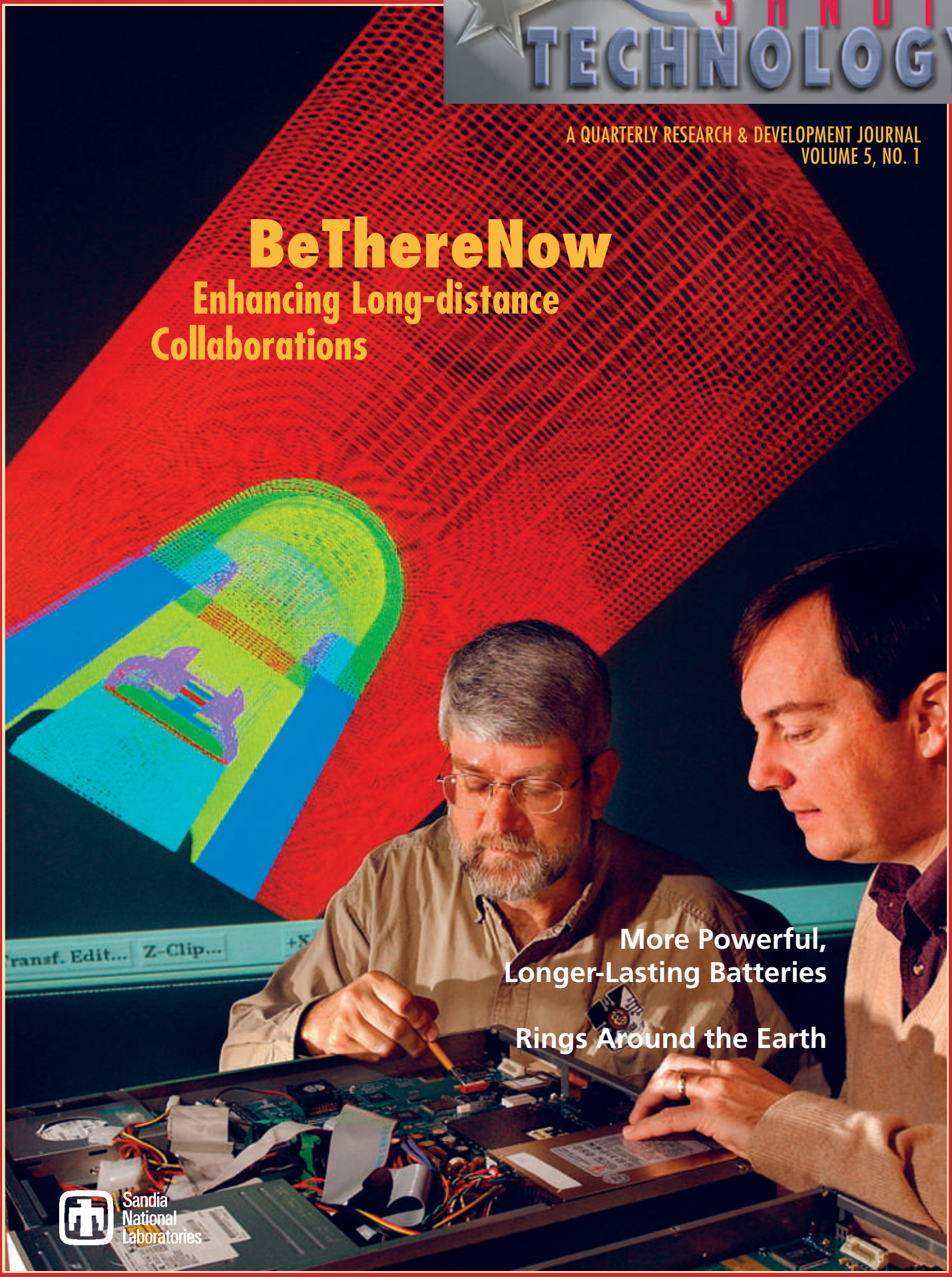
SPRING • 2003

SANDIA TECHNOLOGY

A QUARTERLY RESEARCH & DEVELOPMENT JOURNAL
VOLUME 5, NO. 1

BeThereNow
Enhancing Long-distance Collaborations



More Powerful, Longer-Lasting Batteries

Rings Around the Earth

Sandia National Laboratories

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ON THE COVER: New Hardware that will enable the viewing and minipulation of images based on very large data sets has been developed at Sandia National Laboratories. Here Lyndon Pierson (left) and Perry Robertson examine a video encoder and decoder that allow a user to work interactively with others thousands of miles away.
(Photo by Randy Montoya)

FROM THE Editor

Dear Readers:

This issue of Sandia Technology explores the breadth of Sandia research capabilities, ranging from the possibilities of asteroids creating Earth rings (page 6) to the quest to create more powerful, longer-lasting and smaller batteries for our modern electronic devices (page 4).

Elsewhere, Sandia researchers are hard at work on hardware solutions to the problem of sharing huge data files, so that experts located in various far-flung locations can confer and analyze in a timely manner (page 2). The military, medical, and industrial applications for this are only beginning to be uncovered.

Addressing ongoing public and government concerns about the eventual shipment of spent fuel rods from nuclear power plants to a permanent geologic repository, some interesting Labs research (page 9) is under way. These efforts focus on more precisely defining just how reactive fuel rods are — given that many have now been in cooling ponds or dry storage for several decades.

We also take this opportunity to report on the professional recognition (page 12) accorded four individuals and one Sandia team in recent months. Other projects involving putting man-made carbon dioxide back into the ground instead of into the atmosphere (page 14), making the nation's aging fleet of firefighting aircraft safer (page 15), and helping to create a research road map to reduce the cost of water desalination and ensure a secure US supply of fresh water (page 16) into the future.

As always, we encourage you to respond to the contacts listed with each article for more information on these interesting projects.

