclear fuel under severe accident conditions and to validate the MELCOR accident analysis code. This phased experimental program featured first-of-a-kind electrically heated Zircaloy assemblies, prototypical fuel assembly hardware, and the latest high-precision pressure transducers. The laminar/natural convection data that resulted from the tests and collaboration with MELCOR code developers combined to create unprecedented confidence in MELCOR to accurately simulate spent fuel pool accidents. (6700) ER&N

Sandia is working with US engine manufacturers on a new **engine combustion process** called homogeneous charge compression ignition. HCCI can provide both **high fuel economy and ultra-low emissions** of nitric oxides and particulates. Although dubbed "homogeneous," recent Sandia research has shown that stratifying the temperature and/or mixture of fuel and air can substantially extend the load range of these engines, a problem currently limiting HCCI. The Sandia team was issued a patent for a mixture-stratification technique and a Society of Automotive Engineers award for a paper on thermal stratification. (8300) ER&N



Homogeneous charge compression ignition (HCCI) engine: Low-temperature combustion produces high efficiency and ultra-low NO_x and soot.

The Combustion Research Facility marked its 10th year of leadership of an international collaborative effort, known as the Turbulent Non-premixed Flame (TNF) Workshop, to promote the development and **validation of advanced models for turbulent combustion.** Simultaneous measurements of temperature and multiple species from a progression of flames studied under the DOE Visitor Program form the basis for evaluation of model results. The TNF series is broadly recognized for catalyzing progress toward predictive simulations. (8300) ER&N



These flames, studied during the course of the TNF Workshop series, illustrate a progression of model-validation cases from simple jet flame to piloted flame to flame stabilized by complex recirculation zones.

Sandia's solar energy groups played a key role in the development of the DOE Solar America Initiative (SAI), which seeks to bring **solar energy systems to cost competitiveness by 2015** for residential, commercial, and utility applications. As part of SAI, industry-led teams will focus on improving installed cost and performance of solar systems and will emphasize current and near-term viable technologies and manufacturing improvements. The new initiative includes a \$60 million budget increase for the DOE solar program. (6300) ER&N

The Center for Integrated Nanotechnologies (CINT), a DOE Office of Science nanoscience national user facility, dedicated its new Core Facility and Gateway to Los Alamos Facility in August. CINT is a partnership (Sandia/LANL and NNSA/DOE) designed to bring together researchers to bridge the gap between nanoscience discoveries and **nanotechnology-enabled solutions** to national security, energy, and water challenges. The new facilities include 130,000 square feet of laboratory, office, and clean room space for more than **200 user-initiated projects already underway** in nanoelectronics, nanomechanics, nanophotonics, nanostructured materials, theory, and simulation. (1000) ER&N



CINT Core Facility in Albuquerque

(Photo by Randy Montoya)

"This is the best thing to come out of Washington in a long time," said David Fish, plant manager of Breedlove Dehydrated Foods, a large food processor in Texas. His comment came after participating in a beta version exercise of CARVER+Shock, the **new food safety software tool** Sandia has developed for the Food and Drug Administration (FDA). The software package will assist the FDA in its legal responsibility to **ensure the safety of tens of thousands of food products**, basically everything other than beef, eggs, and chicken. (6700) ER&N

Sandia performed a comprehensive series of engineering tests on a newly **designed spent nuclear fuel transportation cask.** The scaled unit weighed 8,000 pounds. Test activities consisted of 30-foot drops at different orientations and pre- and post-drop leak tests. Diagnostic equipment included 18 cask-mounted accelerometers, thermocouples to record ambient-air and test-unit temperatures, high-speed digital video, and

real-time digital video. Disassembly, inspection, and component measurements were required as part of the program documentation. (6700, 6300) ER&N

Thermochemical cycles are one of the promising methods of large-scale production of **hydrogen from advanced nuclear reactors or concentrated solar energy.** DOE is investigating sulfur-based cycles, which require the high-temperature decomposition of highly corrosive sulfuric acid. Sandia has developed a new approach based on ceramic heat exchangers that eliminates the severe corrosion problems encountered in other methods. This technology was demonstrated in FY06 and will be used in international sulfur-iodine experiments and in a proposed scale-up demonstration at Sandia's Solar Tower facility. (6700) ER&N

Lithium batteries pose a significant hazard to workers when subjected to temperatures greater than about 160°C. An international team including VNIIEF (Russia), General Atomics, and Sandia received an R&D 100 Award for the development of a **solid-state high-temperature battery.** The fluoride-based battery is safer to use and more environmentally friendly than traditional lithium batteries and is suitable for high-temperature (250°C-plus) applications such as oil and gas and geothermal drilling, as well as numerous industrial applications. (6700, 6300, 2500) ER&N

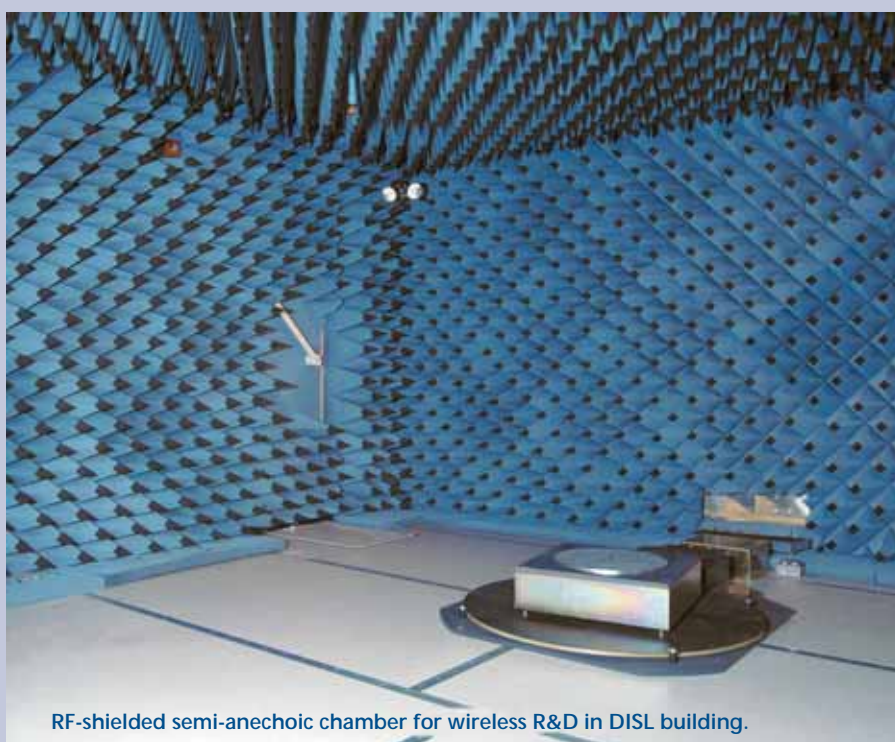


Prototype batteries. One was heated to 250°C and then crushed to demonstrate the battery's safety.

