SANDIA NATIONAL LABORATORIES

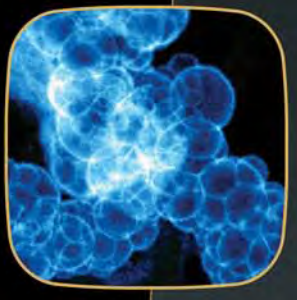
Sandia

ANNUAL 2007

"Exceptional service in the national interest"







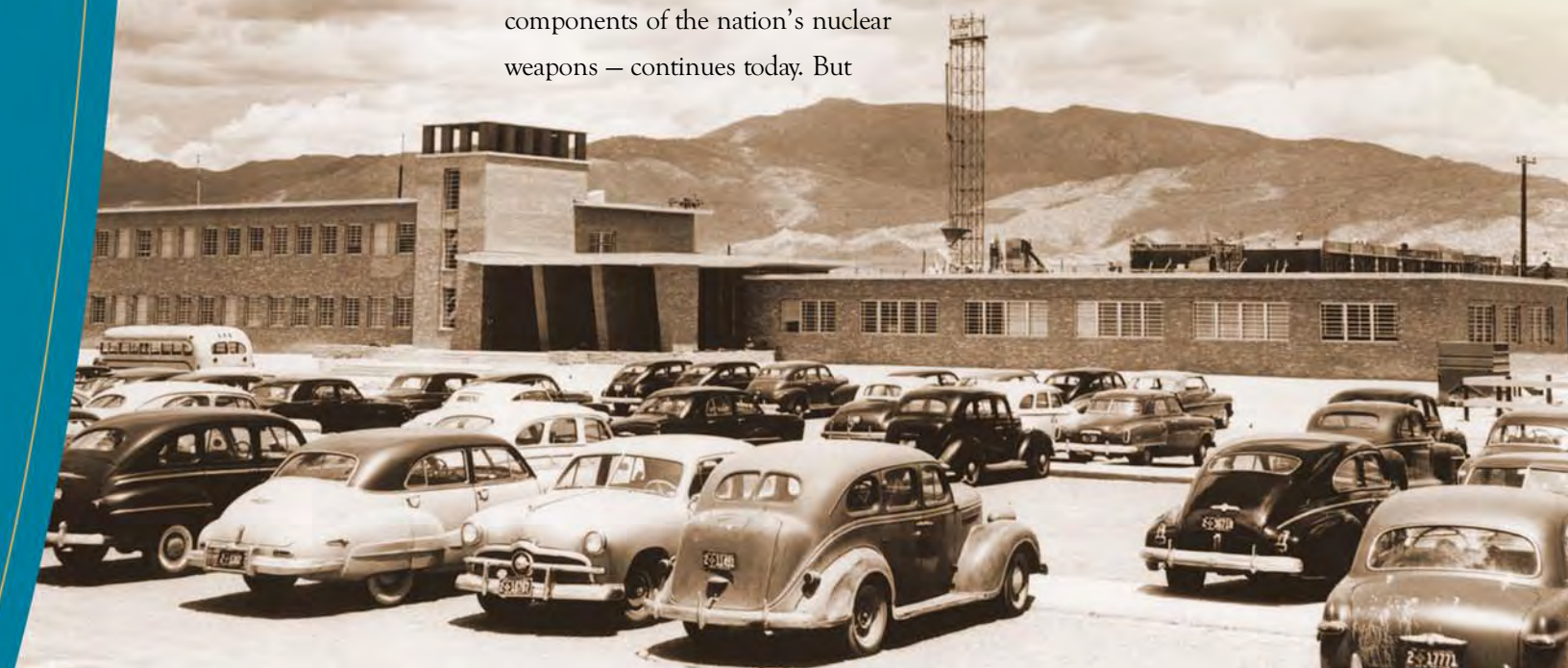
Sandia National Laboratories

About Sandia...

Sandia came into being as an ordnance design, testing, and assembly facility, and was located on Sandia Base, in Albuquerque, New Mexico, to be close to an airfield and work closely with the military. Originally known as Z Division, part of what's now Los Alamos National Laboratory, Sandia was born out of America's atomic bomb development effort – the Manhattan Project.

In 1949, President Harry S. Truman wrote a letter to the American Telephone and Telegraph Company president offering the company "an opportunity to render an exceptional service in the national interest" by managing Sandia. AT&T accepted, began managing the Labs on November 1, 1949, and continued in the role for nearly 44 years. The Labs' original mission – providing engineering design for all nonnuclear components of the nation's nuclear weapons – continues today. But Sandia also performs a wide variety of research and development for other national security efforts.

Lockheed Martin Corporation has managed Sandia since October 1, 1994, for the U.S. Department of Energy (DOE). Most of Sandia's work is sponsored by DOE's National Nuclear Security Administration (NNSA), but the Labs also works for other federal agencies, including the Department of Defense (DoD) and the Department of Homeland Security (DHS). We work cooperatively with a number of government, U.S. industry, and academic partners to accomplish our missions. Today Sandia employs about 8,700 people and has two primary facilities: a laboratory and headquarters in Albuquerque and a laboratory in Livermore, California.



Rising to a new plateau

The future is never what you expect it to be.

Would we ever have thought that the supremacy of our nation in science and engineering would be challenged? Yet it is, and today we face competition from workers who live just a mouse-click away in India, China, and dozens of other nations with well-trained, productive citizens and growing economies. We are fast losing our technological edge. To reverse that trend we will need to transform.

Recognizing the challenge, we at Sandia have begun a very deliberate journey to transform our operations to better support our missions. We are going to take it up a notch, to a new plateau of excellence. In the pages that follow, you will have the opportunity to learn what we've been doing this year to pave the way for these next steps. I have a sense that we can take all the things facing us and turn them into real opportunities and make a difference for our country. It's probably a time like few others this laboratory has had where we can make a real contribution.

Thomas O. Hunter
Sandia National Laboratories
President and Director

I keep thinking this is a super, extraordinary, exceptional place. A place that was created for a reason: to make a difference. A place that holds some really core inherent values that it can demonstrate to the country and truly be a place of unquestioned excellence in science and engineering. A place that's a foundation for national security and a place where we have this impeccable way in which we operate, leading an enterprise that's a model for the world.

The path to the future has to be one of change and transformation because the world is truly in a state of transformation.

Would we ever have thought:

- that natural disasters like Hurricane Katrina would have such a big economic and political impact as they have had?
- that the nation would adopt an energy policy embraced by both houses of Congress and signed at Sandia Labs by the President of the United States?
- that the nuclear weapons complex would come under such very intense scrutiny?
- that the national debt would be approaching nine trillion dollars and that the federal government would be operating in large part on what is money borrowed from our children and grandchildren?
- that the conflict in Iraq would be approaching the duration of World War II and would have an accumulated incremental cost to the defense budget alone of more than 300 billion dollars?

> "Sandia today faces demands from a spectrum of customers. All over America, people are asking their institutions how they can rise above where they are now to a whole new plateau. How they can become something different than they are, because the global and domestic demands are such that the current way we do things will not be competitive in the future."
>
> *Thomas O. Hunter*
> *Sandia President and Director*

TRANSFORMATION

Exhibiting flexibility in a time of change

Sandia's role in the national science and technology arena is undergoing dramatic change. While upgrading and maintaining the country's nuclear stockpile remains a top priority, Sandia also is spearheading other research in the name of national security. The Labs' organization is reflecting this broader focus. Here are some thoughts on this transformation from the Labs Leadership Team.

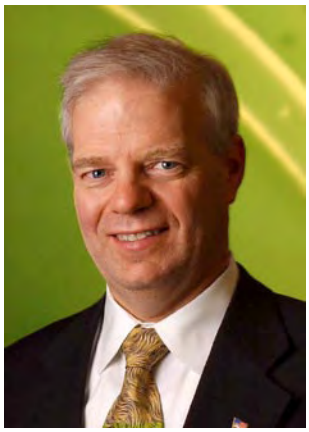
"Complex 2030 envisions transformation of the stockpile from the life-extension project era — where alterations and modifications extend the life of existing weapons — to a stockpile based on the Reliable Replacement Warhead concept. This will require the complex to operate and produce full systems in a way unlike we have in the recent past. An RRW-based stockpile enables better manufacturability, incorporates greater design margins, and enables improvements in safety, security, and use control. It allows us to design weapons in such a way that we can continue to have confidence in our assessment of weapon reliability with much enhanced surety."

Deputy Director Joan Woodard,
Nuclear Weapons

"Our new Strategic Plan reflects a much deeper awareness of the need to transform so that Sandia is properly positioned to meet the nation's expectations in the future. We need to not just be driven by the winds of fortune, but rather be intentional about how we manage the Laboratories and particularly about how we manage the movement of work and people.

"Everyone at Sandia is part of the transformation effort. It isn't about some separate entity that someone, somewhere else is working on transformation. It's something that's deeply embedded through Sandia."

Deputy Director John Stichman,
Labs Transformation



"For the foreseeable future, nuclear weapons will play a critical role in the nation's security. Yet, the nation has also recognized that the threats we face are more diverse than ever, ranging from the terrorist threat of non-state actors, to rogue states, to peer competitors, to economic conflict regarding energy and resources. Sandia is well positioned to offer new ideas and new science, technology, and engineering to address these threats. Sandia's strength has always been to 'deliver the goods,' whether to meet customers' urgent needs or to deliver a technology for which the utility will not be realized for decades into the future. If we continue to create new ideas, solve today's problems for our customers, and deliver the technologies they need for tomorrow, we will always be able to provide 'exceptional service in the national interest.'"

Deputy Director Al Romig,
Integrated Technologies and Systems

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Nuclear Weapons Program

New era brings many new challenges to Sandia

Despite another year of international efforts to halt nuclear proliferation:

- North Korea detonated a nuclear device,
- In defiance of requests to stop, Iran continues developing a nuclear program that most in the West believe is aimed at producing nuclear weapons, and
- Japan — whose constitution many believe forbids even the presence of nuclear weapons on its soil — has talked openly about the possible need to develop them.

On the Indian Subcontinent, India and Pakistan, both of which acknowledge at least a limited nuclear weapons capability, have, in the past year, tested missiles capable of delivering nuclear warheads, as has Iran — despite Tehran's continuing denials of interest in nuclear weapons. As the U.S. debates the need and process for developing the Reliable Replacement Warhead (RRW), the United Kingdom is also nearing a decision on extending the life of its deterrent.

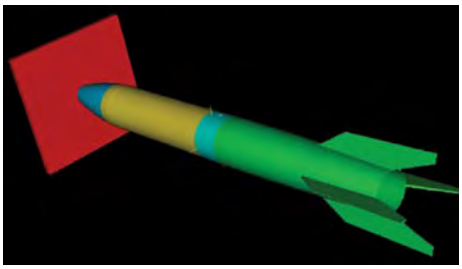
The middle of this first decade in the 21st century has brought with it a new era for nuclear weapons, their development, and the maintenance of a national nuclear deterrent. "On the international scene, the Cold War and the associated bipolar world is a thing of the past," says Joan Woodard, Sandia Executive Vice President and Deputy Laboratories Director for Nuclear Weapons. "Now we face the rise of multifactionalism and the complex environment that comes with it."

Sandia is working to maintain a deterrent that is aligned with national policy. Changes in overall stability of Europe and Asia and the advent of global terrorism have altered the way the stockpile is being thought of by policy makers. The U.S. stockpile of the future will be smaller — much smaller than at the height of the Cold War. Its weapons will be less costly to design, manufacture, and sustain. The threat of theft or sabotage to the stockpile will be considered even more carefully. The loss of a weapon, especially into the hands of a group that will not hesitate to use it, is not an acceptable outcome for tomorrow's world.

Alignment with national policy also means reductions in funding for the nation's nuclear weapons program as a whole and for Sandia. Nuclear weapons staffing levels at the Labs dropped by 200 full-time equivalent positions by the end of 2006.

Strategic objectives

Despite this time of changes within the nuclear weapons complex, Sandia continues to have core responsibilities to sustain the nation's stockpile and nuclear deterrent. With more than 60 years' experience in developing and designing the nonnuclear components and subsystems of the U.S. nuclear stockpile, Sandia is ready to continue to provide answers to the challenges of the nation's nuclear enterprise.

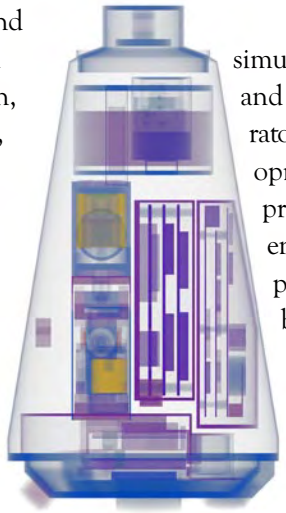


Computational model used for a simulation of a B61-7 impact.

Woodard and her strategic management group are addressing the evolving challenges by seeking to achieve a number of strategic objectives:

- Continue to ensure a credible nuclear stockpile for the nation while, at the same time
  - improving our science-based stockpile evaluation techniques and
  - creating a Common Adaptable System Architecture, making use of microsystems and other advanced technologies for the transformed stockpile.
- Achieve a transformed nuclear weapons enterprise by leading in the production of nonnuclear systems with demonstrated performance at lower cost.
- Assure safe weapon response in all environments at all times, without exception, with absolute control and no compromise in reliability.
- With Sandia's Science, Technology, and Engineering business unit,

accelerate engineering and innovation by integrated application of simulation, scientific understanding, experiment, and test.



Transforming the stockpile

An ideal future vision for policy makers overseeing the U.S. stockpile would include transformation to modular, adaptive designs, improved integration with new weapons delivery platforms and new mission capabilities, robust reliability margins, integrated surety features, and reduced life-cycle costs. But while those goals are being addressed, there is an overriding need to ensure that the existing stockpile continues to be safe, secure, reliable, and capable of meeting its requirements.

Science-Based Engineering is a concept that brings together the fundamental science, computer models, and experimental facilities needed to understand, predict, and verify weapons systems performance. Without underground testing, Science-Based Engineering is critical to the continuing qualification of nuclear weapons.

To back this qualification effort, experiments and modeling and simulations are needed on a variety of scales from large machines — like the Z (pulsed-power accelerator), Saturn (hard X-ray source), and HERMES III (gamma ray source) — to tests in smaller laboratory settings.

Integrated Stockpile Evaluation (ISE), or the evaluation of the stockpile through Science-Based Engineering, is one of several major transformational efforts under way in Sandia's weapons program. ISE is designed to integrate the knowledge collected on a weapon system during its lifetime in the stockpile and use it in a predictive way. This capability will help stockpile stewards know what issues are likely to come up with respect to each weapon.

Information from modeling, simulation, and validation testing and knowledge from Sandia's laboratorydirected research and development efforts will be combined to provide predictions on aging and environmental changes, to anticipate problems, and to fix them before they arise. Information from changes to the weapons or even dismantlement can be used to advance the ISE knowledge base.

Another key feature in the stockpile transformation is CASA, creating a Common Adaptable System Architecture, to make use of capabilities of Sandia's Microsystems and Engineering Science Applications program (MESA) through integrated microsystems. CASA will approach future stockpile requirements using integrated subsystems, small packages developed with advanced technology, in a modular manner.

Built around a centralized controller concept, which establishes standard interfaces among the subsystems, CASA designs will be able to meet requirements identified by the military today and have the flexibility to meet different demands in the future. The concept of CASA will include expansion modules to address self-testing, guidance and navigation, and a variety of other subsystems.

