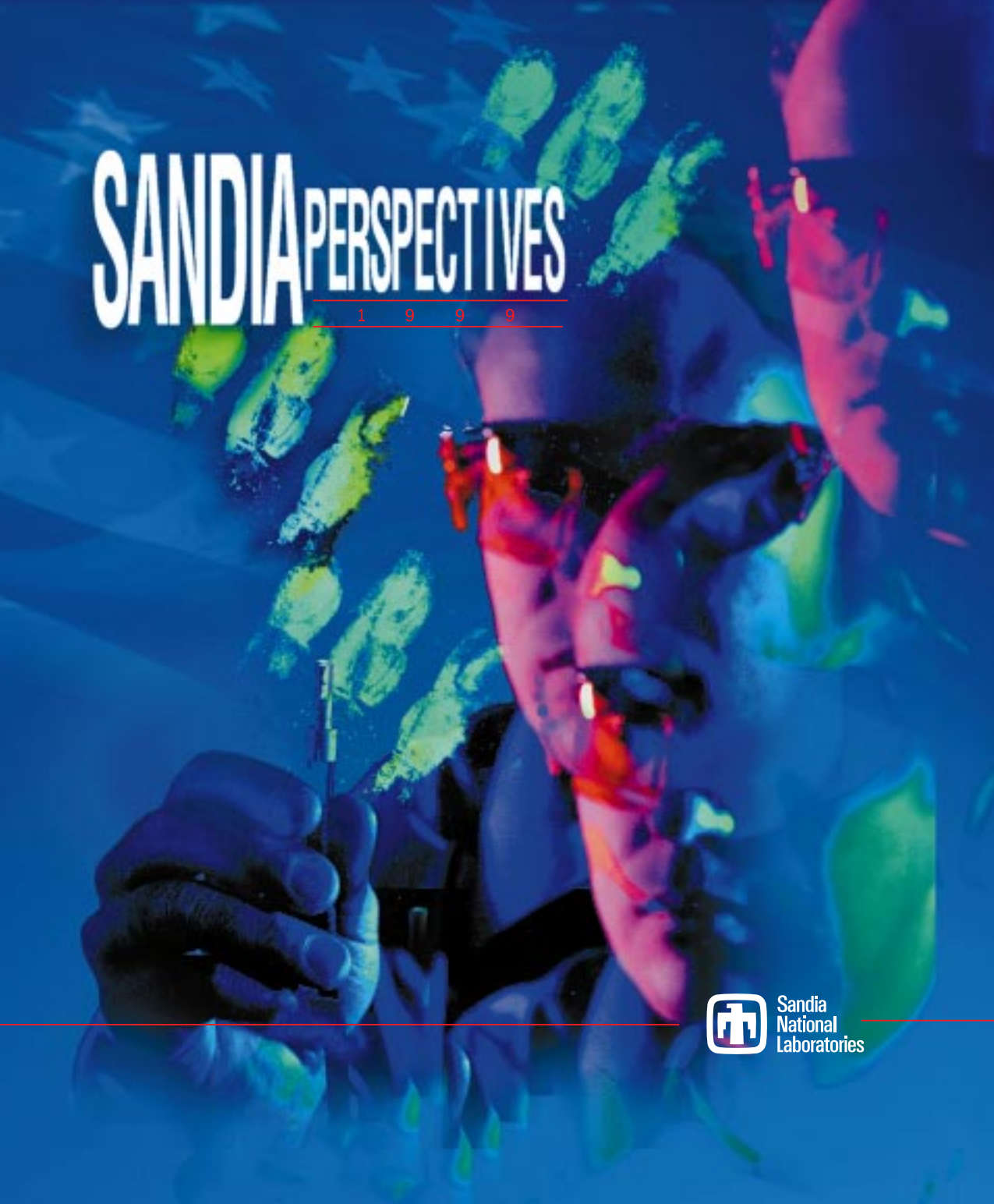
SANDIA PERSPECTIVES

1999



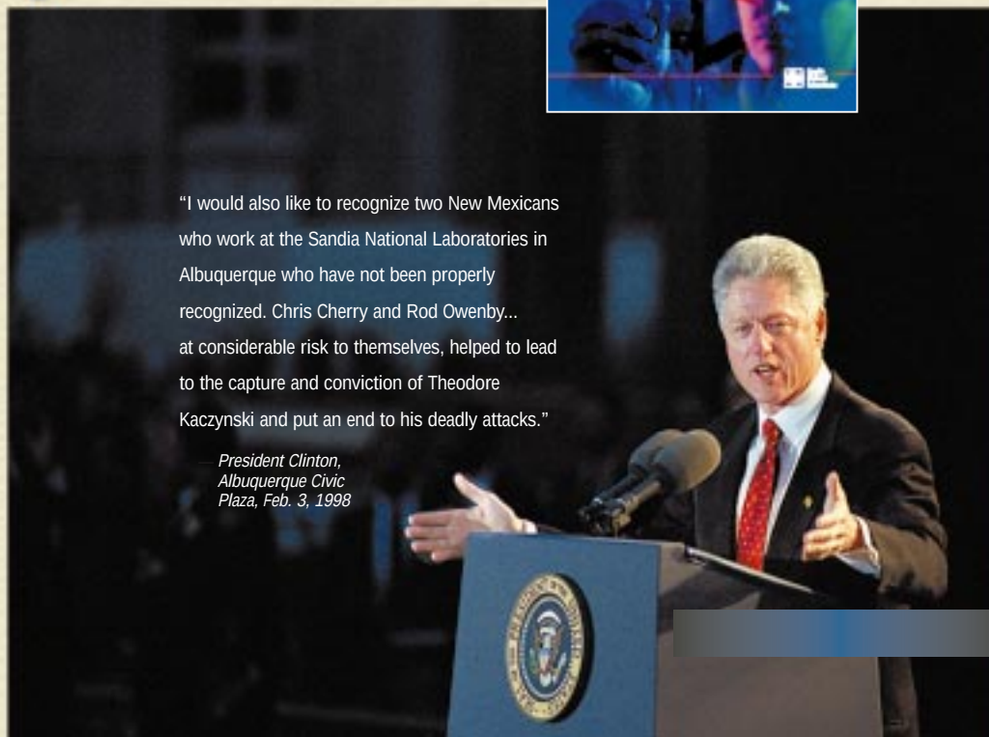
Sandia National Laboratories

CONTENT

Energy Secretary Bill Richardson speaks to Sandia employees during a visit to the Labs in September.