Federal regulations require the US Environmental Protection Agency (EPA) to **recertify DOE's Waste Isolation Pilot Plant's compliance** with performance requirements every five years. Sandia-led performance assessments are primary tools to demonstrate continued compliance. In coordination with five other organizations, Sandia incorporated EPA-specified model and parameter changes to address questions and issues of concern to the stakeholders and executed the work under a highly constrained schedule. Recertification was received in April 2006. (6700) ER&N

Engineering sciences

A 250-square-foot radio frequency-shielded semi-anechoic chamber was built in the Sandia/California Distributed Information Systems Laboratory (DISL) building. Located inside a vault-type-room, the chamber is designed to enable both **classified and unclassified RF research in the 400 MHz to 60 GHz range at 100 dB.** It is well-equipped with the latest network analyzers, turntables, antenna horns, and other equipment. The chamber can be converted to a fully-anechoic chamber for antenna pattern measurement. This unique resource will enable cutting-edge R&D for years to come. (8900, 8200, 8700) NW



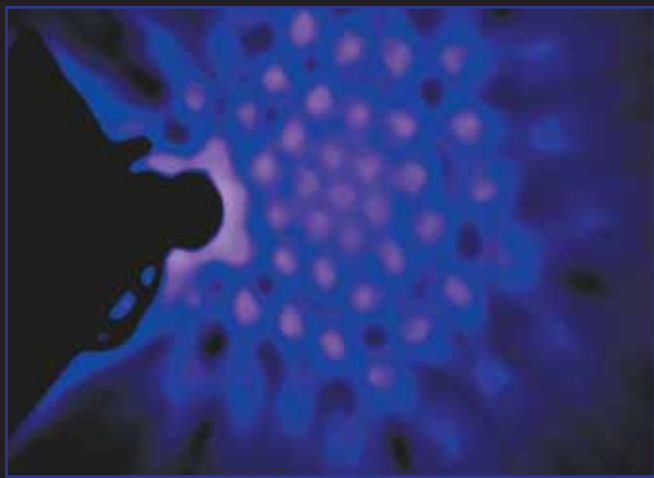
RF-shielded semi-anechoic chamber for wireless R&D in DISL building.

Science-based Engineering (SBE) embeds a scientific understanding of the physical phenomena underlying the operation of an engineered product in validated numerical simulations to improve the efficiency and responsiveness of Sandia's engineering process. Enabled by new computers, advanced computational algorithms, and high-fidelity numerical simulations, engi-

neering teams from every division **made significant progress toward the Labs-wide implementation of SBE.** Successful applications of SBE to projects in the Nuclear Weapons, Homeland Security & Defense, and Defense Systems & Assessments Strategic Management Units were completed in FY06, and future programs have committed to using SBE. (3)

Materials, chemistry, and physics

Energy Secretary Samuel Bodman traveled to Sandia to announce the establishment of a \$5-million-dollar-per-year **National Center for Solid State Lighting Research and Development**, which includes R&D from the five DOE nanoscience research centers. Sandia is designated as lead lab and is receiving approximately \$3 million per year for projects on plasmonic light-emitting diodes (LEDs), nanowire-templated substrates, quantum dot nanophosphors, and nano-engineered nucleation layers. In June Julia Phillips (1100) chaired a **DOE Basic Energy Sciences workshop** on "Basic Research Needs for Solid State Lighting" to identify additional fundamental research needed for this energy-efficient technology. (<http://www.sc.doe.gov/bes/reports/list.html>) (1100) ER&N



Light emission from an LED with an incorporated photonic lattice

Understanding why **thin films and solid surfaces spontaneously self-organize** into ordered patterns at nanometer-to-micron-length scales is a key challenge in nanoscale research. Sandia researchers combined quantitative real-time microscopy and atomistic modeling to understand the physics needed to manipulate nanoscale structures. Analyzing the **naturally occurring thermal vibrations** in these structures revealed that their ordering is accomplished by dislocations that accommodate the lattice mismatch between film and substrate. The value of such nanoarrays could be greatly enhanced if scientists can learn to tailor their properties. (8700) ST&E

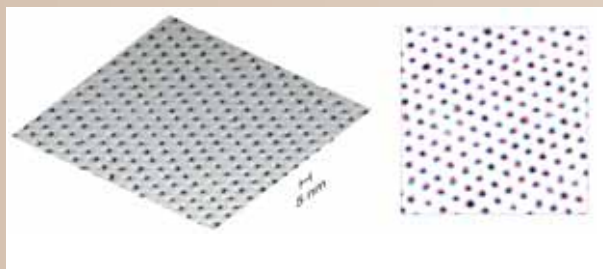
In response to the President's American Competitiveness Initiative, Sandia is developing a concept for national **Discovery Science and Engineering Innovation Institutes** that will be centered at the national laboratories. The National Institute for Nano Engineering (NINE) is being developed as the Sandia prototype Discovery Institute. Labs Director Tom Hunter and Chief Technology Officer Rick Stulen hosted a "**Summit on Accelerating Engineering Innovation**" meeting in June to initiate discussion of Discovery Institutes with industrial and academic partners. A subsequent partner meeting has developed an initial framework for NINE. (1800, 1000) ST&E

TuffFoam™, originally developed to protect weapon electronics from shock, vibration, and impact, is finding commercial applications. TuffFoam was developed under a DOE directive to identify a **replacement material for toluene diisocyanate**, a carcinogen and sensitizing agent. To date, two licensees are evaluating TuffFoam for the surfboard market. TuffFoam does not use ozone-depleting solvents common in commercial polyurethane foams. It is being considered for use in weapon systems and for other applications, including insulation and structural core applications. (8700) NW



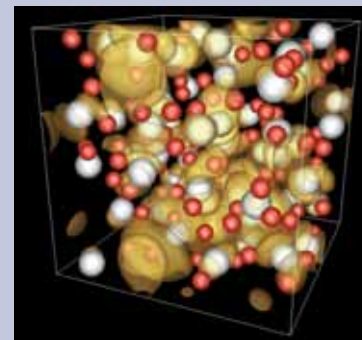
(Photo by Randy Montoya)

When the Pacific Northwest National Laboratory (PNNL) team leading the design of Tritium-Producing Burnable Absorber Rods (TPBARs) for NNSA's Tritium Readiness Program found an unacceptable level of **tritium being released into a Tennessee Valley Authority nuclear reactor**, Sandia was asked to help identify the cause of the excess tritium. Physics investigations and detailed modeling enabled PNNL to develop a new TPBAR design that is expected to meet US tritium needs while not exceeding acceptable tritium release rates. (8700) NW



Scanning Tunneling Microscopy (STM) image of a very regular array of vacancy islands (holes) embedded in a one-atom-thick silver film. At the right, an overlay of two STM images (red and cyan) acquired 12 seconds apart at 80 degrees Celsius shows the thermal vibrations in this self-organized lattice.

