Sandia engineer Bianca Keeler examines this eye-safe laser configuration in which MEMS-based light-wave interference enables naked-eye detection of motion in the 10 nanometer range. Bianca, along with Greg Bogart, John Sullivan, Tom Friedman, and Joel Wendt, were part of a research team headed by Dustin Carr.
Welcome once again to Sandia’s compilation of significant contributions made over the course of the last year. If there is a dominant theme, it is the ever-expanding diversity of important national contributions in many technical fields and to address many urgent national needs.

- From the imaging of biological membranes and understanding fundamental life processes, to the development of bacteria microsensors that can literally diagnose a patient’s disease within minutes.

- From a joint project with the Environmental Protection Agency to protect the nation’s water supplies from chemical or biological attack, to an in-depth analysis done for the Department of Energy on the possible hazards posed by liquid natural gas fires which could result from terrorist attacks on LNG ship transports.

- From development of a new wind turbine built from newly developed materials, to carrying out flights of highly instrumented aircraft to study the role of clouds in determining Arctic climates.

- From leading a government and industry forum to create and adopt future standards for software reliability, to the creation of a new manufacturing process using ultra-short laser pulses (approx 10-15 sec) for precision machining of a wide variety of materials.

These achievements and the many more described in this report attest to the fact that Sandia is fulfilling its national security missions — including a continuing role to maintain the safety, reliability, and effectiveness of the US nuclear deterrent forces — against a wider set of threats than ever before.

I believe as you read this report you will agree with me that:

1. our leading-edge science, engineering, and technology developments are helping to achieve a higher level of security for our nation and the world, and,
2. In all fields, in so many fields and against such a diverse menu of challenges, is making Sandia a much more interesting institution.

C. Paul Robinson
President and Director

In the first quarter of each calendar year the Lab News highlights some of Sandia National Laboratories’ principal achievements of the previous fiscal year. Submissions are selected by the VPs’ offices. Numbers in parentheses at the end of some entries represent the Sandia center (or centers) in which most of the work on a particular accomplishment was done. The work is presented here by category.

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For information about how to contact the researchers involved in the work mentioned here, e-mail Lab News staff member Bill Murphy at wtmurph@sandia.gov.

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Nuclear weapons

Last May, the Armando Sub-Critical Experiment was performed at the Nevada Test Site, investigating possible differences in the impulsive response of cast and wrought plutonium. The Pulled Power Sciences Center led a multi-institutional team to develop and deploy a state-of-the-art flash radiographic capability: the twin-axis Cygnus accelerators provide four Borengangers a meter from a 1-mm-diameter X-ray source at 2.2 million volts, about a factor of 50 greater performance than previously available at the NTS. The accelerators performed perfectly, and the resulting radiographic data obtained on Armando are excellent. The dynamic experiment was conducted within a portable blast containment vessel, so that the unique diagnostic infrastructure may be reused repeatedly as needed by the NNSA. (1600)

New tenants of the Joint Computational Engineering Laboratory (below) began moving in last March. Ultimately, 175 personnel relocated to JCEL. Boasting the largest switching and routing capability for the Sandia customer network, JCEL was also the first to use the new High Performance Computing network architecture, including 10-gigabyte trunks and dedicated HPC distribution infrastructure. JCEL houses a vast unclassified server room containing the 407-node Linux computer cluster and several other large computer resources supported by Engineering and Sciences High Performance Computing team. (9100, 9200, 9300, 9500, 9800)

The construction contract for the MESA Weapons Integration Facility (WIF) has been placed, and construction has commenced. The overall project is approximately 50 percent complete and project performance is on schedule and under budget. The MicroFab and MicroLab facilities are on schedule to complete construction in FY05 and begin operations in FY06. The MESA Institute is Sandia’s micro/nanotechnology interface to the US academic community. It has established collaborations with more than 30 targeted universities, with 50 students coming to Sandia yearly, creating a pipeline for top new hires. (1900)

The second-generation (PA2) Permafrost digital microelectronics Development Laboratory fabricates PA2 in its CMOS7 radiation-hardened technology. Additional functionality in the newer version adds 44 percent more logic gates while retaining a very demanding low leakage current requirement. The added complexity and demanding specs were counte by applying lessons learned and technology improvements to achieve unprecedented MDL yields on a chip of this complexity. (1700, 2100, 1100)

The development of novel silicone gel materials and processing methods for high-voltage devices solved a high-voltage component reliability problem. This technology allows a dramatic reduction in the size and weight of a weapon component, while assuring the high reliability required for weapon performance over a broad temperature range. Because of its exceptional mechanical, adhesive, and electrical stability, this gel encapsulant has been chosen as a baseline material for future weapon electrical designs. (1800, 14100, and 1700)

We designed seven SE3331 data-acquisition systems, which have been used to record the interface data between the aircraft and nuclear weapon for certification of nuclear weapon systems. The SE31, installed in B61 and B83 Compatibility Test Units, is an event-driven data-acquisition system that records the electrical events of voltage, current, time, and noise, and stores this information in non-volatile memory. It has been used successfully on the B-2A and B-52H aircraft to verify compatibility with the B61, B83, and W80 weapon systems. (2900)

We successfully completed a series of high-fidelity JCEL flight experiments at the Analytical Cable Facility. The experiments required close coordination and extensive planning among 9100, 2900, the NWSMU office, Security, FSH, Facilities, NNSA, BWXT/P, and the Sandia Site Office. These experiments were the first high-fidelity experiments authorized by NSO to be conducted at Sandia/New Mexico. Rigorous test planning included integration with the test item construction process, a facility safety assessment, and detailed supporting safety calculations using CTH. (9100, 2900)

The Milestone Reporting Tool is a complex-wide, web-based application that tracks Nuclear Weapons Complex-wide issues. It was developed for NNSA to aid the integration, planning, and assessment of the scope of nuclear weapons program work. Since using this system, NNSA has reduced the time it takes to conduct quarterly reviews from two days to four hours. Recent enhancements enable NNSA to conduct this review via videoconference, resulting in annual savings of at least $400,000. (5400)

Photomurics and Data Acquisition test capabilities facility in Area 3 houses 26 staff, providing the Nuclear Weapons Complex with state-of-the-art photometric and data-acquisition capabilities to support weapons qualification and development, investigations, and model validation. Additionally, this help facility provides a venue to develop and deploy advanced quantitative photometric capabilities for measurements ranging from lab microscale to field macro-scale applications. (9100, 10800)

The MC3600A (shown at left), a nuclear safety-critical component for the W87, successfully passed its First Production Unit status in June 2004. The MC3600A is an inertial switch that closes and latches 10 electrical contacts after experiencing two discrete acceleration-time events. During its first production run in FY04, nine MC3600A units were certified and accepted by NNSA for use in the W87 system. Center 2600 is the design agent for the MC3600A and Honeywell’s PMS at Kansas City Plant is the production agent. (2600, KCP)

Sandia has developed a unique metrology course designed for managers who work in research and development activities. The course consists of examples of lessons learned across NNSA and emphasizes critical thinking applied to measurements, as well as discipline and model validation. Additionally, the course helps managers determine the appropriate level of formality to use in the collection or analysis of data. The course has been presented to more than 200 staff and managers at Sandia, Oak Ridge, Lawrence Livermore, and NNSA. (2500, 3500, 2300)

Size requirements for the MC 4300 neutron tube have led to new concepts for target resistors. Integration of the target resistor into the neutron tube target insulator with a Low Temperature Co-fired Ceramic, or LTCC, design has the potential to enhance reliability, eliminating the need for a hermetic electrical feedthrough, and reduce part count and assembly complexity compared to conventional or thick film resistors. The concept has been demonstrated in prototype, and the technology is being qualified as part of the W87 baseline design. (2500, 14100, 14400, 1800, 2900, 2600, 6700, FM&T)

Eight product testers were built from scratch within a design-bUILD-deliver cycle of only six months. Significantly, efficiencies were realized through the use of common hardware and software, and each includes real-time data acquisition and process control. Three of the testers located at supplier sites have the ability to securely transmit test data to Sandia. (2500)

