Sandia offers the world a fertilizer that fizzles as a bomb

BOMB-PROOFING FERTILIZER — Chemical engineer Vicki Chavez (6633) worked with now-retired Kevin Fleming to prove that iron sulfate mixed with ammonium nitrate could produce a non-detonable fertilizer. (Photo by Randy Montoya)

By Nancy Salem

Ammonium nitrate is an essential fertilizer, high in nitrogen and a staple of the agricultural industry. But it has a dark side.

The raw ingredient in about 75 percent of the improvised explosive devices (IEDs) in Afghanistan is ammonium nitrate, according to US government reports. The fertilizer is illegal in Afghanistan but legal in neighboring Pakistan, where a quarter of the GDP and half the workforce depend on agriculture.

During Afghanistan's 11-year war, IEDs have killed more American troops than any other weapon. About 1,900 troops were killed or wounded in IED attacks in 2012, 60 percent of American combat casualties. Ammonium nitrate was used in about 16,000 bombs in Afghanistan in 2012, up 200 percent since 2008, according to government reports.

US efforts to curb the flow of the fertilizer into Afghanistan through seizures, export controls, and diplomacy have had limited success.

Kevin Fleming, a Sandia optical engineer who also did counter-IED training for the military, took a different approach. He has developed a fertilizer formula as good as, if not better, than ammonium nitrate, but not detonable. And Kevin, with the support of Sandia officials, decided not to patent or license the formula, but to make it freely available in hopes of saving lives.

An Achilles Heel

"I looked at it differently," says Kevin, who retired from the Labs in February. "I've been an organic gar-

(Continued on page 8)

Sandia LabNews

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Sandia National Laboratories

DEPLOYED FOR GOOD

Michelle Racicot, a family nurse practitioner at Sandia and an Army veteran, was one of 14 women recognized on March 19 by first lady Michelle Obama as Champions of Change, honoring women veterans who have made a major impact on the nation's communities, businesses, and schools. Story on **page 12.**

Back in business!

Full-scale test operations resume at the sled track

(Photo by Mark Nissen)

By Stephanie Holinka

Recently, Experimental Operations Dept. 1533, Mechanical Environments Dept. 1534, and Sensing & Imaging Technologies Dept. 1535, with Environmental Safety & Testing Dept. 6234, got the go-ahead to plan and execute the first full-scale sled track test since the suspension in 2008.

The test series included an initial rocket sled track test, followed by a full-scale burn test that subjected the test object to temperatures similar to a catastrophic fire.

The restart challenges were so formidable that some thought Sandia had performed its last sled track test.

Steven Samuels (1534), technical lead and test director, says the team overcame those challenges to meet the customer's requirements, while incorporating engineered safety into the test design.

This test series was planned for a few years ago, but was delayed because of the

(Continued on page 5)

Full-scale test operations also resume at Sandia's outdoor burn site. Story, photos on **page 5.**

Always Safe: Strides along Sandia's safety journey

By Cathy Ann Connelly

"I know we have made good progress with our safety objectives, but an objective examination of our record indicates that we are not where we would like to be. The concept of safety must become a state of mind, integral to our daily behaviors. We need to transform the way we think and approach our work, both here and at home. Safety must be an inherent value and ingrained in everything we do because safety is critical to mission success."

Excerpt from video by Paul Hommert, Sandia President and Laboratories Director and Chief Safety Officer, December 2012

In its 2012 Performance Evaluation Report (PER), Sandia's annual report card, the National Nuclear Security Administration (NNSA) downgraded Sandia's operational performance from "Very Good" in 2011 to "Good."

The 2012 PER states, "Although Sandia is maintaining effective programs in Operations, Sandia continues to have difficulty in several areas. Sandia continues to struggle with demonstrating a safety-conscious work environment and line implementation of Work Planning and Control (WP&C) requirements as evidenced by both operational events and external assessments. Although

(Continued on page 11)

Inside . . .

That's that

NOVA has always been one of the very best science programs on television. Its stories are thoughtful and thought-provoking, informative, balanced, and expertly produced. There's a good reason why the program has survived in a very volatile business for almost 40 years now. Shunning hyperbole and sensationalism (for the most part) NOVA has built and retained a loyal following of viewers who wouldn't miss the show for anything.

My guess is that most NOVA productions are months in the making. But over the years, the program has shown it can turn on a dime when the situation demands. In the latest example, NOVA had a production team on top of the Chelyabinsk meteor impact story within days of the Feb. 15 incident.

The resulting program, aired March 27, examined the meteor incident and the challenges such events pose for the safety of the planet. One of the "stars" of the show was Sandia's own Mark Boslough, one of the world's experts in the field. Watching Mark's quite considerable contribution to the program, it's easy to see why he has become a go-to guy for documentary video crews. He doesn't just know his stuff; he is terrific at conveying a sense of wonder about it all. Here's Mark from the NOVA program: Holding a small fragment of the Chelyabinsk meteor recovered by a Russian colleague, he says, "What's amazing to me, when you think about it, this is part of an asteroid that has been floating through space, orbiting the sun for billions of years, and two weeks ago it exploded in the atmosphere, dropped to the ground, and here I am holding it in my hand. That's amazing."