Will Keener
Editor

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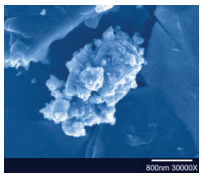

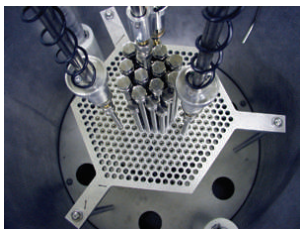

BeThereNow

Enhancing Long-Distance Collaborations

Sandia researchers have developed interactive remote-visualization hardware that allows long-distance collaborations involving the viewing and manipulation of images based on very large data sets. This "Be There Now" hardware is like sitting at the console of a supercomputer from a thousand miles away.

Lyndon Pierson (left) and Perry Robertson examine their group's video encoder and decoder. (Photo by Randy Montoya)

A surgeon in New York wants the opinion quickly of a specialist in Los Angeles.

A commanding general needs to confer with a battle staff spread out across an operational theater, prior to making a key strategy decision.

A petroleum exploration team, investigating across two continents, needs to confer over the latest geophysical data on an oilfield prospect in order to pass a timely recommendation on to management.

Recent options for transmitting the huge amounts of data associated with any of these examples include sending files as e-mail attachments or making them accessible in Internet drop zones. Unfortunately for the hypothetical patient on operating table, the soldiers awaiting orders in the field, or the oil company managers trying to make a timely decision, extremely large files may take a half-hour to transmit and require a very large computer — perhaps not available — to form images from the complicated data.

Additionally, each rotation of the medical image for better viewing can take minutes to appear. The same is true of managing large mapping overlays or the kinds of 3-D geophysical images the exploration team might need.

Now, interactive remote-visualization hardware that allows these professionals to view and manipulate these data-dense files as though standing in the same room has been developed at Sandia National Laboratories.

The tool also will work for a host of applications for anyone with a need to interact with computer-generated images from remote locations.

"The niche for this product is when the data set you're trying to visualize is so large you can't move it, and yet you want to be collaborative, to share it without sending copies to separate locations," says Sandia team leader Lyndon Pierson.

Stretching video cables

The Sandia hardware, for which a patent has been applied, allows the data to be kept at a main location, but sends images to locations ready to receive them. The interactivity then available is similar to two people operating a game board.

The lag time between action and visible result is les than 0.1 second, even though the remote computer is thousands of miles away and the data sets are huge.

"We expect our method will interest oil companies, universities, the military — anywhere people have huge quantities of visualization data to transmit and be jointly studied," says Pierson, who works with Sandia's Advanced Networking Integration group. "Significant commercial interest [in the new device] has been demonstrated by multiple companies."

HowNowNowNow

"We expect our method will interest oil companies, universities, the military — anywhere people have huge quantities of visualization data to transmit and be jointly studied."

Lyndon Pierson
Team Leader

The Sandia hardware leverages the advances in 3-D commercial rendering technology "in order not to re-invent the wheel," says Sandia researcher Perry Robertson, assigned to the Labs' Radio Frequency and Opto Microsystems department.

Graphics cards for video games have extraordinary 2-D and even 3-D rendering capabilities within the cards themselves. But images from these cards, typically fed to nearby monitors, do not solve the problem of how to plug them into a network, says Robertson.

The Sandia extension hardware looks electronically just like a monitor to the graphics card, says Robertson. "So, to move an image across the Internet, as a first step our device grabs the image."

Transmitting image and responses

The Sandia hardware squeezes the video data, flooding in at nearly 2.5 gigabits a second, into a network pipe that carries less than 0.5 gigabits/sec. "While compression is not hard, it's hard to do fast. And it has to be interactive, which streaming video typically is not," says Pierson.

The Sandia compression minimizes data loss to ensure image fidelity. "Users need to be sure that the things they see on the screen are real, and not some artifact of image compression," he says.

The group knew that a hardware solution was necessary to keep up with the incoming video stream. "Without it, the receiver's frame rate would be unacceptably slow," says Robertson. "We wanted the user to experience sitting right at the supercomputer from thousands of miles away."

In an attempt to reduce the need for additional hardware," says John Eldridge, a Sandia researcher who wrote the software applications, "we also created software versions of the encoder and decoder units for testing purposes. However, there is only so much you can do in software at these high resolutions and frame rates."

The custom-built apparatus has two boards — one for compression, the other for expansion. The boards use standard low-cost SDRAM memory, like that found in most PCs, for video buffers. Four re-programmable logic chips do the main body of work. A single-board PC running Linux is used for supervisory operations. "We turned to Linux because of its networking support and ease of use," says Ron Olsberg, a Sandia project engineer.

"We built this apparatus for very complex visualizations. If we could have bought it off the shelf, we would have," says Robertson. Funded by the Advanced Scientific Computing Initiative, a pair of boards cost about $25,000. They are expected to cost much less when commercially available.

A successful demonstration took place in late October between Chicago and the Amsterdam Technology Center in the Netherlands. A second demonstration occurred between Sandia locations in Albuquerque, New Mexico, and Livermore, California, and the show floor of the Supercomputing 2002 convention in Baltimore, Maryland, last November.

"Now that this technology is out there, we expect other applications will begin to take advantage of it," says Pierson. "Their experiences and improvements will eventually feed back into US military capability."