The Sandia Weapon Intern Program graduated its sixth class in September 2003 and started the Class of 2004. The program aims to promote career development. (Continued on next page)
ment at Sandia and to achieve complex-wide excellence in weapon engineering through education. Among the participants are 32 Sandians and four NNSA, two Air Force, one DTRA, and three Kansas City Plant personnel. The one-year curriculum continues to evolve to meet the changing needs of the nuclear weapons complex. This year included increased emphasis in Modeling and Simulation and Weapons Effects education. (2900, 7900, DOD, NNSA)

The stockpile evaluation program executed the first high-fidelity system level surveillance tests under post-9/11 heightened security measures. FY04 accomplishments included a successful B61 flight test at the Tonopah Test Range and completion of all prepreparatory measures for FY05 B83 testing at both Tonopah Test Range and the Sandia Aerial Cable Facility. Implementing these tests required a tremendous amount of coordination and perseverance by several organizations at Sandia as well as Lawrence Livermore National Laboratory, Pantex, and NNSA. (1900, 2800, 2900, 4100, 4200, 8200, 9100, 9700)

On June 30, 2004, the Electronic Systems Center (2300) and Honeywell Federal Manufacturing & Technology delivered the first fully functional MC4635 Warhead Interface Module for the W80-3 Life Extension Program. To fit increased functionality into less than half the previous volume, the WIM team worked with Microsystems Center 1700 and developed the largest mixed signal (digital and analog) application-specific integrated circuit for a nuclear weapon. The WIM will be the first weapon subsystem to use a MEMS system for environmental sensing. (2300, 1700, PMCT)

The first fully functional Cryptic Coded Switch is a 25-foot-diameter target at a velocity of thousands of miles per hour. The W80-3 and W80-4 targets produced by the W80-3 Stockpile Life Extension Program. (Continued on next page)

A ribbon-cutting ceremony was held last fall to celebrate the completion of Sandia’s new Weapons Evaluation Trench as well as the expansion of the Pantex plant in Amarillo. The $22 million state-of-the-art facility replaced the 39-year-old laboratory, constructed when some of the early weapons were first built. It will house more than $90 million worth of testing equipment that will conduct systems/profitability nuclear tests on nuclear weapons and components. WETL is the only US facility that performs these types of tests. (1800, 2500, 2900 and 10800)

We developed and deployed a major enhancement to the Classified Image Management System that copes of all the unclassified images stored on the Unclassified Image Management System to the CIMS nightly. This enables users of the CIMS to work exclusively in the classified environment, which significantly improves the usefulness of the classified environment. The Image Management System is one of our most heavily used engineering information systems (an average of 35,000 documents are downloaded every month by engineers throughout the Nuclear Weapons Complex). (2900, 9300, 9500)

The latest version of the Nuclear Weapons Information Environment Portal was deployed in September. The NWI Portal provides the common user interface to the Engineering Information Systems. Engineering information is now presented in an organized fashion based upon weapon system and weapon component. The NWI Portal portal pulls together the multi-year investment that has been made in the development, deployment, and operation of Sandia’s classified Engineering Information Systems. (2900, 9500)

Interactive Electronic Procedures (IEP) are used to support the development of a BWXT Pantex (PX) initiative to replace the classified paper procedures currently in use. Since Sandia and the nuclear design labs have procedure concurrence responsibility for IEPs this posed both connectivity and platform compatibility issues for the complex. The Qualification Engineering Release was recently released for the on-site qualification of the IEPs at the Pantex Plant. This concluded a multi-year effort by Sandia and nuclear laboratory personnel. (2100)

Center 12300 quality engineers provided Quality Assurance support to the W76-1 Life Extension Program. Numerous product realization teams, Major qualification milestones of the W76-1 Armring, Fuzing, and Fitting Systems components and testers have been met, qualification documentation released, and reviews completed. This project is an excellent example of the successful implementation of the Technical Business Practices and teaming that is taking place among Sandia, the production plants, and commercial suppliers. (2100)

The 12300/2100 Virtual Assessment Facility came online in FY04 to safety assessments for new and existing stockpile systems. The facility provides a 3-D stereo environment for running virtual assessments of weapon system design, functionality, and performance in both normal and abnormal environments. The facility will assist in integrating the Design through Analysis Realization Team program (DART) and Sandia-developed simulation codes into weapons programs assessment/assurance activities in a classified environment. (12300, 2100)

The identification of component-age affecting the resulting impact to system performance, and the prediction of weapon in the end is of increasing importance to the monitoring of the stockpile. Model Based Performance Analysis is providing a predictive capability by using modeling and simulation of weapon electrical systems to act as a bridge between aging effects and system performance. In FY04, circuitry for the W80-3 was developed for the MC2901 and SA2142 (B61 Life Extension Program). MC2971-B83 Fitting Set and MC3719-W87 Fitting Set (Component Surveillance Program). (12300, 8200)

In FY04 Tonopah Test Range became the first site in the DOE complex to meet the physical security requirements for the new NNSA Design Basis Threat (DBT). TTR, with the help of Center 4200, completed a new Vulnerability Assessment, was certified for new test sites. The combination of materials and material combinations were reviewed. No potential materials shown to be component will be used in hardware until several several studies. (12300, 1400)

Tests and analyses were conducted to evaluate the effects of lightning on several unique facilities, including critical assembly areas at the Pantex Plant, the Weapons Engineering Tritium Facility at Los Alamos, and maintenance and storage facilities at Air Force bases. The work encompassed a wide range of activities, which included performing a cost/benefit analysis of competing lighting protection approaches, measuring the effect of various shielding and bonding the energies delivered to load impedances representing electrically sensitive components due to indirect field coupling. (12300, 1600)

An external review panel continued to advise Sandia on the effectiveness of the independent assessment activities of the Weapon Surety Assessment Center. The panel consists of knowledgeable executives with diverse backgrounds and experience in nuclear weapons enterprises and other high-consequence operations. The panel provides an in-depth review of Sandia processes to conduct independent assessments of the Weapons Program in twice-yearly reviews. The panel is comprised of five merchants and two government members. (Continued on next page)
Nuclear weapons

(Continued from preceding page)

responded to by the Weapons Systems Division and the Surety Assessment Center in coordination with the office of the Executive Vice President. (12100, 12300)

The final report of the Joint Nuclear Surety Study initiated by the Air Force to improve the security of nuclear weapons throughout their lifecycle was reviewed in response to the increasing threat environment, a cross-disciplinary team developed a concept, known as SAFE, to provide an integrated physical security/use control architecture to provide enhanced security for nuclear assets. Critical technologies to support implementation of the concept were identified and may be developed in the coming years. (12200, 2100, 8200, 4100)

Development of a unified general purpose constitutive model for geologic materials was completed. This effort, originated in the late 1990s, experienced accelerated development over the last several years. Key applications include projectile penetration, analysis of hard and deeply buried targets, and reservoir mechanics. The SANDIA GEO/MODEL represents a major advancement in the ability to model the complex constitutive response of nonlinear rock-like materials. (6100, 9100, 9200)

Two milestones were completed that increase confidence in the ability of several computer codes to make predictions to help quality new weapon components. The codes, developed by the Advanced Simulation and Computing program, simulate radiation transport and electromagnetics. They model the electrical and mechanical response of components in hostile X-ray environments. A validation process was followed to compare predictions to experimental data. These codes are currently used to support qualification of the new arming, fuzing, and firing component for the W76-1 and the new neutron trigger for the W87. (6700, 1600)

Construction and occupancy of the Distributed Information Systems Laboratory at Sandia/California were completed in 2004. DISL provides Sandia’s Simulation Enabled Product Realization (SEPR) program office and laboratory space to invent the future of distributed computing through computer sciences research and development. DISL will also help stimulate the transformation in engineering through prototyping of new technologies by weapons engineering workgroups located in classified spaces in DISL. (8500, 8900)

The W87 Life Extension Program rebuild of the stockpile was completed at the Pantex plant in September, achieving a major milestone for NNSA, and finishing a production effort that started in 1999. Activities in the last year consisted of resolving worldwide production issues at Pantex, and solving numerous problems at the Kansas City Plant to keep shipment of components in line with the Pantex production schedule. Most notably in 2004, Sandia processed a number of body sections/heat shields with Mark Quality processes to assure that there were enough parts to finish the last warheads.