You can see the NOVA program, "Meteor Strike," on the PBS website. It's worth checking out.

* * *

Staying on subject, the Chelyabinsk meteor, and the unrelated close encounter with asteroid DA14, which on Feb. 15 passed uncomfortably close to Earth on its huge elliptical orbit, ought to be a wake-up call for governments around the planet. These two episodes are a vivid reminder that asteroid impact is not just the stuff of Hollywood blockbusters. If DA14, which was discovered just a year ago, had hit the Earth, instead of passing a too-cozy 17,000 miles away, experts say it would have been energetic enough to flatten London. And here's a scary thought: The Chelyabinsk meteor wasn't charted at all. Scientists didn't know anything about it until it slammed into the atmosphere at 33,000 mph.

We need to listen to retired astronaut Ed Lu, who spoke at Sandia/California a year ago. Lu is a board member of the nonprofit B612 Foundation, whose goal is to have the nations of the earth establish a reliable asteroid early warning system and an associated deflection capability. At that Sandia talk, Lu said: "Our fundamental belief is that humanity is worth protecting. Each and every day, we are putting 10,000 years of civilization on the line. If we don't look for asteroids, then frankly what have we built all this space technology for if not to do this? Odds are we aren't going to be hit by an asteroid tomorrow but long term I guarantee we will be hit unless we do something." He's right, plain and simple.

* * *

Saw an ad the other day for an upcoming tour stop here in Albuquerque by the Kingston Trio. Or should I say "Kingston Trio?" The original Kingston Trio, which emerged out of the coffee house scene in the Bay Area, was really hot stuff back in the late 1950s-early1960, launching a folk music revival that set the stage for such original artists as Bob Dylan and Joan Baez, who opened the way, in turn, for a new kind of American rock music epitomized by groups like The Byrds, Buffalo Springfield, Jefferson Airplane, and . . . this is beginning to sound like a lecture from Jack Black in *School of Rock*. The point is, the Kingston Trio was big. Really big. And they're still on the road. Or should I say "they're" still on the road. I use the quotation marks because the original members of the Trio have long since departed. As the group's own website puts it, "Over the years, the trio has welcomed fresh faces to the act as others move on. Nevertheless, the revolving lineup maintains the spirit and excellence that elevated the original lineup to international fame." So they aren't *really* the Kingston Trio. Or are they? This is a very deep question. Metaphysical, even. All of which reminds me of Grandpa's ax . . . We've changed the handle eight times and the head four times, but we wouldn't part with it for anything. Because Grandpa cleared the whole back 40 with it.

See you next time.

Bill Murphy (505-845-0845, MS1468, wtmurph@sandia.gov)

Take our Daughters and Sons to Work Day, Earth Day observed April 25 in New Mexico

Sandia's New Mexico site will observe Take our Daughters and Sons to Work Day and Earth Day with a full suite of activities on Thursday, April 25.

Sandia employees and contractors can invite children to visit their workplace to learn more about their hosts' work and Sandia's mission. This event can also be an avenue to encourage students to pursue science, technology, engineering, and math careers. Children in grades 5-12 are invited to attend and guests can include children, relatives, or friends. Registration is required for all guests. Management approval is required.

Plan to spend some time on Hardin Field between 10:30 a.m. and 1:30 p.m. enjoying lots of hands-on activities or head over to the Steve Schiff Auditorium to check out the Earth Day displays.

Visit the website (http://info.sandia.gov/todtwd/registration.html) to view registration requirements, download the registration form, view lists of scheduled activities, and review safety and security requirements.

Bring two copies of the completed form with you to Bldg. 825 (Steve Schiff Auditorium/TTC) or Bldg. 10600 (International Programs Building, Research Park) on April 25 between the hours of 6:30 and 9:30 a.m., to register for the event. After 9:30 a.m., registration will take place at the badge office in the IPOC building.

Questions to Pam Catanach (3652) at 284-5211.

Lab News Reader Service

The *Sandia Lab News* is distributed in-house to all Sandia employees and on-site contractors and mailed to all Sandia retirees. It is also mailed to individuals in industry, government, academia, nonprofit organizations, media, and private life who request it.