Transforming the complex

The stockpile of the future demands a nuclear complex of the future. The future complex, discussed in a series of public meetings late last year, is seen as one that needs to transition the skills, capabilities, and facilities of today into new capabilities and skills that will make it responsive, cost-effective, and sustainable.

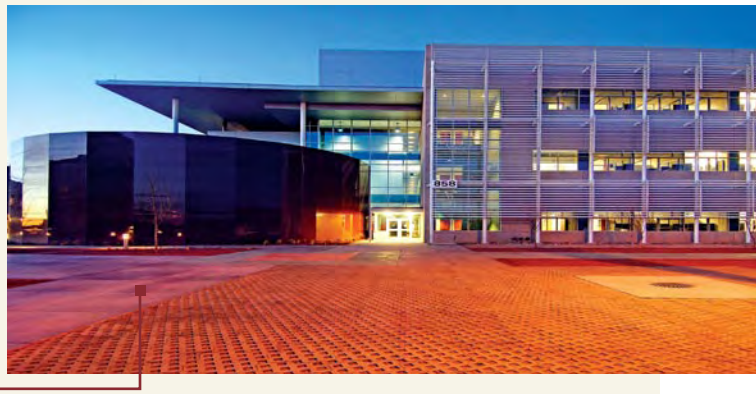
With the unveiling of Complex 2030, the DOE's National Nuclear Security Administration responded with a collection of recommendations based on the input of others. Tom D'Agostino, acting NNSA administrator, testified before the House Armed Services Committee Subcommittee on Strategic Forces, that the 2030 plan will establish a smaller, more efficient nuclear weapons complex able to respond to future challenges.

A smaller, safer, more secure stockpile, with assured reliability over the long term, must be backed by an industrial and design capability to respond to changing technical, geopolitical or military needs, D'Agostino said. The 2030 plan "offers the best hope of achieving the President's vision of the smallest stockpile consistent with our national security needs."

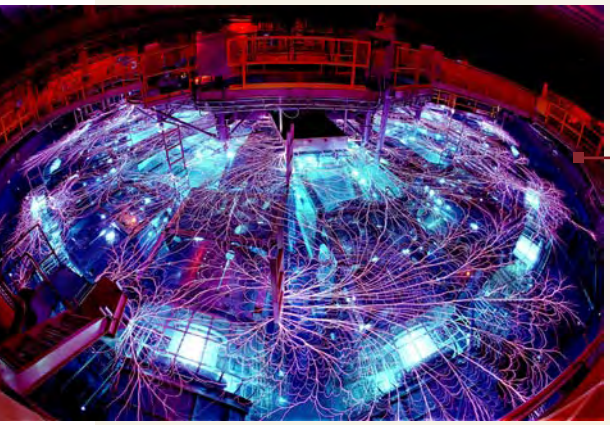
In the past, Sandia held an important role in assessing complex processes and programs. But since the end of the Cold War, the role of system integrator has remained vacant. With changes recommended by Congress and the administration, Sandia is expanding its role in the area of technical support for integration. Sandia's Responsive Infrastructure Team is supporting NNSA and its newly established Office of Transformation. The team's activities are now addressing both near- and long-term mission needs, to develop a path forward to NNSA's 2030 vision.

The underpinning of science and technology

The skill sets of the people in Sandia's weapons program and the facilities that support them are essential to meeting the Labs' nuclear weapons responsibilities.



• The $462 million, seven-year MESA project is the engineering and science underpinning for future warhead designs. On time and budget, the Microsystems and Engineering Sciences Applications complex at Sandia in Albuquerque combines systems designers, component designers, and computer visualization researchers to quickly imagine and design key hardware elements. MESA is scheduled to be fully functional in 2008.



• Sandia's pulsed power capabilities, including the powerful Z machine, are used by all of the nation's nuclear weapons laboratories to understand the fundamental properties of materials critical to nuclear weapon performance. A $60 million refurbishment of the Z machine began in mid-2006.

• Sandia participates in the NNSA's high-performance computing program through the design, acquisition, and use of supercomputers like Sandia's Red Storm machine. Red Storm is one of the world's fastest computers. Upon completion of an ongoing upgrade this year, Red Storm will have a theoretical peak performance of 125 trillion floating point operations in a single second. These parallel-processing computers support sophisticated models and simulations, which allow Sandia researchers to understand the effects of environments and aging on various components and subsystems in warhead designs.

Examples of Sandia's underlying efforts in science and engineering appear throughout the pages of this Annual Report and are identified with the Science Engineering Innovation logo shown here.

Sandia's LDRD

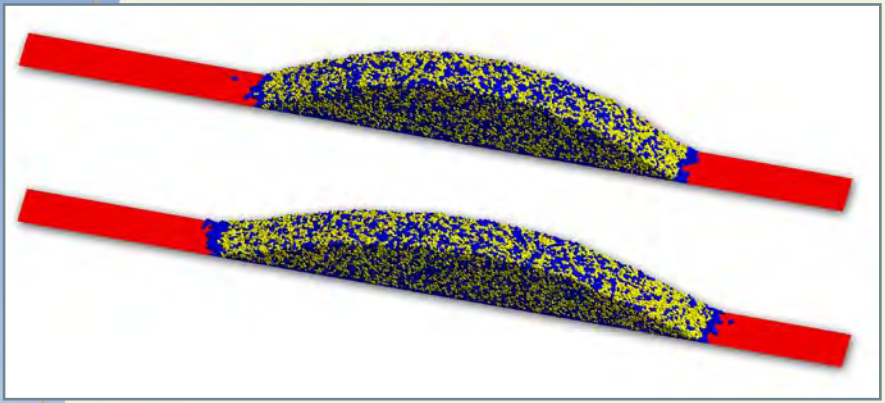
Sandia's world-class science, technology, and engineering define the Labs' value to the nation. Because U.S. security depends on it, Sandia strives to keep its capabilities on the cutting edge.

Sandia's Laboratory Directed Research and Development (LDRD) program provides the flexibility to invest in long-term, high-risk, and potentially high-payoff research that stretches the Labs' science and technology capabilities.

LDRD supports Sandia's primary strategic business objectives: nuclear weapons; energy resources and nonproliferation; defense systems and assessments; and homeland security and defense. LDRD also promotes creative and innovative research by funding projects that are discretionary, short-term, and often high-risk, attracting exceptional research talent from across many disciplines.

Many examples of LDRD projects grown into full-fledged concepts appear in this report and are indicated by this logo:

Coating technology moves to next level with modeling and simulation insights



This time sequence in a coating simulation shows how wetting constituent (blue) forms a monolayer and spreads out along the surface (red). Then the nonwetting constituent (yellow) spreads on top of the wetting monolayer.

The challenge becomes greater as we advance engineered devices into ever-diminishing length scales.

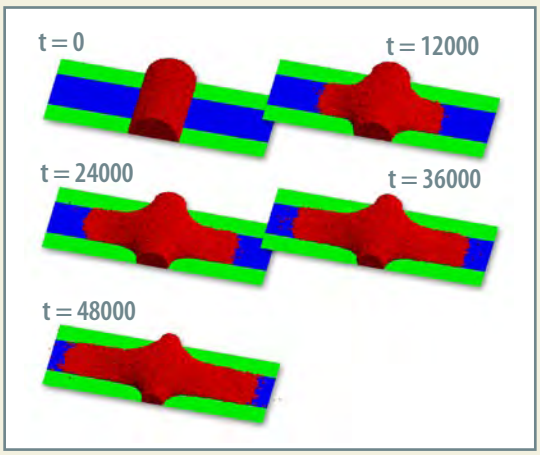
How to ensure that a substrate material is evenly and securely wetted by a wetting agent has long been the challenge in coating technology. Failure to develop a complete wetting of a substrate often leads to coating failure. In epoxy systems, for instance, incomplete wetting of the surfaces to be joined can lead to sealant failure and, in turn, device failure. The challenge becomes greater as we advance engineered devices into ever smaller scales.

Understanding coating failure requires molecular-level descriptions of the coating constituents as well as the interface with the solid material. This is a level of resolution unattainable by existing experimental techniques. Molecular-scale simulations have been used to study wetting phenomena, but until recently computational resources did not exist to study chemically realistic coating materials.

Sandia researchers Gary Grest and Edmund Webb developed numerical simulations of multicomponent polymer nanodroplets being applied to substrates. The simulations, using high-performance, large-scale parallel-processing computers, were done with binary component droplets. Grest and Webb observed conditions where a nonwetting coating constituent was made to wet the substrate by carefully controlling coating constituents.

With sufficient interaction strength between the polymer components, the nonwetting substance spread on top of a molecular layer of the wetting substance. This effort revealed previously unavailable molecular-scale information about phenomena controlling coating behavior.

The model created can address constituents of arbitrary molecular structure and interaction strength, which permits broad applicability across coating engineering science. In addition, complexities such as introducing a chemical pattern on the substrate surface have been studied. Results are helping coatings scientists develop stable multicomponent wetting formulations that allow the use of required wetting agents even when those substances would not otherwise coat the substrate.



In this simulation, a polymer nanodroplet (red) spreads across a chemically patterned surface. The pattern consists of parallel strips of wetting (blue) and nonwetting (green) regions. The droplet spreads on the wetting strip by removing material from on top of the nonwetting (green) region. Understanding the complex patterns of coating can guide engineers in developing new nanodevices.

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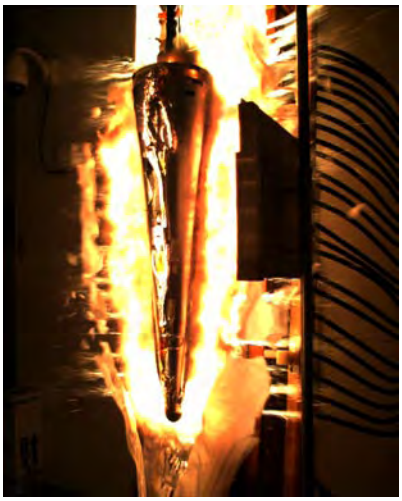
Integrated surety

At Sandia, surety is moving towards the goal of predictable, safe weapon response in all environments at all times, without exception. Electronic systems aid in the control of virtually all major systems in today's world – including nuclear weapons. But unlike commercial electronics, nuclear weapons electronics must remain reliable in severe environments, including those where they are exposed to ionizing radiation in space, on the nuclear battlefield, or from the radiation generated by the materials that form the core of the nuclear explosives package.



If launched, warheads would be subjected to violent shaking, increases in the pull of gravity up to seven times normal, weightlessness, and the thermal shocks of going from sub-zero temperatures in space to extremely high heat on reentry – all while traveling faster than the speed of a bullet.

Additionally, the scale of modern weapon electronics has become very small – sometimes measured in terms of the number of atoms. Very small systems, referred to as integrated, intelligent microsystems, can sense, process information, actuate other elements, and communicate – all within a single package. To support these needs, Sandia maintains a complete design, simulation, and testing capability.

At Sandia, a new effort is under way to better link internal weapon surety – the systems integrated within the functions and operations of the weapon – and external surety – the umbrella associated with weapons storage and handling. Called Integrated Surety, this concept links the internal capabilities and status of the weapon with capabilities and status of the external world, including transportation, storage, and deployment.

Transforming engineering

To achieve President Bush's goal of "a stockpile with the lowest-possible number of nuclear weapons consistent with our national security needs," the complex must continue on its current path of stockpile dismantlement. At the same time it must develop the capability to produce new warheads in a much more agile, timely fashion. The goal, according to former NNSA Administrator Linton F. Brooks, is to "demonstrate that we can produce warheads on a timescale in which geopolitical threats could emerge."

Achieving such a responsive infrastructure presents a challenge to our existing views of engineering, itself – a challenge that Sandia President and Director Tom Hunter has embraced. As the nation's premier engineering laboratory, Sandia should be in a leadership position in this transition, he maintains.

By using simulation-based engineering design, a concept that relies on high-speed computers that fold together design ideas with hard performance data from tests and experiments, use of computer models, and detailed scientific understanding of processes, Sandia is attempting to accelerate engineering and engineering innovation to this end.

(Above) High-fidelity weapon shock test at Sandia's Light-Initiated High Explosives Facility.

The role of RRW

The Reliable Replacement Warhead (RRW) concept is rooted in two clear-cut realities:
- The Cold War is over.
- Nuclear testing is likely gone forever.

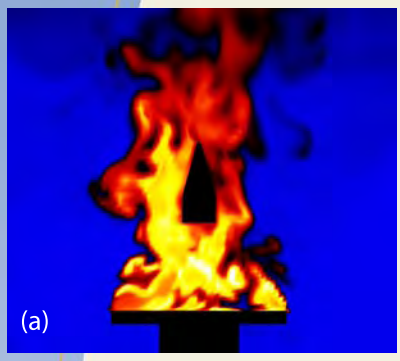
Nuclear weapons design has been changed by these two facts. The end of the Cold War brought with it the reality that the high yield-to-weight designs of the past, based on launching powerful multiple warheads across continents or from submarine- or ground-based missile platforms, no longer match the politics of deterrence in a changing world.

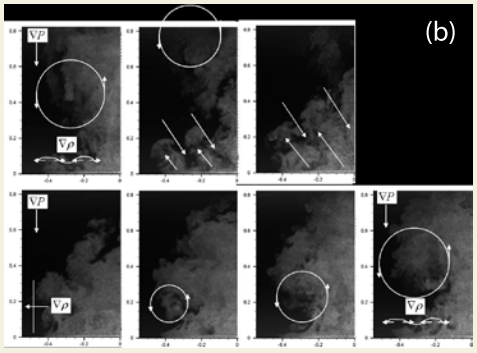
The end to nuclear testing meant that any design must be able to be qualified and certified with high confidence in the absence of real-world test data. Finally, military experts also realized that nuclear weapons don't have to be designed near the edge of their reliability envelope to preserve the yield-to-weight advantage. Instead, restrictions on mass and volume can be traded for greater confidence, greater surety, and easier and cheaper manufacture.

A first design study for the RRW concept was completed in 2006. Due to a new set of requirements for the 21st century, the designs from both New Mexico and California design teams were significantly different from systems in the current stockpile. Designers placed a heavy emphasis on confidence in reliability, surety, ease of manufacture, and flexibility of deployment. While at the publication date of this annual report no decision had been made to move beyond this first study, RRW proponents believe the first new weapons using this concept could be in the stockpile as early as 2012.

WWW.
sandia.gov/mission/nuclear

Generating rich data sets for fire model validation



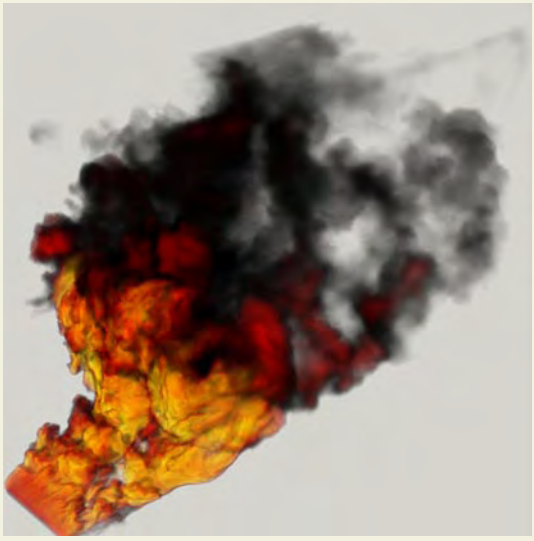


Spatially and temporally rich data sets are helping Sandia researchers understand and corral fire's unpredictable ways.