The Monitoring Technologies group completed a study of the X-ray shielding efficiencies of high-purity tungsten in neutron generator surveillance applications. Results show that box shields of reasonable mass will greatly reduce X-ray-related errors and will improve monitor accuracy by an order of magnitude. This has tremendous implications for production and stockpile surveillance of neutron generators. Monitors incorporating X-ray shield boxes will allow, for the first time, accurate comparisons of production/shield-life and stockpile surveillance measurements. (2500)

The MC4759 SILICON RE-ENTRY SENSOR (SIRE) is Sandia’s first microsystems-enabled component being considered for use in the W76-I nuclear weapon lifetime extension program. Using MEMS technologies, SIREs is intended for geospecific monitoring the decelerations of a re-entry vehicle. During FY04, Group 1 and Group 2 bulbs were produced and tested. Major technical breakthroughs included ultra-low contact resistance and extreme high-shock survivability. The scale of the SIRE chip is depicted here by its size relative to a standard dictionary entry on weapons. (1700, 1800, 2100, 2600, 9100, Kansas City Plant) (Photo by Randy Montoya)

Phase 6.2/6.2A Study, requested by US Air Force Space Command, has been approved by the Nuclear Weapon Council Safety and Standing Committee. (12300, 2100, 4100, 8200)

We conducted various experiments with fuel-air explosives (FAE) to be used for security applications. The major problems encountered were control of the fuel-air ratio and mixing of constituents. A test series was performed to develop a FAE scaling law which allows for future development of prototype components. (12300, 2100, 500)

In response to the increasing threat environment, a cross-disciplinary team developed a concept, known as SAFE, to provide an integrated physical security/use control architecture to provide enhanced security for nuclear assets. Critical technologies to support implementation of the concept were identified and may be developed in the coming years. (12200, 2100, 8200, 4100)

The JTA6 is representative of a new family of factory weapon system functionality and vehicle motion performance in the ability of several computer codes to make predictions to help quality new weapon components. The codes, developed by the Advanced Simulation and Computing program, simulate radiation transport and electromagnetics. They model the electrical and mechanical response of components in hostile X-ray environments. A validation process was followed to compare predictions to experimental data. These codes are currently used to support qualification of the new arming, fuzing, and firing component for the W76-1 and the new neutron trigger for the W87.

Simulations with fuel-air explosives (FAE) to be used for security applications. The major problems encountered were control of the fuel-air ratio and mixing of constituents. A test series was performed to develop a FAE scaling law which allows for future development of prototype components. (12200, 8200, 4100)

We have made breakthroughs in the performance of light-emitting diodes with wavelengths less than 300nm, achieving optical powers of 2.25mW at 297nm and 1.3mW at 276nm. This has enabled significant gains in the capability of non-line-of-sight communication systems and bio-agent detectors. Additionally, LEDs with emission as short as 237nm, the shortest wavelength agent detectors. Additionally, LEDs with emission as short as 237nm, the shortest wavelength
The Hound trace explosives detection system was broadly fielded last year. The New Mexico National Guard used the Hound in a warfighting and civil support demonstration for the National Guard Adjutants General from more than 24 states. The South Texas Specialized Crimes and Narcotics Task Force credited the Hound with the quick identification of a major methamphetamine shipment after a routine traffic stop revealed concealed powder and liquid. The Task Force said the Hound saved lives. Commercialization efforts continue. (4100)

As part of our mission to support our NNSA Nuclear Incident Response Program and the Department of Homeland Security, we delivered Turbo-FRMAC, a software tool that allows first responders and consequence managers to quickly and accurately assess actions required during a radiological event (nuclear detonation, nuclear power plant accident, dispersal of radiological materials, etc.). The software distills three volumes and more than 500 pages of guidance into a useful set of input panels that are user friendly and intuitive to use. The software provides crisis and consequence managers estimates of the near- and long-term radiological effects to the surrounding population, as well as guidance on dealing with supporting infrastructure such as drinking water, food streams, and personal protection guidance. (4100, 5900, 6300, 8100, 12300)

The DHS-IP funded NISAC Western Gulf Coast Infrastructure Interdependency Analysis Project evaluated potential effects of infrastructure disruptions and propagation of impacts to other regions and infrastructures by analyzing disruptions caused by increased homeland security levels, loss of physical capacity in water transportation system, loss of refining capacity, loss of crude oil pipeline capacity, loss of refined petroleum product pipeline capacity, regional electric power outage, and regional telecommunications outage. This achievement included close working relationships with the US Coast Guard, oil industry, and Port Authorities. (6200)

We developed a suite of components comprising a miniaturized “front end” necessary for biodetector systems. Samples from an aerosol collector have been autonomously prepared, processed, and delivered into a microChemLab biodetector. Microseparator/ microimpingers provide aerodynamic particle-focusing, inertial size-separation, and direct-impenetrating into liquid microsamples. Components developed for post-collection sample preparation include particle concentrators based on dielectrophoresis, microlyzers to solubilize proteins, solid-phase extraction and size-exclusion cartridges, miniaturized pumps, valves, and specialized power supplies. Initial results for a breadboard system indicate successful processing of Bacillus subtilis spores. (8100, 8300, 8700, 9100)

We conducted analyses, staffed deployments and provided follow-up assessments for “Orange Alert” activities including the Republican National Convention and New Year’s events to support enhanced radiological and nuclear defensive deployments. The BN2 activity proved that a well-designed concept of operations is required to ensure a successful deployment. Most radiation alarms result from naturally occurring radioactive material, such as ceramics and fertilizer, that can overwhelm the secondary screening capacity. Using Sandia’s Sensor for Measurement and Analysis of Radiation Transients (SMART), spectroscopic detectors, and automatic isotope identification algorithms, nearly all naturally occurring radiation sources can be identified non-invasively. (4100, 5900, 6300, 8100, 12300)

While Livermore, Calif., residents and visitors enjoyed Fourth of July barbecues, music, and other activities, Sandia researchers and members of the Livermore Police Department tested a complex system of sensors and other advanced technologies designed to keep revelers safe from terrorist attacks. The Sensor Management Architecture, developed by the Center for Homeland Security Systems & Development (8100), linked chemical and radiological/nuclear sensors, surveillance cameras, and real-time communications to form a rapidly deployable warning and incident characterization tool for first responders. (8100)

A guideline document intended to improve the preparedness of airports against chemical and biological threats has been published by the DHS PROACT airport chem bio facility protection program. The guide targets near-term facility enhancements and response strategies to prevent or mitigate attacks. This document was developed by Sandia and Lawrence Berkeley labs, combining general chem bio facility defense expertise with detailed analyses of facility experiments and exercises conducted in collaboration with San Francisco International Airport. Dissemination to airports nationwide is being coordinated through the Transportation Security Administration. (8100)

Sandia and EPA are teaming to protect the nation’s water supply from chem bio attacks. DHS-funded work addresses indoor (e.g. courthouses, airports) and outdoor urban air environments. These projects provide guidance for early warning systems and response plans. Sandia helps sites prepare by assessing risk and computing optimal sensor locations. Real-time physics-based algorithms use sensor data to compute optimal strategies for protecting people and decontaminating facilities. EPA enthusiastically writes, “This is an excellent opportunity to leverage the analytical and computational skills at Sandia.” (9200, 6100)
acoustic wave device. Bacteria identification occurs within a few minutes. Prototype systems are being developed by our industrial partner. (1700)

We have developed a laser-scanning confocal microscope that records the entire fluorescence spectrum and lifetime for every pixel in the sample’s image. This allows us to simultaneously monitor, for the first time, the fluctuating spectra and lifetimes of individual fluorescent molecules. By characterizing chemical processes one molecule at a time, this unique tool provides new approaches for studying fundamental biological processes such as antibody binding, enzyme activity, or protein-protein interactions. Single molecule studies reveal details of such processes that are obscured in bulk measurements. (8300)

We have discovered a new kind of phase transition at the boundaries between nanoscale gold crystals in thin gold films. Atomic resolution electron microscopy provided experimental evidence for this transition, which was confirmed using first-principles calculations to model the electron structure and elasticity calculations to model the bending of gold lattice planes. These results are important because they demonstrate that the structure and behavior of nanoscale boundaries between crystals is very different from longer boundaries. (8700)

The Wy80-3 Abnormal Environment Verification approach to code verification and model validation through analysis and testing at increasing levels of geometric complexity and physical phenomena. The project focused on assessing capabilities (with quantified uncertainty) to predict W80-3 response to abnormal mechanical and thermal environments. The results support the W80-3 qualification activities.