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Retiree deaths

Charles L. Ray (age 84) . . . . . October 21
Richard C. Zaluga (88) . . . . . October 25
David Maurice Webb (89) . . . . . November 5
Norman A. Smith (90) . . . . . November 7
James H. Hall, Jr. (90) . . . . . November 11
Willis J. Whitfield (92) . . . . . November 12
Thomas W. Eglinton (88) . . . . . November 16
Roland H. Cleveland (91) . . . . . November 18
Richard Kidd, Jr. (90) . . . . . November 24
Joseph B. Flanagan (79) . . . . . November 28
R.E. Henderson (91) . . . . . November 30
G.F. Wright, Jr. (77) . . . . . December 7
Clement J. Wagner (99) . . . . . December 9
James P. Gallagher (86) . . . . . December 15
Fidelino Carrillo (80) . . . . . December 15
John Noble Johnson (97) . . . . . December 15
Leonard K. Kracko (79) . . . . . December 18
Barbara L. Wheelock (93) . . . . . December 21
Donald L. Werner (79) . . . . . January 4
Robert W. Roberts (90) . . . . . January 11
J. Andrew Johnson (97) . . . . . January 14
Robert W. Weaver (92) . . . . . January 14
Daniel M. Garst (90) . . . . . January 17
Larry M. Claussen (67) . . . . . January 21
John H. Lloyd (82) . . . . . January 26
Roy W. Hunter (80) . . . . . January 27
W. Leroy Thomas (71) . . . . . January 28
Sylvester C. Tafoya (73) . . . . . February 4
Elden L. Prawitz (98) . . . . . February 7
Harry H. Pike (80) . . . . . February 11
Joseph E. Sieglitz (86) . . . . . February 18
Otis L. Cox (83) . . . . . February 21
Orlando Torres (81) . . . . . February 22
Robert C. Romero (72) . . . . . March 9

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Bill Murphy, Editor **505/845-0845**
Randy Montoya, Photographer **505/844-5605**
Mike Janes, California site contact **925/294-2447**
Michael Lanigan, Production **505/844-2297**

Contributors: Michelle Fleming (Ads, Milepost photos, 844-4902), Neal Singer (845-7078), Patti Koning (925-294-4911), Stephanie Holinka (284-9227), Darrick Hurst (844-8009), Stephanie Hobby (844-0948), Heather Clark (844-3511), Sue Holmes (844-6362), Nancy Salem (844-2739), Jennifer Awe (284-8997), Cathy Ann Connelly (284-7676), Jim Danneskiold, manager (844-0587)
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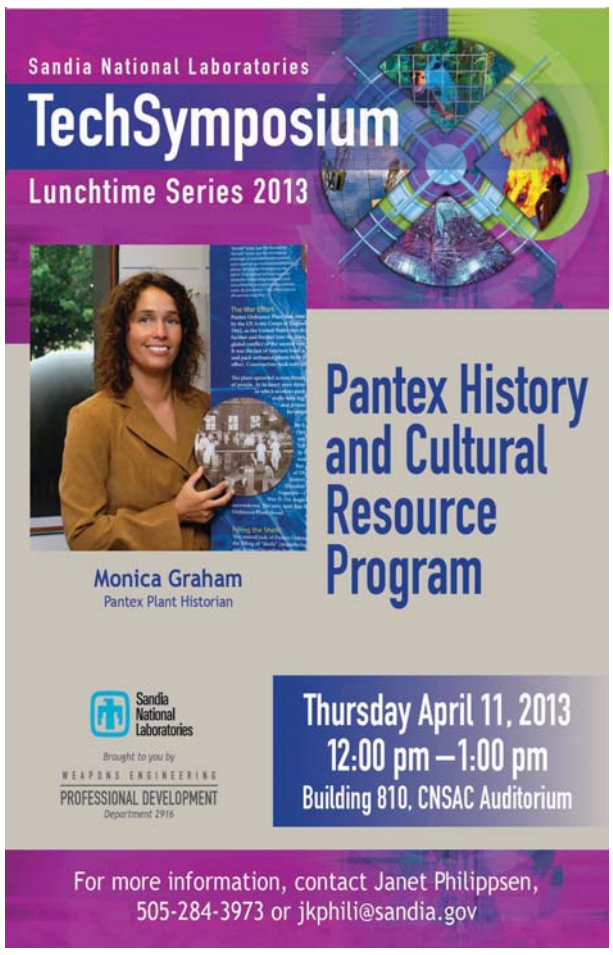


Sandia CaliforniaNews

Long-distance microscopy

By Patti Koning

Just over a year has passed since the day that Doug Medlin and Josh Sugar (both 8656) held their breath as they demonstrated remote operation of Sandia's new aberration-corrected scanning transmission electron microscope (AC-STEM) during the Materials Science & Technology external review panel's visit to Sandia-Livermore. Doug and Josh did their demonstration from an office in building 916 on the California site; the AC-STEM is located in building 897 in New Mexico, more than 1,000 miles and three states away.

"We were pretty nervous with that first demonstration, but it worked beautifully," says Doug.

Since that first day, the remote operation system has transformed the way that the two scientists work. "Sitting here, we see exactly the same thing that someone in New Mexico sees, working just a few feet away from the microscope," says Josh. "The only difference is we have to rely on them to physically load our samples."

The idea for operating the AC-STEM remotely from Livermore came up in planning for purchase of the instrument. "This is a very expensive instrument with a costly service contract, so we decided to share the cost between 1100, 1800, and 8000," explains Sarah Allendorf (8650). "But the reality of traveling to Albuquerque from Livermore is a pretty big barrier to regular use, so we were eager to create a remote solution."

> ***"The microscope has really exceeded our expectations and is an absolute joy to work with."***
>
> **— Doug Medlin**

The challenges to implementing the remote operation system were ensuring fast, real-time adjustments of the instrument from Livermore and working within Sandia's stringent network security requirements.