The Accelerated Strategic Computing Initiative provides the capability to model dynamic events such as an earth-penetrating weapon striking a surface (below).

Dave Sandison lights up a set of fingerprints with a lamp that is part of an evidence-detection system under development at Sandia National Laboratories for the National Institute of Justice.



"I would also like to recognize two New Mexicans who work at the Sandia National Laboratories in Albuquerque who have not been properly recognized. Chris Cherry and Rod Owenby... at considerable risk to themselves, helped to lead to the capture and conviction of Theodore Kaczynski and put an end to his deadly attacks."

President Clinton, Albuquerque Civic Plaza, Feb. 3, 1998

In 1998, Sandia National Laboratories continued its tradition of outstanding technical progress in both its principal mission of nuclear weapon stewardship and in its work with industrial, academic, and government partners. Examples of exceptional innovation received widespread appreciation and attention.

Sandia President and Laboratories Director C. Paul Robinson (right) and Executive Vice President John Crawford discuss the state of the labs at an annual news conference.

As we prepare for the 50th anniversary of our founding, we continue to meet President Truman's challenge to render exceptional service in the national interest. We were especially appreciative of President Clinton's support during two visits to New Mexico. While he singled out the work of two Sandians, as described later in this report, it's important to recognize that there are thousands more just like them working here every day to develop means of countering threats to the safety and security of all Americans.

The challenge of working with nuclear weapons and national security continues to attract America's best and brightest scientists and engineers. The technologies they develop are often the result of collaborations with other leading researchers from universities and industry. We are equally appreciative of growing bipartisan Congressional support, particularly for science-based stockpile stewardship. The soundness of our Laboratories depends on stability and long-term strategic planning.

As a Department of Energy laboratory, Sandia's mission is centered on stewardship of the U.S. nuclear arsenal. Although the United States and the former Soviet Union are dismantling many nuclear weapons, nuclear deterrence to a certain extent remains our defense against aggression. The Indian and Pakistani nuclear tests were the tip of an iceberg and demonstrated that nuclear weapon programs of some depth had been going on for years. They remind us that we can't afford to forget the power of nuclear weapons and the force they exert worldwide.

Each year Sandia's involvement in international issues grows. We continue to work with Russia—Moscow is a frequent destination for Sandians on business travel. We just celebrated the 40th anniversary of our traditional collaboration with the British. Three of our vice presidents met with officials in China, Singapore, Korea, and Japan. We are working with the Japanese government on testing and constructing nuclear reactor containment vessels.

We've seen growth in each of our mission areas: our traditional nuclear weapons work, control of nuclear materials worldwide, nonproliferation efforts, counterterrorism, and protection of critical infrastructures.

Sandia, the National Academy of Engineering, the National Academy of Sciences, and the Department of Energy are partnering with government, academic, and industrial leaders to find ways to protect the nation's critical infrastructures. Today, the need for reliability applies to electrical power grids, telecommunications and information security, counterterrorism, and global control of weapons of mass destruction.

The science and engineering principles that we've developed over the past 50 years are helping safeguard Americans. The same systematic approach that incorporates modeling and simulation, testing and evaluation, risk management, reliability, and physical security can also protect Americans at home and at work as we move into the progressively complex future.

We invite you to learn more on the following pages about the many ways Sandia's people are contributing to the quality of life in the United States.

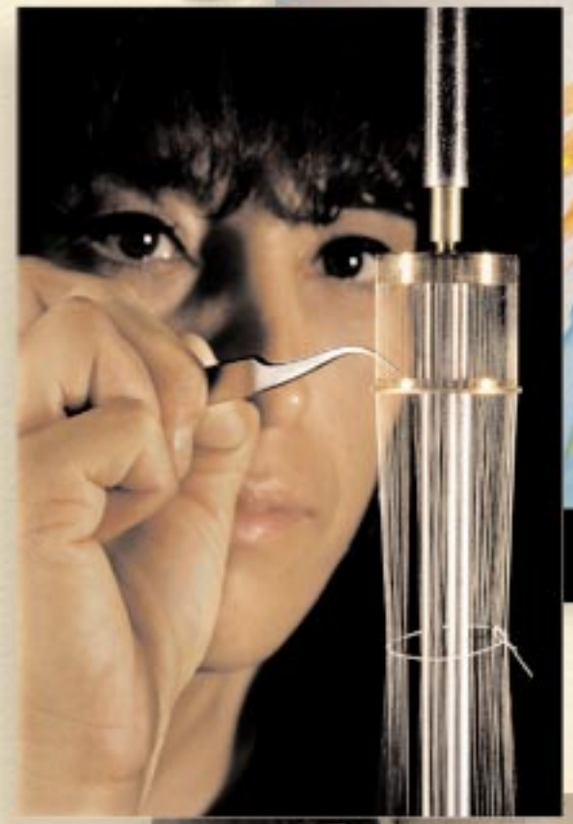
Executive Vice President John Crawford talks with C. Paul Robinson.

Safeguarding the Nation

Since the early days of the Cold War, nuclear safety designs have worked as intended. For example, safety systems have prevented accidental nuclear detonation. Developing a rigorous approach to reliability, safety, and use control and putting it into practice has been a major part of Sandia's mission since its beginning.

After the Manhattan Project, when scientists developed the first atomic bomb, research into nuclear energy soon led to other high-consequence operations, such as the operation of nuclear power plants for electricity and production of special nuclear materials such as plutonium and enriched uranium.

The end of underground nuclear testing and new weapon production has left the U.S. with the oldest stockpile it has ever deployed. Yet this stockpile must be as reliable and predictable when measured by today's standards. Sandia is the Department of Energy laboratory responsible for systems engineering of nuclear weapons and overall technical stewardship of the U.S. nuclear arsenal, with particular emphasis on surety—safety, security, and reliability.