We used a new thermal-electrical-mechanical coupled-physics analysis code to describe the 3-D motion of a microsystems thermal actuator. The actuator could be used in mechanical non-volatile memory devices. This new analysis capability was developed by coupling thermal, electrical, and mechanical analysis programs within the Sierra framework. This analysis capability can run on the world’s fastest parallel computers, and will accelerate microsystems development rates. This project included analysts and code development teams in 9100 and microsystems designers in 1700.

The Analyst Homepage is an online resource for modeling and simulation analysis. It presents a wealth of information about codes, tools, servers, and other topics of interest to analysts. Because of the sheer volume of information and the uncharted nature of the project, it took tremendous effort on the part of the developers and the project owners, including user research, information architecture, interface design, coding, and maintenance. The site has received more than 25,000 hits per month since its deployment. (9500)

DART, the Design Through Analysis Realization Team, has set its sights on improving scientific and engineering analysis times by an order of magnitude. Corporate ownership and careful management has produced a progressive technical roadmap and aggressive changes within a portfolio of 14 projects. Strategic integration has been accomplished via XML metadata files. Critical process knowledge and information has been captured via a comprehensive analyst homepage. A common user support structure has been adopted to enhance usability and supportability of the codes. (9200)

SANDIA’S RECORD-SETTING visualization algorithms were deployed in 2004 through the open-source visualization tool ParaView. Sandia collaborated with external partner Kitware Inc. to deploy the Data Analysis and Visualization Dept.’s high-end visualization algorithms, including the world’s fastest parallel rendering algorithm. These algorithms scale from the desktop to leading-edge visualization clusters and high-resolution display walls. ParaView was recently used to display and explore the results of the largest finite element simulation data set at Sandia (greater than 70 million finite elements). ParaView is downloaded by more than 70 people around the world each day. (9200)
Energy and infrastructure assurance

The Atmospheric Radiation Measurement
Unmanned Aerial Laboratory
Toward a program conducted 14 scientific flights and its participation at the North Slope of Alaska as part of a three-week multi-agency Micro-Blues serene Cloud Experiment. The complex proj ++

Oxygen-containing compounds added to fuels are called oxygenates. The potential for oxy- genates to limit soot emissions from diesel engines has been known for some time. What hasn’t been known is whether (or why) some oxygenates are more effective than others. Research with Lawrence Livermore National Laboratory has significantly advanced the understanding of oxygenated fuel combustion, con- ditionally demonstrating how molecular structure can play an important role in determining the soot- reduction potential of an oxygenate. (6000)

Sandia was selected last March to lead one of three new DOE Centers of Excellence for Hydrogen. The $325 million Nuclear Security Center of Excellence includes eight universities, three com- panies, and five other national laboratories. It focuses on developing new, state-of-the-art technologies and storage materials that will meet or exceed the DOE FreedomCAR goal in 2010 and 2015. (6700, 8000, 8200, 1800, 6200)

We have developed, in collaboration with American Superconductor Corporation, a new magnetostrictive actuator. This new method deploys optical films of superconducting ceramics on a flexible nickel-based tape by the casting of water solutions and enables high deposition speeds of 120 meter/hour. This method holds promise for low production and assembly costs for stabilizing power transmission, increasing efficiency of transform- ers, producing lightweight generators, and improving the sensitivity scale prototypes have been built and will be tested this year. The novel concept was designed using the Sandia-developed NoMAD tool for blade analysis. Early results are promising, and three blade manufacturers have been selected for a $5 million, three-year, cost-shared collaboration to take these concepts to full-scale commercial application.

We developed a customized Common Language for Systems Engineering (CLSE) tool that enables rigorous definition of drilling fluid property requirements and robust well design for deep- water subsea settings. The software integrates across 50 non-linear finite element models in multi-space/time conditions to compute forces on the well bore, and one of the most challenging to reliably model. An important feature of this tool is that it can be used to perform sensitivity analyses on any combination of parameters or on any combination of models with a minimal risk of redundancy in the applied tool software. The results were released to eight oil companies and has been applied to several oil field developments in the Gulf of Mexico. (6200)

In a new initiative of the presidents of Sandia and the Kurchatov Institute in Russia to bolster nuclear energy development and deployment resulted in a joint report signed by seven US national lab- oratories and nine Russian counterpart bodies. The report was agreed on at a 10th Russian-Lab Directors Forum held last summer in Vienna. The summary, signed by 36 research chiefs, asserts “The time has come to develop a comprehensive and realistic plan to correct the LIQUEFIED NATURAL GAS (LNG) is being transported by ship to the United States to meet increasing energy needs. Multiple government agencies reported that accidents have the potential to cause a serious environmental disaster (100s of meters in diameter) LNG fires from potential terrorist attacks. Evaluations of wide variations in pre- dictions from previous studies (including comparisons to nuclear detonations), guidance on best methods for analysis, and key sources of uncertainty were analyzed. New, unique experiments are being assembled at Sandia to obtain critical data. Likely causes of a fire and explosion at an Algerian LNG facility were also identified. (9100, 6200, 4100, 3100)

Sandia’s Center for SCADA Security was established to address security challenges facing the National Critical Infrastructure. Supervisors Control and Data acquisition, or SCADA, systems man- age electric, power, oil, gas, and water, and other critical infrastructures. The Center provides training, standards development, vulnerability assessments, and outreach to government and industry at its facility. CS is a part of DOE’s National SCADA Test Bed program, the Department of Homeland Security Critical Infrastructure Security and Test Center. It has $15 million in SCADA security research through the Department of Homeland Security and the Institute for Information Infrastructure Protection. (5000, 6200)

We have developed wind turbine blades that use carbon/ glass hybrid materials to reduce weight and load caused by turbulence and aerodynamic twist-bend coupling. The first sub-

The Transportation and Materials Management Program completed a structural and thermal impact analysis of an F-16 stark for the Nuclear Regulatory Commission. The analysis assessed the consequences of an F-16 crashing into a 200 square foot steel depot storage facility. This work was critical because the NRC stated the initial accident was too low to consider credible. This work included expert witness testimony and is critical to the future licensing of storage facilities. (6100, 9100, 3100)

Sandia’s Certified Programs Group, home of the nation’s top experts on WDF-related science issues, last year applied expertise to another flinty waste disposal issue. It com- pleted a Performance Assessment analysis that was instrumental in gaining the required EPA approval to dispose of 20,000 cubic meters of super-safe compacted wastes produced by the Advanced Mixed Waste Treatment Facility at the Idaho National Engineering and Environmental Laboratory (4000).

As part of our geothermal research programs, we have developed high-temperature electronics and instrumenta- tion. After 7 years and up to 90°F, a Sandia-developed high- temperature, high-performance soldering tool using a Silicone-Oxide-Infiltrated chip set is setting new records for longevity and monitoring. The Sandia-designed 250°C chip-instrumented, high-temperature flow meter is critical to the heart of a long-life data acquisition system capable of monitoring geothermal wells, advanced fighter aircraft, or even future Venus explorers. (6200)

The US Bureau of Apprenticeship and the New Mexico State Apprenticeship Council have officially certified 31400’s Advanced Manufacturing Training Program as an apprenticeship program. The National Defense Industrial Association recently recognized AMTTP for “Defense Manufacturing Excellence.” AMTTP remains students attending any of these technical institutions. Students must demonstrate the ability to carry out tasks that are characteristic of state and federal or private or governmental responsibilities. The $25 million Metal Hydride Center of Excellence recently recognized AMTTP for “Defense Manufacturing Excellence.” AMTTP remains students attending any of these technical institutions. Students must demonstrate the ability to carry out tasks that are characteristic of state and federal or private or governmental responsibilities. The $25 million Metal Hydride Center of Excellence includes eight universities, three companies, and five other national laboratories. It focuses on developing new, state-of-the-art technologies and storage materials that will meet or exceed the DOE FreedomCAR goal in 2010 and 2015. (6700, 8000, 8200, 1800, 6200)

The new Center 4800 led a Sandia team to provide nuclear reactor and associated design expertise to NASA and its industrial aerospace teams for a proposed Jupiter fly-by mission. The project will develop, and test the 250°C hardware, which was awarded a $7 million, three-year, cost-shared collaboration to take these concepts to full-scale commercial application.