"I was afraid the experience would be like a bad video game. My fear was that if our researchers were unable to make real-time adjustments to the instrument, it would be extremely frustrating to use and possibly unworkable," says Sarah. The researchers need to make fine corrections to the lens optics and position miniscule samples with nanometer scale accuracy to image atomic-scale dimensions.

The solution was to employ a video compression system to enable a data transfer rate fast enough for the researchers in California to see their minute adjustments to the AC-STEM in real time. Without the video compression, says Doug, the lag between user control and visual response would make it nearly impossible to do even routine operations, let alone operate the instrument to its full capabilities.

Implementing the remote access required close cooperation between the information technology departments in New Mexico, California, and the vendor. "We had to get the right group of people together, and then it went very smoothly," says network solutions architect Rich Gay (8949). "This project really brings the sites together, which is our goal with the network."

Rich and his New Mexico counterparts designed a "bubble-net" within the larger network that connects the two sites. The bubble-net allows access only to the microscope and only by a few Sandians.

Reduced travel, increased collaboration

The most obvious benefit to the remote access is that it minimizes travel for Doug and Josh. They have to send their prepared samples to the New Mexico site and arrange for a colleague there to load the samples into the AC-STEM. Otherwise, they work just like their counterparts in New Mexico — scheduling time on the instrument and spending a day or two at a time using it.

The trend of working together as a team across sites has continued from the initial installation of the remote operation to the ongoing experimental work with the AC-STEM. "The teamwork involved between microscopists extends far beyond just loading samples. We are working together to push the limits of what the microscope can do. This is a theme that will continue as we take advantage of this unique capability," says Josh.

The remote access also allows for more collaboration with their colleagues at the California site because they can be present and see the immediate results of the analysis. The remote access is located in the same building that houses the offices and labs of other materials scientists.

"This is a benefit we didn't anticipate during the planning," says Sarah. "Doug and Josh can pull me, Norm Bartelt (8656), or Francois Léonard (8656) into the remote access lab to look at something. This leads to very rich conversations and inspires ideas for changes, follow-on experiments, and new work."

The AC-STEM is at the state-of-the-art of electron microscopes. In an article in the June 1, 2012, issue of *Sandia Lab News*, Paul Kotula (1822) described the instrument as "like a Lamborghini with James Bond features."

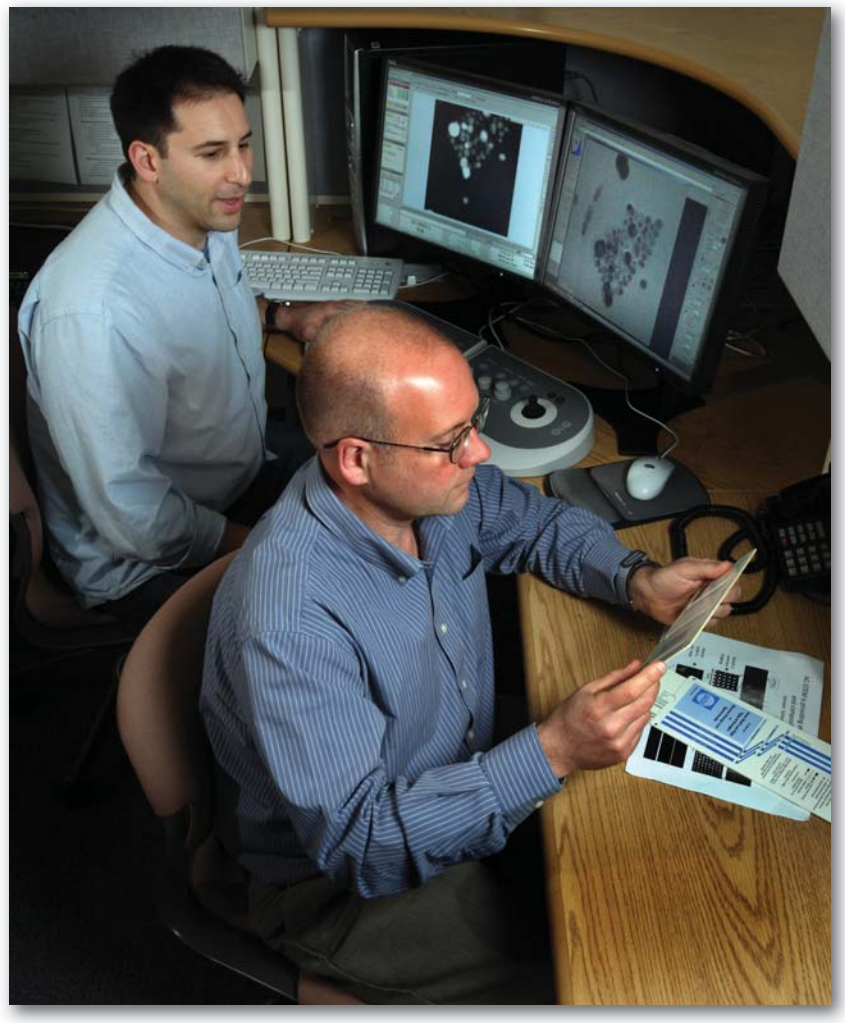
A tremendous benefit of the new instrument, say Doug and Josh, is the increased speed in collecting spatially resolved compositional data. What used to take several hours can now be accomplished in a matter of minutes or even seconds. These capabilities are now being applied to numerous projects at Sandia including work on component performance and reliability; energy conversion and storage technologies, such as thermoelectrics and battery materials; and fundamental materials science questions relating to interfacial structure, composition, and stability.