Theoretical work performed by the Pulsed Power Sciences Center has significantly altered our **understanding of the phase diagram of water at high energy densities**. The computational study shows that an electrically conducting phase of water could occur at a temperature of 4000 K and a pressure of 100 GPa. Although the need to better understand conditions on Sandia's large pulsed power Z machine is driving this research, the findings also apply to conditions that exist inside planets such as Neptune and could carry significant consequences for planetary physics. (1600) ST&E



A snapshot from a computer simulation of water at temperature of 4000 K, density of 2.5 g/cm³, and pressure of 100 GPa (hydrogen = red and oxygen = white). The electron density from a partially occupied electron state responsible for the conductivity is shown in gold.

Computing

The **airburst and impact of a 120-meter-diameter stony asteroid was simulated** using the Red Storm supercomputer.

Ablated meteoritic vapor mixes with the atmosphere to form an opaque fireball with a temperature of thousands of degrees. Scientists hypothesize that such a fireball could be responsible for the **creation of Libyan desert glass**. Sandia's work was featured in a documentary that was broadcast by the BBC in Europe and by the National Geographic Channel in the United States. *Discover* magazine named accounts of the work among its top 100 science stories of 2006. (1400) ST&E

The **Thunderbird Linux cluster** team made a splash in the high performance computing arena recently by showing a **significant improvement in machine performance** as measured by the Linpack benchmark. In a collaborative effort with Sandia, Cisco, and Dell, Inc., the team was able to achieve a performance of 53 teraflops using 8,694 processors, demonstrating an overall efficiency of 84.6 percent. The achievement, which was accomplished solely with software

modifications, marks an improvement of more than 38 percent from the previous performance and an 18.5 percent increase in efficiency per node. (4300, Cisco, Dell)



John Zepper examines a Thunderbird node under the specially designed cold air tarp used to cool the machine.

(Photo by Randy Montoya)



Red Storm simulates asteroid impact

Sandia provided information technology (IT) infrastructure and application **support to the Yucca Mountain Program**, for which Sandia was named the lead lab. The IT project required efforts across all phases of Sandia's IT activities including desktop, enterprise server, networking, database, and applications development teams. The project leveraged the existing network infrastructure, with significant upgrades, and reduced the time necessary to provide full online support to the YMP program staff. (4300, 4500) ER&N

The tri-lab, inter-site Advanced Simulation and Computing Wide Area Network (ASC WAN) was upgraded to a **ring topology providing four times the bandwidth at half the cost**. The network is now faster, cheaper, and more fault-tolerant than before. The new WAN allows improved sharing of high-performance computing resources between the national laboratories and enhances the ability of the labs to meet milestones. The WAN recently demonstrated the capability to send data at 3.7 gigabits per second between New Mexico and California, doubling the previous best performance. (4300)

Staff members participated in the **International Conference for High Performance Computing, Networking, Storage, and Analysis (SC06)** in Tampa, Fla., in November 2006. Sandians contributed to the conference as members of the **conference networking team**, SCinet. The SCinet team designs, builds, secures, and operates wired and wireless networks that provide commodity Internet and research-network access to thousands of conference attendees and exhibitors. This year's network connected the exhibit hall floor at the Tampa Convention Center with over 100 gigabits of wide area network bandwidth. (8900)

The 2006 R&D 100 Award-winning **Compute Process Allocator (CPA)**, which assigns parallel processing resources on supercomputers, is the first allocator to balance individual job allocation with future allocation over 10,000 processors, allowing **jobs to be processed faster and more efficiently**. In experiments, CPA increased the locality and throughput on a parallel computer by 23 percent over simpler one-dimensional allocators. CPA is distributed and scales to over 10,000 nodes, while non-distributed allocators have been scaled to only 4,096 nodes. (1400) ST&E



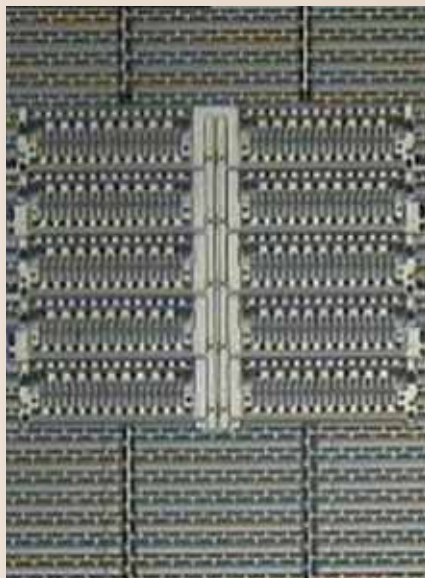
Sandia and Cray, Inc. upgraded Red Storm by adding a fifth row.

(Photo by Randy Montoya)

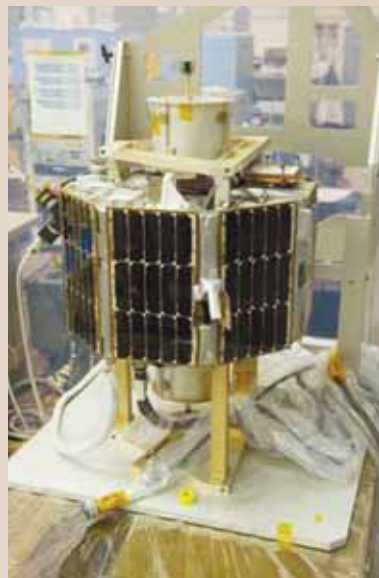
Sandia and Cray, Inc. upgraded Red Storm by adding a fifth row, exchanging the single-core 2.0 GHz AMD Opteron processors for dual-core 2.4 GHz processors, doubling the interconnect performance, and upgrading Sandia's Catamount system software. These upgrades increased Red Storm's measured HPL/Linpack speed from 36.19 teraflops to 101.4 teraflops. When the Top 500 supercomputer list was announced at Supercomputing 2006, **Red Storm placed second overall and first among the general-purpose high-end computer systems** that are useful for the broad range of our engineering and scientific analysis codes. (1400, 4300) NW

Microsystems

Miniature satellites offer greatly reduced launch costs, yet their low masses make thermal management difficult. Sandia delivered SUMMIT™-based MEMS (microelectromechanical system) louvers for NASA/Goddard ST5 microsattellites that evaluated technology options for future vehicles. The shutters modulate emissivity from 0 to 0.4 to enable thermal management. These are the first fully space-qualified active MEMS devices and the first to fly on the exterior of a satellite. By surviving launch and the radiation of space, they demonstrated the reliability of Sandia MEMS devices and encourage further MEMS applications for satellite customers. (1700, Johns Hopkins Applied Physics Lab) DS&A



Enlarged view of SUMMIT™ V MEMS louvers with buried interconnects



Completed microsattellites showing exterior louvers fabricated with Sandia's SUMMIT™ MEMS technology

Sandia's first Tunable Dielectric Monolithic Integrated Circuit (TDMIC) for frequency agile radio frequency (RF) electronics was demonstrated in 2006. This TDMIC enables electrically tunable circuit elements for tuning of filters in multiband RF systems, scanning of phased-array radar, and frequency-reconfigurable communications equipment compatible with standard RF circuits. The circuit is the first monolithic integration of tunable dielectric constant capacitors with substrate vias. The resulting devices are potentially more reliable, lower power, and faster than current tuning devices and filters for radar, satellite, and broadband communication equipment. (1700, 1800) ST&E

