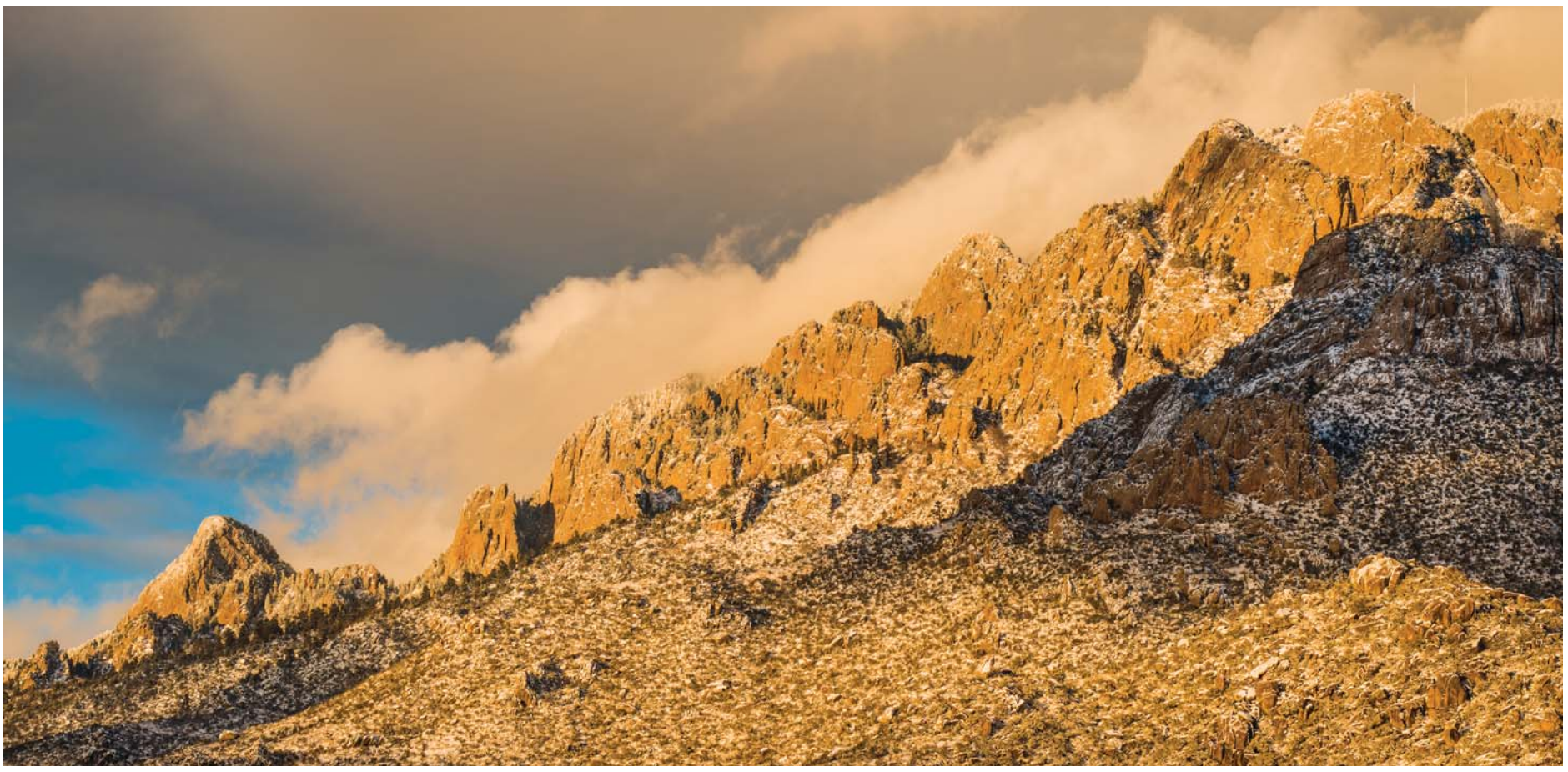

AFTER THE STORM of Dec. 5 that closed area schools and sent workers all over the city home early, the winds subsided, the clouds parted, and the sun broke through, casting a golden late afternoon light on the Sandia mountains as seen from the Elena Gallegos Open Space in Albuquerque's far Northeast Heights. (Photo by Randy Montoya)

Are you a savvy healthcare consumer?

KNOWLEDGE
You and Sandia = Total Health
POWER

Take HBE's Knowledge = Power quiz between Dec. 9 and Jan. 20 to find out how well you know your Sandia benefits. If you score a 70 percent or higher on the quiz, you'll earn 1,000 Virgin HealthMiles. You can take the quiz as many times as necessary. Try your hand at the crossword puzzle on page 7 to practice for the quiz.

Sandia LabNews

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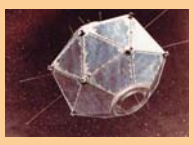
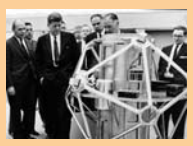



VELA satellite system marks 50 years

See pages 4-5



Sandia conducts B61-11 pull down surveillance test; first in years

By Sue Major Holmes

SAFETY FIRST — On a cold morning, Ed Bystrom (1535) de-ices the B61 pull-down test unit. Ed is wearing a number of different categories of personal protective gear: A hard hat to protect himself from falling debris, a face shield and nitrile gloves for protection against a chemical de-icer, a safety harness for use while adjusting cameras on scaffolding, winter overalls for protection from the cold, hard-toed shoes, safety glasses, and a high-visibility vest.

A dozen Sandians erupted in applause as they watched on video monitors while a rocket-driven B61 — a nuclear weapon, minus its nuclear components — rammed through a target at a test range in Sandia's first such impact test in seven years.

"Really nice work," said Engineering Sciences Center 1500 Director Justine Johannes, who authorized the Nov. 20 test at the aerial cable facility.

"It's been a while," said Science and Technology Div. 1000 VP Duane Dimos, who recalled being told the test of the B61 gravity bomb was up next when he took his previous job as Cen-

(Continued on page 6)

Realizing tunable conductivity in 'tinker toy' materials

Pioneering approach featured in Science magazine

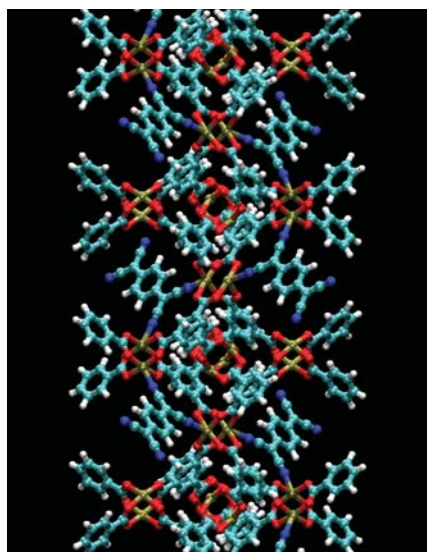
By Mike Janes

Sandia researchers have devised a novel way to realize electrical conductivity in metal-organic framework (MOF) materials, a development that could have profound implications for the future of electronics, sensors, energy conversion, and energy storage.

A paper to appear in *Science* magazine, "Tunable Electrical Conductivity in Metal-Organic Framework Thin-Film Devices," debuted in the Dec. 5 edition of *Science Express*. The paper — co-authored by a group of Sandia researchers and collaborators at the National Institute of Standards and Technology (NIST) — describes a technique that experiments show successfully increases the electrical conductivity of one MOF by more than six orders of magnitude.

"Fundamentally, this sheds enormous light on the conduction process in these materials," says material scientist Alec Talin (8656), the paper's lead author.

Applications for electrically conducting MOFs, says senior scientist Mark Allendorf (8600), include chemical sensing, medical diagnostics, energy harvesting and storage, and microelectronics.



IN EXPERIMENTS, Sandia researchers added a molecule known as TCNQ to a metal-organic framework (MOF). This image depicts the chain of TCNQ molecules that creates an electrically conducting path through the "tinker toy" MOF structure. The turquoise spheres represent carbon atoms, while white are hydrogen, blue are nitrogen, red are oxygen, and bronze are copper.

MOFs: 'Tinker Toys' for chemists

Materials researchers have considered MOF materials primarily for use in gas storage, drug delivery, and other conventional applications for porous materials. Their crystalline structure, which resembles molecular scaffolding, consists of rigid organic molecules linked together by metal ions.

This hybrid of inorganic and organic components produces an unusual combination of properties: nanoporosity, ultra-high surface areas, and remarkable thermal stability, which are attractive to chemists seeking novel materials that combine the superior performance of traditional inorganic semiconductors with the low cost and ease of fabrication typical of conducting organic polymers.

(Continued on Page 3)

Inside . . .

That's that

A few days ago I was invited, via email, to sign up for the trip of a lifetime: A chance, for a mere $95,000, to reserve a seat on the XCOR *Lynx* for a flight into space – suborbital, to be sure, but still, what an adventure.