For instance, in one project, Josh is studying porous palladium particles with a rhodium skin. "Palladium is good at absorbing hydrogen, but the pores collapse at elevated temperatures," he says. "To address this, we can coat the particles with rhodium, which has a higher melting temperature and stabilizes the pore structure. But we need to know that the rhodium is where we want it to be."

The rhodium skin is so thin that with previous instruments Josh was unable to differentiate it from the particle. The aberration correction on the AC-STEM allowed Josh to see the skin clearly.

"The microscope has really exceeded our expectations and is an absolute joy to work with," says Doug. "This is an experiment on how to share capital equipment across all of Sandia."

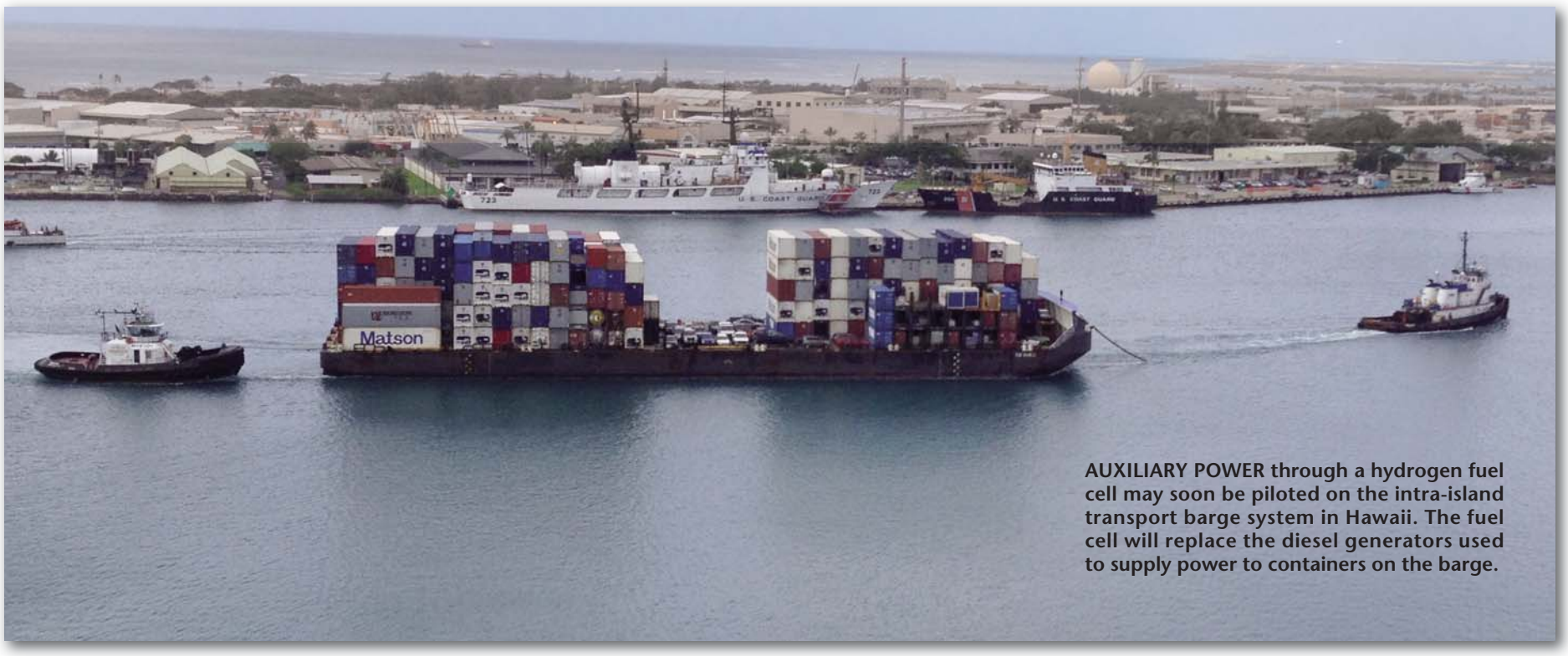
Josh adds that "the success of the remote operation capability demonstrates that access to high end instrumentation is no longer limited by physical location."