Fire has always been one of humankind's greatest threats and one of its most useful tools. To modern-day science, it is an exquisitely complex chemistry problem that results in a self-lofting, turbulent plume, which is engulfed in a sea of mostly unseen infrared photons. Now, high-tech laser-based diagnostics combined with new world-class fire laboratories in Sandia's new Thermal Test Complex and state-of-the-art multiphysics fire simulation tools, optimized to take advantage of large-scale, high-performance computers, are giving Sandia researchers a look into the world of large-scale, complex fires.

These techniques, in turn, are returning spatially and temporally rich data that are helping to better predict how fire reacts and how a weapons system might respond in a fire. Modeling and simulation is the modern application of theory in which the numerical simulation tools are the codification of our theoretical understanding, and the application simulations are scientific hypotheses. Experiments test the hypothesis and the quantitative comparisons validate our current level of understanding. Knowledge gained is then codified. The goal is to quantify our uncertainties to establish weapon system safety in fire environments. An example of a fire simulation of a validation experiment, done on a complex calorimeter in a well-controlled fire, can be seen in the illustration (a) on this page.

High-fidelity experiments often result in new knowledge. An example (b) is a sequence of images showing bubble and spike structures, mixing at the edge of a simple helium plume, as the plume becomes unstable. An edge instability results in a circular vortex that grows, engulfing the bubble and spike structures. This vortex draws in heavy air over the light helium and the cycle repeats itself. The same dynamics occur in a fire.



The codified knowledge permits fire scientists to design experiments to challenge systems realistically. Fire simulations like the one above represent 385 million unknowns, calculated with tens of thousands of time steps. The image here depicts a fire in a cross-wind at a snapshot in time.

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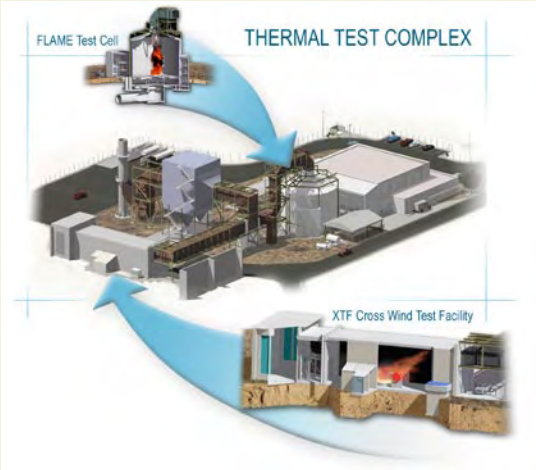

State-of-the-art facilities at Sandia's Thermal Test Complex allow for controlled experiments that permit the development of better fire models.

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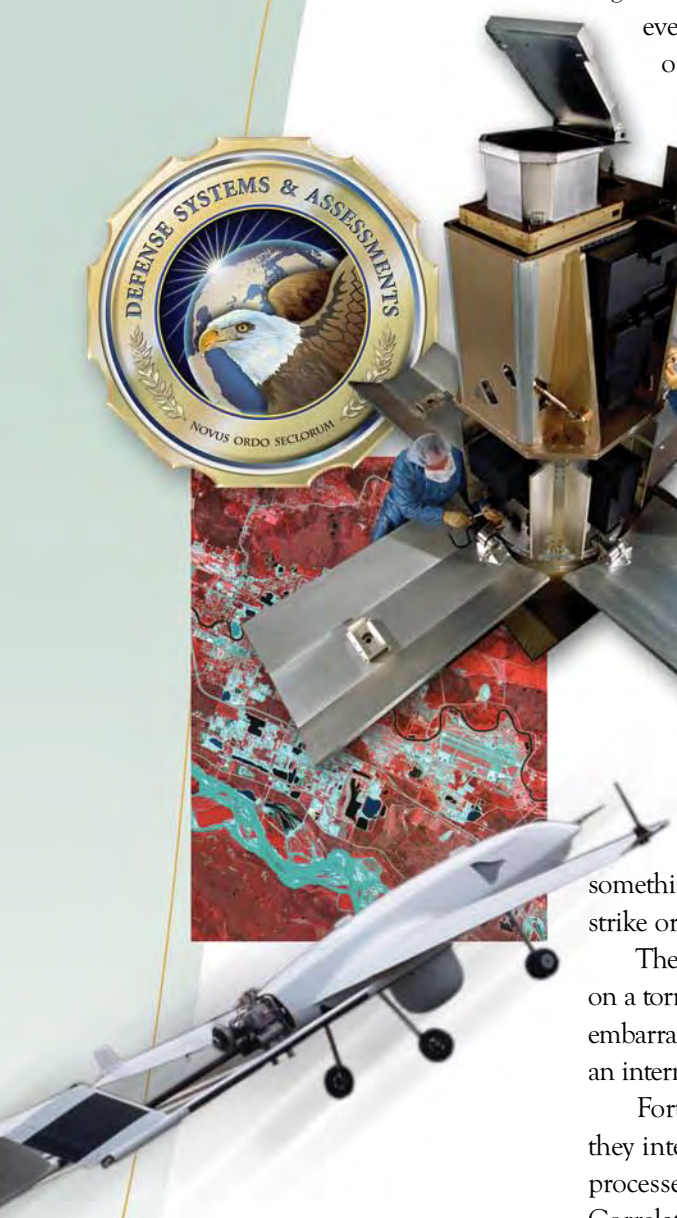
sandia.gov/news-center/news-releases/2004/other/thermal-test-complex

Defense Systems & Assessments

Keeping watch while you are sleeping



Whenever a nuclear device is detonated somewhere in the world — regardless of whether the clandestine event takes place in the middle of the night and in the most remote corner of the globe — a cadre of enlisted Air Force men and women likely is among the first to know.

As data from dozens of nuclear burst detectors aboard a network of U.S. defense satellites flood into their ground stations, it is these operators' jobs to decide, in real-time, whether to refer the event to higher-ups as a violation of international law or to designate the event as something less nefarious — a lightning strike or, perhaps, a satellite glitch.

The critical decisions they make, based on a torrent of data, could result in an embarrassing false alarm, or worse, trigger an international diplomatic crisis.

Fortunately the satellite signals they interpret already will have been processed by ICADS, the Integrated Correlation and Display System, created for the Air Force by Sandia National Laboratories.

ICADS, the guts of the ground station where the operators work, includes the antennae, hardware, and more than a million lines of software code that gather, correlate, and help make sense of defense satellite data available as part of the United States Nuclear Detonation (NUDET) Detection System (USNDS).

USNDS's mission is to reliably detect, locate, characterize, and report in near real-time nuclear detonations anywhere in Earth's atmosphere or near space.

USNDS operators must use the evidence provided through ICADS to determine what happened, when it happened, and exactly where on this vast globe or in space a detonation took place. Ultimately the information would be combined with other evidence to assign responsibility, the second move in the high-stakes diplomatic chess game that would follow.

Above-ground NUDET events have been nonexistent since the U.S. and former Soviet Union declared a nuclear test moratorium in the early 1990s. But USNDS is no Cold War relic. With budding nuclear weapons programs in at least two nations — Iran and North Korea — possibly pressuring whole regions into nuclear deterrence postures, the USNDS may be called upon to gather the facts about a round of 21st century nuclear detonations, which — depending on who carries them out and why — could change the course of history.

ICADS allows operators to quickly compare live satellite data with hundreds of event profiles in its event database. Certain atmospheric phenomena — lightning, solar storms, and even pings to a satellite by energetic micrometeorite particles — can cause energy disturbances that register on the satellites' sensors.

When a signal is verified by detectors aboard multiple satellites and bears the pulse waveform signature characteristic of a nuclear event,

the operators refer the event up the national command structure, ultimately including notification of the U.S. State Department that a treaty may have been violated.

"In some scenarios a nuclear proliferator or terrorist group might detonate a device in a way that makes it difficult to assign blame," said John Williams, Sandia senior manager for USNDS. In that case, he said, U.S. policy makers would need accurate real-time information about the time, location, yield, and any other evidence available via USNDS in order to determine the appropriate response.

"USNDS may be more important than ever to strategic national security," said Jerry McDowell, Vice President for Sandia's Defense Systems and Assessments unit. "The threats are real, and USNDS provides critical global awareness," he said. "We are proud to support our Air Force customer to address one of the nation's most important national security problems." (See DS&A on page 12.)

Sandia and other NNSA laboratories have supported USNDS since the early days of the Cold War. Optical, electromagnetic pulse, and X-ray sensor payloads now in orbit aboard GPS and DSP satellites were developed and built at the national labs. And Sandia has long played the primary payload integration role for USNDS, ensuring newly developed satellite sensors fit seamlessly with the satellite's hardware and software.

National asset

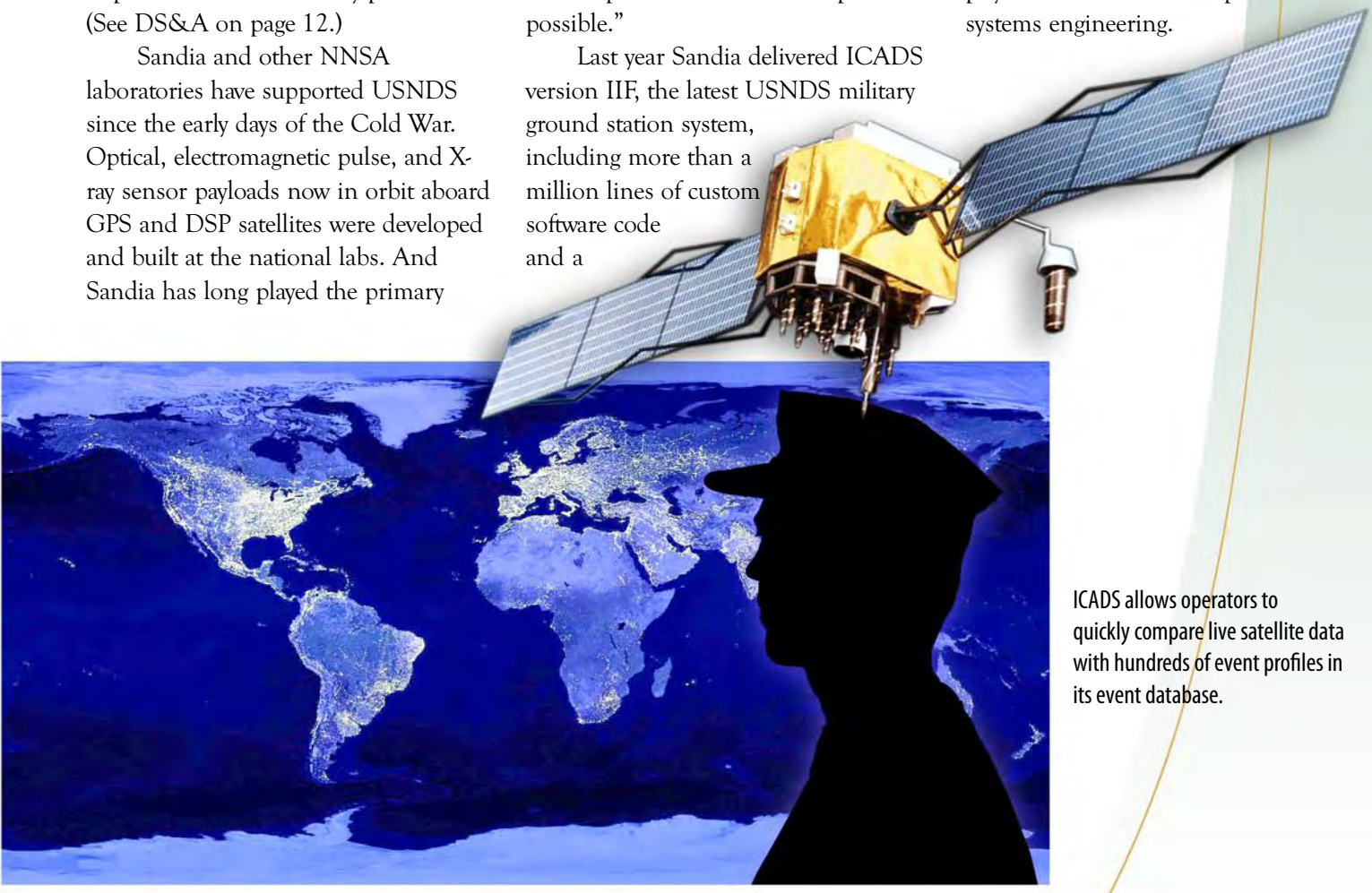
Sandia developed the first ground station for NuDet data processing in the early 1960s. In an effort to make sense of the increasing number of signal feeds from USNDS satellites, the first ICADS was delivered in 1992, with upgrades in 1998 and 2005. Each iteration has included significant new hardware and software functionalities. As a whole, ICADS now is considered a national command structure asset, said Williams.

"This is a complex, data-rich environment," he said. "It would take a very long time to integrate, correlate, and assess the signals from dozens of sensors about a single event. But U.S. decision makers need answers immediately. The analysis provided by ICADS before an operator ever sees the data helps make real-time interpretation possible."

Last year Sandia delivered ICADS version IIF, the latest USNDS military ground station system, including more than a million lines of custom software code and a heavy emphasis on human-computer interface theory, which makes the job of interpreting ICADS data more intuitive and increases the operators' chances of success. (IIF signifies the next generation of GPS satellites; the first GPS IIF is scheduled for launch in 2009.)

The $188 million Sandia ICADS IIF program was unusual in its size and complexity; and because it was delivered, fully qualified and verified, under budget, and on time based on a delivery date set half a decade earlier, it is a rarity for a large military software development program, said Sandia project manager Don Rountree.

"A program this complex is almost expected to fall behind schedule," said McDowell. "To keep the promise we made back in 2000 required an incredible level of dedication and expertise by hundreds of people." The program required a spectrum of Sandia expertise, from atmospheric phenomenology and high energy physics to software development and systems engineering.



ICADS allows operators to quickly compare live satellite data with hundreds of event profiles in its event database.

Sandians continue to support the USNDS program throughout its life cycle, adds Williams. Technical experts at Sandia and Los Alamos national labs are on pager call 24/7, 365 days a year, to provide the Air Force satellite and ground station state-of-health support as well as second opinions regarding Air Force analysis of "zoo events" — unusual data signatures that don't match existing event profiles. Sandians also train the Air Force ICADS trainers, who in turn train the ICADS operators.

Now, under NNSA nonproliferation funding, Sandia is working on the next generation of lighter-weight, smaller global burst detectors to fly aboard the GPS IIF and planned new series of DSP and GPS III satellites. Continued ICADS development to support the new satellite systems is under way as well.

"USNDS is a long-term commitment for us," said Williams.

Defense Systems and Assessments deals with set of strategic national security concerns

As threats to U.S. national security have broadened and intensified, so has the meaning of the term strategic national security, said Jerry McDowell, Vice President for Sandia's Defense Systems and Assessments unit.

Recent federal government policy papers include — as part of their definitions of "strategic national security" — references to a spectrum of capabilities beyond nuclear deterrence.

DS&A's customers include the Department of Defense, the non-proliferation technology community, and other federal agencies.