Think about it: Half a century ago, it took everything we had as a nation, backed by all our wealth and knowledge and industrial might, to launch Alan Shepard on the suborbital mission that got America into the manned spaceflight business.

In the wake of that 15-minute flight, Shepard was hailed by the American public as a hero, feted by presidents and kings, and destined, ultimately, to walk on the moon.

Today, a similar flight experience is accessible, maybe as soon as a year from now, for the combined price of a Chevrolet Corvette and a Honda Odyssey. Not exactly inexpensive, in other words – we're not talking Ford Fiestas here – but if someone, even someone firmly entrenched in the middle class, really wanted to hitch a ride into space, it would probably be doable.

I've written before about Virgin Galactic, Richard Branson's enterprise to send paying passengers into space aboard the Burt Rutan-designed *SpaceShipTwo*. At $250,000 a seat, the Virgin Galactic experience is a bit more dear than that offered by the *Lynx*, probably moving it firmly into the orbit of the super-wealthy (or the profoundly obsessed: I could imagine someone of a certain disposition mortgaging their house for a ride.)

What we have, in short, is an honest-to-goodness space race for which we here in New Mexico have a front row seat. And Virgin Galactic and XCOR aren't the only players in the emerging space tourism game: Several companies have plans to get a piece of the action. As of today, it appears to me that Branson and Virgin Galactic, with operations at New Mexico's Spaceport America, will be first off the pad (or runway, as the case may be), but others will follow, each carving out a market niche by offering something a little different from everyone else. XCOR, for example, plans to train its passengers to serve as copilots and actually help fly its little two-seat spacecraft (in *SpaceShipTwo*, you're just a passenger). Another company plans to offer a science fiction-like vertical take-off and landing experience.

Just as in the Cold War space race, the new competition will drive innovation. Before you know it, orbital flights will be the norm and then stays in orbiting hotels.

Picking winners in all this would be foolhardy at best, but in the bigger sense, we'll all come out ahead. The new space race will, just as the old one did, create new opportunities in science, technology, engineering, and math. The old space race led directly to the modern computer era and our interconnected world.

Who knows where this new race will lead? Here's my guess: It's been argued, pretty convincingly, I think, that the famous Earthrise photo taken by *Apollo 8* astronaut Bill Anders 45 years ago this month launched the modern environmental movement. The photo, showing the Earth as an oasis of life in the vast, empty darkness of space, was electrifying in its emotional impact. It made people viscerally aware of our home planet as a singular, holistic thing, fragile, without borders – and alone. Most especially, alone, the only home we had. Every life ever lived, every thought ever thought, everything that sustains us: It was all right there. It was all we had, that beautiful blue marble, so it was not only desirable, but essential, that we protect it.

The new space race will eventually, I think, sort of flip the picture. When *Apollo 8* travelled to the moon, spaceflight was something reserved for a very, very select few individuals. Access to space was just short of impossible even for the most powerful nations on the planet. That's all changing now. Over the next few years, as access to space opens up, we will see the solar system itself as our home, the proper place for our kind. Will that new perspective give us leave to ignore the lessons and concerns of the environmental movement? Of course not. But it will expand our horizons, magnify our sense of the possible, and bring us one baby step closer to understanding our place in the big scheme of things. I'm glad I've been around to witness not one, but two space races. This new one, I think, will be the more significant one, the one whose impact will be enduring.

And regarding that $95,000 offer? I think I'll hold off on that for now. I suspect the price will be dropping fast.

See you next time.

– Bill Murphy (505-845-0845, MS0148, wtmurph@sandia.gov)

Retiree Paul Souder enters New Mexico Ski Hall of Fame

Retiree Paul Souder has been inducted into the New Mexico Ski Hall of Fame, recognized for serving on the Sandia Peak Volunteer Ski Patrol for 40 years from 1964-2004. He joins a distinguished list of members of the Hall, including Ernie Blake, Ben Abruzzo, and Bob Nordhaus.

Paul was especially active on the patrol in ski- and toboggan-handling instruction and training. During his years of service he interacted with countless skiers, some hurt and needing patrol assistance and many with whom he shared his enthusiasm for skiing. He was instrumental in saving four lives and finding three people in serious trouble on the end-of-the-day patrol sweep of the hill. He once assisted in a vehicle accident recovery after he noticed fresh tire tracks leading off the road.

Paul retired from Sandia in 1991 after a 35-year career. A distinguished member of the technical staff, his DMTS citation reads: "In recognition of his extensive contributions to the US nuclear weapons program and especially his particular work over the years in the use control of these weapons and related activities."

N.M. SKI HALL OF FAME INDUCTEE Paul Souder on the slopes readying a rescue toboggan, one of many tasks he performed while serving on the Sandia Peak Volunteer Ski Patrol for 40 years. (Photo courtesy of Paul Souder)

Upon his retirement from Sandia, Paul continued his patrol activities at Sandia Peak and started teaching in the ski area's program for seniors.

After decades on the slopes, Paul has never tired of the sport, which he says he finds "addictive."

"It's fun at any level," he says. "The more you ski the better you get and the better you get, the more fun it is: A positive feedback loop."

Paul still skis, but not as much as he used to, and enjoys working with patrol candidates who need to improve their skiing skills.

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LOCKHEED MARTIN

Labs, NNSA agree on annual Performance Evaluation Plan

THE STRATEGIC PERFORMANCE EVALUATION PLAN (PEP) is a complex-wide document with site-specific outcomes that is used to evaluate Sandia's performance for the year. Following a lengthy negotiation, the Sandia FY14 PEP was signed between Sandia and the NNSA Sandia Field Office on Nov. 14. Pictured are, left to right, DOE/NNSA SFO contracting officer JoAnn Wright, SFO manager Geoffrey Beausoleil, Sandia President and Labs Director Paul Hommert, Center 11010 Senior Manager James Eanes, and Deputy Labs Director and Executive VP for Mission Support Kim Sawyer. (Photo by Randy Montoya)

'Tinker toys'

(Continued from page 1)

Mark, a chemist and MOF expert who called the research findings the most exciting development in his 28-year Sandia career, likens them to "tinker toys" for chemists.

"When you imagine the 'tinker toys' we played with as children, you recall they are essentially wooden balls with holes that you can link together with sticks," Mark says. "MOFs work the same way, only you substitute metal ions for the balls and organic molecules for the sticks."

The resulting open space within the scaffolding can be filled with guest molecules, which gave Alec the idea to use the pore to make the MOFs electrically conducting.

"Importantly, MOFs possess a characteristic of molecules that allows us to adapt their properties to a specific application. We can perform chemistry on them, unlike traditional inorganic electronic materials, such as silicon and copper," says Alec. Molecules, he says, represent the "ultimate, small-scale unit" at which electronic devices can be made. They are so difficult to manipulate and organize, however, that practical "molecular electronics" have not been realized. "How you connect to molecules, where you place them — those issues have consistently perplexed materials scientists," says Alec.

The power of empty space

So he considered a different approach. "With MOFs, we can get around this problem by using the nanopores to organize molecules. The trick is to pick the right kind of molecule, so that it binds to and interacts with the entire framework." Some MOFs, says Alec, have empty holes in the tinker-toy balls that can bind molecules that infiltrate the pores.

"This isn't like silicon, which can't change its electrical properties," Alec says. "You can add tiny amounts of dopants to silicon or introduce other impurities, but with our approach, you suddenly have the potential to tailor the material to achieve exactly the properties you want. This is the beauty of molecular electronics."

To test their hypothesis, Sandia and NIST researchers added a molecule known as tetracyanoquinodimethane, or TCNQ, to their framework. First, they took a substrate with platinum electrodes patterned on its surface and coated it with a thin film of the MOF. The substrate was then dipped in a solution containing the TCNQ molecule, which they knew would seep into the MOF's tiny pores. The MOF film containing the TCNQ bridged the electrode connection points, which then could be connected to a current meter for measuring.

MARK ALLENDORF (8600), left, Alec Talin and Francois Leonard (both 8656) measure the conductivity of a MOF device, shown on the monitor (upper left). The team has developed a technique that increases the electrical conductivity of one MOF by more than six orders of magnitude. (Photo by Dino Vournas)

"Frankly, I thought it would never work," says Mark. "But that's the great thing about science: Being wrong can be a good thing."

The results are in, and they are good

The research team found that the MOF materials were conducting, though at relatively small quantities at first. "It was clear that something good was happening, so we were very excited," says Mark.

The experiment was repeated several times with slight but important improvements in film quality achieved by optimizing the laboratory fabrication process.

"Conditions matter, and we had to be very deliberate in how we prepared the framework to accept the guest molecule," says Mark. Removing the water and excess solvent from the film is no trivial matter, he says. The research team fine-tuned the process over the course of several months and, in doing so, began to see large leaps in electrical conductivity.