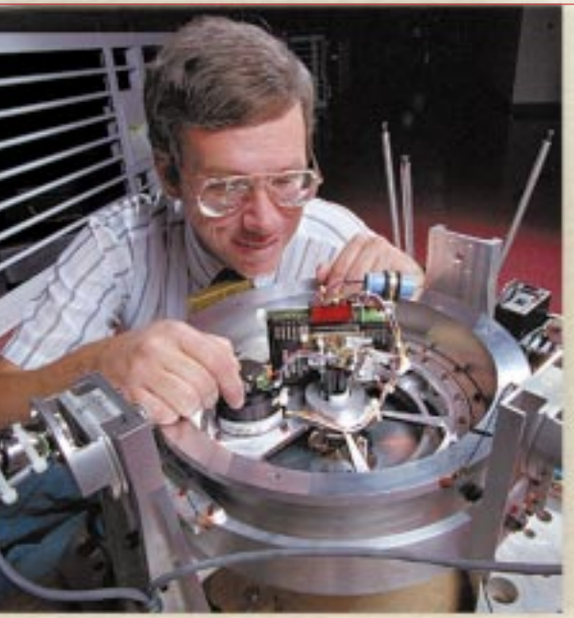
Josh Mason, with KTech Corp., carries out preventive maintenance on Sandia's Hermes III accelerator. Sandia continues its remarkable pulsed power advances to simulate weapon conditions without nuclear testing and to bring laboratory fusion closer to reality.

Sandia scientist David Crawford discusses a computer-generated image that shows the impact of a 1-km comet (or asteroid) hitting the ocean. Such a tremendous impact would instantly vaporize the comet along with 300 to 500 cubic kilometers of ocean water.

Dolores Graham uses tweezers to build an array of wires that form a target about the size of a spool of thread for Sandia's Z accelerator. The Z accelerator has reached peak outputs of 290 terawatts—100 times the output of all the Earth's electric generating capacity—for five billionths of a second.

What is surety?

Surety is a level of confidence that a system will operate exactly as planned under expected and unexpected circumstances. This means it will be reliable in normal environments, safe to people and surroundings in abnormal accident environments, and secure and inoperable in malevolent environments. Surety prevents catastrophic consequences that can result from human error or natural disaster. Based on modeling and simulation, testing and evaluation, risk management, and physical security, the concepts of surety can also safeguard Americans in their day-to-day lives at home and at work.



Mark Vaughn checks connectors on a prototype control system that steers a missile or spacecraft closer to a target. The same approach could reorient a satellite in space. Called the moving-mass trim-control system, the method works by controlling the movement of two internal weights.

Nuclear weapons surety has already paid substantial dividends. For example, nuclear weapon needs drove quality improvements in the first semiconductors. Clean rooms invented at Sandia enabled a $960-billion global electronics industry and revolutionized surgery and pharmaceutical manufacturing. Detection and sensing technologies led to new crime-fighting systems, medical instruments, explosives-detection systems for airports, and chemical and environmental analysis tools. Parachute technology led to better automobile airbags and an inexpensive landing system for the Mars Pathfinder spacecraft.

The nuclear weapons program pioneered many of the principles and techniques used in modern emergency management. Understanding how things fail is essential. Training for rapid response, collecting and managing information, analyzing risk, providing support systems for decision making, and alerting and informing the public are all essential parts of an effective emergency response plan.

Life-cycle engineering

Much of Sandia's work is aimed at preventing the unthinkable. For example, what would happen if an airplane carrying a nuclear weapon crashed?

Supercomputers at the Energy Department's national laboratories allow such concepts to be modeled and tested more exhaustively than ever before. The study of failure modes has led to greatly improved reliability of electronics, including commercial devices used in weapon systems.

Nuclear explosions generate millions of degrees of heat in only billionths of a second. As fast and powerful as that is, instruments that measure the event must be even faster, and must record an enormous range of outputs. Measurements collected from past experiments validate the computer simulations on which modern stockpile surety relies. Without creating an actual nuclear explosion or fire, the only way of testing the outcome is to equip supercomputers with enough processing capability and speed to analyze huge amounts of data.

Sandia scientists are now linking off-the-shelf PCs to create a relatively inexpensive supercomputer, code-named Alaska, that when complete will probably be the fourth-fastest ever, at one-tenth the cost. The computers work together as if they were a single machine, saving money and solving problems involving huge calculations.

Rolf Riesen and Ron Brightwell monitor computations performed on C-plant, a prototype system that links hundreds of desktop computers to perform huge calculations. Sandia recently received a Discover Magazine *Award for Technological Innovation for an inexpensive, memory-retaining device that saves computer data in the event of a power outage.*

First there were microengines, and now scientists and engineers at Sandia have developed microtransmissions as small as a grain of sand, yet theoretically strong enough to generate enough force to move a one-pound object. The tiny transmissions achieve a three-million-to-one gear reduction ratio in less than one square millimeter of area. The devices can serve as nearly invisible locks for nuclear weapons.

Mike Lopez makes adjustments to a neutron tube bake station. Sandia has assumed responsibility for the production of neutron generators for nuclear weapons—essentially the world's smallest particle accelerators. With its product realization environment, Sandia is a leader in providing a single environment to handle preliminary design and engineering all the way to multi-site development and manufacturing.

Competitive advantage

Modern approaches to understanding and managing nuclear weapons rely on simulation and advanced computer modeling to predict performance, materials behavior, and aging and deterioration of weapon components. Computer simulation is spawning revolutions in engineering and manufacturing. The results are cost-effective surety techniques, shorter design and manufacturing cycles, and improved quality and competitiveness.

Encryption standards developed for weapons are improving the security of electronic information networks. Application codes and problem-solving software are helping industry tackle extremely complex problems. Radiation-hardened electronics enable communication satellites and space vehicles to survive solar radiation. The quest for smaller computer chips has led to extreme ultraviolet lithography (EUVL)—the next-generation advance in semiconductor fabrication. These new chips can be manufactured by the thousands for a cost of a few pennies each.