DS&A has programs and capabilities in:

- Surveillance and reconnaissance — Advancing capabilities in synthetic aperture radar and other remote-sensing technologies to provide science, technology, and engineering advances for the battlefield and space.
- Remote sensing and verification — Deterring proliferation and verifying compliance with international agreements using space- and ground-based remote-sensing technology.
- Integrated military systems — Nonnuclear strike systems that advance the DoD's abilities to reach hardened, deeply buried, and other strategic military targets using conventional weapons systems with advanced capabilities including earth penetration. Missile defense work to support the DoD's efforts to develop a missile defense system capable of detecting, intercepting, and killing enemy missiles using interceptor missiles launched from ground or ship. Energetic systems such as electromagnetic launchers for ship-borne aircraft and munitions.
- Information operations — Ensuring critical infrastructure network security using trusted detection systems to detect anomalies and intrusions by sophisticated adversaries such as well-financed terrorists and rogue nations.
- Proliferation assessment — Supporting federal agencies in the nonproliferation community with technologies and systems.
- Intelligent transformational systems/robotics — Developing and delivering complex micro- to macro-sized automated systems, and adapting machine intelligence techniques, to support the warfighter.
- Science and technology products — Employing microsystems and other advanced technologies to give the warfighter new capabilities.
- Strategic industrial relations — Amplifying Sandia's value to the nation and national security by effectively working with the DoD industrial base.

The DS&A seal includes the Latin phrase *Novus Ordo Seclorum*, meaning 'A New Order for the Ages.'

"Our mission is to embrace the new world order by bringing our Labs' outstanding engineering, science, and technology capabilities to bear on the newly emerging and compelling strategic national security problems — those that, if left unattended, could put our liberty and peace at risk," said McDowell.

WWW.
sandia.gov/mission/mta

High-performance computing provides clues to scientific mystery

(Left) Libyan Desert Glass is found in an area spanning 6,500 km^2, in the Great Sand Sea of the Western Desert of Egypt, near the border with Libya. In 1998, an Italian mineralogist showed that a carved scarab in King Tut's breastplate was made of this glass.

Enigmatic silica glass in the Sahara Desert has survived nearly 30 million years. How did it form?

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Most natural glasses are volcanic in origin and have chemical compositions consistent with rapid cooling of lava without opportunity for crystalline structure to grow. The rare exceptions are tektites, which are formed by shock melting associated with the very high velocity, or hypervelocity, impact of a comet or asteroid. But Libyan Desert Glass does not fall into either category, and has baffled scientists since its discovery by British explorers in 1932.

For physicist Mark Boslough and his Sandia colleagues, the 1994 collision of Comet Shoemaker-Levy 9 with Jupiter provided Sandia with a unique opportunity to model a hypervelocity atmospheric impact. Insights gained from those simulations and subsequent astronomical observations of the actual event led to a deeper understanding of the geologic process of impacts on Earth. The hypervelocity atmospheric impact thesis presented a likely scenario for the formation of Libyan Desert Glass.

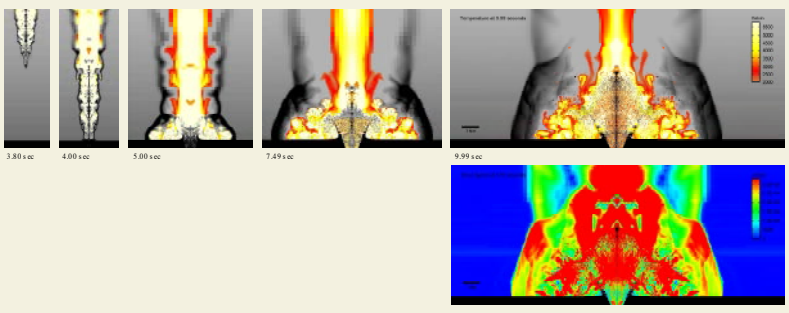
High-resolution computer simulations of the impact process, requiring huge amounts of memory and processing power, support the hypothesis that the glass was formed by the radiative heating and ablation of sandstone and alluvium near ground zero, when a 100-megaton or larger atmospheric explosion resulted after the breakup of a comet or asteroid.

Using Sandia's Red Storm supercomputer, Boslough ran high-resolution shock-physics simulations to show how a 120-meter-diameter asteroid entering the atmosphere at 20 kilometers per second (resulting in an explosion with a yield of about 110 megatons) breaks up just before hitting the ground. The fireball that is generated remains in contact with the Earth's surface at temperatures exceeding the melting temperature of quartz for more than 20 seconds. At the same time, the air speed behind the blast wave exceeds several hundred meters per second. These conditions are consistent with rapid melting and quenching to form the Libyan Desert Glass.

These simulations require the massively parallel processing power provided with Sandia's Red Storm computer.

The risk to humans from such impacts is small but not negligible. Because of the low frequency of these events, both their probability and consequences are difficult to determine. The most likely scenario that would cause damage and casualties would not be a crater-forming impact, but a large aerial burst similar to the one that created the unusual Libyan natural glass. This research is forcing risk assessments to recognize and account for the process of large aerial bursts.

As these simulations show, the heat of an atmospheric explosion created a vapor plume more than 10 kilometers in diameter, which stayed in contact with the Earth for up to 20 seconds with very high temperatures and continuous wind blasts exceeding 100 meters per second. The conditions suggest one way the glass could have been created.



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sandia.gov/LabNews/060915#three

It's not your grandfather's border

When you think of an international border, what most likely comes to mind is a chain-link fence topped by three strands of barbed wire, or perhaps a guard shack and a few armed sentries straddling the center line of a highway.

That was yesterday's border. Today, with the threat of terrorism and a broadening set of socioeconomic problems associated with immigration, and an ever-increasing number of ways to enter the country, a border is no longer just a checkpoint or a line on a map, but a complex concept whose problems require multidimensional thinking.

"Many pathways exist through our borders, and threats can range from people to drugs to hazardous materials to weapons of mass destruction," said Jill Hruby, Catastrophic Event Mitigation Mission Area Leader, of Sandia's Homeland Security & Defense unit. "And the flow of both commerce and contraband extends far beyond our physical boundaries."

Working with a range of sponsors and partners, engineers, and scientists at Sandia are playing a key role as part of the national strategy to enhance and ensure security of U.S. borders. Current efforts focus primarily on maritime and land borders — and the most significant threats and pathways in those areas.

Keeping borders fluid and secure

People and goods can cross U.S. borders in many ways — by air aboard cargo, passenger, and private planes; by land via passenger vehicles, trains, cargo trucks, private vehicles, and on foot; and by sea aboard cargo ships, private vessels, and passenger ships.

An estimated 500 million people, 130 million vehicles, 16 million trucks, 2.5 million rail cars, and 5.7 million cargo containers cross U.S. borders every year. Protecting these borders from illegal entry of people and materials while fostering the flow of legitimate trade and travel is an incredible challenge, said Jane Ann Lamph, Land Borders Program Manager.

Defensive measures must cover not only the hundreds of airports, maritime ports, and land-border crossings considered official ports of entry, but also vast unprotected land and water areas as well. A comprehensive view of U.S. borders also must include awareness and engagement of threats at or near their points of origin, or at their point of embarkation for the U.S., often far outside our borders, said Susan Rhodes, Maritime Borders Program Manager.

Sandia's team applies systems analysis and engineering — a capability built from the Labs' extensive experience in nuclear-weapons stockpile stewardship — to understand these complexities and develop border solutions within an orderly framework.

Sandia has been involved in major border projects at many levels, including understanding the problem, developing security technologies and systems, testing security systems, and placing systems into field operations.

Projecting our borders outward

Ensuring that dangerous materials never approach our borders is a key element of the Materials Protection, Control, and Accounting Program, sponsored by NNSA. A key element of the program is to secure potential threats at the source by improving security of Russian Federation fissile material and nuclear warheads.

Sandia also is involved in NNSA programs to prevent nuclear smuggling across foreign borders that bound potential sources of nuclear weapons and/or material. The Second Line of Defense program — now extending to more than 15 countries — focuses on surveying sites, installing security and radiation-detection systems, and surveying and equipping foreign seaports to prescreen U.S.-bound container cargo.

In another project, the U.S. Department of Homeland Security's Domestic Nuclear Detection Office asked Sandia to develop a concept for detecting radiological and nuclear material in land, sea, and air cargo throughout the transportation-supply chain, and to recommend solutions.

Sandia plays a key role in the joint NNSA/Customs and U.S. Border Patrol Megaports initiative to evaluate the vulnerability of foreign seaports to illegal shipments of special nuclear materials and deploy detection equipment to screen U.S.-bound cargo.

Securing U.S. ports of entry

For the last three years Sandia has supported Operation Safe Commerce for the Ports of Los Angeles and Long Beach. The program funded through the DHS Grants program seeks to identify, evaluate, and demonstrate technologies that would reduce risks arising from containerized cargo.

Labs researchers have created computer simulation tools to evaluate security options at several types of border crossings — including airports, seaports with cargo, pedestrian crossings, and vehicle crossings. The tools model not only the security of an entry point but also the flow of people and goods and the economic consequences of slowdowns resulting from security incidents.

The simulations can help authorities make decisions about selecting security measures that promise the greatest benefits while minimizing unwanted effects.

Sandia has been active in helping secure airports as well. A Sandia team demonstrated a system of sensors to alert authorities of a bioaerosol attack inside an airport by testing this approach using harmless tracer gas through an empty San Francisco International Airport terminal. The team then worked with Lawrence Berkeley National Laboratory to develop guidelines — now being distributed to airport authorities by the Transportation Security Administration — for minimizing human exposures during a bioterrorism incident at an airport.

Securing remote borders

Sandia has done extensive work to help the nation manage the vulnerability inherent in the thousands of miles of unprotected U.S. land and water borders.

A major Sandia study recommended a phased approach to rapidly, efficiently, and effectively enforcing and improving border security. The approach incorporates intrusion detection to boundary defenses, patrol procedures, and interior checkpoints.

Other technologies useful for border security

Several other Sandia technologies and areas of expertise offer potential border security solutions, including:

- Networked sensors,
- Unmanned aerial systems,
- Joint small tactical simulation capabilities,
- Risk assessment,
- Information architectures (to integrate disparate data into actionable knowledge),
- Red teaming,
- Integrated physical security systems,
- The national infrastructure simulation and analysis center, and
- Numerous sandia test facilities.

Sandia operates several centers dedicated to border-security research, including the Outdoor Test Facility (OTF) designed to test sensors, communications links, display technologies, assessment methods, and other integration issues for border-monitoring applications. The work done at the OTF has led to a number of collaborative efforts supporting the DHS Science and Technology Directorate and the Border Patrol.

In San Diego, California, Sandia operates the Border Research and Technology Center (BRTC) in conjunction with the National Institute of Justice to provide technical assistance to federal, state, and local agencies involved with border security. One activity in progress at the BRTC involves developing and deploying an intelligent, secure, collaborative system to track cargo movement.

Also through the Border Technology Deployment Center, Sandia and New Mexico State University evaluate, test, and integrate commercial sensor systems, develop methodologies and train operational personnel, and deploy state-of-the-art technologies for the Santa Teresa, New Mexico, border crossing.

Assistance on the border

At the southern border, for example, Sandia supported the DHS Science & Technology Directorate and the Arizona Border Control Initiative goal of evaluating and selecting several commercial sensor systems for operational testing in 2004 with the Border Patrol in the Tucson sector. Some sensors were transitioned to operational status, leading to programs in 2006 to upgrade the sensors, such as a buried-fiber-optic system now in use along the Nogales fence.

At the northern border, Sandia provides support annually to the Integrated Border Enforcement Teams in their search for sensor systems to provide enhanced capabilities. The team consists of a number of members of the U.S. border-security community and technical representatives of the Royal Canadian Mounted Police Special "I" Division.

Detection technologies

Borders and border crossings are good places to stop smuggling of any number of threats into the country. Sandia has developed, evaluated, and deployed a variety of systems to detect a spectrum of contraband.

Explosives — Sandia's unique explosives "sniffing" technologies, for example, detect traces of explosives on people and objects. These technologies form the basis of detection devices including the hand-held "Hound" and "Micro Hound" systems. Sandia has also developed a walk-through portal, commercialized by Smiths Detection, that has been installed in airports across the country.

Radiation/Nuclear — Sandia has developed a detection system called "SMART" (Sensor for Measurement and Analysis of Radiation Transients) that incorporates proprietary Sandia software for isotope identification. SMART technology can be used to measure and identify radiation signatures within passing vehicles or installed in a vehicle to scan the environment it is traveling through.

People — Sandia has worked to develop a three-dimensional sensor and associated 3-D facial-recognition technologies based on scannerless laser radar, which can produce geometrically accurate spatial and range measurements in uncontrolled environments at ranges to hundreds of meters or more. Its poten-

tial uses in a number of border-security environments are being explored.

Tunnels — Sandia's experience in near-surface geophysical characterization has been applied to the problem of tunnel detection for several customers.

Chemical/Biological — Sandia has developed a handheld MicroChemLab system for rapid detection and identification of chemical and biological agents and is partnering with Lawrence Livermore National Laboratory to develop BioBriefcase, a compact, highly sensitive system for detecting a broad spectrum of biological agents. For DHS, Sandia has developed and deployed SNIFFER (Sensing Nodes Informing and Facilitating Fast Emergency Response) for chemical detection.

"Today's borders present difficult, multifaceted challenges, and the threats they pose require us to think about them as a complex system," said Hruby "Our goal is to present security solutions to border problems that extend far beyond the borders themselves and that include more than just insertion of technologies."

WWW.
sandia.gov/mission/homeland

Homeland Security and Defense deals with three high-consequence mission areas

Sandia's Homeland Security and Defense Strategic Management Unit is organized in three mission areas, each with a program portfolio aligned with the mission responsibilties of its major customer.

- **Catastrophic Event Mitigation — supporting primarily the United States Department of Homeland Security**
  - Chemical and biological protection — applied science, technology development, and systems analysis to deliver solutions to detect, deter, defeat, and mitigate chemical and biological attacks.
  - Radiological and nuclear detection — systems architecture, detection technologies, incident response, and test and evaluation, primarily in support of the Domestic Nuclear Detection Office.
  - Energetics — explosives detection systems and mitigation countermeasures.
  - Border and transportation security — maritime and land-border security analysis; rail security test and evaluation.
  - Command, control, communications, computers, intelligence, surveillance, reconnaissance — communications interoperability, cyber security, and information analysis.
  - Systems analysis — threat and vulnerability studies; systems architecture design.
  - Red teaming — adversary-based assessment of systems and designs.
- **Homeland Defense and Force Protection — supporting elements of the Department of Defense**
  - Physical security, DoD — security systems architecture for high-consequence military assets.
  - Chemical and biological warfare defense — systems to detect, defeat, and mitigate chemical and biological attacks on military installations or troop deployments.
  - Weapon remediation — systems for destruction of residual chemical munitions.
  - Force protection systems and initiatives — protecting critical mission functions, personnel, high-value assets, installations, infrastructure, and forces on the move.
- **Risk Management and Infrastructure Protection — supporting the National Nuclear Security Administration and other federal agencies**
  - Critical infrastructure protection — modeling and simulation to anticipate the consequences of disruptions to national infrastructures (National Infrastructure Simulation and Analysis Center).
  - Physical security, DOE — security systems architecture for high-consequence DOE assets.
  - Risk assessment and management — methodologies to help responsible agencies prioritize threats and response investments.