"The increase was massive," says Alec. The conductivity in the material, he says, is now a million times higher than that of the starting material, and a thousand times higher than anything previously reported using a metal-organic framework.

The researchers plan to patent their approach and also hope to land additional funding to experiment with other guest molecules.

Keeping up with Moore's Law and other applications

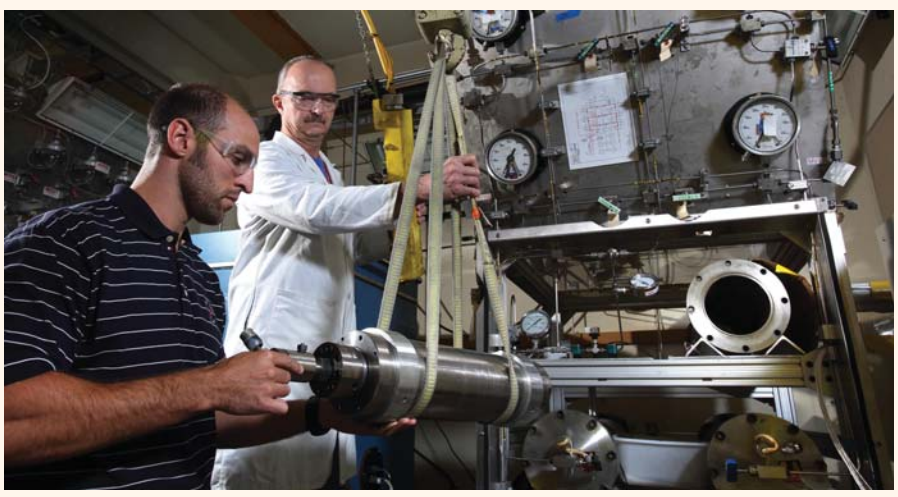
"The overwhelming success of this project opens a whole new way to design electrically active materials," says Alec. Organic materials, he notes, offer low costs and mechanical flexibility. "There are probably hundreds of potential applications for this work that come into play, such as breath analysis and microelectronics," he says.

The ability to make smaller and faster electronic devices to keep up with Moore's Law has always been a motivator in the field of molecular electronics, Mark says. MOFs have the potential to create molecular electronic devices on the scale of their pore dimensions, or approximately 1 nm.

Solar technology is another potential application, says Mark, and DOE's SunShot Initiative has funded some of the initial research. "With electrically conducting MOFs, we might very well be able to combine the high efficiencies achievable with traditional inorganic thin film materials such as polycrystalline Si with the low cost and flexibility aspects of organic photovoltaics," he says.

"Our next step needs to be the exploration of other hosts and guest molecules," says Alec. "We'd like to experiment with different MOF structures and different organic molecules to see if new behavior emerges. We want to see where this new learning takes us."

Quantifying the oxygen effect on hydrogen embrittlement



IN THE HYDROGEN EFFECTS on Materials Laboratory, Joe Ronevich, left, and Jeff Campbell (both 8252) use a crane to maneuver a stainless steel pressure vessel containing material test specimens into place before connecting it to the manifold piping and filling it with high-pressure hydrogen gas. (Photo by Dino Vournas)

By Patti Koning

Hydrogen embrittlement, the process by which metals become less ductile and more susceptible to fracture during exposure to hydrogen, is a problem that has vexed scientists for more than a century. As a small and highly mobile molecule, it seems that nothing can stop hydrogen from working its way into and degrading any structural material, especially high-strength materials — except perhaps hydrogen's water partner, oxygen.

"In the materials science community, there has been some discussion that hydrogen embrittlement can be inhibited or even stopped when certain gas species are blended with the hydrogen, even at parts per million quantities," says principal investigator Brian Somerday (8252). "Oxygen is one of those gas species."

Brian and Joe Ronevich (8252) had the opportunity to put this theory to the test in the Hydrogen Effects on Materials Lab through a collaborative project with the US Army Armament Research, Development and Engineering Center (ARDEC), headquartered at Picatinny Arsenal, N.J. ARDEC is developing a next-generation artillery technology, the Combustion Light Gas Gun (CLGG), that propels projectiles through the combustion of hydrogen and oxygen.

The CLGG substitutes gaseous hydrogen and oxygen for traditional gun propellant. Combustion gases are significantly lighter than those used in a conventional gun, permitting considerable increases in muzzle velocity. This results in the potential for greatly extended range and about 11 times the coverage of conventional artillery. Using hydrogen as the primary propellant has other advantages, like environmentally benign steam as the combustion byproduct. Hydrogen can also be rendered harmless by venting the gas into the atmosphere, and the gas has the added advantage of dual use: as a gun propellant and a fuel to power military vehicles.

But with hydrogen comes hydrogen embrittlement, exacerbated by the high-strength materials of the CLGG. The wild card is the added presence of oxygen, a necessary component of ARDEC's combustion scheme.

"This raises a fundamental science question," says Brian. "Can the oxygen present mitigate the inevitable hydrogen embrittlement? And if so, can you quantify that effect? From a science perspective, we think what we are doing to define the boundaries and variables that promote this inhibition is unique."

He was well-prepared when the call came from ARDEC. In a recent project for the DOE Fuel Cell Technologies Office, Brian has been working to quantify the mitigating effects of oxygen on hydrogen-assisted crack growth in steels for hydrogen pipelines. "We have some experience now in mixed-gas tests, as opposed to pure hydrogen, which we were able to apply immediately to ARDEC's problem," he says.

ARDEC represents a new type of customer for Sandia's core capability in hydrogen embrittlement. This research originated in the nuclear weapons program, specifically for gas transfer systems components. Over the last 10 years, Sandia has successfully applied this expertise to the hydrogen energy arena. "This project applies that core capability to a dimension of hydrogen embrittlement that has not been explored in much depth," says Brian.

The oxygen effect

In April, Joe conducted a series of experiments for ARDEC in the Hydrogen Effects on Materials Lab. In 100-hour tests, he compared the effects of pure hydrogen against hydrogen with 0.5 percent O_2 on two different high-strength materials, martensitic steel and a nickel-based superalloy.

"In the samples tested in pure hydrogen, we saw what we expected — the propagation of cracks quite quickly," says Joe. "In the samples tested in mixed gas, we still saw crack propagation, but there was a significant time delay. These results were intriguing because the time delay indicated that oxygen had some mitigating effect, but the hydrogen embrittlement was not absolutely inhibited."

In the pure hydrogen, cracks developed in both the martensitic steel and nickel-based superalloy within minutes. In the mixed gas, cracks did not begin to develop in the martensitic steel for more than 94 hours and in the nickel based superalloy for over one hour.

In September, Joe ran another series of experiments on a different martensitic steel that was heat-treated to two distinct strength levels and subjected to a hydrogen/1 percent oxygen mixture for 100 hours.

"This was an interesting result," says Joe. "We anticipated that doubling the concentration of oxygen would have a higher inhibiting effect, but that is not what we saw. In both pure hydrogen and the mixed gas with 1 percent oxygen, the time for crack initiation ranged from minutes to hours, depending on the steel strength and applied stress level. The mitigating effect of oxygen was most pronounced for the low-strength steel, in which the onset of crack initiation in the mixed gas was about 40 times longer compared to the pure hydrogen."