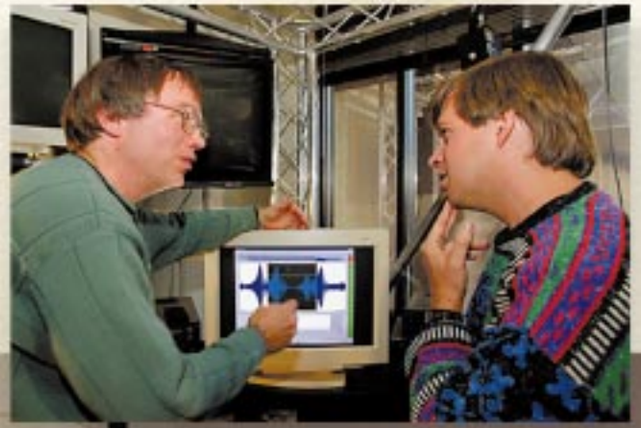
Intelligent micromachines can make a weapon impervious to traditional countermeasures. Microelectromechanical systems can be used as optical switches, mechanical locks, and smart sensors. They can sense, act, and communicate. On a larger scale, these devices are fueling a second silicon revolution, which will impact as much as a third of our present economy.

The accomplishments of the nuclear weapons program have demonstrated that complex, high-consequence systems do not have to fail. Analyzing and managing the complexities of data collected during Sandia's field-testing era—when scientists smashed a jet fighter into a concrete barrier or a 120-ton locomotive into a truck—are helping to verify the predictions of computer programs today.

Nuclear waste

For more than 20 years, Sandia has played a key role in managing the nation's radioactive waste. In partnerships with universities, industrial firms, and other national laboratories, Sandia uses its

Sandia computer scientist Carl Diegert, left, and New Mexico Museum of Natural History and Science paleontologist Tom Williamson collaborated to reproduce the sound the Parasaurolophus *dinosaur was capable of making when it lived 65 million years ago. The computer-modeling techniques used to create the dinosaur sound are the same ones Sandia uses to create complex, three-dimensional models of weapon performance that cannot be determined by real-world tests. The dinosaur imaging allowed Sandia scientists to expand their computing expertise.*

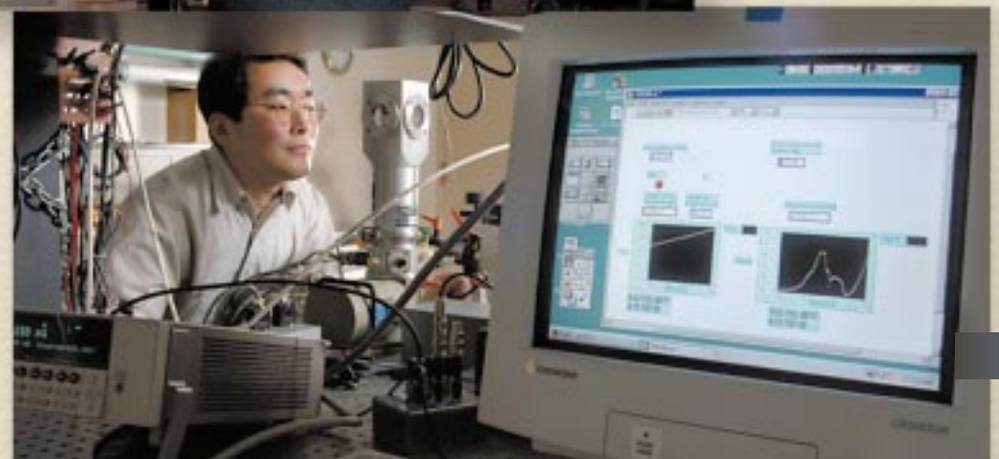


Painting of Parasaurolophus *dinosaur by Rich Penney, paleoartist, Santa Fe, N.M.*

Engineer Terri Calton reviews design specifications for a B61 tail assembly, shown in the foreground and on the screen behind her. Archimedes 3.0 is the latest and most advanced version of a Sandia-developed planning and visualization software tool that generates, optimizes, verifies, and examines mechanical assembly sequences by directly exploiting three-dimensional computer-aided design (CAD) models. Archimedes has already helped solve some highly complex assembly problems for Sandia and private companies.

computer modeling and field testing capabilities to help customers comply with federal, state, and local requirements for safe waste disposal. A key technology is probabilistic risk assessment, originally applied to studies of nuclear reactor safety. Nuclear reactor studies involve such variables as component reliability, human reliability, fire protection, structural integrity, accident potential, seismic reliability, missile impacts, equipment operability, reactor safety, and safeguards and security.

Clearly, reliability and safety are not only integral to science-based stockpile stewardship, they also provide economic advantages for American business. This dual benefit of scientific research is the reason why partnerships with industry, universities, and other government laboratories are essential to continued U.S. leadership in technology and commerce.



Ed Lee, a researcher at Sandia's California site, analyzes compound semiconductor materials used in radiation detectors. Sandia is partnering with universities and private industry to commercialize sensitive, room-temperature radiation monitors that can be used to detect smuggled nuclear materials as well as cancer, heart disease, and osteoporosis.

Kent Biringer (center) shows Nazir Kamal (left), an international relations expert from Pakistan, and Pravin Sawhney, a journalist and former army major from India, a model of a nuclear missile being transported. Sandia's Visiting Scholars Program has brought political and technical analysts from Russia, Germany, and other countries to the Cooperative Monitoring Center to study how monitoring technologies can help enforce regional cooperative agreements. Several joint studies between Indian and Pakistani scholars have addressed conventional forces and nontraditional confidence-building measures.

Safeguarding the Globe

The Cold War has ended, but the threat posed by weapons of mass destruction remains. To address that threat, Sandia constructed a new, ultrasecure, 85,000-square-foot facility to tackle the complex challenges of national security. In essence, the goal of the new Center for National Security and Arms Control is to wage peace.

Researchers in the facility are developing technologies to monitor arms-control agreements, security systems to ensure that nuclear materials do not fall into the hands of terrorists or aggressive states, and satellite systems to detect and characterize manufacturing emissions associated with nuclear, chemical, or biological weapons.