A REMOTE OPPORTUNITY — Josh Sugar, left, and Doug Medlin (both 8656) review images on the AC-STEM using remote operation in building 916 on the California site. (Photo by Dino Vournas)

Below, Paul Kotula, left, and Ping Lu (both 1819) have a nearly identical setup in New Mexico, except that they are within arm's reach of the AC-STEM. (Photo by Randy Montoya)

MARITIME PORTS may be the next deployment for hydrogen fuel cells



AUXILIARY POWER through a hydrogen fuel cell may soon be piloted on the intra-island transport barge system in Hawaii. The fuel cell will replace the diesel generators used to supply power to containers on the barge.

By Patti Koning

Hydrogen fuel cells may be heading out to sea in the not-too-distant future. Hydrogen fuel cells are being used in a variety of ways to provide efficient, pollution-free power — mobile lighting systems, forklifts, emergency backup systems, and light duty trucks, to name a few. Providing auxiliary power to ships in berth may be added to that list soon.

Joe Pratt (8366) and Aaron Harris (8367) recently completed a study for DOE's Office of Energy Efficiency and Renewable Energy that found hydrogen fuel cells may be both technically feasible and commercially attractive as a strategy for providing power to ships at berth and replacing on-board diesel generators.

Auxiliary power to stationary ships in port, usually provided by on-board diesel engines, is a significant contributor to greenhouse gas emissions and air pollution, accounting for one-third to one-half of the in-port emissions attributed to ocean-going vessels. For a busy place like the Port of Los Angeles, those average daily emissions could exceed that of nearly 200,000 vehicles, according to the paper "Harboring Pollution — Strategies to Clean Up U.S. Ports," by D. Bailey, T. Plenys, G. M. Solomon, T. R. Campbell, G. R. Feuer, J. Masters, and B. Tonkonogy, published by National Resources Defense Council, N.Y., August 2004.

Fuel cell strategy

The fuel cell strategy is simple — a hydrogen-fueled proton exchange membrane (PEM) fuel cell mounted on a floating barge. Supplying a container ship with average power and run times (1.4 megawatts over 48 hours) requires four 40-foot containers, two for the fuel cell and two for the hydrogen storage, which could readily fit on a typical flat-top barge. For ships requiring less power, like a tugboat, a single container housing both the fuel cell and hydrogen will suffice.

To evaluate the feasibility of this strategy and analyze potential deployment options, Joe visited ports along the West Coast and in Hawaii. He gathered data from two Department of Transportation Maritime Administration MARAD facilities and the ports of Long Beach, Los Angeles, Oakland, Portland, Tacoma, Honolulu, and Seattle.

"While Sandia has previously examined the potential for hydrogen and fuel cells in aircraft, construction equipment, electrical generators, telecom backup, man-portable power, and mobile lighting systems, this is the first study of a maritime environment," he says. "During the course of this study I learned what complex and amazing places ports are, with so much activity and so much variety between the individual ports."

An alternative to auxiliary diesel engines is a practice called "cold-ironing," in which a vessel at berth connects to a source of electricity on the shore. The engine, made of steel or iron, literally becomes cold, hence the name. Electricity supplied by a hydrogen fuel cell can be another form of cold-ironing.

Grid-based cold-ironing

The Navy has been employing grid-based cold-ironing for many years to save fuel. California is now turning to the practice to meet the state's tough environmental regulations. While only a few berths have grid-based cold-ironing, infrastructure is being installed at ports across the state to meet California Air Resources Board regulations that take effect in 2014.

Grid-based cold-ironing is complex and costly to implement, as most ports lack the necessary infrastructure to meet the power needs of multiple ships at berth. Those costs can run to $5-$10 million or more per berth. The Port of Oakland is installing 11 berths on six terminals at an estimated cost of about $70 million.

In addition, switching to grid-based power doesn't eliminate emissions. Instead, this approach shifts the emissions to the source of electricity. Depending on the electricity source, the overall reduction in emissions can be quite small.

The hydrogen fuel cell barge bypasses the need for electrical infrastructure. The barge also has the potential for higher usage because it can be moved from berth to berth as needed and to anchorage points to power vessels waiting for berths.

"In California, ports are already installing the necessary infrastructure for cold-ironing because of the regulations introduced a few years ago," says Joe. "So the need for hydrogen fuel cell auxiliary power isn't there. While this was an unexpected finding, we discovered other locations and applications for hydrogen fuel cell power."

At ports in Oregon and Washington, grid-based cold ironing infrastructure is limited or nonexistent. Using a hydrogen fuel cell for powering container ships at berth has attracted interest for the potential economic and environmental benefits. Joe continues to work with those ports on quantifying the benefits and deployment options.

In Hawaii's Honolulu Harbor in Oahu, a different need was found. Much of the cargo is unloaded and then reloaded onto barges for distribution to the other islands. As the barges have no power, they carry diesel generators to provide power to shipping containers that require refrigeration, known as "reefers."

"You can replace the diesel generator with a hydrogen fuel cell without changing the operations. It's just a power source in a box, a shipping container in this case," says Joe. Hawaii ports aren't facing the same strict regulation of emissions as California ports, but the potential savings in fuel cost is attractive for the company operating the inter-island transportation service, along with anyone else suffering from high fuel expenses.