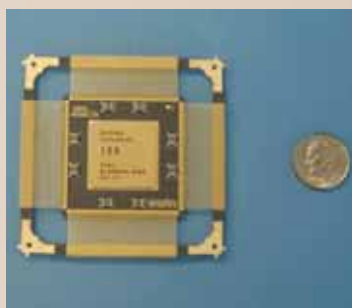
Batteries often are among the largest and shortest-lived components of remote unattended systems. Under Defense Advanced Research Projects Agency Phase 1 sponsorship and in partnership with Oak Ridge National Laboratory, the Naval Research Laboratory, and Lockheed Martin, Sandia developed Radioisotope Micropower Sources (RIMS) that employ micro thermo-photo-voltaic converters and high-efficiency photonic crystal emitters. Phase 1 results (1.76 mW from a 4 cm³ volume) are already an order of magnitude higher energy density than the most competitive battery chemistry. (1700, NRL, LMCO, ORNL) DS&A



Assembled micropower source ready for testing at Oak Ridge National Laboratory

Sandia designed, built, and evaluated GaN (gallium-nitride) amplifiers for S-band (2.5-3.5 GHz) radars with greater than 20-watt output power. GaN/AlGaN (gallium-nitride/aluminum-gallium-nitride) layers were grown on silicon-carbide substrates by metal-organic chemical vapor epitaxy and fabricated into power transistors. We measured less than 10-nanosecond switching of 19 watts of pulsed output power, with continuous-wave power ranging from 19 to 23 watts. Packaged amplifiers utilized either copper or diamond heat spreaders for excellent thermal management. These results provide compelling evidence that Sandia's GaN transistors are a viable technology for future multipurpose, multifunction radars. (1700, 1100) NW

The Permafrost application specific integrated circuit is the brains of the W76-1 Arming Fuzing Subsystem and provides fuzing control, timing, communication, and self-monitoring functions. Sandia's MESA (Microsystems and Engineering Science Applications) facility fabricated and shipped these devices at War Reserve quality on schedule and within budget to complete technology maturation (Technology Readiness Level 9) of Sandia's 0.35-micron silicon-on-insulator radiation-hardened BUSFET (Body Under Source Field Effect Transistor) technology. Sandia was awarded a Weapon Award of Excellence for inventing and implementing this novel custom transistor technology specifically for radiation-hardened applications. (1700, 5300) NW



Packaged Permafrost ASIC

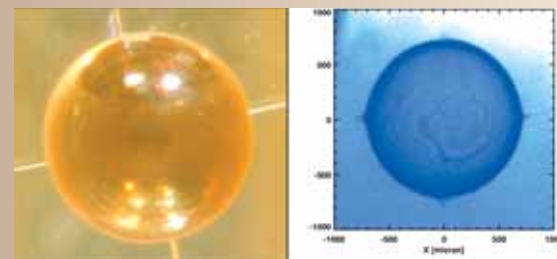
Pulsed power

Experiments to measure the dynamic response of plutonium in support of high-level Campaign 2 milestones for both Sandia and Los Alamos National Laboratory were conducted using an isentropic compression technique on the Z machine. The collaborative experiments were the result of several years of work to design and qualify a robust containment system, ensure all ES&H requirements were addressed, and gain NNSA approval. The experiments provided data that have long been needed by the weapons community. The effort will continue with the commissioning of the refurbished Z machine. (1600, 5400, 4200, 10200, 10300, KTech, NSTech) NW



A successfully contained hazardous material experiment being removed from the Z machine's center section

Perturbations on millimeter-scale inertial confinement fusion capsules arising from the presence of tiny (10-micron diameter) fill tubes were studied. Using X-rays provided by the Z machine, capsules



Left: Optical image of a 2-mm-diameter inertial confinement fusion capsule with four glass tubes attached. Right: Monochromatic (6.151 keV) X-ray image of the same capsule as it is imploded by X-rays from the Z machine.

with multiple glass tubes attached were imploded and the configuration was imaged using a one nanosecond-duration monochromatic X-ray source. The resulting high-quality data enabled detailed comparisons with simulations for the first time. The agreement between experiment and simulation increases our confidence that fill tubes will not hinder ignition attempts on the National Ignition Facility. (1600) NW

Pulsed Arrested Spark Discharge (PASD), a unique patented wiring diagnostic, has been licensed to Astronics Advanced Electronics Systems. PASD has been demonstrated to detect and accurately locate wiring insulation defects in the most challenging wiring systems. Existing wiring system diagnostics are



KEVIN HOWARD inspects the wiring in an aircraft landing gear bay. (Photo by Randy Montoya)

incapable of locating insulation damage such as cracking, chafing, breaches, and other defects that can develop as a result of aging or improper installation. PASD could revolutionize the inspection and maintenance of new and aging wiring systems, a significant issue in the aging commercial aircraft fleet. (1600) ER&N

Electronics



Sandia's SAR (synthetic aperture radar) Systems organization achieved significant milestones with its MiniSAR family of radars. Building on a first-ever full-quality fine-resolution (4-in.) stripmap demonstration in September 2005, the MiniSAR's capabilities were applied in a US Marine Corps operational exercise and

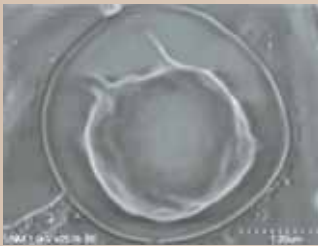
then demonstrated on the Lockheed Martin Maritime Systems and Sensors' SkySpirit Class III UAV platform, making MiniSAR the highest performance radar ever to fly on such a small UAV. Additionally, a fieldable variant was deployed in Antarctica for crevasse detection for landing-strip surveying. (5300) DS&A

Biotechnology, nanotechnology, and cognitive science



STEM image of hollow platinum nanocages

For the first time, research has shown a one-to-one **correspondence between porphyrin photocatalyst molecules and platinum seed particles** that they initiate. This process could provide the capability for nanotagging biological molecules and other structures labeled with a photocatalytic porphyrin, including the possibility of **imaging drug receptor locations by electron microscopy**. This new way of using methods developed for nanostructuring metals produces small uniform-sized dendritic sheets at growth centers formed by porphyrin molecules between liposome bilayers. These sheets produce a network of platinum nanospheres that preserve the liposome shape. (1100) ER&N, ST&E



Yeast encased in custom silica nanostructure

Scientists have long sought to fabricate biosensors by **integrating planar silicon technology with living cells** to exploit the cell's capacity for sensitive detection of biomolecules. Because cells cannot remain viable without an aqueous buffer, Sandia developed a procedure

whereby cells create their own **custom nanostructures from silica and components of cell membranes**, enabling their survival under harsh conditions. In July, these "armored" yeast biosensors were launched on the space shuttle for testing in the vacuum and radiation of space. (*Science* 313, 337-340, 2006). (1002, 1800, 1700) ST&E, ER&N