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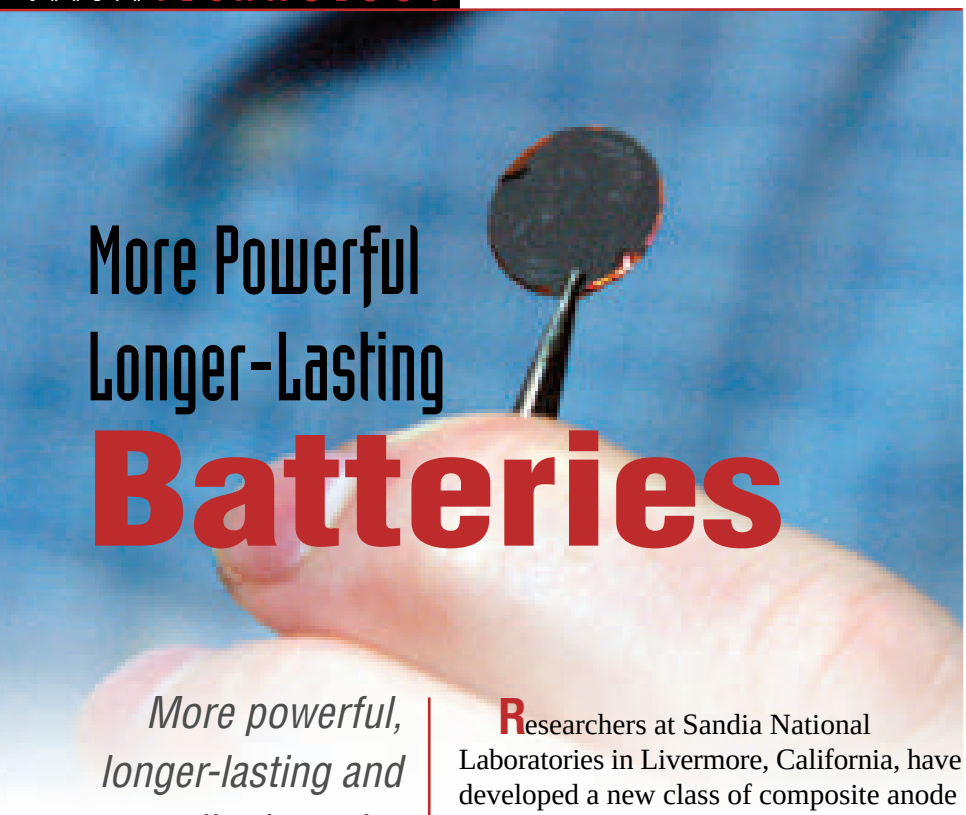


More Powerful Longer-Lasting Batteries

An electrode made by coating copper foil with the new silicon/graphite material, like the wafer-sized disc shown at left, could serve as a more compact, longer-lasting power source for rechargeable lithium-ion batteries.

More powerful, longer-lasting and smaller batteries are on the horizon for laptops, cell phones, and other systems, thanks to a Sandia-developed materials breakthrough. Some material properties may be improved by as much as 400 percent.

Researchers at Sandia National Laboratories in Livermore, California, have developed a new class of composite anode materials composed of silicon and graphite that may double the energy storage capacities currently possessed by graphite anodes. This provides the potential for rechargeable lithium-ion batteries with more power, longer life, and smaller sizes.

"Manufacturers of electric automobiles, laptop computers, cell phones, power tools, and other hybrid microsystems will likely all benefit from this kind of technology," says Scott Vaupen of Sandia's California Business Development group. Sandia is actively seeking collaborators to further develop the technology for eventual licensing and commercialization, he says.

The marriage of silicon and graphite may improve the specific capabilities of commercial graphite anode materials up to 400 percent, says Jim Wang, manager of Sandia's Analytical Materials Science department .

"Currently, no device exists that is altogether small, robust, long lasting, and high-powered enough to meet the requirements of hybrid microsystems," says Wang. "Electronics designers are forced to use low power-consumption components and designs that are limited in their longevity. Our newly discovered anode materials can improve the performance of microsystems by allowing for more powerful, sophisticated electronic components and by reducing the size and weight of the overall system."

Improved capacity retention

Wang explains that researchers have, for years, been vexed by the capacity limits associated with traditional lithium battery anodes. Sandia turned to silicon, which offers more than 10 times the lithium capacity potential of graphite, but is hampered by a rapid capacity loss during the battery cycling phase. When small particles of silicon are combined within a graphite matrix, however, the large capacities are retained.

"The promising aspects of these materials are the large capacities, the capacity retention during cycling compared to other high-capacity materials, and the ability to control performance by changing the composite composition and microstructure," Wang says.

Karl Gross, one of the principal investigators on the team, said the silicon/graphite composites could be produced via a simple milling process. The production technique is common within the battery industry, and the raw materials needed to produce the electrode material have proven to be inexpensive and abundant, Gross says.

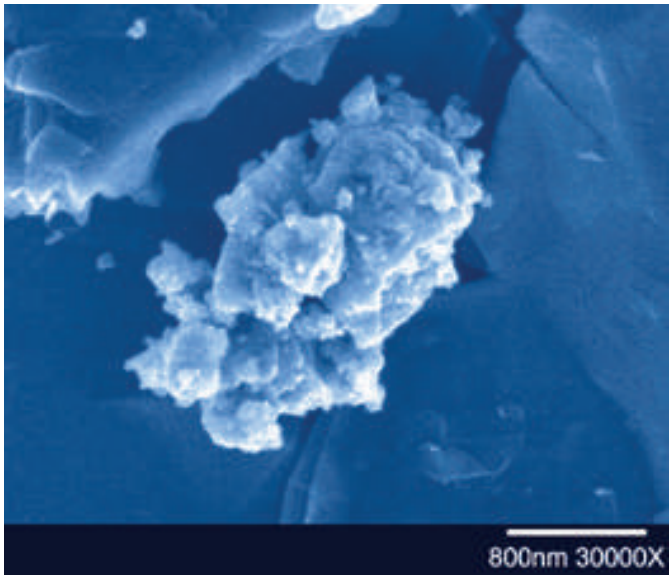
The discovery could have wide-ranging impact on both consumer and national defense applications, says Ken Wilson, deputy director of Sandia's Materials and Engineering Sciences center. Sandia's hybrid microsystems program, Wilson explains, focuses in part on wireless radiation detectors and other microsensor systems and devices used for homeland security applications. These systems are in need of enhanced sources of power and longevity.

A Sandia researcher assembles an electrochemical cell to test the capacity of a silicon/graphite electrode. The silicon/graphite mix could improve the specific capabilities of commercial graphite anode materials by up to 400 percent.

Each material has unique advantages and disadvantages that need to be considered when designing a battery for a specific application.

In studying the new material's performance, Wang and other researchers at Sandia took a methodical approach that spanned three years. They first produced composite powders with varying silicon-to-carbon ratios and microstructures, then produced electrodes from those powders and evaluated their performance by electrochemical measurements. They then examined structural changes in the electrodes during cycling to understand the lithium transfer mechanism and materials phase changes to further improve the new material.