The three principal components of Sandia's micro-chem lab nestle easily inside a snow-pea pod. The top component is the surface acoustic wave sensor array, the detection mechanism. In the center is a preconcentrator that absorbs or adsorbs chemical vapors. The device on the bottom that looks like a tiny CD is a miniature gas chromatograph column. Together they collect, concentrate, and analyze a gaseous chemical sample weighing less than a single bacterium. Other Sandia micro-chem labs analyze liquids.

They are also sponsoring scientific collaborations with nuclear weapon scientists in the former Soviet Union to redirect weapons technologies into commercially viable non-weapon products. In so doing, they are helping to build trust and confidence among nations and agencies throughout the world.

"As we stand on the threshold of the 21st century, we can see we won't be fighting a cold war, but the gains we have made have to be preserved," says Roger Hagengruber, Sandia's senior vice president for National Security Programs. "There's always a risk in making peace. You must be constantly vigilant, never letting down your guard, or the peace will prove to be short-lived and just an interlude to the resumption of war."

Sandia's Cooperative Monitoring Center (CMC) continues to play a growing role in addressing regional and international security issues. Political and technical experts from around the globe come to the CMC to acquire the technology-based tools they need to assess,

design, analyze, and implement nonproliferation, arms control, and other cooperative security measures. Sponsoring organizations include the Department of Energy, the Department of Defense, the U.S. Arms Control and Disarmament Agency, and the State Department.

In recent months, delegations from Jordan, Southeast Asia, Kazakhstan, and China have completed training programs at the CMC. Delegates from India, Bangladesh, and Nepal have participated in a focused workshop on cooperative monitoring of the Ganges River. Weapons experts from the CMC have conducted two workshops in India on cooperative monitoring of security and the environment.

The CMC hosted the Eighth Annual International Arms Control Conference, attended by 200 internationally known experts representing the United States, NATO, and 40 other nations. The conference focused on the spread of chemical, biological, and nuclear weapons and the technologies required to monitor them.

Russian researchers joined Sandians in California recently to celebrate a year of successful lab-to-lab collaboration. Instrumentation of nuclear materials containers and Internet connectivity allowed Russian and U.S. inspectors to monitor each other's nuclear materials systematically without always traveling back and forth.

Los Alamos nurse Dianne Vandiver and medical technologist Brent Butler obtain a blood sample from an emergency room patient at a public hospital in Los Alamos, one of three hospitals in New Mexico participating in a Sandia-led hepatitis-C study. A fourth hospital in Chelyabinsk, Russia, also is participating. The goals of the program are to help identify risk factors for contracting hepatitis C and to demonstrate how the sharing of health information over the Internet can serve as a worldwide early-warning system for disease outbreaks and covert biological weapons research. Four thousand volunteer patients in New Mexico and Russia will fill out questionnaires and provide blood samples for the study.

Sandia researcher Tom Friedmann looks out through 600-angstrom-thick membranes of amorphous diamond. The slightly rotated membrane on Tom's right eye reflects light, demonstrating the presence of a very clear, nearly invisible window of diamond.

A complete inertial guidance system developed by Sandia and the University of California at Berkeley is smaller than a paperclip. The chips can be made thousands at a time for a few pennies each and are impervious to traditional countermeasures. Their miniscule size allows many devices to be incorporated into the space of an older device.

Monitoring with satellites

The recent nuclear weapons tests of Pakistan and India have emphasized the need for improved methods to gather information on nuclear production and testing. The Multispectral Thermal Imager will give nonproliferation experts and policy-makers a powerful new means of obtaining intelligence. This satellite will collect and process detailed images that could be used in future systems to characterize facilities that produce weapons of mass destruction. Scheduled for launch in late 1999, the satellite will orbit the Earth for three years. Some 50 government, academic, and industry organizations are involved in the project, along with parts suppliers and customers who will use the data. Similar information will be used to study the environmental integrity of rain forests and croplands.

In a related effort, researchers at Sandia and Los Alamos national laboratories are analyzing data from the FORTE satellite, now orbiting 500 miles above the Earth. FORTE, an acronym for Fast On-orbit Recording of Transient Events, was developed jointly by both laboratories with funding from the DOE's Office of Nonproliferation and International Security. Launched in August 1997, the satellite is testing new ways of spotting atmospheric nuclear tests and gathering data on the physics of lightning and the ionosphere. FORTE is the first satellite to be monitored and controlled from Sandia, much the way mission specialists control the space shuttle from NASA's Johnson Space Center in Houston.

Analyzing openly available satellite imagery, Sandia and military experts recently showed it was possible to predict troop movements during the Gulf War. Their analysis of French SPOT satellite images was an unprecedented demonstration that countries could use commercially available images to provide early warning of attack preparations.

Monitoring with sensors

In a world where black market means of moving and concealing fissionable material are becoming harder to detect, Sandia is developing ever more sensitive methods to identify these movements. A low-power, handheld device about the size of a soft drink can was developed with Sandia business partners to sense and safeguard radioactive materials. COMRAD (Field-Portable System for Characterization and Monitoring of Radiation) was honored by *R&D Magazine* as a top technology of 1998.

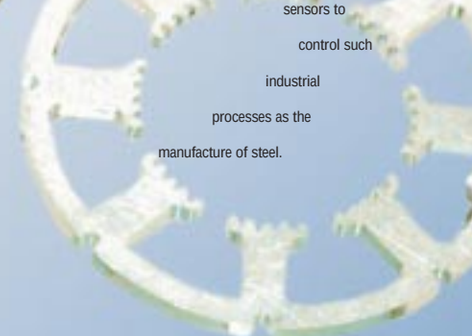
Tiny precision rotors and stators produced with X-rays can be inserted in millimotors or safing systems. Sandia is partnering with NASA's Jet Propulsion Laboratory to produce parts for upcoming space missions that will study solar flares and the ozone layer. The micromachining technology for producing the parts is known as LIGA, from the German words for lithography, electroplating, and molding.