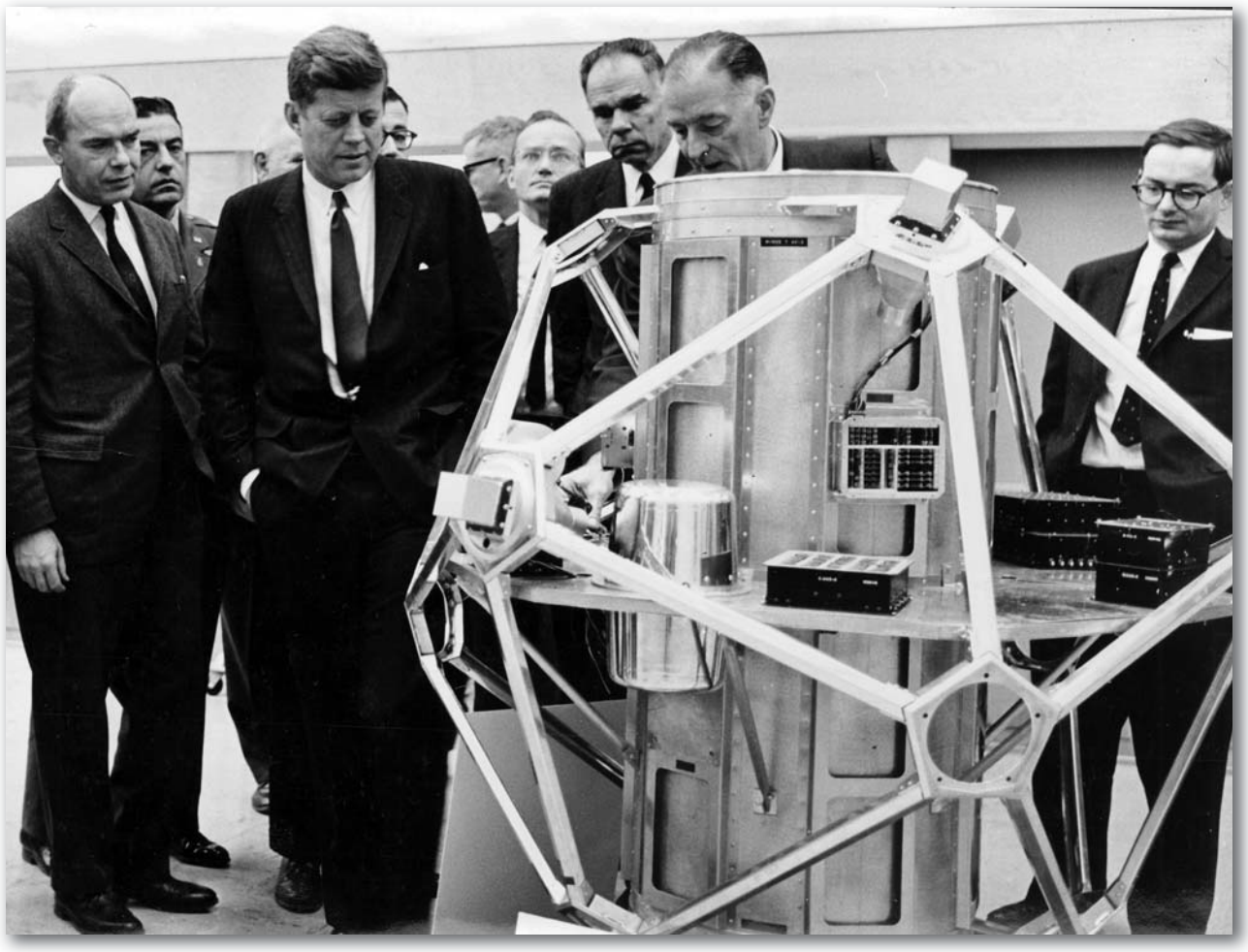
Brian anticipates that a third series of experiments could start soon, this time looking at the effects of a hydrogen/oxygen mixture on high-strength materials with a cycling mechanical load.

"The delay in crack propagation that we saw could be specific to these high-strength structural materials," says Brian. "Or, on a different class of structural materials, maybe the inhibition effect is absolute. These results inform our understanding and endorse the value of this avenue of research. We could be looking at the hydrogen embrittlement problem in a very different way."

VELA marks 50 years

Vela crew celebrates 50 year anniversary of first launch of nuclear detonation detection satellite

Story by Heather Clark
Photos by Randy Montoya
Historical photos courtesy of Sandia Corporate Archives



COMMANDER IN CHIEF ATTENTION — President John F. Kennedy saw the Vela satellite under development during his visit to Sandia in 1962. A year later, Kennedy signed the Limited Test Ban Treaty and Vela was launched about a week later.

A we mixed with worry about whether his circuitry designs would work played on Dick Spalding's mind that Florida night in Cape Canaveral as he watched the first successful launch of a pair of Vela satellites 50 years ago.

"As soon as the 10, 9, 8, 7, 6 … the countdown, began, we could run right out and watch the launch. It was pretty spectacular that close. We were looking right up the tailpipe once it got up a mile or two," says Dick (5730), an electrical engineer. "Today, you'd never be able to stand outside that close."

The first pair of Vela satellites developed by Sandia and Los Alamos National Laboratory (LANL) was launched aboard the Atlas Agena D rocket on Oct. 17, 1963. Twelve Vela satellites were launched in pairs from 1963 to 1970 into an orbit of about 60,000 nautical miles above Earth. They sent telemetry back until 1984.

Sid Singer, a staff member at LANL who worked on Vela, spoke at a recent celebration at the National Museum of Nuclear Science & History to more than 100 current and retired researchers. He recalled that it was not uncommon for rockets to blow up on launch pads in those days.

"We were successful because we relied on the work that went before us. Like Isaac Newton once said, 'I stood on the shoulders of giants.' Whether our generation was giants, who knows, but I urge those who are still doing the work to continue and to do better than we did," Singer says now.

The concept of Vela grew out of concerns in the mid-1950s about the dangers of radioactive fallout from atmospheric nuclear tests and the launch of the Soviet satellite Sputnik in 1957.

So the US created the Vela program to detect ground or atmospheric nuclear testing and verify compliance with the Limited Test Ban Treaty (LTBT) of 1963 and, subsequently, the Threshold Test Ban Treaty of 1974. The space segment of the program, called Vela Hotel, marked the start of the US Nuclear Detonation Detection System and was followed by the Defense Support Program satellites, and today's Global Positioning System satellites.

"Vela" is the Latin word for "sail," and is the name of a constellation in the Southern Hemisphere that represents the sail of a ship from Greek mythology, says corporate historian Rebecca Ullrich.

Vela seemed a mission impossible

When Vela Hotel started in 1959, Dick says, it was a research and development project to determine whether monitoring nuclear explosions from space was even feasible.

According to a *Lab News* article written for Vela's 25th anniversary in 1988, Sandia's charge was to: "Build a highly complex electronic system. It needs the capabilities of a room-sized IBM 704 computer. Even though computer components can fail in an office with a constant temperature, put the system atop a powerful rocket and blast it into space where it must work perfectly in extreme temperatures. It must distinguish natural radiation from nuclear-blast radiation, produce reliable data, reduce that data down to a meaningful package, and transmit it back to Earth where it can be deciphered easily. The satellite can't weight more than about 500 pounds or be more than five feet in diameter. And, by the way, it has to have an on-board, self-sustaining power system."

It seemed an impossible mission in turbulent times, but the work also was exciting.

Paul Beck, who was hired at Sandia in 1965 and retired in 1998, recalled watching Vela's engineers working across the hallway from his office. The new employee was fascinated and soon got his wish to move to the project.

"I think it's a privilege that I lived in this time to be in space development only six years after Sputnik," he says. "I was just awestruck at the technology I got into and I wanted to be part of that."

The US and then-USSR stopped atmospheric tests in 1958, but the former Soviet Union resumed in 1961. A year later, President John F. Kennedy stood next to the Vela satellite still under development at Sandia.

Al Hachigian (2916), now a senior mentor in the Weapons Intern Program, was charged with setting up the exhibits for Kennedy. He recalled Sandians cheering for the young president who had just handled the Cuban Missile Crisis.

"It was just exciting to be there when the president walked into the room," Al says. "He was at the apex of his popularity . . . . We were thrilled for him to be there."

In 1963, Kennedy signed the LTBT and the first Vela pair was launched about a week later.

The pairs — each an icosahedron about the size of a washing machine — were launched on single rockets. Their triangular surfaces were covered with solar cells to provide electrical power to operate the instrumentation. As the satellite spun about its axis, neutron, X-ray, and gamma-ray detectors developed by LANL would scan space.

At the time, LANL scientists estimated Vela could detect a 10-kiloton explosion at a distance equal to the diameter of the Earth's orbit around the sun.

The DoD Advanced Research Projects Agency was responsible for program oversight, the US Air Force developed the spacecraft, launch operations, and control of the satellites in orbit, and a company then called TRW Systems Group designed and built the spacecraft.

Sandia and Los Alamos still partner in much the same way on GPS as they did on Vela, says Dick, who is one of seven Sandians to begin work on Vela and stay with it throughout its duration.

The late W.C. "Bill" Myre, then-supervisor of Space Projects Division I (then-7432), was the project engineer for the Vela program. Dick credits Vela's early success to Bill's leadership. "He let everybody know that if anything failed that you were responsible for, you were going to hear about it. In other words, be very careful and make sure that what you do is not going to fail. Those words were accepted by all the workers and adhered to," Dick says. Later, when someone asked Bill why Vela was so successful, his answer was, according to Dick, "because we were all running scared."

CELEBRATING 50 YEARS — Sandia and Los Alamos researchers who worked on Vela over the years celebrated at the National Museum of Nuclear Science & History the 50th anniversary of the launch of the first pair of Vela satellites. (Photo by Randy Montoya)

THEN AND NOW:

Dick Spalding (5730) is one of seven Sandians who began work on Vela and stayed with it during the program's duration. Dick credits Vela with his life-long love of astronomy.

(Photo by Randy Montoya)

Monitoring atmospheric nuclear detonations from space

Sandia designed and built the data processing electronics in the satellites and the ground equipment to test the performance of the payloads. The Sandia logics systems made it possible to transmit, record, reduce, and analyze significant data collected by the detectors, according to the *Lab News* at the time.

Beck says the group was proud about using thousands of transistors per satellite. "That was a wonderful step in miniaturization and integrated circuits," he says, explaining that today we carry around 100 million transistors in our cell phones.