According to Greg Roberts, a Post Doctoral team member, research and development focused on the replacement of graphite electrodes in rechargeable lithium batteries has taken many forms over the years. Possible replacement candidates, he explains, have included non-graphitic carbons, intermetallics, oxides, nitrides, and composites. While each material has unique advantages and disadvantages that need to be considered when designing a battery for a specific application, Roberts says the silicon/graphite electrode materials are promising for applications that require high capacities delivered at low-to-moderate rates.



Scanning electron microscope image of silicon-carbon nanocomposite.

Setting the standard

Sandia researchers acknowledge that some potential vulnerabilities exist with the new material. The complete elimination of fading of long-term cycling capacity in the silicon-based electrodes, may not be possible, though it can likely be minimized by the design of the carbon-silicon composite microstructure.

Still, Wang is confident that the silicon/graphite electrode materials have set the bar for future breakthroughs. "We believe that only other silicon-containing electrode materials can compete with the large capacities that our silicon/graphite composites have demonstrated," he said.

The work was sponsored by Sandia's Laboratory Directed Research and Development (LDRD) program, in collaboration with David Ingersoll of Sandia's Lithium Battery Research and Development Department in New Mexico.

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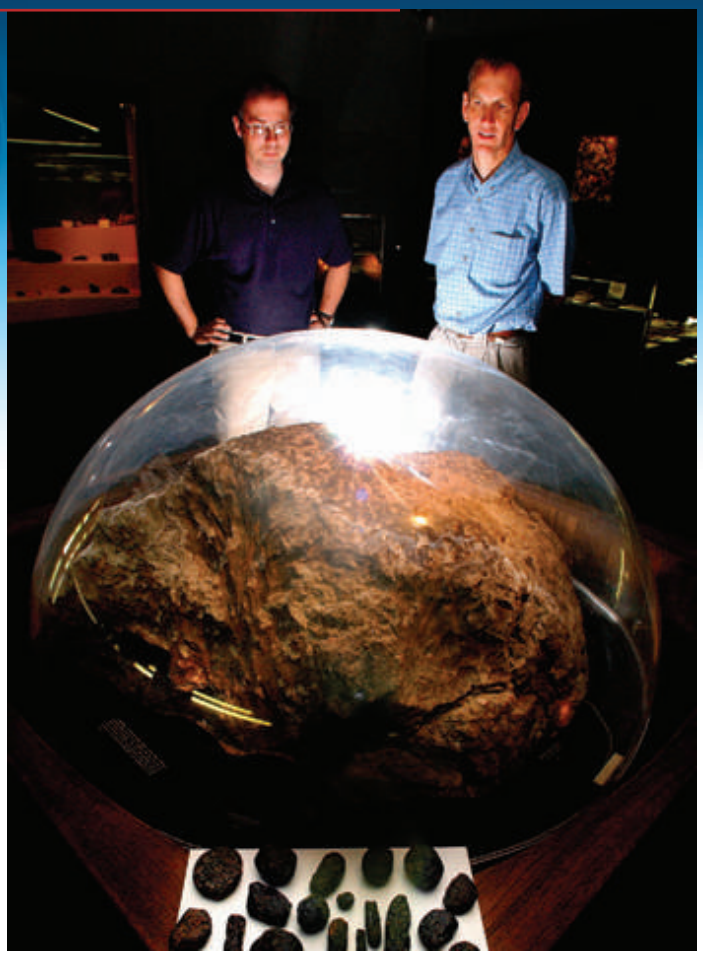
Rings Around the EARTH

While most of us know about the rings around Saturn and Jupiter, some scientists believe there may once have been rings of rock debris around our own planet. Further, the rings may very well explain some records of unusual climate change, trapped in Earth's geologic record.

Could Earth have had rings around it?

Two scientists — Peter J. Fawcett, of the University of New Mexico, and Mark B.E. Boslough, of Sandia National Laboratories — have suggested that a geologically "recent" collision (about 35 million years ago) may have caused such a temporary debris ring.

The two also suggest that such temporary rings — lasting from 100,000 to a few millions of years — may have cast massive shadows, altering patterns of climate. These conclusions were spelled out in a recent article in the *Journal of Geophysical Research, Atmospheres.*



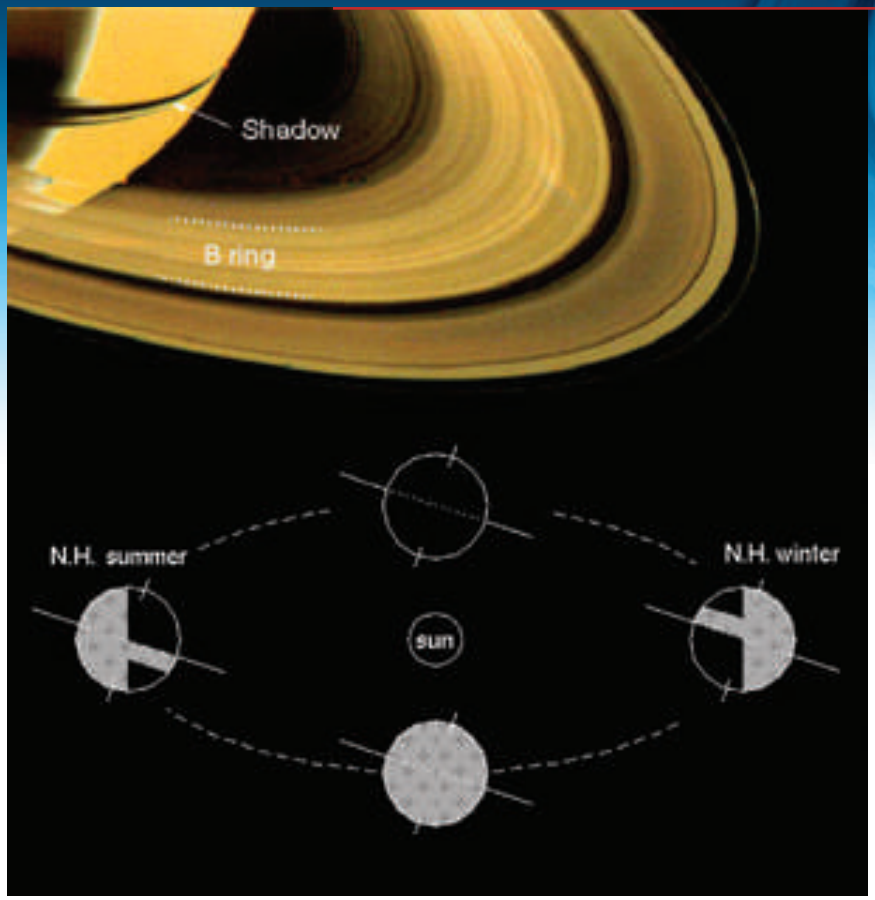
Peter Fawcett, left, and Mark Boslough examine some of the possible materials involved in creating rings around the Earth at a display at the University of New Mexico Meteorite Museum, in Albuquerque.
(Photo by Randy Montoya)