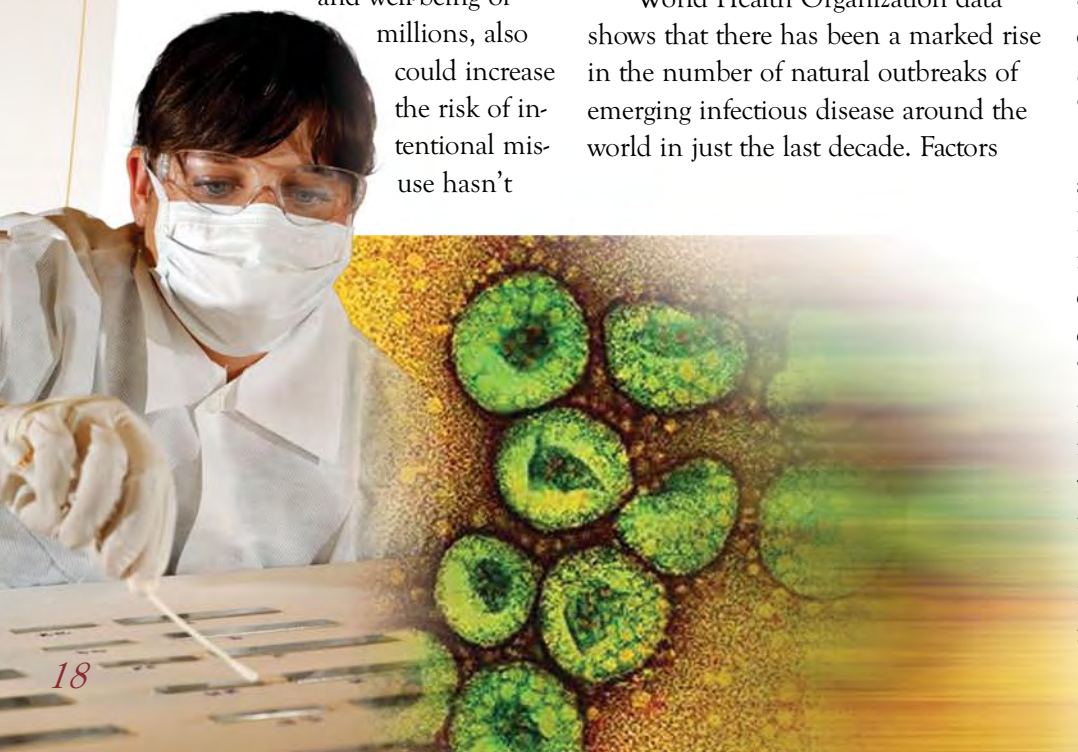
Bioterrorism — reducing the threat

The anthrax attacks of 2001 and more recently the threat of avian influenza demonstrate that infectious diseases — whether natural or man-made — pose a significant hazard to international peace and security.

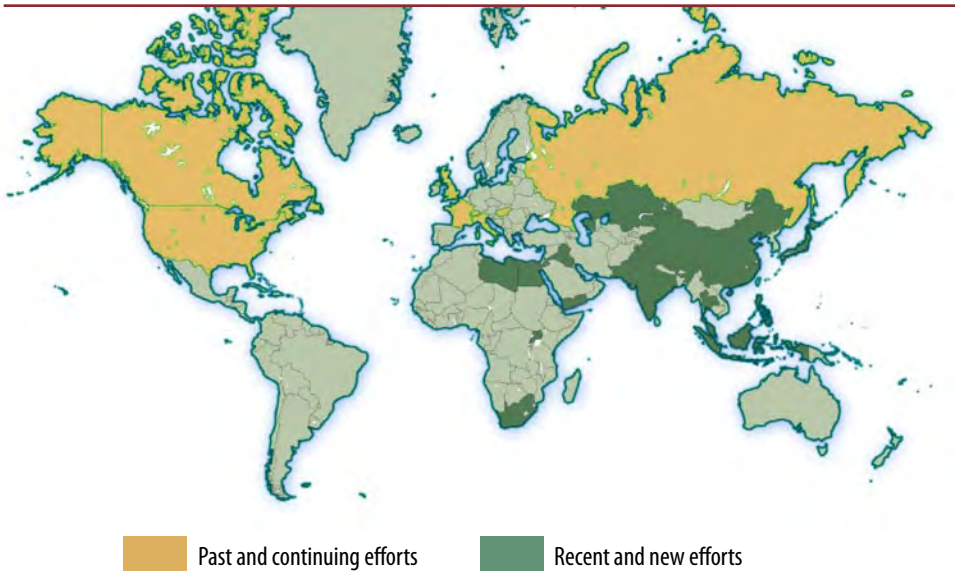
Although bioweapons are difficult to make and have been used only sporadically, the psychological impact of even a low-consequence weapon could make them attractive to terrorists.

Sandia's Reynolds Salerno — a biosecurity expert and manager of the Labs' International Biological Threat Reduction department — concedes that while the threat today is relatively low, it will increase over time. "The worry for me is that the threat will escalate as it becomes easier and easier and less and less expensive for people to misuse biology," he said. "Today, there is a large technical hurdle for terrorists to overcome to use biological weapons successfully. But in the next five to 10 years, the height of that hurdle will be significantly lower."

The irony that advancing biotechnology, while improving the health and well-being of millions, also could increase the risk of intentional misuse hasn't escaped Salerno. He believes that over time there will be more bioscience facilities and more bioscientists and technicians — globally — with the necessary technical skills to misuse biology.



International Engagement To Date



Thus, there will be more institutions and individuals whom terrorist organizations could exploit for their own malicious purposes, he believes.

World Health Organization data shows that there has been a marked rise in the number of natural outbreaks of emerging infectious disease around the world in just the last decade. Factors such as changing demographics, urbanization, and closer human-animal contact are likely the cause of this abrupt appearance of more infectious disease.

Double-edged sword

"Highly pathogenic avian influenza (H5N1) is a good example," said Salerno, scanning through maps on his computer screen that show the epidemic spreading across Asia and Europe. "This is a disease that did not exist 10 years ago and now it's endemic in almost half of the world," he said. Public health organizations are investing in infrastructure to address infectious disease outbreaks and this, in turn, could create opportunities for abuse. "This is a double-edged sword. While public health will surely benefit from more infectious disease work internationally, the risk that someone may misuse biology will also increase."

Following the anthrax attacks of 2001, the U.S. government dramatically increased spending to respond to this

Special symposia to raise awareness of the risks of working with dangerous biological materials around the world are one of the key elements in the IBTR program. Sandia also offers design and implementation services to evaluate and establish security and safety systems at bioscience facilities.

threat – $36 billion since 2001. Primarily, these new U.S. programs have focused on enhancing the nation's ability to respond to a bioterrorist attack. While many Sandia programs, including MicroChemLab and other devices, are actively involved in bolstering the U.S. response posture, the Labs more recently became involved in a preventive effort as well.

"We spent some time looking at the gaps that existed and asked if it was really wise for the U.S. to put all of its eggs in this one [response] basket," Salerno said. As a result, Sandia now assists the new Department of State Biosecurity Engagement Program designed to reduce future biological threats globally, as well as related NNSA biosecurity efforts.

Sandia's International Biological Threat Reduction (IBTR) program advances U.S. threat reduction and counterterrorism goals by working to develop and implement systems and practices that promote the safe, secure, and responsible use and management of high-risk biological agents across the globe. Because almost all of biology is potentially dual use – for improving public health or attacking it – Sandia's experts are equally concerned with naturally occurring, highly infectious disease and those that are maliciously introduced, Salerno explained.

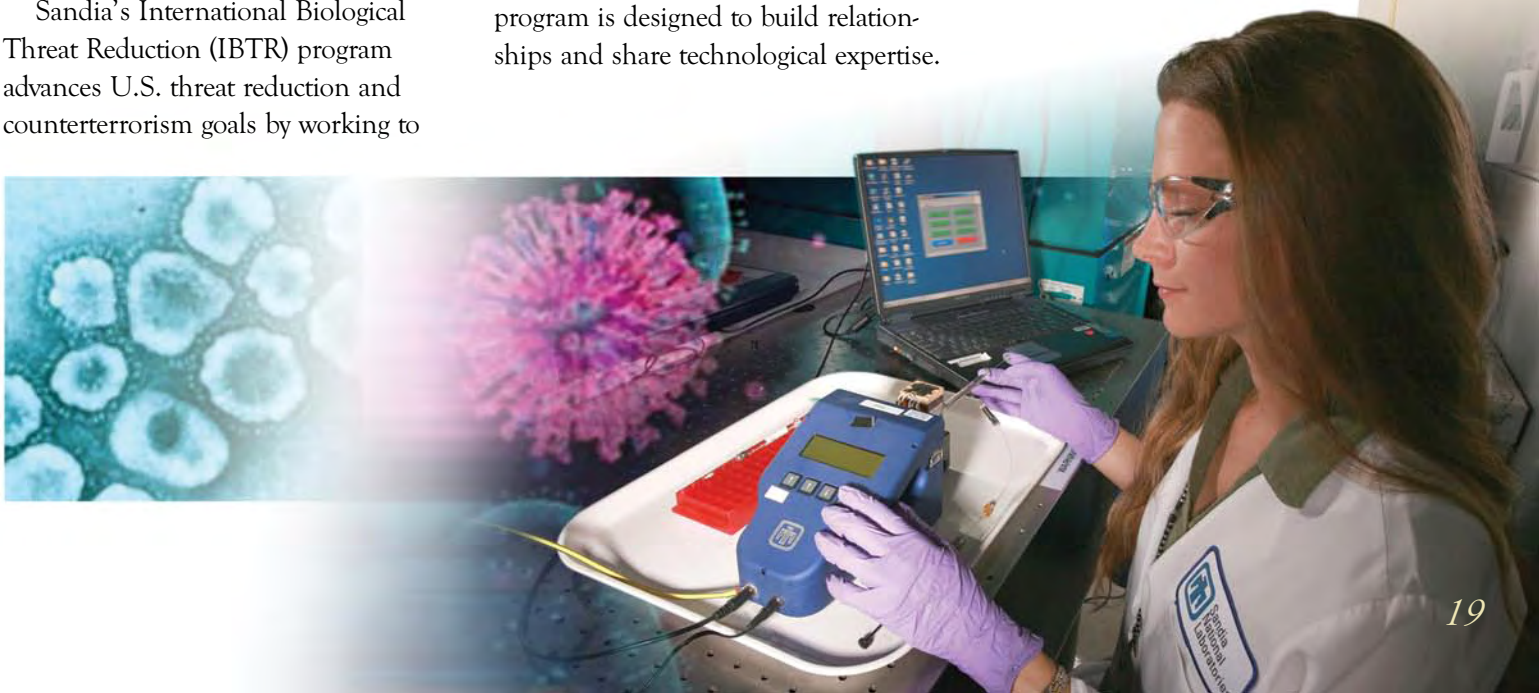
Integrated approach

IBTR is a policy support program; it does not include a bioscience research laboratory function. "We take a multidisciplinary approach, with a variety of the life sciences, veterinarians, nonproliferation and physical protection experts, IT specialists, software engineers, and others," Salerno said. The program is designed to build relationships and share technological expertise.

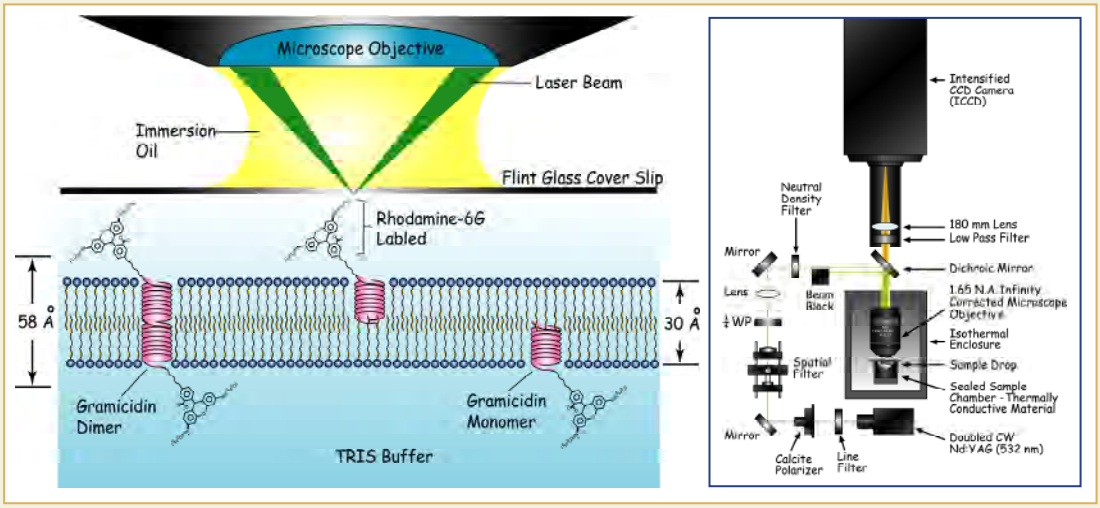
"We want to protect international legitimate bioscience communities from exploitation by terrorists," he said.

"This is fundamentally about helping good scientists understand that the bad guys may want to take advantage of their materials, technologies, and expertise," he said. "Perhaps one of the best ways to prevent bioterrorism at home is to work with international scientists to help them protect themselves from terrorist exploitation.

"It's not a foolproof system by any means. It won't definitively stop bioterror, and that's why biodefense programs designed to improve response systems remain critical. What we're trying to do is raise awareness to biological risks and persuade the international community to act responsibly."



Transmembrane protein function evaluated in biomimetic environments



Prototype drawing of a microfluidic instrument for simultaneous optical and electrochemical measurements on a single transmembrane protein.

The scientists can now perform optical fluorescence and electrochemical studies, isolating a single protein on these microspheres.

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Many cell membrane functions — such as regulation of cellular potential, selective filtration, molecular recognition, and regulation of nutrient and waste movement — are mediated by transmembrane proteins. Despite decades of intensive research about the relationship of these proteins' structure to function, there is much to be learned.

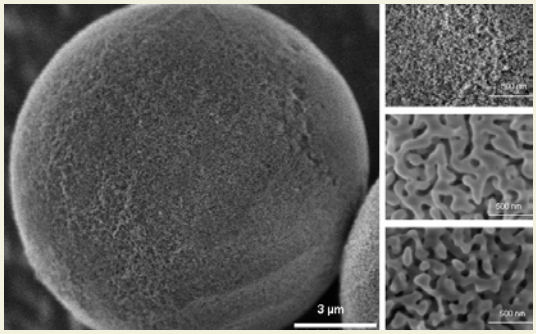
Now, Sandia researchers, led by Susan Brozik in collaboration with scientists at the University of New Mexico, are developing artificial biomimetic structures, where they can place transmembrane proteins, eliminating the complications of the cell and cell membrane during study.

This approach — borrowing design from nature — allows scientists to isolate individual proteins for study, while retaining their native structure and function. This team of researchers is also adapting optical and electrochemical techniques to probe the structure and function. The goal is the creation of a body of knowledge that could benefit drug development, medical treatment, and biosensing technologies.

Initial work focused on the thermodynamics of gramicidin ion channel formation (see above) in supported lipid bilayers, investigated through single molecule fluorescence imaging. More recently, lipid-coated nanoporous silica beads have shown promise as convenient platforms for the study of transmembrane proteins.

Team members, including Gabriel Lopez, Ryan Davis, and James Brozik from UNM, have learned that the proteins can be correctly oriented in these artificial substrates, have near-native diffusion characteristics, and retain their functions in the biomimetic environment. To date, the beads have been the most stable biomimetic platform reported. The scientists can now perform optical fluorescence and electrochemical studies, isolating a single protein on these microspheres.

Ultimately, the goal is to produce new microfluidic instruments, in which single transmembrane proteins can be simultaneously measured with electrochemical and optical probes. These single-molecule spectroscopic measurements would offer a unique opportunity for obtaining a dynamic view of structural/functional relationships on transmembrane proteins.



scanning electron microscope images of nanoporous silica microspheres used to help understand transmembrane proteins. Image at the left is a 10,000 times enlargement of a 10-micrometer bead with 10-nanometer-diameter pores. Images enlarged to 100,000 times actual size in right column show beads (from the top) of 10-, 50-, and 100-nanometer pores.