Basic fuel cost analysis

The study's basic fuel cost analysis showed that hydrogen at about $4 per kilogram with a fuel cell can break even with maritime fuels at today's prices with a combustion engine. Subsequent analysis has shown that when generators are frequently producing less than maximum power (part load operation), such as in the Hawaii application, the efficiency difference between the fuel cell and combustion engine is widened. Even hydrogen at $5 per kilogram can potentially save tens of thousands of dollars per year for each generator.

"Fuel cost is only part of the total economic picture, but discovering that the cost-effective hydrogen price matches that which is expected to be available is an important finding," says Joe.

He is now developing a detailed plan for the Hawaiian inter-island transport barge application. "A successful deployment of the containerized fuel cell on a floating platform in a typical marine environment will be useful not only in this particular service, but also because it validates the concept for the larger, container-ship sized application," he says. "It's challenging on many levels, but technically feasible with potential commercial and worldwide impact."

SHIPS AT LOCATIONS such as the Port of Los Angeles, seen here, could reduce greenhouse gas emissions dramatically by using hydrogen fuel cell power for electricity needs while in port rather than relying on shipboard, diesel-powered generators.
(Photo courtesy of Wikipedia Commons)

Crash and burn: Full-scale test operations resume at the burn site

Story by Stephanie Holinka • Photos by Randy Montoya

Imagine having to design and perform a large-scale outdoor burn test that subjects an object to intense heat, when you weren't sure what condition the object would be in by the time it arrived at your door.

That was the challenge facing members of the Fire & Aerosol Sciences Dept. 1532 team as they prepared for their role in a recent test series of an engineering prototype designed by engineers in Environmental Safety & Testing Dept. 6234.

Large, potentially energetic fire tests can't be done at Sandia's indoor Thermal Test Complex, so the test was done at the Labs' outdoor burn site, which hadn't performed a full-scale energetic test in several years.

The series called for a sequential accident. First, crash the object on the sled track, then subject it to a catastrophic burn test that focused the flames on the most vulnerable part of the crashed test object, which could react violently if the prototype fails.

THE FIRE BURNED hot and tall for this first large-scale burn test in many years.

Despite the delay that resulted from a sled track accident in 2008 and its lengthy restart process, the customer chose Sandia because it could perform both tests in one place, a unique capability.

There were uncertainties going into the burn test.

"The burn test is the simplest one to do but it's the most risky because of all the work leading up to the test. It's tough because we are the last to get the package," says test director Walt Gill (1532).

FIRE & AEROSOL SCIENCES Dept. 1532 personnel prepare Sandia's Burn Site for a major test.

For burn testing, a test object is securely mounted to a stand in the middle of a large open pool. During the test, the pool is filled with fuel, which is set on fire. Instrumentation measures the characteristics of the fire, including temperature and duration.

"This is the first crash and burn series where we didn't know what we were mounting until after the sled track test," says manager Randy Watkins (1532).

Technical co-lead Sylvia Gomez-Vasquez (1532) says the team has done smaller fires at the outdoor burn site in the past few years, but had to revitalize the site for this test since it had been battered for years by New Mexico's high winds and harsh sunlight. Cables and instrumentation needed to be re-run and tested, in addition to other changes needed to support the test's larger scale.

Electrical power a concern

Technical co-lead Shane Adee (1532) says the energetic hazards of the fire meant that equipment the team could get to normally was unavailable because of a thousand-foot hazard zone. Many systems had to be automated and plans had to include redundancies in case of mechanical failures.

Walt says the team worried most about electrical power, which is often unreliable at the site since it's at the end of the power line. The team decided to use generator power; the setback requirements would prevent hooking up a second generator in the event of a failure during a test.

Walt says the fire met the customer's boundary conditions, burning for the right amount of time.

Doug Ammerman, Environmental Safety & Testing Dept. 6234 and the internal customer for the test, says the test was exciting, partly because damage from the sled track test differed from predictions.

"The prototype lost some of the insulating capability during the crash, so the fire was a little more nerve-wracking than normal."

Despite that, Doug says, the prototype performed well.

"The team spent five days validating that the materials inside survived the sequence of events. The materials survived, and the customer went away very happy that this concept will work for them," Doug says.

Walt says Sandia considered closing the outdoor burn site a few years ago.

"Because many types of fire tests can be done using models or inside the Thermal Test Complex, there was little attention paid to the outdoor site for the past few years, but it looks like we may be using it more during the next decade because we have customers calling for it," Walt says.

Randy says the site definitely will host more testing over the next few years, including possible crush and burn tests of car batteries.

Sled track restart

(Continued from page 1)

accident, and the lengthy path to restart.

The velocities and weights involved in the test, and the stringent hard target requirements made Sandia uniquely qualified for the work, Steve says. Additionally, Sandia's capability to conduct the burn test made the logistics easier, he adds.

Steve West (1535), electrical and systems engineer for the test, says the team felt a lot of pressure, but used the process to improve the technical basis of operations, and to make the most of the changes.

"We ensured safe operations without going overboard and burdening the staff in a way that would prevent us from doing the test," he says.