Lore of the Rings

"One way to get a ring," says Sandia's Boslough, "is with an impact." There is a growing body of evidence showing that the earth has been subjected to numerous impacts by comets and asteroids throughout its history. Among these impacts are the Meteor Crater, in Arizona, the buried Chixulub crater, in the Yucatan Peninsula of Mexico, and a chain of at least five craters spread across several continents.

Several studies, both theoretical and with laboratory data, suggest that some large impacts are capable of ejecting material into space in the form of debris rings, if the mechanics of the impact meet certain requirements. The authors conclude that the mostly likely scenario for ring creation is a low-angle impact by a large asteroid. Some earth materials spewing out into near space from the collision and melted meteoric debris, called "tektites," would form the ring materials.

Boslough describes the low-angle impact as a case where the collision object ricochets back into the atmosphere. The ricochet becomes part of an expanding vapor cloud, setting up an interaction that allows some of the debris to attain orbit velocity. The orbiting debris will collapse into a single plane based on the same mechanisms that led to the rings of Saturn and other planets, Boslough explains. Such a ring would most likely form near the equator, because of the dynamics involved with the moon and the earth's equatorial bulge.



A Saturn-like ring around Earth would create a shadow, reducing solar radiation. Illustrated is how the position of the shadow would change with the seasons.

Much of the work has focused on the Cretaceous-Tertiary (K-T) boundary event, which marked a mass extinction and the end of the age of the dinosaurs about 65 million years ago.

Speculation on climates past

The effects of the larger impact events on earth's environment and climate have been the subjects of much speculation and research over the past two decades. "Clearly, large impacts have affected the evolution of the earth, life on it and its atmospheric environment," says Fawcett.

Much of the work has focused on the Cretaceous-Tertiary (K-T) boundary event, which marked a mass extinction and the end of the age of the dinosaurs about 65 million years ago. A number of these studies suggest an impact resulting in the suspension of a layer of dust in the upper atmosphere blocking sunlight and cooling the earth. The two researchers asked if other impacts might result in different atmosphere-altering phenomena?

An equatorial ring would cast a shadow primarily in the tropics, as it does for Saturn. Depending on location, surface area, and darkness of the ring shadow, the amount of incoming solar warmth, or insolation, could be significantly altered, the two authors conclude. To test their theory, the two assumed an opaque ring, like Saturn's B-ring, scaled to earth-size and tested global climate affects using a climate model.

The model selected and modified for the simulation was developed by the National Center for Atmospheric Research. The Center's "Genesis" climate model includes atmospheric circulation information and layers of vegetation, soil, snow, sea temperature and land ice data. The goals of the LDRD funded project were for Sandia to adapt a popular climate code to run on distributed-memory parallel computers and to establish relationships with the climate change research community, Boslough explains. The Labs made use of its Sandia University Research Program to fund Fawcett's efforts to analyze the data from the adapted code.

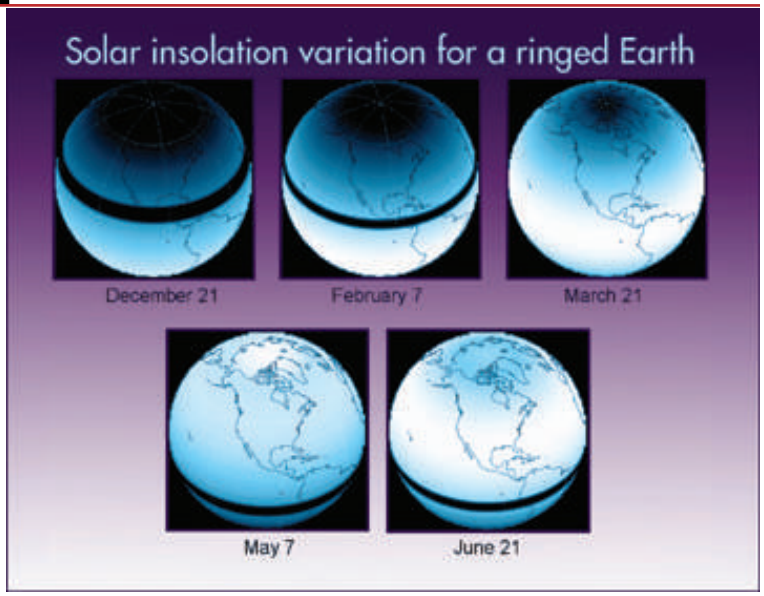
A Ring World

"The equatorial debris ring has a profound effect on climate, because it reflects a significant fraction of tropical insolation back to space before it can interact with the atmosphere," the authors conclude. Surface and atmospheric temperatures, changes in temperature ranges from equator to poles, circulation patterns and the rain and snow cycles were all impacted by the ring, the model shows.

The two scientists looked at changes shown in the model to predict changes that might be found in the earth's geologic record as a way to test their work. In addition to the K-T boundary event, they looked at a more recent impacts and a much older one.