Leading a new center for solid-state lighting

Dramatic changes are unfolding in lighting technology as semiconductor light-emitting diodes, or LEDs, have become as bright and efficient as incandescent bulbs. Until recently LEDs were used mainly as simple indicator lamps in electronics and toys, but now they are beginning to replace incandescent bulbs in many applications, such as traffic, automotive, display, and architectural area lighting. Applications requiring durability, compactness, cool operation, and directionality are all LED candidates.

In 2006, U.S. DOE Secretary Samuel W. Bodman announced an effort to further this technology shift by naming Sandia as the new home of the National Laboratory Center for Solid-State Lighting Research and Development.

Sandia will conduct solid-state lighting research and coordinate related efforts at several other national laboratories. Sandia also continues to work with leading universities and private industry in this research area.

DOE will provide $5 million for seven research projects in solid-state lighting through the Office of Energy Efficiency and Renewable Energy.

The research will be conducted through the Center for Integrated Nanotechnologies (CINT), jointly operated by Sandia and Los Alamos National Labs, and four other DOE nanotechnology centers around the country. New LED technologies "offer excellent prospects for meeting our future lighting needs in a less costly, more efficient way than today's incandescent and even fluorescent fixtures," Bodman said. The research area also presents an opportunity to assume a leadership role in an emerging industry, he said.

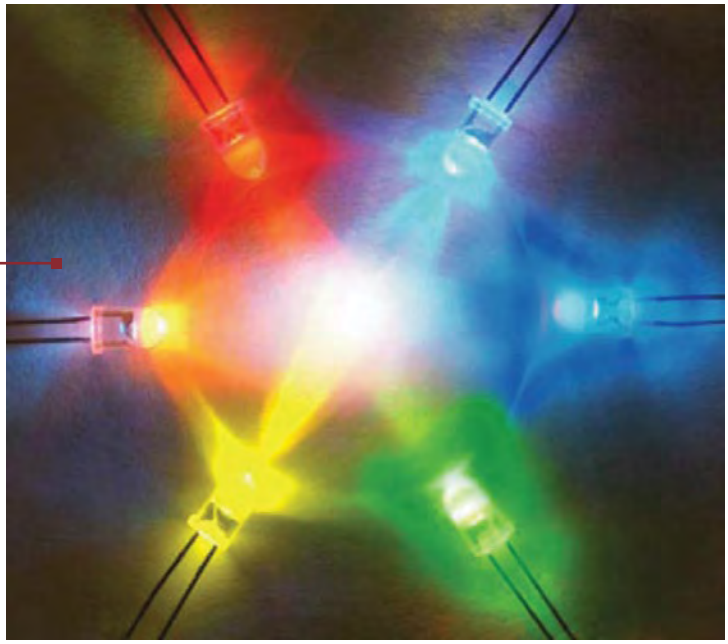
Research is centering on several key challenges, including:

- Understanding of the physics of LED materials and nanostructures,
- Improving optoelectronic devices for efficient photon generation and extraction,
- Improving packaging technologies for high-power lamps,
- Developing new wavelength-conversion and color-mixing technologies for generation of white light,
- Designing new lighting fixtures and systems, based on the unique ways people can interact with solid-state lighting, and
- Developing a science and technology foundation for high-volume, low-cost manufacturing.

Researchers believe further major LED improvements are achievable. Electrical-to-optical energy conversion efficiencies of more than 50 percent have been achieved in infrared light-emitting devices. If similar efficiencies can be achieved in visible light emitting devices, the result would be a white light source twice as efficient as fluorescent lamps, and 10 times more efficient than incandescent lamps.

Such a new source would:

- Reduce electricity for lighting worldwide by more than 50 percent,
- Reduce total consumption of electricity by 10 percent,
- Reduce carbon emissions, and new capital infrastructure associated with electricity generation, also by 10 percent,
- Enhance the human viewing experience through digital and independent control over the color, intensity, and spatial distribution of lights, and
- Further the development of compact visible and UV light sources, for water purification and detection of bioagents.



Mixing of light from LEDs of multiple colors to create white with high color-rendering quality.

Courtesy of Fred Schubert, RPI

WWW. sandia.gov/news/resources/releases/2006/led-center

Nanoscience—collaborating at a very small scale

Nanoscience, nanotechnology, and nanoscale are words that have slipped into our 21st century vocabulary: the science, technology, and measurement standard for things very small. Researchers in the field believe that nanodevices will very soon find their way into the lives of many of us.

The technical ability to work at the nanoscale is now being developed. But reliable nanodevices still await an increased understanding of the physical principles that operate at this scale, which are often very different than at other scales.

That is a key focus of the $75.8 million Center for Integrated Nanotechnologies (CINT), a DOE Office of Science Nanoscale Science Research Center with its Core Facility in Albuquerque and Gateway Facilities at both Sandia and Los Alamos national labs. CINT is operating as a national user facility devoted to establishing the scientific principles that govern the design, performance, and integration of nanoscale materials.

At CINT, which officially opened its doors at an August 2006 dedication, the emphasis is on exploring the path from scientific discovery to the integration of nanostructures into the micro and macro worlds. CINT research and associated outreach activities are bringing together university faculty, students, other national laboratory scientists, and industrial researchers to propose, design, and explore the integration of new nanoscale materials into novel architectures and microsystems.

The Center for Integrated Nanotechnologies' curved front wall of stacked stone, symbolically links New Mexico's history of innovation by Native Americans, nearly a thousand years ago, with that emerging today.

During its pre-operational phase, CINT launched 90 nanoscience projects. An additional 130 were approved during 2006.

The CINT Core Facility houses low-vibration laboratories with sensitive microscopes for materials characterization, chemical/biological synthesis labs, and a clean room for nanomicrodevice fabrication and integration.

Success in CINT's mission to discover, understand, and exploit novel properties of nanostructered materials requires much more than new facilities and instrumentation: It requires a scientific community of world-class experts to attract the leading external researchers as users/collaborators.

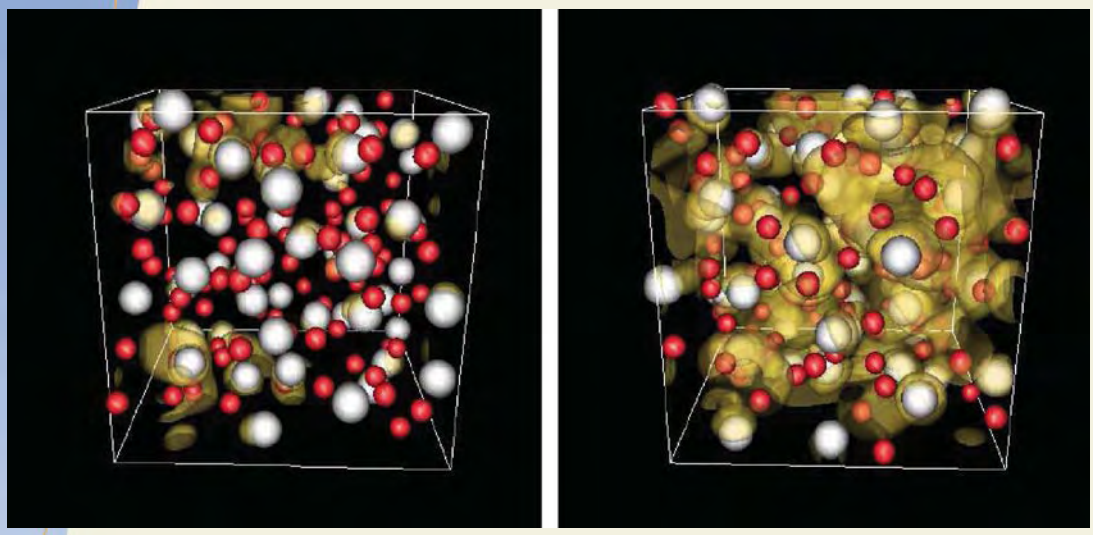
Recognizing this, CINT has established four science thrusts that will provide the knowledge foundation for integrated nano-microtechnologies:

- Nanoscale Electronics, Mechanics, and Systems
- Nanophotonics and Optical Nanomaterials
- Soft, Biological and Composite Nanomaterials
- Theory and Simulation of Nanoscale Phenomena

CINT Director Julia Phillips visits with New Mexico's two U.S. senators at the center's dedication in 2006.

WWW.
http://cint.sandia.gov

Z machine study of 'metallic water' reveals new insights



Taken from first-principles simulations, these figures show the increasingly disordered structure of metallic, or conducting, water. Red spheres are hydrogen atoms, white spheres oxygen. The electron density responsible for conductivity is shown as a gold color. High-energy-density water is more than twice as dense as regular water.

Data from Sandia's high-energy-density water studies add to the body of knowledge about the electronic properties of water, a prerequisite for correctly describing the physics of various objects such as giant planets and shock waves in water

While researching the conditions of shocked water found in the heart of Sandia's Z machine pulsed power system, Sandia researchers discovered a new phase of water, which is relevant to the physics of giant planets.

Sandia researchers began work in the high-energy-density water arena to better understand the short-lived, high-temperature, high-pressure fluid environment inside Sandia's Z machine. The Z machine, which is the size of a major college basketball arena, is the highest peak-current pulsed-power device in the world.

The Z machine is used for studying the physics of nuclear weapons and for learning about fusion reactions that may someday produce commercial power.

Earlier work predicted that water would transition to a state where it would behave like a metallic fluid at 7,000 Kelvin and 250 gigapascals of pressure. The new findings place the temperatures and pressures significantly lower — at 4,000 K and 100 GPa. The new work also shows, unexpectedly, that on a pressure-vs-temperature phase diagram, the conducting, or metallic, phase of water directly borders the superionic phase of water. This is a phase where the water molecule's two hydrogen atoms are free to move about while the oxygen atoms remain frozen in place.

One ramification of the work by researchers Thomas Mattsson and Mike Desjarlais is a revision of astronomy calculations of the strength of the magnetic cores of gas-giant planets, like Neptune. Because the planet's temperatures and pressures lie partly in the revised sector, electrically conducting water probably contributes to Neptune's magnetic field.

In the current year, Sandia's Z accelerator is undergoing an extensive renovation that will increase the machine's pulse from 20 to 26 million amps — a 30 percent rise. The question to researchers: How will water behave, subjected to these more extreme conditions?

The effort thus began with a look at a specific problem. "We were trying to understand conditions at Z," said Mattsson, a theoretical physicist, "but the problems are so advanced that they linked to other branches of science."

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WWW.
sandia.gov/news/resources/releases/2006/metallic-water

Strategic partnering to achieve national and global impacts

U.S. security needs will evolve rapidly in the next 10 years and become more diverse as major demographic shifts, trends in energy and technology, and increased threats from radiological and biological materials produce new threats. Given this diversification of emerging security challenges, the degree of global economic integration, and the velocity of information flows, cascading change will impact U.S. interests in unpredictable ways.

Sandia's Energy, Resources, and Nonproliferation (ERN) unit is meeting the goals of its complex mission by establishing strategic partnerships with a variety of government and nongovernmental organizations, universities, and with industry. Sandia's ERN customers will depend upon Sandia's ability to engage globally as never before. ERN's energy lines of business will require more effective integration of security design into engineering solutions.

ERN's Fuel and Water Systems efforts include an emphasis on focused solutions for transportation fuels for the 21st century and infrastructure issues associated with water. The program develops and demonstrates persistent energy sources for electricity and transportation and takes aim at creating a flexible, enabling energy infrastructure. Energy storage capabilities are also a focus of this program.

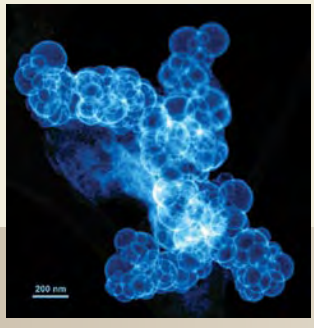
Energy-efficiency activities reduce demand on national energy resources. Sandia's pioneering work in solid-state lighting (See story on page 21) is an example of work in this area. Exploring the transition to a hydrogen-based economy and developing more efficient, less polluting automobile engines — work now under way at Sandia's Combustion Research Facility — are other examples.

Researchers in Sandia's Nuclear Energy program are evaluating the safety and security of existing power plants and helping develop the next generation of nuclear power technology. They are also developing approaches for new risk-informed regulations, using risk assessment, accident modeling, structural analysis, and large-scale experiments to provide a scientific basis.

Sandia is working at the Waste Isolation Pilot Project and the Yucca Mountain Project (See story on page 25) on performance assessment, geoscience technologies, and engineered barriers research. Other efforts focus on the security and management of sealed radioactive sources, hazardous, and nuclear materials.

The goal of ERN's Global Security programs is to create sustainable, technology-based system solutions through international cooperation. Sandians in these programs are at work in nuclear, regional security, and biological thrust areas. In addition to international safeguards efforts in Europe and Asia, programs are under way to reduce radiological threats, increase biosurveillance and biosecurity (See story on page 18), and strengthen regional security in South Asia and the Middle East.

Sandia's Science Research portfolio of projects includes fusion energy research, biological and environmental research, and computational technology research. Basic energy sciences research in materials sciences, chemical sciences, and earth sciences continues to open new possibilities. Sandia's Center for Integrated Nanotechnologies (See story on page 22) is among the world-class research and development laboratories engaged in these projects.



Looking one million years into the future

The road to a global future where nuclear energy contributes clean, affordable power to developing nations along with strong safeguards to prevent proliferation begins in Nevada.

Until the U.S. can demonstrate the concept of geologic storage for high-level nuclear fuel at Yucca Mountain, progress toward advanced nuclear energy concepts is likely to be very slow. That's the challenge the Department of Energy presented Sandia with early in 2006.

The DOE's Office of Civilian Radioactive Waste asked Sandia to step up to the responsibility of becoming Lead Lab for Repository Systems. The Labs officially stepped into the lead role in October 2006.

Moving from its position as one of many laboratories and institutions working on the huge Yucca Mountain Project in Nevada to the central role of coordinating the scientific activity would be a big step for any company. "We know this work and we have the most relevant management experience in performing and managing work to support the regulatory process," said Andrew Orrell, Senior Project Manager.

Sandia is using its experience at Yucca Mountain, the Waste Isolation Pilot Plant (WIPP), near Carlsbad, New Mexico, and other relevant projects to more efficiently direct efforts in Nevada. The goal: deliver to the Nuclear Regulatory Commission by June 2008, a defensible license application showing that YMP will be safe and meet federal requirements as the nation's sole repository for high-level waste.

Sandia is stepping forward with an excellent mix of staff and management with relevant experience. "Our position is that the license application has to be done and that we can do it," said Orrell. "There is a strong sense we can, we have to, and we will do it."

Sandia is responsible for about half of a 7,000-page license application and for most of the underpinning science. The long-term performance section, called the post-closure performance assessment, will be Sandia's contribution. Recent regulation changes have pushed the post-closure timeframe from 10,000 years to one million years. The license must take into account all of the things that could happen and their effects.

One example of the work involved is the project's approach to the waste packages that will hold the spent fuel rods underground beneath Yucca Mountain. The large, corrosion-resistant steel containers will be exposed to an evolving environment, with thermal, chemical, and hydrological aspects. Researchers need to assess and predict how long these containers will last before they corrode and what the consequences of the containers breaching is.