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Sandia delivered the Ground-Based Nuclear Explosion Monitoring Knowledge Base Version 6 to the Air Force (images above). The Knowledge Base was a collaboration among Sandia, Los Alamos, Lawrence Livermore, and Pacific Northwest labs, where Sandia acts as both a contributor and as system integrator. The Knowledge Base is critical in improving the ability of the US to detect, locate, and identify clandestine nuclear tests by providing detailed knowledge of the earth’s structure, signal propagation characteristics, and analysis tools. There are now 99 unique products in the Knowledge Base. (5700, 5500)

Sandia has transitioned a new sensor microsystem from concept to spaceflight-quality fabrication in only three years. These microsystems are based on custom sensor read-out and signal processing Integrated Circuits (ICs) designed and built at Sandia. Two hundred fifty-six of these ICs are assembled onto two-sided multichip modules and integrated into a multi-layer assembly with a photodiode array. We are fabricating these highly integrated sensor microsystems for the next generation of Global Positioning System satellites, and two-flight-quality sensors are complete. (5700, 1700, 1800, 14100)

For applications requiring both data encryption and authentication, we have developed new algorithms that use information from the internal state of a standard cipher to provide data authentication at little more than the computational cost of encryption alone. Their “Cipher-State Mode of the Advanced Encryption Standard” is a National Institute of Standards and Technology (NIST) candidate mode of operation for an authenticated encryption standard. This same algorithm was recently integrated into a commercial software product to support Sandia’s Cyber Security of Utility Operations project. (5600)

At the conclusion of a 6-year, $15 million effort, we delivered a suite of advanced radiological debris collection and analysis systems to harvest gas and particulate samples. The work is part of an Air Force mission to conduct international nuclear test ban treaty monitoring. The Advanced Atmospheric Research Equipment provides significant enhancements in computer control and data management, real-time radiation monitoring, and crew safety radiation monitoring. Last summer the equipment was installed on an Air Force WC-135 (Boeing 707) aircraft and successfully flight-tested. (5500, 5900)

The AURA (Advanced UV Remote-sensing Application) airborne lidar, a technology developed to perform standoff detection of WMD proliferation “markers,” underwent extensive flight test evaluations. The system was installed on a Proteus aircraft and completed 50 hours of flight testing over a period of 11 days. Airborne collections were successfully performed to validate design performance estimates and better understand the limits of this technology for operational applications. (1100, 2300, 5700, 6100, 8100, 8300)

In October, the twenty-third Defense Support Program satellite (DSP-23) passed its final inspection prior to being shipped to its launch site. This launch will be the last for a DSP satellite, which has been a major element of the US Nuclear Detonation Detection Systems for more than 30 years and a major activity in the Monitoring Systems and Technology Center. (5700)

Sandia’s Center for Cyber Defenders (CCD) program uses highly qualified students interested in becoming cyber security professionals to address cyber security challenges facing the nation. Students work on research projects and develop security technologies relevant to Sandia’s mission: network visualization, supervisory control and data acquisition (SCADA) security simulation, sensor network security, computer network mapping, and wireless network security analysis. So far, the program has supported 52 students from 22 universities across the country. Thirteen CCD alumni are now Sandians. (5600)

Sandia has delivered the first of the next-generation Global Burst Detector (GBD) payload for operation with the first Block IIIF Global Positioning System (GPS) spacecraft. The GBD encompasses a suite of sensors that perform the nuclear event monitoring mission of the US Nuclear Detonation Detection System. The GBD sensors are designed and produced by Sandia and Los Alamos National Laboratory with Sandia also responsible for overall system engineering and integration. (5700)

The Radiological Threat Reduction (RTR) Program at Sandia secured 24 sites with high-end radiological sources. In Lithuania, five hospitals and one waste repository site received security upgrades and a search for off-site sources was conducted at 39 locations. Sandia is working with the Russian Federation Navy to dispose of Radiological Thermoelectric Generators (RTGs), replacing them with explosive energy systems. Also, in preparation for the 2004 Olympics in Athens, the team secured 18 sites and trained Greek officials on safeguarding radiological materials. (6900)

The Sandia-developed Special Sensor F, or SSF, was launched on an Air Force weather satellite in late 2003. During 2004, Sandia completed early-exit testing and extensive calibration of SSF, and declared it ready for operational use. The sensor provides laser threat warning for its host satellite; it is the first of its class — it not only detects laser illumination, but it also characterizes the laser’s energy (both waveform and incident energy) and provides location of origin. (5700)

The Dynamic Explosive Test Site hosts training, research, development, test and evaluation for nuclear emergency responders, the special operations community, and other federal agencies. Explosive testing supports units in the field (gaulement test). Lifelike replicas of improvised explosives, nuclear, or radiological devices set in realistic training venues (e.g. the Rubik Maru provide challenges for responders’ tools, tactics, and procedures. Lessons learned during training guide development of new tools and techniques, which are immediately put to use around the world. (5900)

The Megaports team successfully developed and installed an integrated information technology and communications system for use by Dutch Customs in the
Materials, chemistry, and physics

We have developed a simple and robust general sensors platform for chemical and biological detection based on self-assembled nanosensor materials. This sensing device is easy to fabricate and can be integrated with Sandia’s advanced microsystems. The specific and selective binding of biomolecules is translated into electronic signals without requiring the complicated labeling steps used in the preparation of most other electrochemical sensors. This ultra-sensitive sensor enables the detection of protein and sequence specific DNA at the femtomole (10^-15 mol) level. (1800)

Metal hydrides are used to store hydrogen and its isotopes in neutron generator targets. The presence of tritium in hydride systems results in a time-dependent change of the target material due to the radiative decay of tritium to helium-3, resulting in a potential negative impact. The behavior of radiogenically produced helium-3 in metal tritide films has been an active area of interest for more than 50 years but remains a poorly understood phenomenon. Recent experiments using several neutron scattering techniques have been applied to this problem resulting in first-time observations of helium ordering within an erbium tritide matrix. Studies are under way to determine the underlying reasons for these observations. (14.400)

We have developed a revolutionary new method for comprehensive 3-D chemical analysis that requires no a priori knowledge of the chemistry. This method provides detailed characterization of critical materials, such as aging stockpile materials. The X-ray spectral images, analyzed with Sandia’s patented and award-winning Automated Expert Spectral Image Analysis software, reveal rich detail not previously available. This information has been essential for resolving materials problems, such as identifying causes of component corrosion and ways of mitigating future problems. (1800)

The Enhanced Radiometer (ENRAD) was launched from Cape Canaveral on June 23, 2004, on board the GPS Mission IIR-12 satellite. ENRAD is a demonstration of the next generation of optical sensors which will be included on future GPS satellites. These sensors will provide significantly enhanced optical sensor performance for worldwide nuclear threat monitoring. During the early orbit test period a series of tests were performed to verify functionality and set operating modes and the sensor was tested with ground-based optical pulses. (5700, 5500, 1700, 14100)

The disassembly/sanitation process for material that was exhumed during remediation of the Classified Waste Landfill was completed last September. The activity started in February 2000, with no disposal path available for mixed classified components and no other facility available to perform this work. Therefore, the material was sorted and disassembled on-site, involving combinations of cutting, shredding, and melting. Approximately 10,000 classified items were excavated. A few items could not be disassembled because of ES&H concerns and were managed as classified low-level waste. Approximately 90 percent of the original volume of materials was recycled. (6100, 6300)

Facilities, Procurement, and Pollution Prevention (P2) staff implemented comprehensive recycling and green purchasing programs for construction. Major projects recycle over 80 percent of construction waste, and 99 percent of their purchases meet the EPA’s recycled content requirements. Sandia received a White House Closing the Circle and NNSA P2 award for green purchasing. For construction recycling, Sandia received an NNSA P2 Award, the EPA Waste Wise Program Champion Award for the Federal Government, and the New Mexico Recycling Coalition “Federal Facility Recycling Program of the Year” award. (6300)

Nonproliferation

(Continued from preceding page)

leading international Port of Rotterdam, one of the busiest container terminals in the world, to detect, deter, and interrupt illicit trafficking in special nuclear materials. This program has strong Iraqi participation and its results are widely recognized and praised. (16000)

ENRAD launch at Cape Canaveral.