The capability to rapidly and remotely determine whether a battlefield is contaminated with chemical or biological agents is of critical importance. A Sandia-led team is developing an **integrated sensor device powered exclusively by biomolecular motors and chemical energy** (thereby eliminating the need for batteries) that can be deployed as "smart dust" on target battlefields and be remotely interrogated by unmanned aerial vehicles. Sandia has demonstrated the ability to **capture, tag, and detect a variety of biological agents** using this approach and has developed techniques to enable longevity and robustness. (8300) DS&A

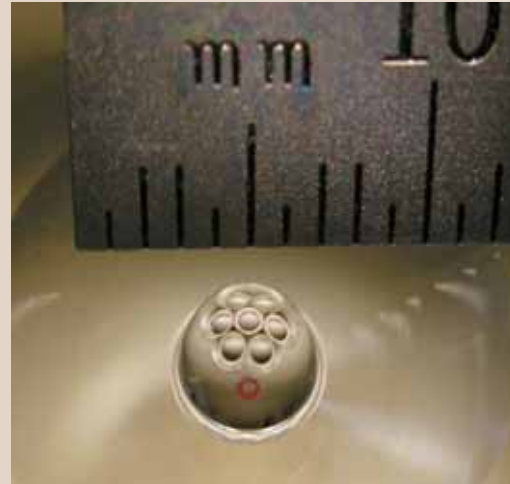


Artist's conception of an integrated sensor device. In the foreground is the analyte capture section; in the center section the analyte is tagged with quantum dots; in back they are collected for detection.

One of the most important functions of cellular membranes is detecting changes in the environment around the cell and triggering a response, such as that of the immune system to combat infection or disease. By using a **unique advanced imaging capability** (atomic force microscopy with simultaneous fluorescence imaging) to study cells from the immune system, Labs researchers have obtained results suggesting that new models of **membrane signaling based on protein-to-protein interactions** are needed to understand the immune response rather than the prevailing lipid raft model of sequestration. (8300, University of New Mexico) ST&E

Researchers have designed and proven a modular automated processing system (MAPS) that enables continuous automated protocols customized for any complex **biological sample preparation** problem. Recently licensed to LabSmith and featured in *Genetic Engineering News*, MAPS translates traditional batch-mode processes (such as extraction/concentration, centrifugation, and lysis) to continuous-flow operation. Currently there are no commercial counterparts that can manipulate molecules and cells over the same volume and dynamic range. Applications range from **high-throughput biomarker discovery to in-line sensors and analyzers**. (8300, 8100) HS&D

The proper functioning of all living cells relies on protein-moderated transport across cell membranes. However, the complex environment of a living cell hampers our understanding of this crucial process. Sandia researchers have developed simplified, transmembrane protein-compatible **biomimetic structures to replace cell membranes in experimental studies**. Our approach allows us to isolate individual proteins for evaluation by optical and electrochemical techniques while retaining the native structure and function of the proteins. Ultimately, this advance will benefit drug development, medical treatment, and biosensing. (1700, UNM Department of Chemistry) ST&E



Partially completed miniature optical array based on a dragonfly eye. The finished array includes 80 precision lenslet pairs on a 2-mm-radius sphere that permits surveillance of a broad area with reduced image-processing requirements.

The Manufacturing Science and Technology Center developed novel focused ion beam techniques and instrumentation for precision, **nanometer-scale patterning of surfaces and membranes**. The ability to tailor curved-surface shapes in a variety of materials has proven useful for several programs, including optically driven ordnance devices and the dragonfly optic for a mesoscale surveillance vehicle. Additionally, the unique capabilities have contributed significantly to science and

technology efforts including the Interfacial Water Laboratory Directed Research & Development project, studies of DNA translocation through mesoporous coatings, and nanophotonics. (2500, 2400, 1700, 6000, 1800) NW

The Advanced Concepts Group — collaborating with the Consortium for Science, Policy, and Outcomes at Arizona State University — sponsored a workshop on the policy implications of **converging nano-, bio-, info-, and cognitive technologies** for enhanced human cognition. These technologies raise many complex technical, social, ethical, economic, and political issues. The workshop, held on the ASU campus, brought in a variety of experts (including neuroscien-

tists, bioethicists, policy scholars, and nanoscience and society scholars) to explore a wide range of possible US public policies in this area. (7000) ST&E

Security



Trainee using the Augmented Reality Training System (ARTS), an immersive virtual training system where multiple ProForce officers can exercise their tactics against virtual bad guys who emerge from real corners and fire back at them

Sandia collaborated with the DOE National Training Center to evaluate a new **virtual training methodology for small tactical response teams** called the Augmented Reality Training System (ARTS). Using immersive augmented reality, ARTS pits multiple ProForce trainees against virtual enemies, allowing users to move freely in three dimensions, a feature that makes it unique among tactical trainers. FY07 customers include the Department of Justice, DoD, and DOE. (6400, 6300) NW

During 2006 the Secretary of Energy directed **removal of large quantities of special nuclear material (SNM)** from Sandia. Sandia developed, and the NNSA approved, a technical package to request Termination of Safeguards on specific SNM assets. Not only was this the first package of its kind to have such authorization for this specific material, it was considered a model in technical significance and a benchmark for future packages. (4200) NW

As a leader in the nuclear weapon complex for **use control technology and operations**, Sandia hosted and led discussions during use control guidance meetings at which information was gathered and debated and changes were recommended to the Joint DOE/DoD Topical Classification Guide for Nuclear Weapon Use Control. Use control has become a critical considera-

tion to improve weapon survivability and reliability and is considered in most aspects of nuclear weapon design and vulnerability work. (4200) NW

The intrusion detection team protects Sandia information through **prevention, detection, and mitigation of increasingly dynamic threats to network assets**. This year the team implemented new information security technologies, including improved network traffic capture speed and storage to handle increasing network capacity, a wireless network defense system, and home-grown analysis tools. The team has increased efficiency and effectiveness of its work through process automation and tiered analysis. The team also built information-sharing relationships and collaborations with security analysts in New Mexico, at other labs, and at other government organizations. (8900, 4300) NW

In partnership with the Videoconference & Collaborative Technologies Dept. 8947, student interns from the Center for Cyber Defenders program conducted **vulnerability assessments of collaboration devices** for a third consecutive summer. Their findings have been shared with and were well received by device manufacturers as well as DOE, DoD, and US Computer Emergency Readiness Team customers. (8900)

Integrated Enabling Services

Sandia's Energy Management Program continues to ensure that utility systems are reliable and efficient and conserve resources as much as possible. The program strives to integrate and institutionalize energy efficiency into planning, design, construction, and operations. In FY06 electrical reliability was 100 percent (exceeding the industry standard of 99.982 percent), conservation initiatives saved millions of dollars in energy costs, and Bldg. 833 was re-roofed with a new membrane containing embedded photovoltaic cells that may serve as a pilot project for larger implementation. (10800, 10300, 6300) IES