Dick says the sensors also were able to trigger the recording mechanism when potential nuclear detonations were detected, rather than constantly record. "I think very few other sensors used this triggered recording mechanism," he says.

By the late 1960s, what started as R&D to see whether satellites were feasible had been deemed a success. Six satellites by then had logged 210 million transistor hours without a failure and the *Lab News* hailed Vela an "unprecedented achievement in the field of space research and development effort."

In May 1967, an improved fourth pair of Vela satellites was launched, carrying Sandia-developed optical and electromagnetic pulse detectors and associated electronic systems that allowed Vela to monitor for nuclear bursts in the atmosphere. The satellites were larger; each weighed 730 pounds, compared to about 500 pounds for the earlier versions. They were polyhedrons with 26 sides, 24 of which are triangular solar panels, according to the *Lab News*.

While optical detectors had been deployed for nuclear tests in the Pacific Ocean, Sandia's Brick Dumas and the optical sensor group applied them to Vela. "That was an innovation that Sandia produced: the idea of these nuclear burst detectors looking down at Earth and sensing what was happening in the atmosphere," Dick says.

Secondary research of phenomena and preparation for manned space flight

Vela also contributed significantly to astrophysics, interplanetary physics, and the understanding of the Earth's magnetosphere, Dick says.

On the second Vela launch, LANL designed environmental sensors to learn more about the Van Allen radiation belt that Vela was orbiting through. Later Vela satellites discovered super bolts of lightning, particularly in the waters off the coasts of Japan, and the existence of cosmic gamma ray bursts, he says.

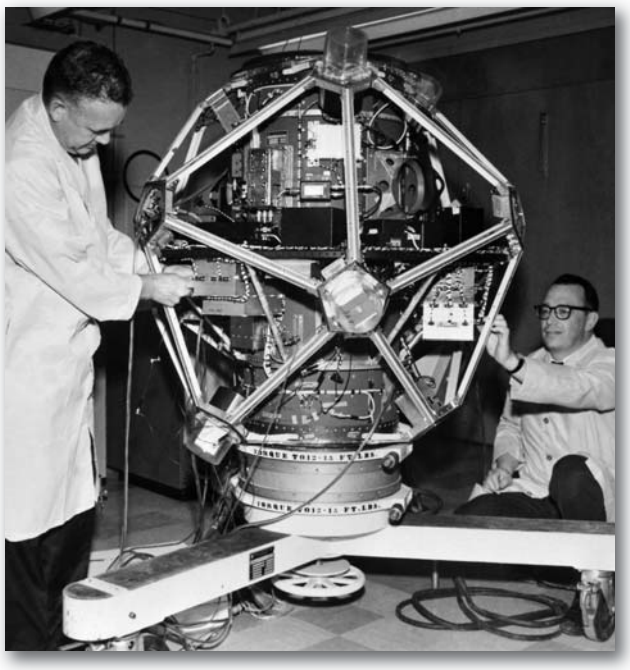
"There was enough time difference between the detections on the four orbiting satellites to determine two possible vectors into space to answer the question: 'Where did the gamma ray bursts come from?' The astronomers, in the beginning, thought these gamma ray bursts can't be from way out there, but Vela showed they were not from our galaxy," Dick says.

The last pair of Vela satellites was launched in April 1970 and turned off Sept. 29, 1984.

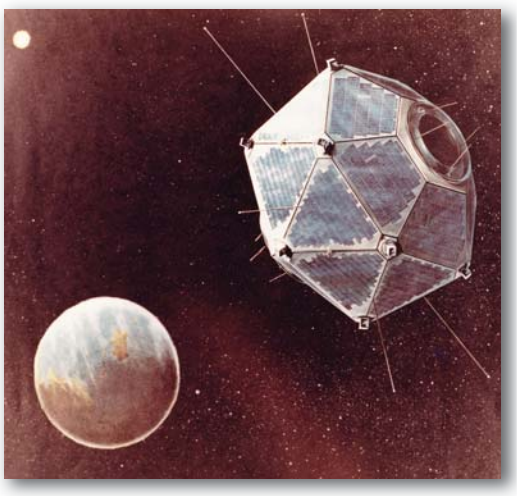
Those who worked on Vela marveled at their longevity. "They were only supposed to last for a year, but they lasted for 10-20 years," Beck says.

While Dick says he doesn't remember the last telemetry arriving at Sandia from Vela, he still thinks about the hardware up in the sky.

"It's out there somewhere," he says, but the practical engineer adds: "It would take a really good telescope to find it."

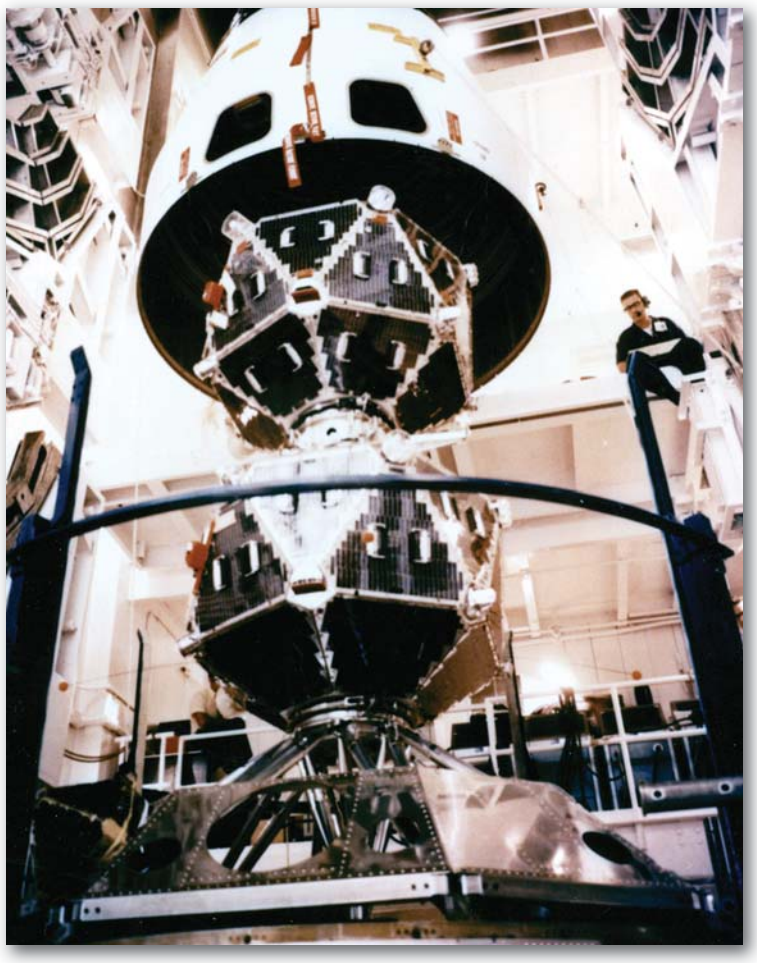


RESEARCHERS prepare a Vela satellite for its orbital mission.



AN ARTIST'S RENDERING of Vela in orbit.

VELA'S OUTER CASING was made up of solar power panels like this one.