The Advanced Concepts Group has developed a process — called “fests” — for large group brainstorming. Fests are particularly effective in bringing together diverse groups to address open-ended questions requiring new approaches. Two successful Fests were held in FY04 dealing with international approaches to countering terrorism. PACFest involving Singapore, Australia, Guam, Fiji, and Palau in the Pacific region; and NorthAm Fest involving Canada, Mexico, and the US. (16000)

The ACG developed a strategic architecture for understanding and anticipating terrorist threats to enable a full range of actions for countering terrorism. An ACG-funded LDRD for “The Hypothesizer” has created a prototypical AI-based tool that generates terrorist scenarios. Those scenarios, in turn, provide the data this architecture needs for a better understanding of the full range of hypothetical terrorist actions. This has led to a fledgling program in the Information Systems Center ($5000) in Knowledge, Discovery, and Dissemination with the intelligence community. (16000)

An understanding of terrorist motivation and intent will greatly improve our ability to anticipate terrorist targets and methods, disrupt their operations, and narrow the field for homeland defense. The ACG developed a prototype for this purpose, including the establishment of a knowledge base, a network of terrorism experts now available to the homeland security and intelligence communities. ACG concepts have been adopted by the DHS and incorporated into a new ACG-funded 3D00 program for that agency. (16000)
Military technology and applications

Sandia designed, produced, and tested shoulder-length gauntlets to help protect the arms and lives of military personnel in combat. The gauntlets, forearm and upper arm protective inserts as seen at right, made of Kevlar layers with carbon-composite, protect soldiers riding atop military vehicles from Improvised Explosive Devices (IEDs). Army representatives are collecting statements from troops who have worn the gauntlets. Among the comments: “They really like the gauntlets and think they are a great item,” “impressed with the gauntlets,” and “looking forward to receiving many more gauntlets.” (6900, 15300)

Exoskeletons for soldiers require advanced sensing of their environment, including ground reaction forces and terrain sensing. To solve this problem, a Sandia team (15200, 1700, 14100, and 9100) produced a custom MEMS-based pressure sensor array and integrated it into an exoskeletal boot sole. The team advanced the state-of-the-art in microsystems deployment by packaging a delicate MEMS device to withstand the abusive environment encountered by the bottom of a soldier’s boot. (15200)

The US military needs a rapid-response, precision-strike conventional weapon capable of holding hardened and deeply buried targets at risk. The Tactical Missile System Penetrator project is an Advanced Concept Technology Demonstration to design, develop and demonstrate such a weapon system. The US Navy Strategic Systems Programs Office is sponsoring Sandia’s work in this conventional warhead payload effort. The project is in the flight demonstration phase. An FY05 deliverable will be six combat-capable residual assets. (1800, 2300, 2500, 2680, 2900, 3100, 9100, 10200, 12300, 14100, 15400)

The Intelligent Systems Controls Department (15224) has recently developed a Wheeled Hopping Vehicle (photo at right) for DARPA’s Advanced Technology Office. This man-packable robot vehicle uses a combustible cylinder to jump over 8-foot-high obstacles. This capability allows a small vehicle to negotiate rough terrain previously considered impossible. Applications for this robot vehicle include searching caves and deeply buried facilities. (15220)

The Targets Program delivered target payloads to support Missile Defense Agency launches in early FY05. These launches test the effectiveness of our nation’s missile defense system. Five additional target payloads reached various stages of completion in FY04, all of which will support flight tests in FY05. The newest of these payloads, designed by Sandia in FY04, involves highly advanced development work, including Wireless LAN technology. This advanced development work aligns with our program’s future objectives as well as the Labs’ vision. (15400)

The Penetration Science and Technology Department, designed and successfully demonstrated a new, two-piece penetrator with a jointed-nose that provides the following advantages: Precision deep-cavity machining of high-strength steel alloys; uniform heat-treatment; expanded assembly options; forward fuse placement; nose-shape, nose-material optimization, and reduced production costs. The elements of these designs have been used across the Lab, and are being embraced by DoD laboratories and contractors.

We are developing the technology for an eye-safe, robust, low-cost, lightweight, 3-D structured light sensor for use in broad daylight outdoor applications. Structured lighting requires image processing to isolate or segment a laser signal from background clutter in a camera image, which is difficult to accomplish under bright outdoor conditions and with highly absorptive surfaces. Applications include precision mapping, autonomous navigation, dexterous manipulation, surveillance and reconnaissance, part inspection, geometric modeling, laser-based 3-D imaging, simultaneous localization and mapping (SLAM), aiding first responders, and supporting soldiers with helmet-mounted LADAR for 3-D mapping in urban environment scenarios. (15200)

Sandia staff are helping the US Navy create next-generation aircraft carrier operations by conducting analyses leading to improved performance, reduced manpower, and reduced costs. After successful completion of a four-month evaluation of current Navy air wing operations, structure, and preliminary improvement alternatives in FY04, a strategic partnership has been formed through at least FY07 to develop a “system of systems” analysis capability providing greater quantitative understanding of the aircraft carrier system to improve decision-making regarding organizational structure and resource allocation. (6800, 6200, 15200)

The Micro Analytical Systems Department is completing work for the Defense Emergency Response Project. The project is a cooperative effort of the Lab, and is being embraced by DoD laboratories and contractors.

AS PART OF the Enhanced Perception (EORD) program, we’re developing robotic vehicles capable of autonomously generating maps. The map at left was generated from a laser scanner mounted on a mobile robot. The robot uses these maps to plan its own paths. The robot continuously correlates its scanned data to the map to localize itself as it navigates. Data from upward-looking sensors are stitched together to generate 3-D maps. 3-D maps provide enhanced situational awareness to the operator.

The Micro Analytical Systems Department is completing work for the Defense Emergency Response Project. The project is a cooperative effort of the Lab, and is being embraced by DoD laboratories and contractors. We have overcome many of these issues and have developed apparatus to reproduce deposit polymer films and sol gels for our chemical analysis system components. In addition, we have established commercial manufacturers for each of the critical components for MicroChemLab. (1700)

Significant new electromagnetic launch capability has been achieved this year as a result of new launch programs supported by DoD and Lockheed Martin. A program has been initiated by the Defense Advanced Projects Agency to analyze and demonstrate EM launch capability for mortar-class artillery. The goal of this program is demonstration of full-scale launchers (both 120mm and cologn variant) at muzzle velocity of 420 m/s for 120 mm mortar projects, with kinetic energy of 1.6 MJ. The EM Mortar team is composed of the following organizations: Sandia (lead), Institute for Advanced Technology (IAT) at the University of Texas, The Army Research and Development Command, Picatinny Arsenal; the National High Magnetic Field Laboratory at Florida State University and Los Alamos National Laboratory; and TPL, Inc. (15300)

A full-size EM launcher for vertical launch missile systems has been demonstrated at Sandia through a Shared Vision program with Lockheed Martin Marine Systems and Sensors Division in Baltimore. Our missile launcher demonstration test-stand has been assembled and tested with full mass (1430 pounds) and velocity of 10 m/s, the velocity predicted for the five-stage launcher. The payload is launched to a height of more than 20 feet, as predicted from launcher simulation. This revolutionary launch capability is being presented to the Navy Sea Systems Command and Office of Naval Research in a series of briefings and demonstration launches. (15300)

John Ojeda (15335) prepares the electromagnetic missile launcher for a test flight. (Photo by Randy Montoya)
Sandia chaired the Society of Automotive Engineers’ Software Committee that published six software reliability and supportability standards and guidelines that subsequently were adopted by national security organizations including the US Army and NATO, and industries including Boeing and Lockheed Martin. The lessons learned from major software-intensive programs such as the Eurofighter were incorporated. These publications provide a comprehensive approach to addressing the concepts, strategy, processes, and implementation of a software supportability program and software reliability program within a systems context. (12300)

A Presidential Early Career Award for Scientists and Engineers was presented to Tammy Kolda (89000), in September 2004. The award is “the nation’s highest honor for professionals at the outset of their research careers,“ according to the White House Office of Science and Technology Policy. Tammy was nominated by Sandia and DOE’s Office of Science for her innovative research in algorithms and software for optimization, parallel computing, and nonlinear solvers. Tammy is the third Sandian to receive the award since its inception in 1996. (8900)

Strategic Web Infrastructure Framework & Technologies (SWIFT) used portal technology with Sandia’s existing infrastructure to improve the content, presentation, and usability of Techweb, Sandia’s internal website. Techweb gives Sandians better access to the information they need. Portal technology allows SWIFT to build flexibility into information delivery, avoid user information overload by allowing users to customize their Techweb site, distribute maintenance of corporate information, offer a single point of access to multiple data resources around the labs, and facilitate online communities of interest. Many groups contributed, including Corporate Communications, CEDIT, Infrastructure, IIS, Oracle Financials, PeopleSoft HRIS, San- dia/California, and the Technical Library.