A compact, sensitive "chem lab on a chip" is being designed to sniff out explosives and warfare agents. Swarms of robotic sniffers could sort through hundreds of liquids and gases at one time to map safety hazards.

Munitions disposal

Sandia has delivered to the U.S. military an environmentally friendly system to dispose of vast stores of such obsolete munitions as smokes, dyes, and markers. Rather than burning the materials, the system breaks down components through a self-contained process called supercritical water oxidation.

Sandia is also working with the military to safely explode unstable munitions wherever they are unearthed. The materials are shielded in a container mounted on a flatbed trailer. To study the behavior of explosive emissions, Sandians have detonated excess rocket motors in an underground chamber fitted with new chemical and particle sensors. They have developed similar sensors to control such industrial processes as the manufacture of steel.



Safeguarding Citizens

Sandians Rod Owenby (left) and Chris Cherry discuss their work on the Unabomber case. In the foreground is the boom of a bomb disablement device.

President Clinton Thank-you

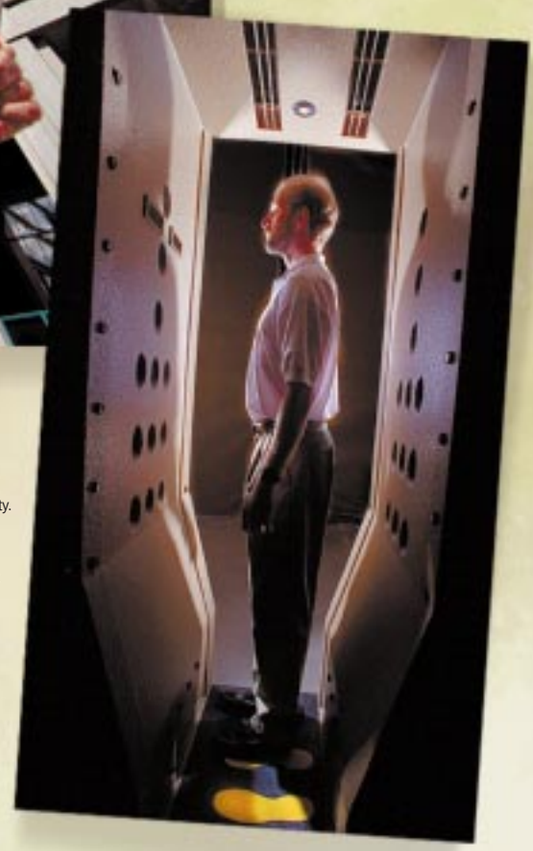
When Sandian Chris Cherry received an urgent call in the middle of the night from the FBI asking him to lend his expertise to the Unabomber case, little did he think it would result in a personal thank-you from President Clinton. The FBI asked Cherry and colleague Rod Owenby to travel immediately to the remote Montana cabin of Theodore Kaczynski to disable a sophisticated, ready-to-go letter bomb, all the while keeping it intact for evidence. It was a crucial step in the government's case against Kaczynski, and it was an episode that remained secret until President Clinton publicly thanked Cherry and Owenby in February 1998 during a speech in Albuquerque.

Sandia is the Department of Energy's lead laboratory for physical security of nuclear weapons and nuclear materials. In the early 1970s, the DOE directed Sandia to address the potential theft of nuclear materials being transported between facilities. Sandia developed technical capabilities in security modeling and systems analysis, security equipment and components, and security systems engineering, integration, and implementation. The results were innovative and cost-effective solutions that protect nuclear and other vital assets, enhance the security of citizens, and mitigate crime, fraud, and theft.

Landmine detection

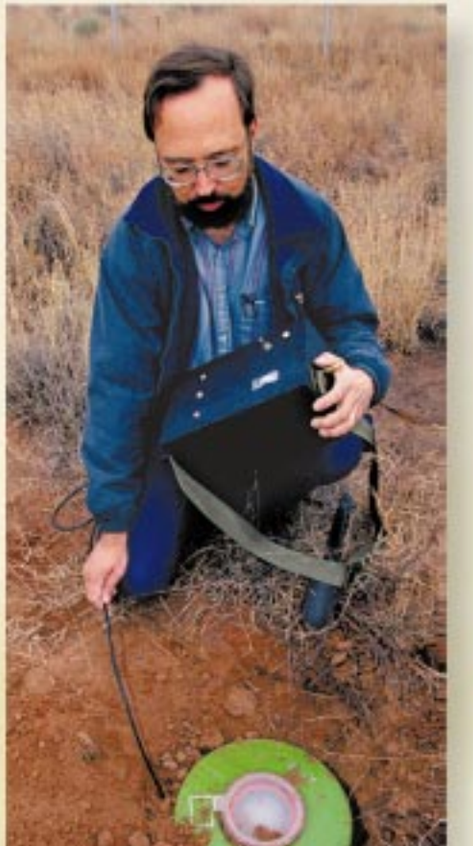
Sandia has joined the effort to rid the world of one of the worst forms of pollution—landmines. Researchers are developing ways to detect and disable landmines using techniques that range from chemical sensing to laying down a quick-hardening foam that provides a safe path for military vehicles. They also are developing robotic vehicles and backscattered X-ray technologies to support demining efforts.

Rudy Matalucci leads a project to improve architectural surety. Sandia is working on the safety and reliability of buildings and other structures such as bridges, dams, and tunnels.



Chuck Rhykerd demonstrates a detection portal developed at Sandia that recognizes minute traces of explosives residue.

Phil Rodacy demonstrates a mock chemical-sensing detector on an unfuzed antitank mine. An easy-to-use, field-ready sensor will be similar to this one in appearance.



The chemical-sensing method works on the premise that all mines emit molecules of the explosive chemicals contained inside them. Sandia is helping to develop a portable system incorporating ion mobility spectrometry—the same technology Sandia helped develop for an explosives-detection portal that checks airline passengers. A new concentration technology chemically amplifies the strength of the molecular emission.

Evidence detector

Sandia researchers are developing an evidence-detection system to help police investigators locate potential evidence more quickly and efficiently. The system relies on weak fluorescent emissions given off by all organic substances. These emissions normally are invisible to the naked eye because they are washed out by brighter sources of light. The Albuquerque Police Department's crime lab soon will be testing a prototype system at actual crime scenes.