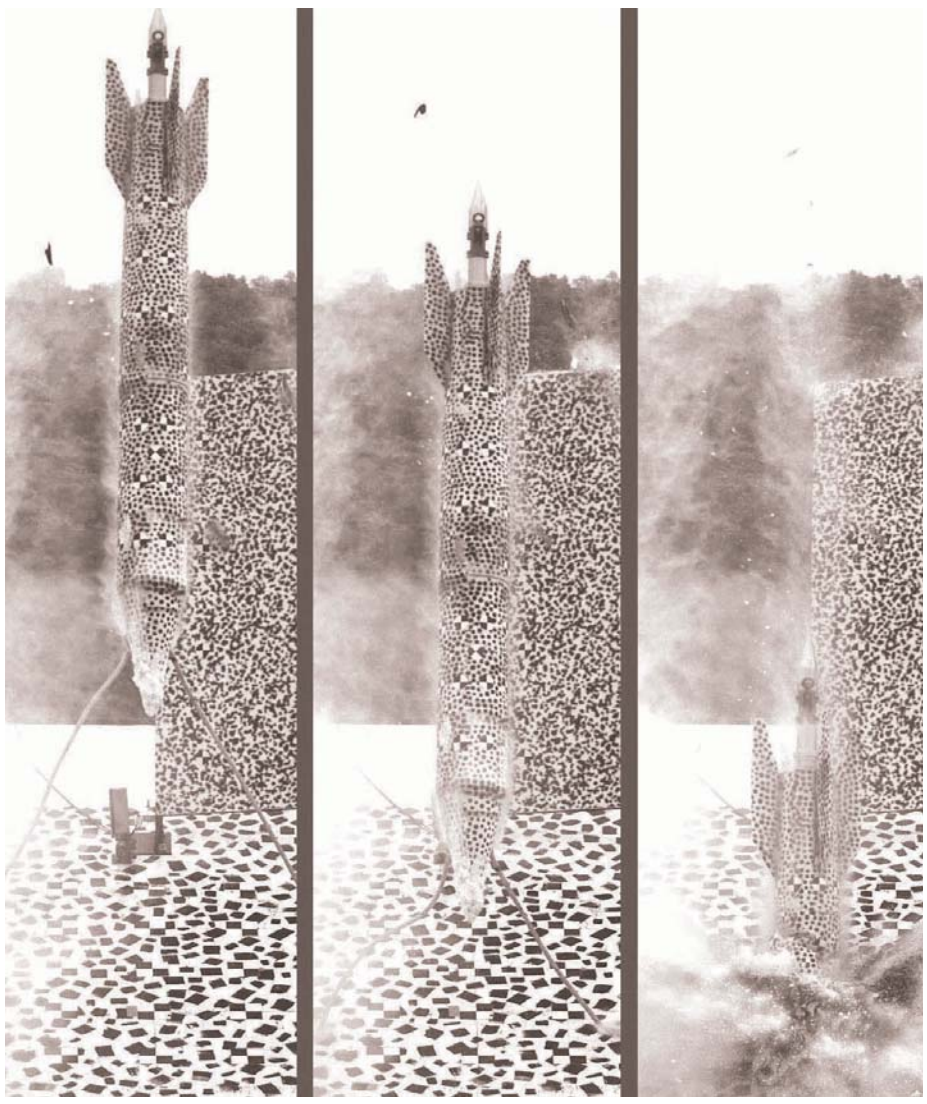


A VELA STACK ready for its flight. Velas were always launched in pairs.

VELA SATELLITE PAIR boosted into orbit atop a Titan rocket. Early Vela satellites were launched aboard Atlas rockets.

PANORAMIC IMAGE of the cable pull down setup within test arena at the Aerial Cable Facility. The concrete target is in the center of the image. The scaffolding on the left and right are in place to support high-speed video cameras that capture image data for later analysis of impact angles and velocity.

B61 pull-down test a success



THIS IS A COMPOSITE of three images captured from high speed video showing the test unit in free flight as it approaches and penetrates a concrete target. The images show water vapor (from the light rain that was falling at the time of the test) surrounding the test unit. The square speckles on the test unit and the concrete target provide a random pattern that is used in digital image correlation algorithms to calculate test unit motion in 3-D using special equipment.

(Continued from page 1)

ter 1500 director in March 2010. "Thank you all," he told the team.

Preliminary results look good

The test unit will be disassembled and final data analyzed, but data available the day after the test showed Sandia's components worked as expected. The test weapon was equipped with instruments to measure component performance and velocity as it slammed into the target. Org. 2110 senior manager Patrick Sena says preliminary data showed the test met the requirements of the worst-case conditions the B61 is expected to meet with high reliability.

"One of the main purposes of the stockpile is deterrence, and one important way to ensure deterrence is to have a successful surveillance test that shows our systems work," Patrick says.

The test unit was cooled to an internal and external temperature far below 0 degrees Fahrenheit. It had to be de-iced twice before the test as falling rain froze on the casing.

With weather conditions worsening, test officials decided to go ahead as soon as technicians had everything ready. As a result, the test went off 15 minutes earlier than scheduled on Nov. 20.

Dennis Miller, senior manager of the Validation and Qualification Group (1530) that conducted the pull-down test, sent an email a few minutes after the test, saying preliminary information was all positive. "The test unit was released successfully, and there is a big hole in the concrete target," he wrote.

Emails of congratulations came in from around Sandia, including from Deputy Labs Director and Executive VP for National Security Programs Jerry McDowell ("Early congratulations to all.") and Div. 2000 VP for Weapons Engineering and Product Realization Bruce Walker ("Fantastic news. My congratulations to the team.")

"It's been a long time coming," Dennis said shortly before the test. "There's been a lot of planning and anticipation."

Data is precious

Sandia's annual surveillance program for each weapon type consists of flight tests, lab tests, and component and material tests.

Flight tests, the most realistic, subject the test unit to shock, vibration, temperature extremes, rotation, weather, and so on. "Data from flight tests is precious because it is from a single-shot device," Patrick says.

Sandia had worked toward the test since March 2010, the end of a hiatus on all such testing that was prompted by an October 2008 accident at Sandia's 10,000-foot sled track. In the last three years, Sandia rebuilt its ability to run the tests, including reconstructing the firing set and safety systems that ignite the rocket motors and explosives-driven cable-cutting systems at the aerial cable facility, acquiring new rocket motors, and putting a strong emphasis on safety and technical performance assurance for the test. In addition, it rebuilt a team. Dennis says nearly all the employees and contractors who set up November's test had never participated in a pull-down test before.

"This is a very complicated test," he says. "There were about 60 test participants at the pre-job briefing. This team has been great to work with and together they really did an excellent job."

Sandia pulls units randomly from the stockpile for such tests, as well as for lab tests on the weapon's nonnuclear components. Flight tests drop units from aircraft the Tonopah Test Range in Nevada.

The nuclear package, removed prior to the tests, is studied separately by the design laboratory, either Los Alamos or Lawrence Livermore national laboratory. Lab tests study the nonnuclear components under different conditions. Environments are more controlled so researchers can closely measure how components function. Other laboratory tests examine components and materials for signs of aging by repeatedly subjecting them to various conditions.

As test preparations moved forward on Nov. 20, a radio on a table in the room crackled with updates: the rocket motors and explosives were wired; the test team pulled back to a control facility 5,000 feet away to arm the firing system remotely; the final countdown of 5-4-3-2-1. A camera that had been focused on the weapon panned down to the target at T minus 30 seconds to capture the weapon slamming through the concrete.

An unimaginable amount of detail and work goes into getting as much information as possible out of the tests. This one involved a series of calibration tests and qualifying reviews beforehand, dozens of people from Divisions 2000, 4000, and 1000, as well as researchers from Los Alamos who had components on the weapon and personnel helping set up and monitor the test. Some of the test team arrived to begin final preparations at 4 a.m. on test day. Sandia's Emergency Operations and the Kirtland Air Force Base Fire Department were on hand when the test went off.

Afterward, the radio continued to snap out updates: no fires — a possibility from burning rocket fuel debris; no debris from the weapon around the target; levels of toxic gas from the burning rocket propellant at zero; the cable cutters all fired; in short, everything at the scene indicated the test was normal.

"Boring is good," commented Justine.

The area was declared safe about 15 minutes after the weapon hit the target, and the test team moved in to begin moving cables and cleaning up the site. Two large cranes moved the target the next day to allow technicians to excavate the B61 in preparation for sending it for disassembly at the Pantex plant in Amarillo, where it was built and where it will be disassembled for analysis.

"So, when can you run another one?" Patrick asked Dennis.

WORKERS DIG INTO THE EARTH to excavate a test B61-11 after removing a concrete target that covered the ground. Sandia conducted a rocket-driven test of the earth-penetrating weapon, minus its nuclear components, at the aerial cable facility last month.

(Photo by Randy Montoya)

Sandia Classified Ads

Note: The Classified Ad deadline for the January 10, 2014 paper will be 5 p.m. on Monday, Dec. 23. This change in the deadline applies only to the Jan. 14 paper.

MISCELLANEOUS

XBOX 360 CONSOLE, w/Kinect & controller, $125; HDTV, 55-in., Insignia, $650. Bennett, 936-223-1369.

HOLIDAY RENTALS, 2, Westin, Ka'anapali Ocean Resort, Maui, Dec. 28-Jan. 4, studio $1,000/wk., condo, $2,000/wk. Blanch, 505-850-9428.

BRIEFCASE, leather, new, $150; magnifying light w/outlet, like new, $60; large reptile tank w/extras, good condition, $150. Werner, 286-9393.

CHAIR & OTTOMAN, brown, leather, oak trim, chair measure 36" x 32", ottoman measure 24" x 24", $75. Potter, 505-999-7787.

FIREWOOD, used landscaping timbers, untreated wood, safe to burn, pile about 2' x 3' x 8', free. Schreiber, 977-4139.

WOOD, cedar & apricot, 3.02 cords, you load, $435. Gonzales, 505-296-8006.

iMAC, '06, 17-in., version 10.6 (Snow Leopard), w/1 GB memory, 1.83 GHz Intel Core, keypad & mouse, $150 OBO. Kepler, 296-0402.

ELLIPTICAL CROSS TRAINER, Kettler Vito XL, used 4 times, like new, retails for $1,200, make offer. Stockham, 505-449-7248.

RECUMBENT EXERCISE BIKE, Schwinn SRB-1500, $50; ski/snowboard rack, off '04 Subaru Forester OEM, Yakami, $50. Hietala, 610-1252.