Sandia Anywhere collects into one place (http:// anywhere.sandia.gov) the established methods for remote access to resources on Sandia’s internal network, and adds a new production capability — “Remote Desktop.” After authentication through SecureS, Remote Desktop allows a user (from any Internet-connected computer) to establish a secure desktop connection to the Restricted Network. Users can also connect to their own desktop computers to access data or run programs as if they were sitting in their office. (9300, 9600)

Three buildings were completed in FY04 that provide modern office, laboratory, and computer room space to support high-performance computing programs. These buildings included the Joint Computational Engineering Laboratory (JCEL) and the Distributed Information and Simulation Laboratory (DISL) in California. Construction of the SuperComputing Annex to house the Red Storm supercomputer was also completed. (9900)

On July 13, 2004, Sandia placed a $9.8 million contract with Hewlett-Packard to purchase three production capacity computing clusters for the Nuclear Weapons program. These clusters, built on processors based on Intel’s Extended Memory 64-bit Technology (EM64T) and Myrinet 2000 interconnect, provide Sandia with 16 teraops of computing resources. Delivery was speedy: Spirit, the New Mexico restricted network cluster, was in production, as planned, by November 16, Justice, the New Mexico classified network cluster, and Lasen, the California classified network cluster, were released to the users the following month. (9300)

Sandia was a major participant in the NNSA Integrated Cyber Security Initiative, which designed and purchased the security infrastructure for a classified NNSA Enterprise Secure Network. This network will enhance the ability of sites to securely and conveniently share data across the NNSA in a web environment. Requirements were gathered from all labs and plants and consolidated into an NNSA-wide competitive procurement handled through Kansas City. The purchased hardware and software will be deployed in FY05-06. (9300, 9500)

The Information Management policies were updated to improve usability and to identify and initiate development of needed requirements arising from new technology and new drivers. The redevelopment included a self-assessment of existing policy, added sections on new capabilities and processes, updated terminology and definitions, and improved search capabilities. A topical structure, with an associated application, was created to make it easier for users to find the requirements. The Corporate Process Requirement pages were reduced by 30 percent, and the number of policy documents dramatically reduced. (9600, 9300, 9500, 8900, 4200, 10750)

The e-mail team in Center 9300, with support from Center 9600, completed the migration of all (13,000 plus) Sandia electronic mailboxes to Microsoft Exchange 2003 with increased mailbox size. Macintosh users now have access to their mailboxes with a full-featured client (Entourage), giving them such capabilities as shared calendaring with co-workers. In addition, the new Exchange servers give BlackBerry wireless users remote connectivity to their Sandia e-mail. (9300, 9600)

The Enterprise Data Warehouse has grown to include 13 data sources used by customers across the Labs. Oracle Manufacturing, Stockpile Unsatisfactory Reports, legacy databases from Pinellas for neutron generator components, underground test data, the NNSA Weapon Information System, the Product Test System, neutron generator components, the weapon Record Of Assembly, and Engineering Bill of Materials are examples of warehouse information available to the weapons program. In addition, the warehouse effort supports Oracle Financials, satellite data, facility data, and corporate HR data. (9500)

Three computer programs mark major progress by 9200 staff developing agile microsystems design tools and high-fidelity process simulators. Two codes provide a breakthrough, automated design loop for MEMS (made using standard microelectronics masking and deposition techniques). The unique program FAETHM generates a mask set from a 3-D part design. SummitView, given a mask set, now renders a 3-D part 100 times faster than previously. CHISELS, a 3-D massively parallel code, accurately models key microsystem fabrication processes such as plasma-enhanced chemical vapor deposition and deep reactive ion etching. (9200)
Pulsed power

Z pinch implosions on the Sandia Z machine have been photographed for the first time using bent crystal radiography diagnostics. The crystals screen out most of the ~1 million joulles of X-rays produced by the pinch implosions, allowing high-resolution radiographs to be made using <1 joulles of X-rays from San-dia’s Z-beamlet laser. The photos provide quantitative information about the initial formation and implosion of the Z pinch plasmas that will help researchers optimize future designs and improve X-ray yields. (1600)

Quantum molecular dynamics simulations based on empirical functionals have been used to generate an accurate wide-range electrical conductivity for stainless steel in the metastable austenitic state. The simulations are calculated for samples in the metastable austenitic regime. Optical conductivities are calculated for sampled atomic configurations. These new QMD-based predictions provide unprecedented high-fidelity simulations of high energy density physics and are in advanced modeling codes, such as ALEGRA. (1600)

In the field of complex radiation-hydrodynamics, “rad-hydro,” the Z accelerator has recently extended its applications to another area of high energy density physics and inertial confinement fusion. Specifically, in conjunction with the Z-beamlet laser as the radiography diagnostic, Z has generated indirectly driven “jets” that, in addition to being of interest to basic science, may provide critical experimental data for benchmarking certain weapons science rad-hydro codes. The project is a close collaboration among Los Alamos, AWE UK, Lawrence Livermore, and Sandia. (1600)

A Z-Pinch Inertial Fusion Energy (IFE) program was initiated by Congress to extend the single-shot Z pinch fusion target results on Z to a repetitive-shot Z pinch fusion power plant concept for the economical production of electricity. Initial results on recyclable transmission lines, repetitive linear accelerator wall shock mitigation, proof-of-principle experiment results, and Z pinch IFE power plant technologies support development of long-range Z-Pinch IFE program. (1600)

Experiments on Z produced a world-record peak energy density of 34 km/s for a mag-netically accelerated aluminum flyer plate, which is a factor of four larger than is possible by conventional gas gun techniques. Shots were designed using the ALEGRA-HEDP magnetohydrodynamics code combined with circuit simulations to accelerate the 0.085 cm thick flyer with an efficiency of 56%. (4200)

IES: Integrated Enabling Services

A Sponsor Showcase sponsored by Sandia and the City of Albuquerque was held last year. Sixty-five suppliers in the areas of homeland security, optics, and biotechnology met with buyers and technical personnel from around the state and the region. Following the success of the 2004 event, the 2005 Showcase will focus on homeland security, manufacturing, and vital resources such as water and environmental quality. (10200)

The Sandia Project Management Portal consolidates project management resources into a central location and provides information on PM events and requirements. The Project Management Users Group will serve as a community of practice for PM at the Labs. It also provides the opportunity for the Sandia PM community to provide feedback into future PM efforts, including the newly established Project Management Resource Office. Phase 2 of the PM Portal will include a PM repository, collaboration zone, and resource feedback methods. (10200)

In FY04, Sandia received a $2 million New Mexico gross receipts tax refund for FY2000. We will be filing refunds for approximately $7 million for 2001-2003. These deductions reduce our liability going forward and bring our effective tax rate from an average of 3.2 percent to 2.86 percent. This translates to an additional $4.6 million for 2003 and $9 million for 2004. (4200)

Over the past several years, various internal and external audits identified a number of concerns related to security. Beginning in 2003 and continuing in 2004, these problems within Sandia’s Safeguards & Security (S&S) Program received significant management attention resulting in substantial improvement in the S&S Program. Simulation of Deployment Review for San-dia/New Mexico in a letter to the Governor, formally certified Sandia’s EVMS in a letter to Sandia’s National LaboratoriesPage 14  •  Sandia Lab News Sandia’s National Laboratories Security