The performance assessment team must take into account normal as well as possible disruptive events, such as volcanic or seismic activity. This requires multidisciplinary expertise involving math and science, engineering, software, field and lab testing, as well as business systems and quality engineering specialties. All the supporting data and modules developed over the years by numerous participants are then integrated into a total system-performance assessment, which determines if the project complies with the regulations the NRC has set.

"It's a big step from a 35-person workforce and $10 million budget a year ago to coordinating the efforts of an estimated 600 contributors (350 full-time equivalent workers) around the world and a $130 million budget," said Orrell. "This is very analogous to what we did at WIPP and that's why DOE has asked us to take this role."

Its status as lead laboratory (logo above) for repository systems puts responsibility for the Yucca Mountain Project license application squarely on Sandia.

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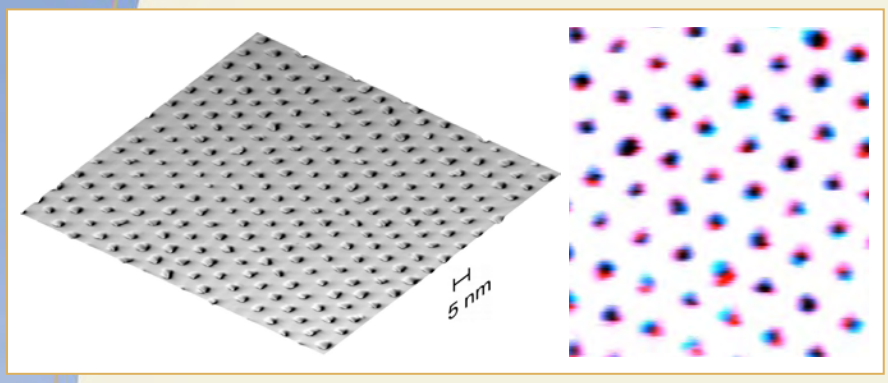
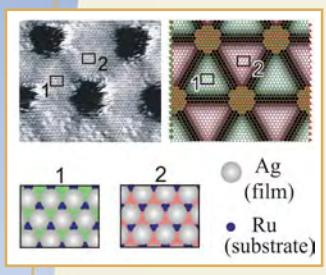
sandia.gov/LabNews/070105.html#one

Using STM to determine origins of self-organized surface patterns



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



An atomically resolved STM image of the hole-array structure shown above and a model, based on the data collected.

A novel combination of quantitative real-time microscopy measurements and atomistic modeling helps solve the problem of manipulating structures at the nanoscale.

The ability to work in the nanometer range offers the prospect of continuing the drive to miniaturization in electronics and designing novel devices with specific properties that rely on very small dimensions.

Two Sandia researchers used a tool called scanning tunneling microscopy (STM) to understand "self organization." Thin films and solid surfaces are often observed to spontaneously "self-organize" into ordered patterns at nanometer to micron length scales. Such patterns are often too large to be manufactured by chemical synthesis and too small to be accessible to existing microtechnologies, based on photolithography.

Understanding the physics of nanoscale self-organized patterns is challenging, because it is difficult to manipulate them in any controlled way. This difficulty is compounded by the complexity of the involved nanometer-scale forces.

To surmount these difficulties, Sandia researchers Konrad Thürmer and Norm Bartelt combined quantitative real-time microscopy measurements and atomistic modeling to understand the physics needed to manipulate nanoscale structures.

The two first quantitatively analyzed the naturally occurring thermal vibrations in these structures using variable-temperature, atomic-resolution scanning tunneling microscopy. They chose a system simple enough to allow a precise determination of its atomic structure — a triangular array of vacancy islands, or holes, in a one-atom-thick monolayer silver film that develops spontaneously when a monolayer of silver grown on a ruthenium crystal is exposed to a tiny amount of sulfur.

They found that although the holes wander about their respective average positions, the arrays are extremely stable. Combining the real-time STM measurements with atomistic modeling, the researchers were able to determine the origin of this stabilizing force.

The thermal hole vibrations observed by STM were inconsistent with the conventional explanation for the surface ordering, which involved elastic distortions of the substrate. In a search for an alternative ordering mechanism, the researchers used atomically resolved STM images.

The hole-hole interactions originated from dislocations, which often formed to help accommodate mismatches between the lattice constants of the film and the substrate. The tendency of the dislocations to run along specific crystallographic directions connecting the holes, created stabilizing interactions, the researchers noted.

Since dislocations are extremely common in crystalline solids, scientists expect to discover other systems where self-organization is accomplished through similar mechanisms. The value of such ordered nanostructures could be greatly enhanced if scientists learn to tailor their properties.

In the case of the studied vacancy island lattice, the possibility of achieving this tailoring exists, because control of the hole-hole spacing can be obtained by adjusting the composition of the film.

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Advanced Concepts Group

Think tank for national security

For Sandia's Advanced Concepts Group, formed in 1999 to harness the knowledge and creativity of diverse groups around the Labs, new approaches to national and global security issues are the organization's trademark. And empowering others to pursue these ideas is their "coin of the realm."

The future of warfare, the looming Asian influenza pandemic, the workings of the human mind under pressure, energy and water, transportation, aging, health care, or dealing with the social, political, and security issues along our nation's borders are examples of subjects being tackled by this group.

Led by Sandia Vice President and Principal Scientist Gerry Yonas, the group consists of a small staff with diverse technical backgrounds, serving rotational assignments of two to three years. It's a highly interactive group, inside and outside the laboratories. The staff takes advantage of the power of diverse expertise and disciplines at Sandia to understand current approaches to problems without allowing those approaches to limit thinking.

Working in small information teams, supplemented by other collaborators, ACG staff and leadership recruit individuals and groups to test new ideas.

Student Science Symposium

In a three-hour session in late 2006 at Albuquerque's National History Museum, 20 high school students discussed future global problems or opportunities with Yonas and ACG staff members. Sitting under the museum's towering ceilings with a huge prehistoric flying reptile suspended overhead, one group discussed what might be the effects of electronic communication that involved all five senses. Another group delved into alternative means of rising into outer space, while a third group brainstormed ideas to save polar bears, western pine forests, and coral reefs from extinction due to the forces of climate change. The small groups debated their ideas and then presented a briefing to the larger group afterward.

Human brain research

An increasing tempo of interactions between Sandia's Advanced Concept Group and the Albuquerque-based MIND Institute promises yet another new engineering direction opening to Sandia researchers: the human brain.

Following discussions last fall, the Institute is conducting a study of ways to accelerate learning for warfighters and intelligence analysts, says Rex Jung, a MIND Institute psychologist and neurologist and part-time staffer in Sandia's ACG. The Institute is a national partnership committed to expanding neuroscience research by discovering new ways to understand human behavior, as well as to treat and cure brain disease and mental illness.

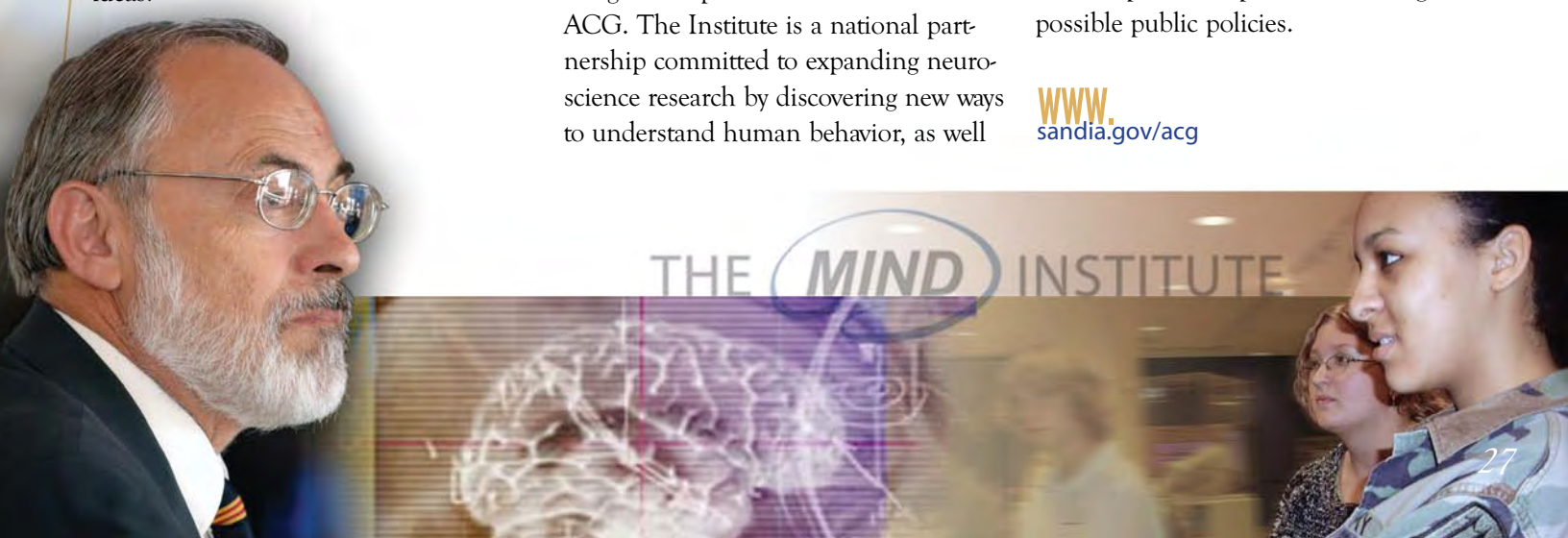
Sandia can provide computational power, systems expertise, and modeling, says Yonas, who describes the proposed project "as challenging as anything we've ever attempted at Sandia."

Integrated workshops

In collaboration with the Department of Defense, the ACG hosted workshops on the future of war and effects-based information operations. A War in 2035: The Role of Emerging Technologies workshop was cosponsored by the Center for Strategic and Budgetary Assessments and about a dozen invited experts on nano-, bio-, and neurotechnologies, and intelligent machines discussed potential applications of these technologies in military conflicts.

ACG researchers — collaborating with the Consortium for Science, Policy, and Outcomes at Arizona State University — conducted a workshop on the policy implications of converging nano-, bio-, info-, and cognitive technologies for enhanced human cognition. These technologies raise complex technical, social, ethical, economic, and political issues and the workshop brought together neuroscientists, bioethicists, policy scholars, nanoscientists, and social experts to explore a wide range of possible public policies.

WWW.
sandia.gov/acg



Strategic Relationships

Developing better products through partnerships

Industry partners come to Sandia seeking innovative solutions to a vast range of engineering and design problems. When they do, they receive a huge return on their investment. "Sandia offers its partners access to a wide spectrum of exceptional technical talent, world-class facilities, and high-quality science-based engineering solutions," said Rick Stulen, Vice President and Chief Technology Officer.

Sandia also receives a huge return on investment in the process. Partnerships provide validation for new ideas and commercial sources for mission components.

"In the dynamic business world of today, we have to provide an innovative partnerships program that is tailored to the needs of our various management units," said David Goldheim, Director for Sandia's Strategic Relationships Center. Working with the Labs' California Business Development Support Department, the program "facilitates partnerships and develops novel approaches," Goldheim said.

Rockwell Collins

Aerospace leader Rockwell Collins announced that it will spend several million dollars over the next two years to turn Sandia's miniSAR technology into a product that can be deployed tactically by the U.S. military. Rockwell Collins designs, produces, and supports communication and aviation electronics, and global surveillance solutions. MiniSAR is a small synthetic-aperture radar developed at Sandia that can see through clouds and in the dark to provide images for use on the battlefield and in other intelligence applications. The partnership provides a strong and complementary match to bring advanced radar remote-sensing capability to the warfighter, said Brett Remund, Deputy Director, Microwave Intelligence, Surveillance, and Reconnaissance.

An umbrella Cooperative Research and Development Agreement, or CRADA, is allowing Sandia and Rockwell Collins to explore further projects in a number of fields.

Advent Solar

A breakthrough photovoltaic cell design and fabrication process that eliminates collection grids from the front surface and makes cells more efficient and less costly to build led a Sandia researcher to a new startup company. The startup, Advent Solar, is located in Albuquerque, New Mexico, and has licensed Sandia's back-contact photovoltaic cell technology.

To help Advent and speed the commercialization of this critical solar technology, Sandia's licensing team and technical line worked closely with the company to craft a partnership over a matter of months. Later, the partnership was modified to satisfy Advent Solar investors.

With these changes, Advent was able to secure $38 million in venture capital funding and begin construction of a production plant with a capacity of 25 megawatts of solar cells at Mesa del Sol, a new 12,000-acre development in Albuquerque.

Novint's Falcon Controller is the first consumer 3-D touch controller that gives a user a very precise sense of touch on a computer.

Advent Solar's innovative cell design has resulted in a startup company that currently employs nearly 100 engineers, technicians, production operators, and administrative staff, and is projected to have 300 employees in a few years. The company's new Mesa del Sol plant in Albuquerque is pictured in this architect's rendition.

The Novint Falcon makes interactive 3-D touch possible and practical for consumer computing applications for the first time, fundamentally changing how people play and interact.

Novint Technologies

Novint Technologies, Inc., has taken software it licensed from Sandia and paired it with a 3-D touch controller to make interactive "touch" possible and practical for consumer applications for the first time. With a product called the Novint Falcon, users feel realistic weight, shape, texture, dimension, dynamics, and force effects. This technology, called haptics, is applicable to many fields, including military applications, medical training and visualization, and computer gaming.

To meet Sandia's goal of commercializing the technology and Novint's goal of getting financial backing, negotiations took a creative turn. The solution involved Sandia taking a stock position in the company in lieu of most royalties — representing a challenge, as do most "firsts."

Today Novint has raised $6.5 million to expand its team and finalize a design for its first commercial product. The company, which went public in 2006, is partnering with game developers to create games and software and with hardware manufacturers to expand the use of its technologies.

Lockheed Martin

After designing and manufacturing the Joint Strike Fighter, the pivotal next-generation strike aircraft for the new century, to be used by Navy, Air Force, U.S. Marine, and allied forces, Lockheed Martin Corp. began the job of creating a support system for its warbird around the world.

Through a "Shared Vision" partnership with Sandia, the company has incorporated a creative tool — called the Support Enterprise Model (SEM) — to provide a supply- and repair-chain process worthy of the new fighter's nickname: "Lightning II."

In fact, SEM is able to design, evaluate, and refine logistical support concepts for an array of aircraft and weapons systems. Recent improvements allow planners to determine which system inputs have the most impact on the system (sensitivity analysis) and how to cope with a broad range of possible conditions (uncertainties).

Given that life-cycle costs on the F-35 Joint Strike Fighter alone are expected to reach into the billions of dollars, such a system can maximize the "bang for the buck" of taxpayer dollars dramatically into the future.

The Lockheed Martin F-35 Joint Strike Fighter

Rockwell Collins' partnership with Sandia took the path of a traditional Cooperative Research and Development Agreement. In addition to efforts to commercialize the miniSAR technology for use on unmanned aerial vehicles like the Shadow 200 used by the U.S. military, the partners will pursue other mutual technology interests.

WWW.
sandia.gov/bus-ops/partnerships

FY 2006 Financial & Staffing Report

As a contractor to the Department of Energy and other government agencies, the bulk of Sandia's revenue is from tax dollars. Sandia's Fiscal Year 2006 total revenue, total expenditures, and total employment levels were slightly below the Fiscal Year 2005 record-high levels. Throughout Fiscal Year 2006, Sandia business staff continued to improve the Labs' financial stewardship of entrusted taxpayer funds through implementation of best-in-class practices in financial business operations and internal control policy and procedures to ensure compliance with all accounting standards and provide accountability to our customers.