Bldg. 833's unique roof containing embedded photovoltaic cells

The Sandia Wi-Fi deployment and development team deployed secure wireless networks that enable the laboratory to work and collaborate more efficiently. The team also designed and piloted a wireless network that allows visitors and external collaborators to access their home networks, email, and the Internet while keeping Sandia's data networks secure. Visitors from Lockheed Martin, Cray, and many universities already have benefited from this new capability. (4300, 8900) IES

Sandia's Supply Chain Management Center earned two prestigious White House Closing the Circle Awards. The first was awarded for implementation of DOE's fleet petroleum fuel reduction initiative to use alternative fuels. Sandia's fleet program has one of the largest alternative fuel vehicle populations in the DOE fleet. The second was in partnership with Sandia's Pollution Prevention (P2) staff for implementing a comprehensive Environmentally Preferable Purchasing (EPP) program. EPP excels at ensuring purchasing mechanisms include requirements for environmentally preferable product purchases. (10200) IES

Sandia's construction program managed several multi-million-dollar construction projects with FY06 funding totaling \$172 million, adding almost 360,000 square feet of new space to the New Mexico site to support new mission work. Projects included the Microsystems and Engineering Science Applications (MESA) complex, the Center for Integrated Nanotechnologies (CINT) Core Facility, and the Test Capabilities Revitalization project. The program also constructed the new National Infrastructure Simulation and Analysis Center (NISAC), which was the first building at Sandia built completely with Department of Homeland Security funds. (10800, 10200, 1100, 1500, 12900, 6300) IES



Construction of the National Infrastructure Simulation and Analysis Center

Pathways to Success, a financial business competency program, was implemented in FY06. Pathways provides a complete suite of career development tools and programs to help enhance competencies, knowledge, and abilities for the 400-plus financial analysts within Sandia. Pathways offers a structured approach to career development, a clear understanding of the expectations to achieve success in financial positions, and a pathway for the Sandia business community to improve customer service. (10500, 8500, 10200, 1000, 2000, 5000, 8000, 4000, 3000, 6000, 10000, 12000) IES

Twenty five MS/PhD top recruits from across the country visited Sandia as part of the Science and Engineering Expo (SEE) Sandia program. This innovative pilot program showcased the Labs to top candidates and gave line organizations an opportunity to assess the skills of the candidates. The goal is to hire top candidates into Sandia in an effective and efficient manner that provides a

mutually beneficial solution for both the candidate and Sandia. (3500) IES

Sandia/California achieved ISO 14001:2004 certification of its Environmental Management System (EMS) in September, the first ISO 14001 certification at Sandia. The California site EMS core team managed the certification effort, which followed a three-step process required by the selected registrar, NSF-International Strategic Registrations, Ltd. Many of the lessons learned by the California team may be valuable to the Sandia/New Mexico site, which is planning to seek certification for EMS in 2008. Certification is expected to improve Sandia's relations with environmental regulators, DOE, external customers and suppliers, and potential new hires. (8500) IES

Techweb, Sandia's internal web, has been redesigned to meet high performance information delivery objectives for Sandia's internal population. It is built on Oracle Portal technology and has redundancy in the supporting hardware for information reliability. Intelligence was built into the system to personalize information specifically for users. Sandia's Web Infrastructure Framework and Technologies (SWIFT) team led the project with major contributions from Oracle Tools, Infrastructure Computing, Cyber Security, Oracle Databases, WebCo teams, and other partners across the laboratory. (4500, 4300) IES

The Corporate Learning & Professional Development and Weapons Engineering Professional Development departments integrated the New Hire Orientation Program with the New Employee Orientation Program. The program, called Excellence from the Start, helps new employees develop knowledge and skills to effectively navigate and operating procedures. The Excellence from the Start program eliminates redundancy of program elements and reduces operational costs while retaining the benefits of the individual programs. Many elements formerly available to select audiences are now available to all employees. (3500) IES

The Lab News received the 2006 Grand Award in the annual Ragan Recognition Awards as the best nonprofit employee newsletter. The award was based on the overall quality of the Lab News, including its writing, photography, graphic design, and relevance to employees. The competition attracts entries from around the nation from some of the country's largest and most successful businesses and nonprofit organizations. The awards program is sponsored by Lawrence Ragan Communications Inc., widely regarded as the go-to experts in the field of employee communications. (3600) IES

Identity theft is affecting millions of people every day. Sandia is taking precautions to limit exposure of employees' social security numbers. As part of the corporate effort, the Labs' financial, manufacturing, management reporting, facilities, procurement, and travel card systems no longer use the social security number as the employee

Management

Sandia's executive management team released a new Sandia Strategic Plan that reaffirms Sandia's core purpose of exceptional service in the national interest. The plan's answers to "What constitutes success for Sandia?" helped define a unifying three-part strategy that addresses Sandia's commitment to its missions in nuclear weapons and national security, excellence in operations, and the science and engineering that enable the missions. (12100)

Sandia's highest goal is to become the laboratory that the U.S. turns to first for innovative, science-based, systems-engineering solutions to the most challenging problems that threaten peace and freedom for our nation and the globe.

When we achieve our highest goal, we are widely recognized as a national leader in preventing technological surprise, in anticipating threats, in providing innovative, science-based, systems-engineering solutions to our nation's most challenging national security problems, and in managing the Laboratories in a way that inspires customer confidence.

The excitement and importance of our work, our exemplary work environment, our partnerships with academia, industry, and other partners, and our record of historic contributions help us to attract exceptional staff. Our employees are recognized by their professional peers for their outstanding contributions.

Service to the Nation Excellence Each Other Integrity Teamwork

identifier. Business Liaison/Technologies Dept. 10750 and Business Intelligence Systems Dept. 4540 have written programs to convert from social security numbers to new SNL-ID numbers. More than 90 million changes have taken place, and the applications have been changed to accept only the SNL-ID. (10700, 4500) IES

The Integrated Enterprise Information Architecture Roadmap, released in June, describes a systems approach to develop information mastery that accelerates enterprise transformation and operational excellence for Sandia. The approach is based on enterprise architecture and is initially being applied within Sandia's integrated information community and environment. This community affects the success of virtually every business unit at Sandia. As Sandia implements this roadmap, business processes for the Chief Information Officer and an enterprise data architecture will be defined that enable Sandia to more efficiently provide value to customers. (4500, 2900, 4600) IES

Videoconference & Collaborative Technologies Dept. 8947 deployed 13 collaborative conference rooms in MESA's new MicroLab facility. The rooms are built around high-performance displays capable of satisfying Sandians' needs for high-resolution shared-computer presentations in interactive meetings. MESA's MicroLab was also the first



Videoconference between MESA MicroLab facility and Sandia/California. Users at various Sandia sites are taking advantage of the latest communications technologies in Sandia's collaboration rooms. (Photo by Randy Montoya)

deployment of a new user-interface standard for collaborative rooms. To enable multiroom distributed meetings, a server infrastructure was deployed to support a variety of meeting configurations. More than 28 rooms will be built with some form of collaborative technology during the FY07 construction phase. (8900) IES

(Continued on next page)