The most recent event — about 35 million years ago — is identified by an iridium layer (often associated with meteors) and two pronounced micotektite fields, where these melted meteor-related materials have been

The "Snowball Earth" theory holds that the planet was completely frozen over at the surface as many as four times.



The climate code was modified to include a ring shadow in its calculation of the daily average incoming solar radiation (insolation) at the top of Earth's atmosphere, which varies with the season.

found strewn across the landscape and dated. Climatic records from sedimentary materials just above the iridium/microtektite interval indicate a 100,000-year cooling interval. Orbiting debris in a ring, casting its shadow in the subtropics, could have sustained such a cooling trend, the authors suggest.

The K-T boundary impact — about 65 million years ago — was much larger than the more recent impact and had a much larger immediate effect on the environment as measured by extinctions and atmospheric changes. But there were no long-term effects on the climate, leading the authors to conclude the event probably did not generate a debris ring.

Snowball Earth

Another interesting aspect of the modeling work is its implications for the so-called "Snowball Earth" theory. This theory holds that the earth was completely frozen over at the surface as many as four times in the neoproterozoic period — 750 to 580 million years ago. While much remains to be learned about the geologic evidence for this theory, "an opaque ring could have acted as the trigger to at least one episode of global glaciation," the two researchers say. This would address one difficult question for the theorists: how did earth come to be frozen?

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Geologists have found evidence that leads some to believe that our planet has been completely frozen several times during its history.

Sandia researcher Gary Harms conducts experiments with a new Sandia-built reactor that are paving the way toward possible changes in regulations on transport and storage of nuclear waste. (Photo by Randy Montoya)

NEW REACTOR probes spent fuel reactivity

Spent fuel is made from enriched uranium pellets, which are placed in fuel rods and used to power reactors for a number of years.

Recent experiments by Sandia researcher Gary Harms and his team are using a new Labs-built reactor to show that spent nuclear fuel —used at nuclear power plants — is considerably less reactive than the original fresh fuel. This could mean significant savings in the eventual safe transport, storage, and disposal of nuclear waste.

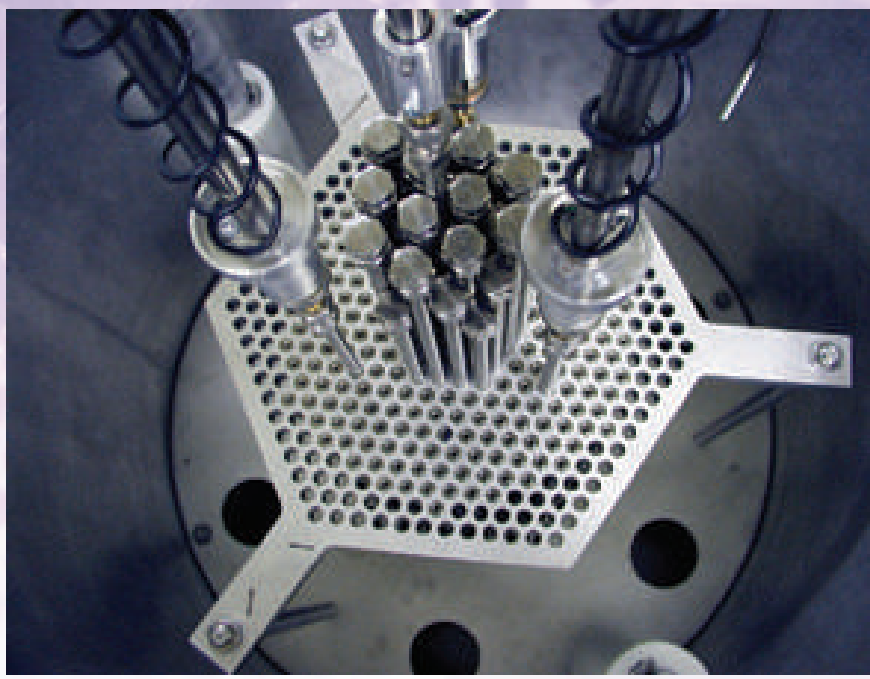
"The conservative view has always been to treat spent fuel like it just came out of the factory with its full reactivity," Harms says. "This results in the numbers of canisters required for handling of spent nuclear fuel to be conservatively high, driving up shipping and storage costs."

Harms, a member of Sandia's Applied Nuclear Technologies department, is project leader for the experiments.

Spent fuel is made from enriched uranium pellets, which are placed in fuel rods and used to power reactors for a number of years. When the uranium fuel's potential to produce electrical power is exhausted, the fuel is described as "spent." Typically, power plants store spent fuel in enclosed cooling ponds or dry storage casks. Eventually these rods will be moved to a permanent storage repository.

The more realistic view is that as nuclear fuel is burned, the reactivity of the fuel decreases. This is due to the consumption of some of the uranium and to the accumulation of fission products, the "ash" left from burning the nuclear fuel. Accounting for this reactivity decrease, or taking a so-called "burnup credit," would allow spent nuclear fuel to be safely packed in more dense arrays for transportation, storage, and disposal than would be possible if these composition changes were ignored.

"Allowing such burnup credit would result in significant cost savings in the handling of spent nuclear fuel," Harms adds.



A look at the reactor core during its construction.

The experiments involved a few hundred rods full of pellets of clean uranium that originally came from the nuclear-powered ship NS Savannah.

This seems obvious on the surface, but in the ultraconservative world of nuclear criticality safety, an effect must be proven before it is accepted. Thus, prior to the Nuclear Regulatory Commission ever agreeing to allow any transportation, storage or disposal changes, conclusive proof is needed. This will have to come from actual experiments and from computer models showing the same effects.

In 1999 Harms obtained a three-year grant from the Department of Energy's (DOE) Nuclear Energy Research Initiative to make benchmark measurements of spent nuclear fuel reactivity. The project was called the Burnup Credit Critical Experiment. Rhodium, an important fission product absorber, was chosen for the first measurements.

To do this, the team first designed and built a small reactor — technically called a critical assembly — which uses low-enriched fuel. The reactor, which operated during the experiments at a lower power than a household light bulb, was subjected to several layers of safety reviews. During the experiments, it performed safely and exactly as predicted.