The Nuclear Safeguards and Security Center has completed testing and evaluation of new perimeter vehicle barriers that can defeat threat vehicle energies of up to 65,000 lbs at 50 mph. These barriers will be clustered to span ten feet. Computer models of barrier designs were also developed for validation. New vehicle perimeter barriers and high-speed vehicle targets can defeat threat energies up to 65,000 lbs for vehicles traveling at speeds of up to 50 mph. Sandia’s EVMS in a letter to the Department of Energy . . . con-firmed that the information presented via the CPR format was too specific identified. (4200)

One of the strategic themes of the DOE Complex to have a significant compliance program for mission organizations. IES also began operating the IES also began operating the (Continued on next page)
IES: Integrated Enabling Services  
(Continued from preceding page)

DOE facilities attended. Accomplishments included a quality educational forum, an 80 percent increase in membership, online registration, national website, developing Logistics best practices, showcasing information available to our line customers helps eliminate that it helped to increase the line’s understanding of the Labs’ rate structure. (10,000)

More than 23 new technical courses were implemented to support the Strategic Education Plan initiative. This Plan — and new course offerings — aim to bring a renewed commitment to continuous education at the Labs. Program categories include engineering, bioscience, material science, energy efficiency, and computer science/software engineering. Data show that program participants are applying knowledge and skills gained from the training directly to their work and that the Technical Education Program is on target in meeting core and critical needs of the Labs. (3,500)

Employee and Labor Relations, in partnership with Corporate Education, Training, and Development, has implemented a Tier Career Path Development Program. This program created a curriculum and learning opportunities that strive to enhance the existing skills of Tier employees and help develop new skills. It will also help ease the consistent labor shortage and prepare more qualified internal fodder for available Tier positions. Other represented employees have found the program resources beneficial. The Tier Career Path Development Program is open to all represented employees and received a Turquoise PQ Award in 2004. The Integrated Safety Management System Software program is the cornerstone of ES&H management at Sandia. Rewritten during 2004 to become web-based, IAMS Software incorporates requirements from DOE, federal law, and subject matter expertise into simple-to-use programs that establish safety envelopes and environmental requirements for all operations. Reporting capabilities allow users to retrieve information in PDF reports or Excel spreadsheets. Creation, editing, review, and approval activities are simplified, saving up to two-thirds of the time needed to train users and produce safety and environmental documentation. (5,900, 6,300)

Sandia’s Secure IP Videoconference team was awarded the National Nuclear Security Administration (NNSA) Defense Programs Award of Excellence for deploying a Nuclear Weapons Complex (NWC) secure videoconference capability. The team led six NN5A organizations in deployment and certification of a cross-organization secure communications resource. The secure IP-based videoconference capability is now routinely used throughout the nuclear weapons complex with the capacity to support 24 locations connected simultaneously. The capability is designed to support full digital collaboration capability, including data sharing, visualization, and model manipulation. A cross-functional team implemented best practices in developing an integrated and comprehensive method of orienting Sandia/California new hires. A systematic approach ensured the program was embraced by all stakeholders and that the design incorporated a holistic foundation. Quality metrics were imbedded to drive for continuous process improvement. The program received an ERA award and was also cited by Corporate Internal Auditing as an observed area of excellence, being described as “professionally developed, thorough, comprehensive, and effectively delivered.” (8,500)

The Ninth Annual Student Internship Symposium, held last August at the Albuquerque Convention Center, brought together approximately 800 attendees, including 475 Sandia student interns, with 225 interns participating with oral and poster presentations. More than 30 exhibitors represented 20 different organizations ranging from fellowships, colleges and universities, and Lockheed Martin recruiters. (3,500)

Sandia’s Disease Risk Management Clinic has demonstrated that many of the complications of diabetes can be prevented through education, treatment with diet modification, exercise, and new pharmacological approaches. The clinic is currently helping some 800 employees and their dependents manage the management of high blood pressure and cholesterol. For self-insured employees, the focus on providing optimal care to those individuals with chronic disease has been shown to be an effective cost-containment strategy. (3,300)

Sandia signed an MOU with the Inter-Tribal Economic Alliance (ITEA) and Intertribal Information Technology Company (IITC) to develop and deploy technologies related to microsystems, aging aircraft, and manufacturing. ITEA and IITC are owned by a strategic consortium of sovereign tribes, Alaska native corporations, and native Hawaiian organizations to promote development in Native American communities. (12,000)

In FY04 Contract Audit, Procurement, and Oracle Project departments implemented Phase I of the Integrated Contract Audit System. The system integrates contract data, supporting the efforts of Sandia’s Los Niños in Albuquerque, which provides care for homeless children. In the photo at left, Coolidge volunteer “granny” Bleah Haynes comforts a child.

COMMUNITY INVOLVEMENT continued to have a very positive impact. We distributed more than $2 million in corporate contributions to our communities. Overall, our donations totaled more than $100,000 to Shoes for Kids, which enabled us to fit school children from 20 elementary schools. More than 175 Sandia volunteers participated in 10 projects for Make a Difference Day. More than 275 volunteers last summer completed our fifth Habitat for Humanity House (photo of Habitat family below).

Overall, our volunteers donated almost 90,000 hours to community projects. In addition to the corporate contributions, Sandia employees pledged more than $2.5 million for the 2004 Employee Contribution Plan/United Way/Livermore Employees Assistance Program Campaign. Funds donated by Sandia employees and the United Way supported community programs such as Los Niños in Albuquerque, which provides care for homeless children. In the photo at left, Coolidge volunteer “granny” Bleah Haynes comforts a child.
The Sandia Chile Meter is an intelligent image-based system for automatically measuring the amounts of chile and trash in chile processing operations. It is being used to optimize the configuration and effectiveness of a mechanical chile cleaner in an effort to improve automation in the state’s $200 million/year industry. Intelligent Systems and Robotics Center 15200 has been working on the automation problem with the New Mexico Chile Task Force, an industry and university consortium, through Sandia’s New Mexico Small Business Assistance program.

The Navy Wolf-Pack (MTA+Tech Partnership Business Development Team) successfully initiated a new Navy relationship that cascaded through four Navy Program Offices (including Carriers, Deepwater Ships, Coast Guard, and Naval Air) and produced four memoranda of understanding. The relationship affords the opportunity to work with 11 defense contractor industry partners to provide pathways for Sandia systems solutions for the war fighter. Initial funding has reached DOE, and Phase One tasks have been accomplished. (1300, 15000)

The Sandia Science & Technology Park continues to foster economic development in New Mexico. It attracted four new tenants in FY04: Ktech, Sunwest CAD, Heel, and Sandia’s Controller and Pension Plan Management Center. The Park now boasts 19 companies employing almost 1,100 people. An economic impact analysis in 2004 found that the average salary for each job in the Park was $55,000 and also determined that the Park created an additional 3,200 indirect jobs. Public and private investment in the Park exceeds $161 million. (14000)

Sandia’s Military & Technologies Application business unit has established a new strategic partnership with Rockwell Collins. On Oct. 1, 2004, DOE approved a five-year umbrella CRADA with Rockwell Collins. On Oct. 5, 2004, Rockwell accepted Sandia’s first project and task. The project will conduct and document a capability study to identify how Sandia’s expertise in the area of high-density interconnect substrates, thermal management, and RF power transistors can be applied to support Rockwell Collins’ development of a miniaturized data link. This effort will support the Air Force Research Laboratory Weapon Data Link Architecture Program.

Sandia and Waters Corporation successfully concluded a three-year CRADA to develop an electrokinetically pumped high-pressure liquid chromatography system. Biomolecule separations were demonstrated with a prototype microfluidic gradient system. The work resulted in record-setting microfluidic performances in high-pressure electrokinetic pumps exceeding 55,000 psi, nanoliter flow sensors, ultra high pressure microfluidic valves, and high-pressure plastic microchip materials fabrication processes. Nine patent applications were filed. These technologies are being commercialized by Waters and incorporated in Sandia Chem/Bio Detection programs, DHS BioIlfRescase, and DoD µChemBioLab. (8100, 8300, 8700, and 8500)

Eleven bellwether emergency responders from across the nation met for two days with Sandians and representatives of Smiths Detection last summer. Developers of the uChemLab Chem/bio detector met face-to-face in no-holds-barred discussions with people whose lives might depend on the performance of our system. In broader discussions, we shared the possibilities of a range of Sandia technologies and confronted realities of real-world conditions and situations. We learned from each other and began enduring personal relationships. (8300, 8100, others)