DVD PLAYER, Sony, DVP-SR510H, w/remote, excellent condition, 2 available, $15 ea. Hennessey, 915-241-8634.

DOUBLE WALL OVEN, Whirlpool, 24-in., electric, black, fair-good condition, $150 OBO. Ludwig, 856-5111.

UTILITY TRAILER, enclosed, 5' x 8', $1,800 OBO. Gonzales, 975-4047.

HUTCH, small, handmade, perfect for girl's tea set or doll collection, free. Dodge, 301-6172.

PLAYSTATION 4, brand new-in-box, never opened, $650 OBO. Martinez, 505-205-3336, ask for Erik.

ACURA ROOF BOX, 55" x 35" x 18", used once, fits '03-'14 MDX, '07-'14 RDX, $250. Adams, 821-0899.

BILLIARD TABLE, Brunswick, 9-ft., mission-style, cherry finish, slate, drop pockets, beautiful, excellent condition, $2,900 OBO. Gjullin, 505-898-6784.

TIMESHARE, Wyndham, Durango, or other Wyndham property anywhere, $200/weekend up to $1,000/wk. Garcia, 280-5815.

GAS LOG FIREPLACE, built-in, zero clearance, complete w/logs, chimney pipe, valve, propane or natural, used, $300 OBO. Rector, 286-1217.

POOL TABLE, Sportcraft, $200. Norwood, 331-8608.

POOL TABLE, 8-ft., 44" x 88" playing area, MDF core, great shape, light brown oak, $500. Stromberg, 828-0892.

MOVING BOXES, packing paper, and tape, free. Salem, 259-0693.

DWARF PLECOSTOMUS catfish, about 10 yrs. old and 6" long. Free to good home. Montoya, 296-4268.

TABLE, beautiful, ornate, side buffet rectangular table, light/medium golden brown, excellent condition. de la Fe, 903-0717.

APPLE AIRPORT EXPRESS, never used, sealed in box, 802.11n Wi-Fi, $50. Hall, 280-4344.

TRANSPORTATION

'05 MONTE CARLO SUPER SPORT, 2-dr., AT, 110K miles, great condition, $7,900 OBO. Hunter, 363-8822, ask for Becky.

How to submit classified ads

DEADLINE: Friday noon before week of publication unless changed by holiday. Submit by one of these methods:

- **EMAIL: Michelle Fleming (classads@sandia.gov)**
- **FAX: 844-0645**
- **MAIL: MS 1468 (Dept. 3651)**
- **INTERNAL WEB: On internal web homepage, click on News Center, then on *Lab News* link, and then on the very top of *Lab News* homepage "Submit a Classified Ad." If you have questions, call Michelle at 844-4902. Because of space constraints, ads will be printed on a first-come basis.**

Ad rules

1. Limit 18 words, including last name and home phone (If you include a web or e-mail address, it will count as two or three words, depending on length of the address.)
2. Include organization and full name with the ad submission.
3. Submit ad in writing. No phone-ins.
4. Type or print ad legibly; use accepted abbreviations.
5. One ad per issue.
6. We will not run the same ad more than twice.
7. No "for rent" ads except for employees on temporary assignment.
8. No commercial ads.
9. For active Sandia members of the workforce, retired Sandians, and DOE employees.
10. Housing listed for sale is available without regard to race, creed, color, or national origin.
11. Work Wanted ads limited to student-aged children of employees.
12. We reserve the right not to publish any ad that may be considered offensive or in bad taste.

'88 FORD E150 ECONOLINE VAN, white, 58K original miles, very clean, $4,000 OBO. Barboa, 859-1510.

'07 HONDA CIVIC LX, 2-dr., 5-spd. manual, black, 1 owner, 35K miles, 30/40-mpg, $10,500. Wareing, 505-652-2883.

'05 NISSAN MURANO SE, 1 owner, 97K miles, excellent condition, $9,000 firm. Cheng, 823-9160.

'08 HYUNDAI SONATA GLS, 26-30-mpg, 113K miles, very clean, very good overall condition, $8,400. Gregerson, 417-4907.

'05 TUNDRA DOUBLE CAB TRD, 97K miles, w/new water pump & timing belt at 90K miles, $11,500 OBO. Liddle, 505-352-4856.

'96 CORVETTE, AT, AC, radio/CD, custom wheels, purple, 96K miles, everything works & runs great, good tires, $9,300. Kelly, 797-1475.

'79 EL CAMINO, new 350ci Chevrolet engine, transmission, front suspension, tires, interior, $4,500. Marchi, 933-0688.

'02 FORD FOCUS ZX5, 4-dr. hatchback, new tires, dealer maintained, 130K miles, reliable, fun to drive, excellent condition, $3,500. Galbraith, 269-2889.

RECREATION

'95 GULF STREAM, class A, 34-ft., slide out, new tires, Ford 460 engine, 18-ft. awning, 6.6-KW generator, 2 TVs, excellent condition, $22,500 OBO. Garcia, 505-554-2690.

'12 GREEN KONA SHONKY DIRT JUMPER BIKE, hardly used, 26-in. rims, single speed, cromoly frame, $700. Russell, 414-2325.

'08 5TH WHEEL BUNKHOUSE, 36-ft., 1-1/4 bath, '05 Dodge dually 1 ton, quad cab, 4WD, $48,000 OBO, will sell camper separately. Rankin, 505-238-9963.

'10 JAYCO JAY FEATHER TRAILER, loaded w/options, sleeps 5, like new, $12,500. Sanchez, 505-639-4235, ask for Frankie.

REAL ESTATE

4-BDR. HOME, 2 baths, 1,800-sq. ft., covered porch & deck, gated & walled backyard, newly remodeled, San Francisco/Wyoming, owner will finance, easy terms. Mihalik, 281-1306.

4-BDR. CUSTOM BRICK HOME, 3 baths, 2 living areas, 3,867-sq. ft., finished basement, pool/spa, Foothills, great views, MLS#770605. Maestas, 505-239-1054.

WANTED

ROOMMATE(S), in Volterra, 5 mins. from Eubank gate, $500/mo., utilities & WiFi included. Guillen, 505-385-8189.

WORKING VCR, w/remote & manual, will pay $50. Chorley, 296-1454.

USED SUBARU IMPREZA 2.5 RS ENGINE, to replace damaged motor, miracle needed. Sotelo, 298-0358.

GOOD HOME(S), 2 dogs, 4-lb. Pekingese/Yorkie, 14-lb. Pekingese/Tibetan Terrier, very affectionate, neutered, playful, photos available. Orozco, 505-301-7807.

HIGH SCHOOL LACROSSE REFEREES, or interested in learning to referee, call for more details. Owens, 823-9099.

HOUSEMATES, large home, Nob Hill, 6-bdr., 4 bath, bomb shelter, backyard. Jameson, 240-217-1658.

ROOMMATE, 3-bdr. home, 2-1/2 baths, finished basement, near Wyoming/Academy, furnished room, $600/mo., utilities included. Atchison, 235-5651.