"It took us most of the three years to build the reactor and get authorization to use it. Only in the last few months have we begun actual experiments," Harms says. "

The experiments involved a few hundred rods full of pellets of clean uranium that originally came from the nuclear powered ship NS *Savannah*. Thirty-six of the rods can be opened to insert experiment materials between the fuel pellets. Prior to conducting experiments with the rhodium, the researchers loaded the reactor to the critical level with only the uranium fuel. This provided a baseline point of where uranium goes critical — information that could be compared to later experiments.

Then, the team added about 1,200 circular rhodium foils between the uranium pellets in the 36 rods. The intent was to measure the extent to which the rhodium reduced the reactivity of the uranium. "We then compared the critical loading of the assembly with the rhodium foils to the critical loading without rhodium," Harms says.

Rhodium foils were added between uranium pellets in the test fuel rods.

Now at the end of the three-year funding period, Harms says the Sandia program has come a long way in proving that the reactivity of spent fuel is considerably less than that of fresh fuel.

And, not to anyone's surprise, it took significantly more fuel to reach the critical level with the rhodium-doped rods than without them.

Months before running the physical experiments on the reactor, Harms was modeling on Sandia's sophisticated computers to determine where the uranium doped with rhodium would go critical. "I was curious," Harms says, "I did calculations ahead of time so I could lay out the experiment and get a peek at what the experiments would say. In the end, I was fairly impressed with how accurate the calculations were compared to the actual physical experiments."

Harms says two other fission products absorb neutrons better than rhodium. However, he selected rhodium to run the experiments because it is one of the few byproducts of fission that has a single stable isotope, which meant that the experiment would not be contaminated by the effects of other isotopes. Also, no one else has done any experiments with rhodium in a critical assembly. Subsequent experiments could address the dozen or so other fission products that are important to burnup credit.

It appears that Sandia is the only lab in the US doing actual burnup credit experiments, says Harms. Oak Ridge National Laboratory is running codes to determine how the reactivity of spent fuel is reduced by fission products, but not doing actual experiments.

Now at the end of the three-year funding period, Harms says the Sandia program has come a long way in proving that the reactivity of spent fuel is considerably less than that of fresh fuel. "In essence Sandia is helping pave the way for the Nuclear Regulatory Commission to address the safe and cost-efficient transport and storage of nuclear waste."

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Three Named to National Academy of Engineering

"I was extremely proud to hear that the National Academy had elected three more Sandians to membership."

Paul Robinson
President, Sandia National Laboratories

Three Sandia engineers — James Asay, Charles "Jack" Jakowatz, Jr. and Alton Romig — have been elected to membership in the National Academy of Engineering. This is one of the highest professional distinctions that can be accorded an engineer. Academy President William A. Wulf announced the awards in February.

"I was extremely proud to hear that the National Academy had elected three more Sandians to membership," says Sandia President C. Paul Robinson, who himself was elected to the academy in 1998. There have been about 15 Sandia employees elected to the Academy since its formation in 1964.

Asay, recently retired deputy director in Sandia's Weapon Science Applications group, was honored "for leadership in engineering research and management of shock waves and for the development of tools that have contributed to national security." He is currently a research professor and associate director at the Institute for Shock Physics at Washington State University, Pullman.

Jakowatz, manager in the Labs' Signal Processing and Research department, earned recognition for "innovations in synthetic-aperture radar-image processing critical to military applications and environmental monitoring."

Romig, vice president for Science and Technology and Partnerships and the Labs' chief technology officer," earned election for "outstanding contributions to the science and technology of materials and for innovative research and development of defense systems."

Sandia's Salinas code shares Gordon Bell Award

Sandia National Laboratories' supercomputer program Salinas, a structural dynamics code that simulates the response of a structure under various loads, shared the prestigious Gordon Bell Award at the Super Computer 2002 conference held in November in Baltimore. This is the third time Sandia has won the Gordon Bell Award.

The Gordon Bell Award was established to reward practical use of parallel processors by giving a prize for the best performance improvement in an application. The award is given annually at the high performance computing and networking conference.

Sandia shared the 2002 award with three Japanese contestants and the University of Illinois at Urbana-Champaign.

Making it to the finals of this year's Gordon Bell Awards was a great achievement for the creators of Salinas. Only 38 entries worldwide were deemed acceptable to be judged by a committee of experts. The

contest was characterized by one Sandia researcher as "the Superbowl of supercomputing."

Salinas, which tested out at a speed of 1.16 teraflops per second, is a practical, widely used program to simulate the stresses on aircraft carriers and buildings, as well as on reentry vehicles and aspects of the nuclear weapons. "This is the first time a true engineering code has won the Gordon Bell award," said Tom Bickel, director of Sandia's Center for Engineering Science. "Salinas is already having impact on Sandia's nuclear weapon mission."

Julia Phillips is the recipient of the first US Department of Labor Women's Bureau's Horizon Award for contributing significantly to the advancement of women in science and engineering.

Julia Phillips wins first Horizon Award

Julia Phillips, director of the Physical and Chemical Sciences center at Sandia National Laboratories, was awarded the US Department of Labor Women's Bureau's Horizon Award at an October ceremony. This is the inaugural year for the Horizon Award, which goes to a New Mexico resident for contributing significantly to the acceptance and advancement of women in science, engineering, math or technology.

Phillips' efforts in helping women and girls develop an interest in science and engineering as a career over the past 20 years are impressive. "Julia's resume shows she is the consummate role model for girls and women aspiring in science and engineering," says Al Romig, Sandia vice president for Science and Technology and Partnerships, who nominated her.

Phillips pursued an undergraduate degree in physics from the College of William and Mary and a PhD in applied physics from Yale. After Yale, she took a job as a research scientist at AT&T Bell Laboratories where she worked with thin films and found herself active in programs that encouraged young people, particularly women, to develop an interest in science.

Now as a leader at Sandia, she finds different ways to encourage women in science. Finding balance between work and personal life is one of the keys to a successful career, she says.