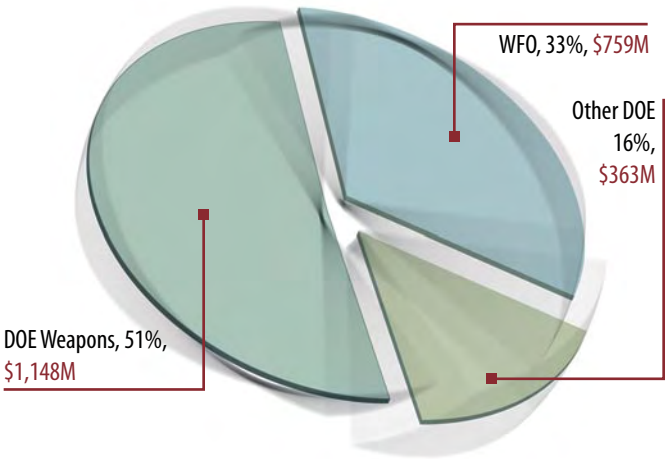
At the end of the fiscal year, Sandia counted:

- $2.270 billion total revenue received,
- 8,722 employees,
- 188,327 acres of land,
- 1,197 buildings with 7.0 million square feet of space,
- 48 leased buildings totaling 419,000 square feet, and
- 12,400 total workers, counting contractors, consultants, and students at all sites.

Sandia's revenue for FY 2006, $2.270 billion, represents a $58.8 million (2.5 percent) decrease from the previous year. The majority of Sandia's income, 67 percent, came from the Department of Energy – 51 percent for weapons work and 16 percent for all other DOE programs. The remaining 33 percent came from "Work for Others" customers, comprising other federal agencies, state and local governments (including universities), and private companies partnering with the Labs.

FY 2006 Actual Revenue by Source: $2,269.8M

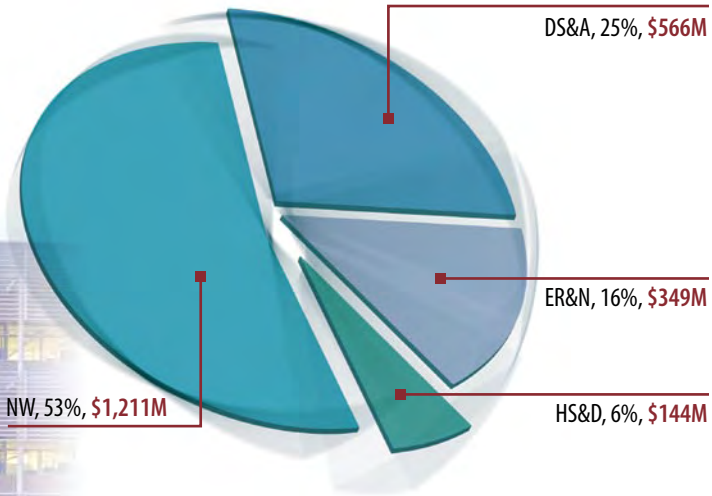
(Budget Authority in Millions)



The total revenue provided by Sandia's customers is allocated to four mission organizations, or business units, within the Labs. These organizations conduct the missions assigned to Sandia by our customers. The Nuclear Weapons unit continues to be the largest, using 53 percent of the revenue. The remaining three business units share 47 percent of the revenue as shown here:

Application of FY 2006 Sandia Revenue by Strategic Management Units (SMU): $2,269.8M

(Budget Authority in Millions)



NW, Nuclear Weapons; DS&A, Defense Systems and Assessments; ER&N, Energy, Resources and Nonproliferation; HS&D, Homeland Security and Defense.

Another way of looking at the division of Labs revenue is to categorize it by (1) operations and maintenance, (2) capital equipment, and (3) construction. This table shows this division of revenue for the past two fiscal years:

Total Revenue by Category

(Budget Authority in Millions)

TOTAL REVENUE BY CATEGORY	FY 2005 ACTUAL	FY 2006 ACTUAL	% CHANGE
Operations & Maintenance	$2,1000.1	$2,124.3	1.2
Capital Equipment	$76.4	$54.4	-28.9
Construction	$152.1	$91.2	-40.0
Total SNL Revenue	**$2,328.6**	**$2,269.8**	**-2.5**

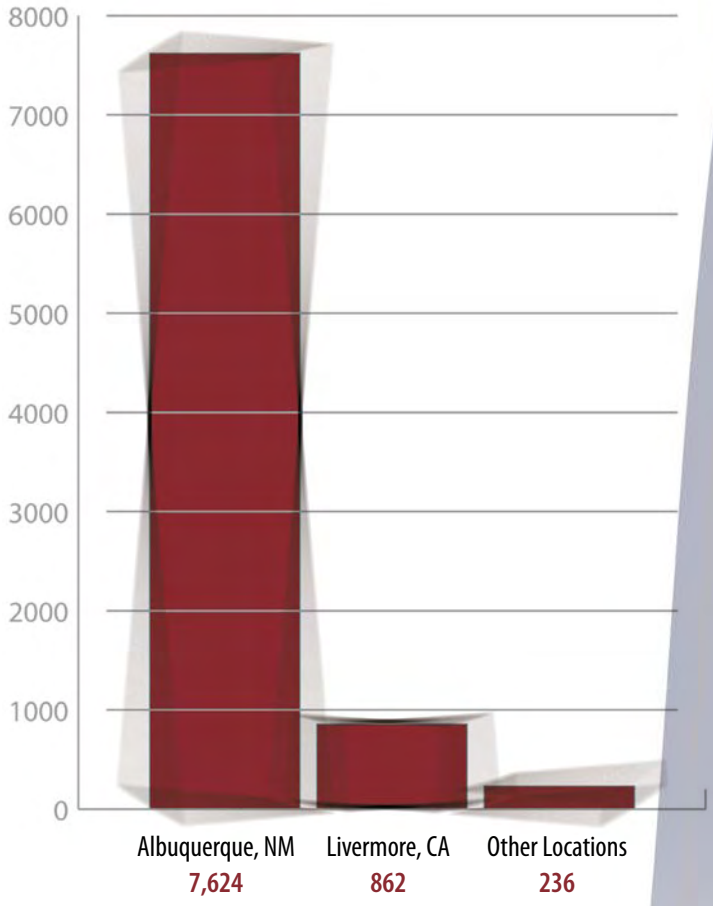
Capital equipment declined in FY 2006 to normal equipment funding levels following completion of major computer acquisitions in FY 2005. The decrease in construction revenue is due to the completion of two construction projects in FY 2006, the Center for Integrated Nanotechnologies and the Exterior Communications Infrastructure Modernization projects. Further, funding for the Microsystems Engineering and Science Applications Facility is decreasing as the project nears completion over the next two years.

Sandia's total full-time equivalent employees climbed from 8,560 in FY 2005 to 8,625, an increase of 65 employees. Sandia's Human Resources group continues to work with line organizations to ensure a stable and sustainable work force, with highly qualified staff for Sandia's future.

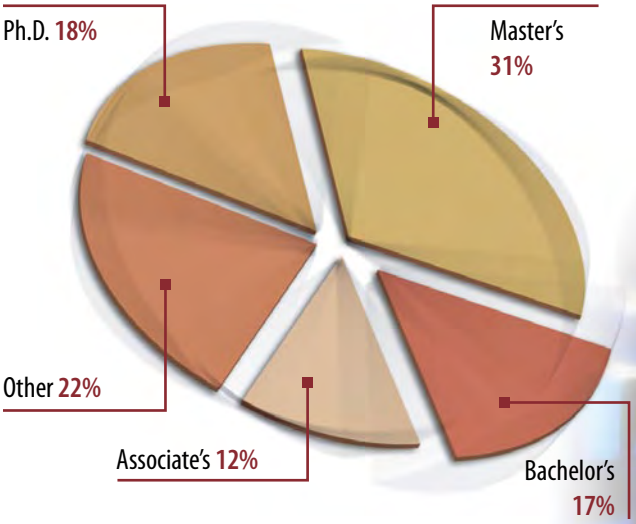
Here's a look at Sandia's regular workforce by education level. These numbers show the Labs' commitment to continuing education and to hiring the best and brightest engineers and scientists available for the national challenges we face.

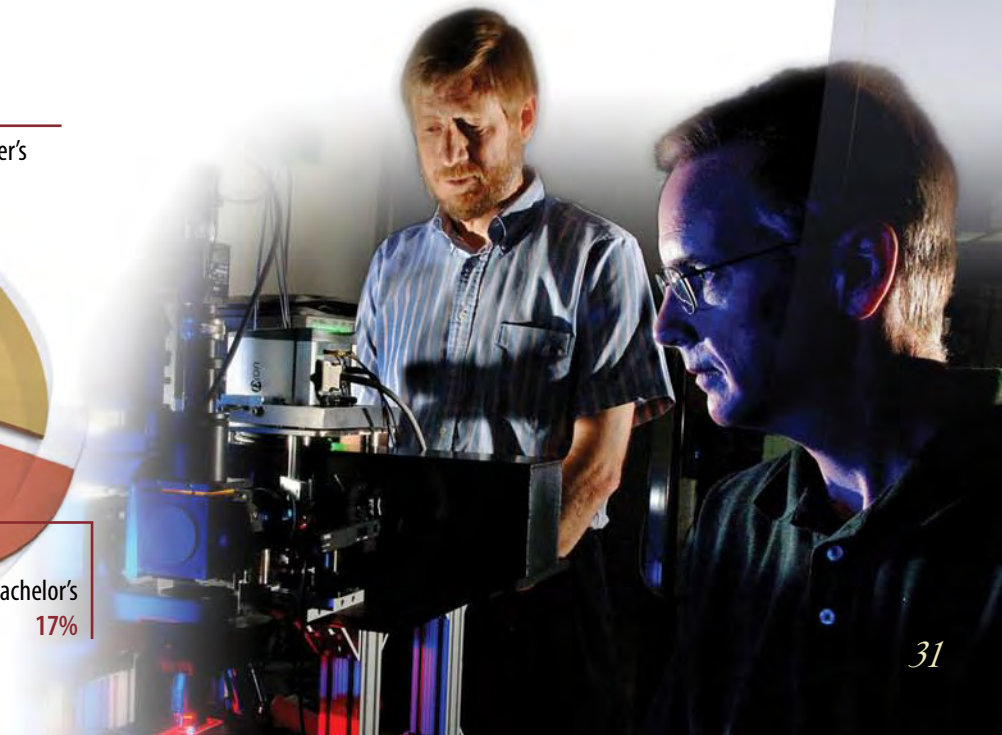
Although most Sandia employees work at Albuquerque, New Mexico, or Livermore, California, others are scattered among dozens of sites in the U.S. and abroad.

FY 2006 Employees by Location



SNL's FY 2006 Workforce by Degree Level





Community Outreach

Serving where we live

Sandia's long history of service to our communities continues with programs in education, a spectrum of volunteer activities, employee participation in civic efforts, and contributions from employees and Lockheed Martin Corporation to United Way and similar programs.

Sandia's long-standing involvement in education aims to improve opportunities for students in kindergarten through college. Family Science Nights provided hands-on science evenings for more than 6,000 elementary students and their families in New Mexico and California during 2006. More than 500 Sandia employees volunteered to teach science, judge science fairs, tutor, or help with academic competitions like Science Bowls for middle and high school students.

In Albuquerque, School to World, New Mexico's largest career exploration event, provided 2,000 eighth- and ninth-grade students information on some 150 careers and a chance to meet a variety of professionals. Sandia outreach groups promoted science and engineering careers to underrepresented youth: Manos, for Hispanic students; Dream Catchers, for American Indian students; and HM Tech, celebrating its 20th year, for African-American students.

In an effort to better prepare students for the workforce, our STAR student intern program provides an intensive summer research experience for 12 top-notch high school students. The Write Thing To Do essay program links literacy and science and awards five high school winners for their thoughtful response to a current scientific issue.

Professional development programs recognize excellent science and math teachers and fund continuing education in New Mexico and California.

Sandia logged more than 100,000 volunteer hours in its database. Volunteerism includes participation in activities like Make a Difference Day, where 200 volunteers worked on more than a dozen projects; Habitat for Humanity, with 200 volunteers and seven houses built; Roadrunner Food Bank, for the sorting of food from the biannual Mail Carrier Drives in November and May; and other causes.

Sandians in New Mexico pitch in on corporate drives to gather books (more than 4,000 last April) and school supplies (more than 25,000 items in July) for low-income students. During the year-end holidays, employees donated more than 30,000 pounds of food to needy families and funding for 500 pairs of shoes for low-income students. In California, the Holiday Spirit Gift & Grocery Campaign is held during December each year as an opportunity for Sandians and contractors to give to those less fortunate in our local communities. Gifts are wrapped by the employees and delivered to appropriate agencies in time for the holiday season. The "grocery" portion of the campaign provides nonperishable food to support the Family Crisis Center in Livermore and San Joaquin County Food Bank in Manteca.

Lockheed Martin, on behalf of Sandia, has donated more than $15 million to nonprofit organizations in the Middle Rio Grande communities since 1993. The focus is on projects that encourage the development of youth to foster a next-generation workforce that is skilled, educated, and maintains community values. Recipients include museums, literacy programs, music in schools, the Albuquerque Tricentennial celebration, and service awards for Sandia volunteers.

Finally, 2006 figures show that Sandia employees gave more than $3 million to the United Way of Central New Mexico and provided $223,600 to the SHARE Program in the Livermore, California, area. The average individual gift of the participating employees is $490 per year. Lockheed Martin provides an additional $50,000 in New Mexico and $5,000 in California.

Shoes for Kids recipients (left) admire new footwear. Student (above) poses for infrared camera at Livermore, California, Science Night event.

WWW.
sandia.gov/about/community

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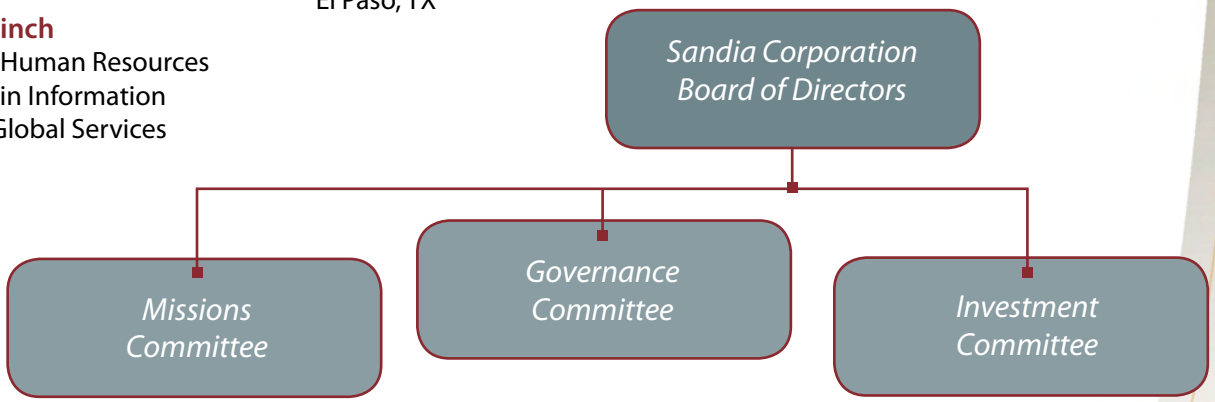

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