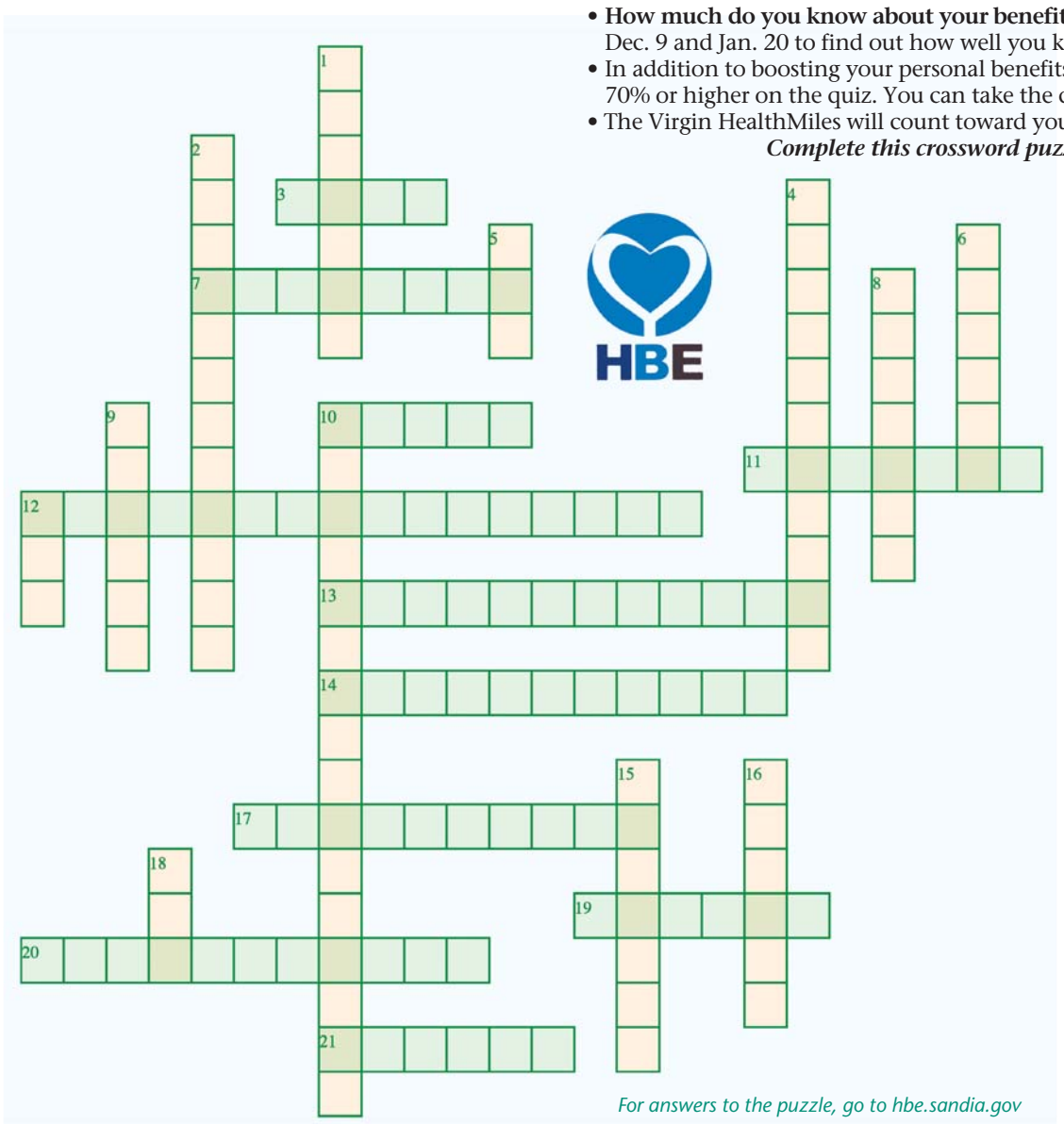
LOST AND FOUND

FOUND, bicycle helmet, left in 802/3394 sometime in the last few months. Brosseau, 844-1049.

Be a savvy healthcare consumer: Take HBE's Knowledge = Power quiz

- **How much do you know about your benefits?** Save the date to take HBE's Knowledge = Power Quiz between Dec. 9 and Jan. 20 to find out how well you know your Sandia benefits.
- In addition to boosting your personal benefits knowledge, you will earn 1,000 Virgin HealthMiles if you get a 70% or higher on the quiz. You can take the quiz as many times as necessary.
- The Virgin HealthMiles will count toward your 2015 Health Reimbursement Account (HRA) earnings.

Complete this crossword puzzle to prepare for the Knowledge = Power Quiz.



For answers to the puzzle, go to hbe.sandia.gov

KNOWLEDGE
You and Sandia = Total Health
POWER

ACROSS

3. This narrow network requires members to pay 10% coinsurance (acronym)
7. Prescription for zoster/zostavax is used to prevent __ and is covered at 100%
10. Blue Cross Blue Shield replaced this medical administrator
11. On average, this doctor visit costs $135
12. Complete each year to earn $250 towards HRA
13. Go here during the workday when you're injured
14. You can use an __ of benefits to file manual claims
17. My individual __ is $750 for the plan year if I visit in-network providers
19. Name of Sandia's incentive program
20. Important preventive screening covered at 100% for people 50+
21. Employees share approximately this percentage of medical & prescription plan costs

DOWN

1. How much do covered preventive services cost the member?
2. Express Scripts is the administrator of which benefits program?
4. After I pay my in-network medical & Rx deductible, I will pay 20% in this
5. Funds that do not roll over to next year and paid out first (acronym)
6. Northern California Sandia Total Health Administrator
8. $2500 is the ___ I can contribute to my FSA
9. Any healthcare expenses when filed with an insurance company
10. An onsite representative that can help with plan and benefit questions
12. Funds contributed by Sandia, capped, and paid out second (acronym)
15. The name of Sandia's __ and prescription plan is Sandia Total Health
16. $1250 is the maximum HRA annual contribution for this coverage type
18. Delta Dental network with the most savings (acronym)

Engineered Safety: Examples from Div. 1000

By Sue Major Holmes

Manager David Epp (1522) has a pointer for doing Engineered Safety: Use what already works.

His organization had a Work Planning and Controls process before the advent of Engineered Safety. It had looked at hazards in its laboratories, figured out what could be done to mitigate them, and documented what it had done.

But Engineered Safety ramped up a rigorous identification of hazards, David says.

"We really tried to focus on improvements. How do we implement Engineered Safety and improve the system we have without throwing it all out and starting from scratch?" he told a November Engineered Safety brown bag that Div. 1000 sponsored to allow different groups within the organization learn by examples presented by other groups.

Engineered Safety entails a fundamental shift in how Sandians think about safety. Rather than relying on processes such as checklists, it concentrates on assuring safe operations through critical thinking in a system's design and operation. New activities are now conducted under Engineered Safety procedures and policies.

"The thing that keeps people safer is not us writing down what we're doing. It's thinking critically about the hazards and how we're mitigating those hazards for our people," David says. "It's talking to the people who might be immediately exposed to those hazards, making sure they understand how we want them to behave. . . . It's something we were doing before that we're trying to emphasize even more now."

Manager Gordon Leifeste (1647) said the Shock Thermodynamics Applied Research facility, or STAR, also had safety plans before Engineered Safety. When it came along, existing plans became the foundation for thinking about what new work needed to be analyzed.

"You take the best things you were doing before, test-drive a problem you face, then go forward" by looking at and talking about an operation and summarizing its hazards, he says.

Duane Dimos, VP of Science and Technology Div. 1000, says safety cases now do a "better blending of design with the formal conduct of operations." Engineered Safety, he says, "is really about conducting safe operations in a way that makes good sense for us as technical people with the right amount of documentation."

Gordon says safety plans for STAR define standard and non-standard shots, examining the procedures for setting up tests with engineered and administrative safety controls, and detailing how to mitigate each test's unique hazards.

David says Group 1520's 15 test facilities, ranging from shock and vibration to radiography, ran more than 700 tests in 2012. Since it's impossible to write an engineered safety case, or plan, for every test, the group wrote a case for each of the 15 operations. Plans look at the entire system rather than individual parts, and focus on changes to a particular operation, he says.

ENGINEERING SAFETY INTO OPERATIONS — Bill Reinhart, left, and Tom Thornhill (both 1647) stand beside a gun at the Shock Thermodynamics Applied Research (STAR) facility, checking out a projectile before it is loaded for a physics material test. Plans for every shot include Engineered Safety. (Photo by Randy Montoya)

"The general hazards associated with the facilities don't change," he says.

What changes are the parts sent into labs for testing, so those tests became modifications to the engineered safety case for each particular lab. "Treating tests as modifications or changes that we could track made a lot of sense," David says.

If a test falls within normal operations, facility managers make sure equipment works, everyone's training is up to date, and review standard operating procedures. If a test is outside normal operations, managers not only check equipment, training, and standard procedures, but also evaluate how to mitigate the new hazard, then add those modifications to the safety case for that particular lab, David says.

N.M. Safety Professional of the Year awarded to Sandia Labs employee

By Heather Clark

A Sandia environment, safety, and security professional has been awarded the New Mexico Safety Professional of the Year Award by the American Society of Safety Engineers (ASSE) for her expertise in the safety profession, including her work with Sandia researchers to make their labs as safe as possible.

Terri Wallis (1835), who has been a safety professional for 13 years, joined Sandia in 2011. She works with researchers who routinely deal with a variety of potential chemical, electrical, and pressure hazards in their laboratories.

TERRI WALLIS

"I chose safety as my career because I don't want anyone to get hurt or sick, whether at work or in the community. The management support of the safety culture we have at Sandia is the best of any employer in my experience," Terri says. "Working with ASSE has provided opportunities to improve my knowledge of safety and share best practices with other safety professionals locally and nationally. I am truly honored to receive this award."

Sandia manager Hazel Barclay (1001) says Terri works side-by-side with researchers to plan their work to mitigate safety issues. Terri helps them identify hazards and the proper controls for a variety of laboratory projects.

"I'm so proud of Terri and her achievement. She is extremely active in the environmental, safety, and health community," Hazel says. "At Sandia, safety comes first, and Terri works closely with other employees in proactive work planning and engineered safety. This award shows that Terri is at the forefront of that effort, demonstrating her vigilance about safety and embedding safety practices in everything she does."

Terri serves as vice president of the New Mexico Chapter of the ASSE and brings information from the organization to her safety co-workers at Sandia, Barclay says.

Terri gained certification from the Board of Certified Safety Professionals in 2007. She became a certified hazardous materials manager with the Institute of Hazardous Materials Management in 2009 and a certified ergonomic assessor specialist from the Back School in Atlanta in 2008.