TWA Flight 800 investigation

Sometimes the same technologies that help counter terrorist threats can also help rule out terrorist activity. Sandia used its scientific investigative expertise to help determine the probable cause of the TWA Flight 800 crash, which killed 229 people in July 1996. Working with the California Institute of Technology, Sandia helped model the fuel tanks of the Boeing 747 to ascertain whether fumes generated in the center wing tank as a result of summer heat may have been ignited by an errant spark after takeoff. Sandia's efforts supported the National Transportation Safety Board investigation into the cause of the crash.

America, Where Things Work

Jim Pacheco checks a heliostat during a recent test. Sandia has been a leader in the development of solar energy since the mid-1970s.

Like nuclear weapon systems, critical infrastructures require a high level of surety.

For example, a modern car has about 20 microprocessors—more computing power than an Apollo spacecraft on its mission to the moon. We don't think much about the electronic systems that manage the engine, the anti-lock brakes, or the air conditioner unless one of them fails.

As things become more complicated, so too do the techniques to make sure they work. Examples are power systems, gas pipelines, water supplies, bridges and buildings, emergency services, and computer banking networks. Computers are everywhere, even in our toasters. Computers design and build our newest commercial airliners, which have thousands of microprocessors controlled by tens of millions of lines of computer programming.

What are critical infrastructures?

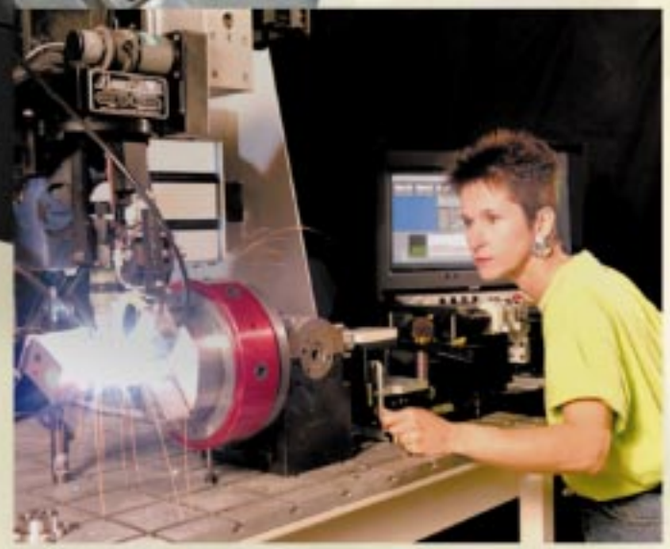
Air traffic control systems, financial networks, satellite communications, medical networks, telephone systems, highways, railways, waterways, mass transit systems, and police, fire, and medical services are all examples of critical infrastructures. Fifteen years ago, these infrastructures—some in government, some in the private sector—were separate and distinct. Today they are linked by vast computer networks that greatly increase productivity but are vulnerable to disruption.

A recent report by the President's Commission on Critical Infrastructure Protection noted that a single damaging command sent over a computer network to a power-generating station could be as effective as a backpack full of explosives. And the perpetrator would be harder to find.

Most such failures are not intentional. In August 1996, power cables in the Northwest sagged into tree limbs and plunged much of the West into darkness. In January 1998, an ice storm left much of New York, New England, and southern Quebec without power, in some cases for weeks. In May 1998, a single failed communications satellite disabled 90 percent of the pagers in the United States, along with automatic teller machines, credit card systems, and TV and radio networks around the world. A cascade of such failures could cripple a regional economy or weaken national security.

Sandia is already working with industry and government to avoid such disruptions by planning ahead and being prepared for them. Following are some examples.

Sandia has been designing and building instruments for satellites since the early 1960s. The latest is an R&D satellite to demonstrate and evaluate advanced multi-spectral and thermal imaging for nonproliferation applications.



Annette Newman checks a tungsten-arc welder with a PC-based imaging system that analyzes weld integrity.

Engineer T.Y. Chu (left) and Commissioner Nils Diaz of the U.S. Nuclear Regulatory Commission examine a fracture in a simulated nuclear reactor vessel. A similar project with Japan focuses on the safety of reactor containment vessels—shown here at one-tenth the actual size.

Nuclear power

Sandia is teaming with the Nuclear Regulatory Commission and electric utilities to extend the lives of nuclear reactors by 20 years. New instrumentation and control systems and techniques to reduce the effects of aging are improving reliability and reducing maintenance costs. Nuclear reactors provide a little more than one-fifth of all electrical power in the United States. The need for security and reliability of nuclear weapon systems has led to new technologies, which in turn has led to our role as the lead laboratory for the Nuclear Regulatory Commission for the safety of nuclear power plants. Sandia also works with foreign countries on nuclear reactor safety experiments, computer code development, and risk assessments.

Because of the need to predict the long-term reliability of polymers in weapons, Sandia has expertise in predicting the effects of radiation on the aging of electrical cables, a subject of interest to the nuclear power community. Sandia's polymer characterization facilities allow scientists to conduct accelerated aging experiments in a variety of environments including gamma radiation, heat, ultraviolet radiation, humidity, and chemical, mechanical, and electrical stresses.

Sandia partners with many energy suppliers and users, such as the automotive industry, manufacturers, the oil, gas, and geothermal industries, providers of solar and wind energy, regulatory bodies, electric and gas research institutes, and state and local governments to improve reliability and reduce the chance of disruption to energy supplies.

Transportation Safety

The safe and economical transportation of hazardous wastes generated by industrial and military activities requires a surety approach that anticipates future system needs, identifies potential problems, and develops innovative solutions. Sandia has long worked with the

Sandians invented and patented a sensor that changes color when temperatures rise above 32 degrees F. The invention, a byproduct of a solar research project, depends upon an inexpensive "smart" material that "remembers" multiple shapes and acts as a sensor. The color code alerts shoppers if food has been thawed and refrozen.

A youngster learns about the physics of bubbles using equipment donated by Sandia at a communitywide science carnival sponsored by schools, museums, and other organizations in the San Francisco Bay Area.