ES&H

The Lab has continued its **downward trend in recordable accidents** and has achieved approximately a 10 percent reduction from last year. Sandia ended the calendar year at a rate of 2.2 accidents per 200,000 employee hours worked. This is the lowest rate the lab has had in recent history. In addition, for the months of July, August, September, and October, the rate was approximately 1.5 accidents per 200,000 hours worked. (10300) IES

DOE's Office of Independent Oversight inspected **Sandia's Emergency Management (EM) program** in May 2006. The inspection found no significant weaknesses and no repeat findings and noted that **Sandia has made significant strides** in addressing past deficiencies. Positive attributes of the EM program noted in the inspection report included: commitment by senior managers, nearly all weaknesses identified in 2005 were either effectively addressed or will likely be satisfactorily completed as scheduled, and emergency responders' improved ability to manage emergency events. (10300) IES

To improve radiological safety, Radiation Protection Dept. 10328 provided technical support and leadership of the **Laboratories' Radiological Work Pause in April and May 2006**, including resources to develop the training content for a radiological awareness training course, management briefings, and a new triennial assessment process including instructions and assistance in reporting. These actions have led to an improved radiological safety assessment process. (10300) IES



Emergency responders during exercise

(Photo by Randy Montoya)

Integrated Enabling Services

(Continued from preceding page)

Every year Sandia carries out some 3,000 personnel moves. The Moves Team partnered with the CSU (Computer Support Unit) Support Groups, Telecommunications/Networking, and application designers and developers to implement the **AM/PM Moves Process to enable faster move time**. A move can now be completed within a specified 2-1/2 hour period rather than requiring a full day or more. Shorter downtime means increased productivity for the customer and enables a quick return to mission work, saving both time and money. (4300) IES

Sandia's Integrated Safety Management System Software was enhanced to better **protect people from workplace hazards and environmental accidents** by identifying hazards within buildings, adding new workplace safety requirements, using employee identification numbers to ensure worker privacy, expiring Primary Hazard Screening documents on regular schedules, publishing data used by work planning systems, and properly protecting restricted information. (10300, 10300, 4500, 4600) IES

In support of Labs goals and objectives outlined in the 2006 Performance Evaluation Plan, the Supply Chain Management Center submitted the **Transportation Documented Safety Analysis** and associated Technical Safety Requirements to the DOE, NNSA, and NNSA Sandia Site Office for final approval. These documents were a culmination of a multiyear, multi-disciplinary effort that will allow the **on-site transportation of Hazard Category 3 radioactive material**. (10200) IES

The Intellectual Property Center in conjunction with Enterprise Information Systems Development and Support Dept. 4524 deployed a **web-based system for electronically submitting technical advances (TAs)** to report inventions to Sandia and NNSA pursuant to the requirements of Sandia's prime contract. This web-based system, called the Partnerships, Agreements, and Licensing System (PALS), also allows Sandia inventors to track the status of their TAs through the patenting process. (11500, 4500) IES

A Sandia cross-functional/cross-discipline team fully **implemented the requirements of OMB (Office of Management and Budget) Circular A-123**. OMB A-123, the federal government's version of the Sarbanes-Oxley Act, defines management's responsibility for internal control in federal departments and agencies. The implementation gives the A-123 team the ability to fulfill the aggressive and dynamic milestone schedule established by the NNSA and to remediate deficiencies. (10500 with Labs-wide representation) IES

links risk identification to strategic planning and approved work scope, categorizes risks by policy area, and uses assessments to assure the effectiveness of risk controls. IES

Sandia's Integrated Laboratory Management System (ILMS) is the **framework for all management requirements** and the instantiation of the Labs' contractor assurance system. In FY04 ILMS continued to improve through: updating and codifying of the Corporate Policy Statement



ILMS enterprise model

Requirement; identifying vital operational metrics; conducting quarterly and annual Labs-wide executive assessments; improving and integrating supporting processes and tools (such as enterprise risk management, policy area self-assessment, corporate self-assessment, comparison activities, issues management, and the Corporate Corrective Action Tracking System); and strategic positioning for future ISO certification. IES

Legal Division 11000 teamed with the Technology and Business Partnerships Center and Human Resources Information Systems to develop and implement the **electronic Personal Conflict of Interest Form**, which automates the annually required process. The automation and review by management, Legal, and Partnerships helps identify and mitigate risks. The automated process also saves employees and management significant time. (11000, 9100, 4500) IES

(Continued on next page)

Sandians and retirees pledged \$3.341 million to the United Way of Central New Mexico during the 2006 Employee Caring Plan (ECP) campaign. Sandia's overall participation rate was 73 percent, an increase over last year. The new-hire participation rate was 58 percent, up from 54 percent last year and 27 percent in 2004. Sandia retirees contributed or pledged \$373,801. Lockheed Martin's \$50,000 contribution to the Corporate Cornerstones program pays United Way administrative costs, which enables 100 percent of Sandians' contributions to go to helping people. (3600) IES

(Photo by Randy Montoya)



An enhanced **Enterprise Risk Management process** (part of Sandia's Integrated Laboratory Management System) has been deployed by the executive office, strategic management units, and divisions. This process has resulted in the identification of 71 high-level risks that are being tracked quarterly by the Laboratory Leadership Team. Thirty-six of the highest risks relate to mission, program, or project performance. The new process explicitly

Integrated Enabling Services

(Continued from preceding page)

Sandia was acknowledged as an **employer of choice** for qualities important to employees as part of *Aviation Week's* fourth annual workforce survey. Sandia was rated at the highest ranking for technological challenge. Sandia also was among *DiversityInc's* "Noteworthy 25" out of 256 companies measured in the "valuing people" area for "strong, consistent, and unbiased retention across all races, ethnicities, and genders, and mandatory Tier II supplier diversity." Diversity Cinema was named a DOE best practice for providing learning and discussion opportunities. (3500) IES

Health, Benefits, and Employee Services provides accessible workplace preventive, behavioral, and medical services; offers competitive benefits; and deploys short- and long-term cost containment strategies in an era of escalating health care costs. The Disease Management Clinic (DMC) provides health services for employees with diabetes, hypertension, hyperlipidemia, and obesity. As of November DMC had 1,440 participants. Benefits provided a new web-based open enrollment process for active employees. Nearly 4,000 employees took advantage of the one-time increase in Voluntary Term Life Insurance. (3300) IES

In FY06 Sandia benchmarked its Labs-wide finance, information technology, human resources, and procurement processes against industry standards using the Hackett Group methodology and database. The benchmark found, in general, that the **effectiveness of the Labs' processes was world class** but that efficiency was less than world class. The Hackett Group identified Sandia efficiency issues as process complexity, lack of standardization, and failure to leverage technology. In support of Sandia's strategic objectives, Sandia's Deputy Laboratory Director chartered a Process Efficiency Transformation Project to close this efficiency gap. (10700, IES SMU) IES



Jacqueline Griffin views through a microscope a circuit she designed. (Photo by Randy Montoya)