Putting the Carbon Dioxide Back

Norm Warpinski (left) and John Lorenz examine core samples from the carbon sequestration project. Sandia is supporting the geologic modeling and studying the chemical reactivity of the CO_2 with the host rock in laboratory tests. (Photo by Randy Montoya)

Researchers at Sandia are helping the US government take the first small steps toward reducing net fossil-fuel emissions by returning some human-produced carbon dioxide (CO_2) to where it came from – in oil fields.

From late December to February, a multi-organizational research team pumped CO_2 gas into a depleted oil reservoir near Hobbs, New Mexico. The CO_2 capture effort, referred to as carbon sequestration, is one of several under way around the country to slow the rate at which carbon dioxide is accumulating in the atmosphere.

The project goals: improve existing models to help researchers predict where CO_2 will go after it is pumped into a reservoir, learn how far and how fast it will move, and determine what chemical reactions occur as the gas interacts with underground minerals.

Researchers also want to identify remote sensing techniques that will measure these changes. And they want to know what the capacity of the reservoir is and how close that capacity matches their estimates.

Fossil-fuel power plants each year pump some 2.4 gigatons of carbon dioxide into the atmosphere in the US. Automobile emissions account for similar volumes each year.

The southern New Mexico collaboration is one of several regional partnerships that make up the DOE's Carbon Sequestration Program, funded by the Office of Fossil Energy. The larger program supports the President's Global Climate Change Initiative and is exploring a variety of ways carbon dioxide could be captured at the smokestack and disposed of in a safe places.

The DOE's National Energy Technology Lab is leading the project. Also involved are Los Alamos National Laboratory, the Petroleum Resource Recovery Center at New Mexico Tech, Strata Production Company, the Colorado School of Mines, and Kinder Morgan, an enhanced-oil-recovery company. A variety of seismic techniques have generated gigabytes of data that the team will be using to create three-dimensional images of the underground geology. The data also will be used to adapt 3-D geophysical computer models used for oil and gas exploration to help predict results of future geologic carbon sequestration efforts.

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NEWS NOTES

Returning Firefighting Air Tankers to Service

The US Forest Service has begun re-activating large firefighting tankers using an improved aircraft inspection and certification program designed at Sandia National Laboratories.

It's shaping up to be another summer of wildfires.

After two fatal accidents involving firefighting air tankers last summer, a Blue Ribbon panel on aerial firefighting recommended that none of the large air tankers on contract be returned to service until an enhanced inspection program could be put in place. In late March, using an enhanced inspection program recommended by Sandia, the Forest Service certified that a contractor had met all inspection requirements for two P-3 Orions and returned them to service.

Sandia has also completed a similar inspection and certification process for the DC-4, DC-6, and DC-7 classes of tankers and development of the improved inspection process for the Lockheed P-2V is under way.

The large air tankers, (sometimes referred to as "slurry bombers") including P-3 Orions, DC-4s, DC-6s, and DC-7s, and P-2V Neptunes, are owned and flown by private companies under a contract administered by the Forest Service for all firefighting agencies.

"Until we can acquire newer aircraft down the road, this partnership with Sandia is a definite step towards safer operations with the current contract fleet," said Tony Kern, Forest Service Assistant Fire Director for Aviation.

In consultation with the Federal Aviation Administration (FAA), Sandia is evaluating contractor procedures for maintaining and inspecting air tankers and is developing recommendations for enhanced procedures to improve the ability to find and repair cracks and other structural problems before they pose a threat to aircraft and their crews, says Sandia's Richard Perry, manager of the Labs' Airworthiness Assurance department.

"Our initial objective is to use modern inspection technology and what we know about the aging of aircraft and materials and get the large air tankers safely back in service as soon as possible for the 2003 fire season," says Perry. In addition, Sandia will recommend long-term inspection procedures for each class of aircraft, including determining how often each aircraft needs to be inspected to ensure cracks don't have time to grow into structural defects.

Sandia has pioneered or refined a number of nondestructive techniques for aircraft inspection at the Airworthiness Assurance Center in Albuquerque, managed and staffed by Sandia for the FAA.

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Route to Cost-Effective Water Desalination

Desalination technologies could change the way the nation manages and uses water by providing new processes to cost-effectively and efficiently remove salts and other contaminants from impaired waters.

Sandia National Laboratories and the Bureau of Reclamation have announced the release of a research road map to guide future investments necessary to reduce the cost of water desalination.

The road map, compiled by a panel of experts, also discusses related advanced water treatment technologies and enhanced use of desalination.

The road map defines a research and development path for desalination technologies, beginning today and continuing through the year 2020. If implemented, the research path would support finding solutions to the nation's water supply-related needs by advancing water desalination technologies.

"Cost reduction is the single most important factor necessary to increase the implementation of desalination, which will in turn reduce pressure on our limited fresh water supplies," said John Keys, Commissioner of the Bureau of Reclamation. "As we enter the fourth year of a drought in many western states, it is imperative that we develop new technologies to increase our domestic water supply. This innovative report is a step in the right direction."

The Bureau is the largest wholesale water supplier and the second largest producer of hydroelectric power in the United States, with operations and facilities in the 17 western states. The National Academy of Sciences National Research Council (NRC) will now review the report to address whether the roadmap offers an appropriate and effective course to provide freshwater needs in the United States. A final report will incorporate the comments of the NRC and other desalination experts.

The expert panel included representatives of the private sector, municipal water agencies, academic and other research institutions, and the federal government representing the breadth of desalination issues.

To see the report:
http://www.usbr.gov/water/desal.html

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"I was extremely proud to hear that the National Academy of Engineering had elected three more Sandians to membership. Each is exceptionally worthy of membership, and it's even more remarkable that the specialties of these three are so diverse. I'm particularly proud that the Academy has seen fit to induct these individuals, particularly since some of their greatest accomplishments have been performed in the classified realm. It should be encouraging to all... that such outstanding work can be awarded Academy membership."

C. Paul Robinson

Sandia President and Labs Director

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

SAND 2003-1218P

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