Making a Difference in the Community

Department of Energy and the Department of Defense to protect such materials while in transit.

The Federal Aviation Administration is using techniques developed at Sandia to improve the safety of the traveling public. The FAA's next-generation air safety system will significantly enhance the safety of U.S. air travel, already the safest in the world.

Under Sandia's direction, the Bay Area Rapid Transit System in San Francisco is improving safety, capacity, and service, and suppressing vibration and noise.

Sandia is also working with the FAA to improve the safety of aging aircraft through more sensitive ultrasound detection of cracks, thermal imaging, and bonded composites that reinforce aircraft hulls.

Building Safety

Building safety in office complexes and homes often relies on locks and barriers that delay rather than identify intruders. Some office buildings in Europe, however, are adopting a different approach used by the nuclear materials industry. In this approach, intruders who attempt to break into a sensitive facility are first detected and then delayed by various barriers while a security team mounts a superior defense force. The result has been a dramatic increase in the apprehension of burglars, who are usually caught by entrapment systems that follow a seemingly soft entry.

Computer research at Sandia helps predict the effects of explosions on physical structures and provide a basis for managing risk and making design improvements. An example is window glass that minimizes injury to occupants. Several universities are developing courses in architectural surety in partnership with Sandia.

As always, the sharing of critical information requires accuracy and authenticity. Sandia is an expert in encryption techniques and is using them to protect the integrity and limit the availability of sensitive information.

Sandia has a rich and long-standing tradition of community outreach. Together with Lockheed Martin Corporation and the Department of Energy, Sandia is committed to improving the quality of life in the local community. Recently, the New Mexico Chapter of the National Society of Fund Raising Executives awarded its Outstanding Business in Philanthropy Award to Sandia and Lockheed Martin.

Sandia has long been the largest supporter of Central New Mexico United Way. This year, Sandia employees contributed $1.6 million, 20 percent of all contributions in the greater Albuquerque area. For more than a decade, Sandia has been the only company to contribute more than $1 million each year. In California, Sandians contributed $192,000 to Bay Area charities.

Sandia and Lockheed Martin provide financial support for many charities, especially those dedicated to youth

Sandia volunteer coordinator Redd Eakin shares a hug with Fidelia Montoya at La Amistad, a senior citizens center.

development. The largest gift ever received by the New Mexico Museum of Natural History and Science was a $1 million grant from Lockheed Martin on behalf of Sandia to build a new theater. Sandia is working closely with the Hispanic Cultural Foundation to make the dream of a new Hispanic Cultural Center a reality.

Sandia's employee contributions support search and rescue, the Albuquerque Biological Park, Youth Development Inc., Junior Achievement, the Albuquerque Indian Pueblo Cultural Center, Albuquerque Public Schools, the Thunderbird Awards, the Martineztown Project, and many other community service organizations.

In California, the Lockheed Martin Foundation donated $10,000 to Crayons to Computers, qualifying the nonprofit organization for matching funds from the state to provide Pentium computers to area schools. A total of 1,500 computers, along with teaching supplies, will be donated to support computer education.

Sandia employees continue to embrace the Shoes for Kids drive, donating funds during the past year that purchased new shoes for 450 students.

More than 2,000 Sandia employees volunteer their personal time for nonprofit agencies, donating more than 50,000 hours of service to the community. Their efforts range from putting on a fresh coat of paint to providing computer support to answering crisis hotlines to collecting food and clothing for families in need. Many Sandians serve in leadership roles for nonprofit organizations.

With support from Lockheed Martin, Sandia employees provide classroom support for young people through the Science Advisor program. Sandia provides hands-on learning materials for teachers in the Science, Math, and Resources for Teachers library, called SMART for short.

Sandia and Lockheed Martin partnered with Albuquerque Public Schools and United Way to create the Sandia Literacy Project. Lockheed Martin Corporation committed $150,000 and Sandia provided volunteers to help classroom teachers at Wherry Elementary School on Kirtland Air Force Base implement a successful model literacy program. The goal of the program is to have all youngsters at Wherry reading at their grade level by the end of the third grade. Project developers hope the program will become self-supporting at the end of three years.

In 1998 the Department of Energy selected Sandia as the Management & Operating Contractor of the Year, recognizing Sandia's support for small business program policies. This is the second time in the past five years Sandia has received this award.

During fiscal year 1998, Sandia's $1.4 billion budget had a major impact on the economies of New Mexico and California, including salaries of $400 million to 6,600 employees in New Mexico and $60 million to 900 employees in California. Payments to retirees totaled

The Shoes for Kids project provides warm, durable shoes to grade school youngsters throughout Albuquerque.

$60 million in New Mexico and $8 million in California. Commercial purchases totaled $511 million in New Mexico and $50 million in California. New Mexico received $42 million in gross receipts taxes and California received $60,000 in sales and use taxes from Sandia.

Sandia matches its needs for products and services with a network of suppliers, including local businesses in New Mexico and California, who can provide high-quality products and services quickly and cost-effectively.

Volunteers Yvonne Batchelor (left) and Patrice Sanchez spruce up apartments for people with disabillities during a communitywide Day of Caring.

Sandia electroplated a miniature mass spectrometer for the Jet Propulsion Laboratory (background).

Sandia, working with the City of Albuquerque and several landowners, is planning a 240-plus-acre campus-style technology center. The proposed Sandia Science and Technology Park, located adjacent to the Labs in Albuquerque, will serve as a "next generation technology community." Its first tenant, EMCORE, is a leading provider of integrated compound semiconductor solutions. The technology park will provide companies with easy access not only to Sandia, but also to a variety of world-class technology centers in the New Mexico Technology Corridor. The corridor stretches about 250 miles from Los Alamos National Laboratory south to New Mexico State University in Las Cruces. The close association between Sandia and Lockheed Martin-founded Technology Ventures Corporation has helped establish 20 companies based on Sandia-derived technologies.

For information about Sandia National Labs, please visit our Web site at: http://www.sandia.gov

To request additional copies, please contact Marketing Communication at (505) 884 4902 or e-mail: cimeyers@sandia.gov

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