Sandia's Supply Chain Management Center, in conjunction with the NNSA's Sandia Site Office, implemented a number of innovative **property accountability initiatives** that align risks with appropriate assurance and are expected to facilitate more efficient operations and cost avoidances of nearly \$3 million in FY07. The new initiatives include: adherence to the American Society for Testing and Materials standard for an inventory find rate of 98 percent; raising the accountable equipment threshold from \$5,000 to \$7,500; and incorporating net book value into record-keeping and inventory of government assets. (10200, NNSA SSO) IES

Sandia's Supply Chain Management Center negotiated **cost savings of more than \$69 million and awarded more than \$1.1 billion in subcontracts** in FY06. Of this amount, more than 53 percent went to small businesses. In addition, Sandia's Supply Chain Resource and Development Dept. 10222 initiated a campaign to promote awareness and communicate the advantages of subcontracting with small business. The commitment by many throughout the Labs allowed Sandia to achieve its corporate socio-economic goals in 2006. (10200) IES

Accounting Services completed its first full fiscal year of transmitting Sandia's financial information, on a monthly basis, to DOE using the new **DOE Standard Accounting and Reporting System (STARS)**. The accurate and timely transmission of financial data is a DOE requirement and is an integral component of DOE's financial statements. The team also performed detailed reconciliations between DOE and Sandia, automated other reconciliations, and streamlined processes to ensure the Labs consistently meets DOE requirements. (10500) IES

In 2005 Sandia's Executive Staff Directorate began the process of **documenting decision space** for entities throughout Sandia, including the board of directors, programmatic and operational councils, and individuals. In FY06, the executive team took the next step by developing a **web site dedicated to communicating Sandia's decision-based authorities**. This site, which implements Sandia's Integrated Laboratory Management System, has

been used by Sandia's management to clarify and enhance decision space throughout the Labs. (12100) IES

In FY06 the **Ethics and Business Conduct Center was formed**. In addition to overseeing the Ethics and Corporate Investigations functions, the center addresses all aspects of business conduct throughout the Laboratories. Among the center's FY06 contributions: achieving 100 percent ethics awareness training for all employees, providing ethics advice to more than 300 members of management and staff, encouraging new managers and employees to address ethical concerns, and conducting 35 investigations into alleged misconduct. (12400) IES

The Independent Audit and Advisory Services Center responded to customer comments about a need for better coordination among numerous external and internal audits by forming an **Audit Discussion Group**. The group is composed of members of Sandia's frequently audited organizations and representatives from DOE. Among the benefits so far are rescheduling of overlapping audits, scheduling of joint audits to reduce the number of audit visits, and identification of audit areas important to customers. (12800) IES

Sandia's Independent Audit and Advisory Services Center strives to be a partner in the success of the Labs. In FY06 many Sandians worked with the Center as **Sandia hosted 24 audits** performed by the DOE Office of the Inspector General and the Government Accountability Office. The center **audited more than 200 contractors** resulting in more than \$13 million in cost avoidance or savings. This year the center will be auditing intellectual property agreements to ensure royalty payments. Internally, more than 40 audits were conducted, resulting in numerous process improvements. (12800) IES



The new Sandia/California Technical Library

The Sandia/California Technical Library moved to a **redesigned, enlarged, and customer-configured facility** in April. While most of the library's collection is digital (databases, e-journals, and e-books number in the thousands), the new facility also provides quiet study areas and collaboration options, wireless capability, a comfortable periodical reading nook, and ample computers for locating needed items and performing web searches. (8500, 8900) IES

Partnerships

In undeveloped countries, a modern lower-limb prosthesis can cost twice a person's typical yearly wages. Efforts to fit and service prostheses in these countries have so far been inadequate. Sandia's Universal Leg project is developing an ultra-economical, maintenance-free **prosthesis that enables amputees to fit and adjust themselves**. This project is funded by NNSA's Initiatives for Proliferation Prevention and includes California-based Numotech, Inc. and Spektr-Konversia, a spinoff of VNIITF, as partners. (6400, 6700, 1700) ER&N

To improve the probability of detection of fissile material passing through America's ports, Sandia recently concluded a cooperative research and development agreement with Thermo Electron Corp. that resulted in licensing the Sandia-developed FitToDB algorithm for commercial use in a **spectroscopic portal to identify concealed nuclear devices**. Thermo Electron has used the FitToDB algorithm and sensor design principles imparted during the technology transfer process to construct several sensors that have been delivered to various sponsors for both domestic applications

and for use overseas under the Megaports program. (5900) HS&D

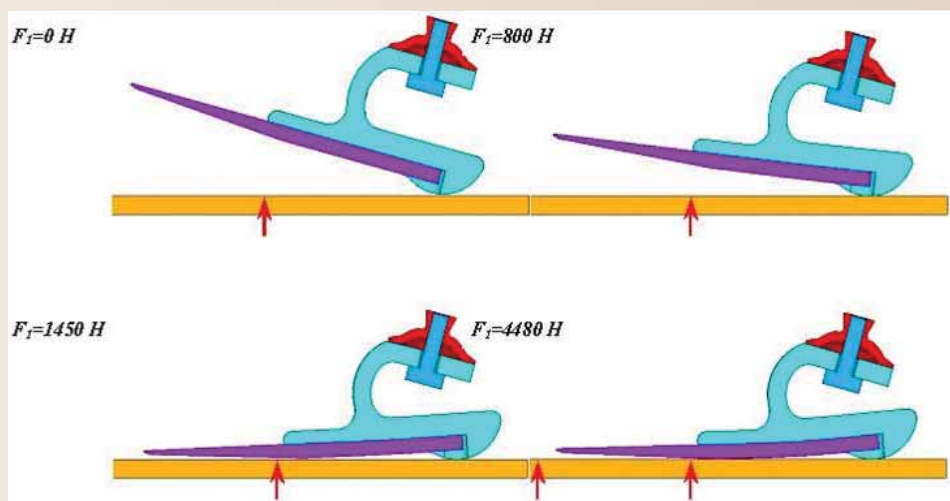
Under the Goodyear cooperative research and development agreement, Sandia has developed constitutive equations and computational tools to predict a wide range of **nonlinear behaviors of rubber-like materials**. The physical attributes of rubber have been incorporated in a framework to make predictions under variable loads and temperatures at high strains. This new capability provides the

essential ingredient for modeling life cycle performance, both in tires and weapon component seals and gaskets. (1500, 1800) ST&E

Advent Solar, an Albuquerque startup company, licensed a Sandia **back-contact photovoltaic cell design and fabrication technology** that eliminates the current-collection grids from the front surface of the cell. This advance makes the cells more efficient by exposing more of the top surface of the solar cells to sunlight and reduces assembly cost by eliminating the front-to-back connection. Subsequent venture capital investment has allowed the company to construct a 25-megawatt production plant near Albuquerque and employ more than 150 people. (6300) ER&N



Advent Solar will employ more than 150 people at its Albuquerque plant.



Russian-designed prosthetic foot and analysis illustrating deformed states during heel strike

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Labs Accomplishments • February 2007