A more systematic approach to safety

Lead explosives operator Richard Ivey (1534) says, "Sled track testing is performed in an extreme environment. There's been a lot of outside attention on the energetics, but there are many other hazards that require the same level of attention when working in these environments."

Richard says that through an exhaustive hazard analysis, complete electrical design safety checks, and rocket motor inventory and selection practices, most potential risks "can be eliminated or mitigated."

"An internal goal of ours was to incorporate engineered safety practices into our operations, creating a more systematic approach to safety," says sled track facility director Michael Vigil (1533). "We looked at everything, with documentation to ensure that safety was repeatable and sustainable."

Michael, who was involved in the readiness reviews leading up to the restart, says the restart activities concluded that Sandia's technical activities were expert-based, and were run by exceptional people who were very good at what they did, but that safety practices weren't rigorously documented.

"If you don't document what you're doing," Michael says, "how are you going to pass on what you know and what you did to the next generation? We've learned from the experts who helped us figure out our approaches, but we then documented that information, so we don't have to go back to the expert again. The documentation lives on past the expert."

In addition to the technical evaluation, the team also paid close attention to human factors. For example, to ensure that fatigue wouldn't impair safety, the test plan implemented a 14-hour time limit for operations.

"We are now consciously accepting risk, when in the past we were unconsciously accepting risk. Because we understand the risks more thoroughly, we can better mitigate those risks," Steve says.

Applying this rigor across the board had unexpected benefits.

"We documented margins and the technical basis of both new equipment and legacy equipment," says instrumentation lead Quentin Kramer (1535).

The team discovered flaws in the safety basis for some equipment, which led to manufacturers issuing safety warnings and updates to their customers, Quentin says.

"We don't think of instrumentation and photometrics as being engineered, but they are," Quentin continues.

Steven says the test data will be used to ensure the customer's model is correct or to help redesign it. This test needed to capture data such as the object's impact velocity, impact angle of the test unit, accelerations of the test item during impact, and test object velocities as it travelled down the track.

"The cameras and instrumentation need to survive and capture the information. If there are no data or images the test is a failure," says photometrics lead Mark Nissen (1535).

More rigorous documentation

Steve says the work has also resulted in plans for updates to Sandia's explosives safety manual, so future test designers can design against this more detailed information.

More rigorous documentation is especially crucial because nearly half the team had never seen a sled track experiment at Sandia.

Though he's done a few small tests since starting at Sandia a few years ago, console operator Luke Lebow (1534) says he came to Sandia anticipating large-scale tests such as this one.

"Those of us who have never done a large-scale test wanted to do what we came here to do. This test is the coolest thing I've ever done," Luke says.

Michael says the team has trained a lot of new people such as Luke, but cross-trained experienced team members as well, using the revised documentation as the foundation for ongoing training.

Steve says some people thought that "we were putting systems into place that didn't bring any value. But the value those systems provide goes beyond a single test.

"Over time, we will forget that these things are requirements. Soon, they will just be how we do business every day."

Computer model used in softening steel

Predicting heat impacts on stainless steel microstructure

By Sue Major Holmes

Sandia researchers Lisa Deibler and Arthur Brown had a ready-made problem for their computer modeling work when they partnered with NNSA's Kansas City Plant to improve stainless steel tubing that was too hard to meet nuclear weapon requirements.

When steel is too hard it becomes brittle, so the plant ended up getting new tubing. However, Lisa says KCP needed a backup in case it couldn't find replacements in time to meet deadlines.

Sandia's modeling, coupled with experiments, allowed the rapid design of an annealing process to soften the tubing while keeping the metal's desired structure. The model predicted how the microstructure would be affected by variations in the process, which improved researchers' confidence that the heat treatment would produce parts that met specifications.

Arthur (8259), a modeler at Sandia/California, says working on the model was a natural extension of a larger project, supported by Sandia's Nuclear Weapons program, called Predicting Performance Margins. Under that program, numerous Sandia researchers are studying the way microstructure affects properties of materials at various scales. Arthur became involved in the project as a member of a team that developed a thermal-mechanical modeling tool to predict how microstructure and properties change during forging. That led to his collaboration with Lisa and her technical adviser, Joe Puskar (1831), on thermal profiles for welds.

When the need arose to address the tubing issue, Arthur says Joe contacted him to see if Arthur could work with Lisa to help optimize a heat treatment.

Experiments, modeling work together

Lisa, a post-doc in Sandia/New Mexico's Materials Characterization and Performance Department, provided experimental data that Arthur fed into his model of recrystallization in stainless steel. Recrystallization, in which grains in deformed microstructures are replaced by strain-free grains, occurs during annealing — the process of heating metal to dissipate energy built up while the metal is compressed, twisted, or otherwise worked. Heat makes the metal softer and more ductile.

Lisa and Arthur were able to solve the plant's real-life problem since recrystallization is part of the annealing process. And they were able to do it quickly because the model already existed.

> *"Looking at how different heating and cooling rates affect the microstructure during welding would give us valuable information."*
>
> **— Lisa Deibler**

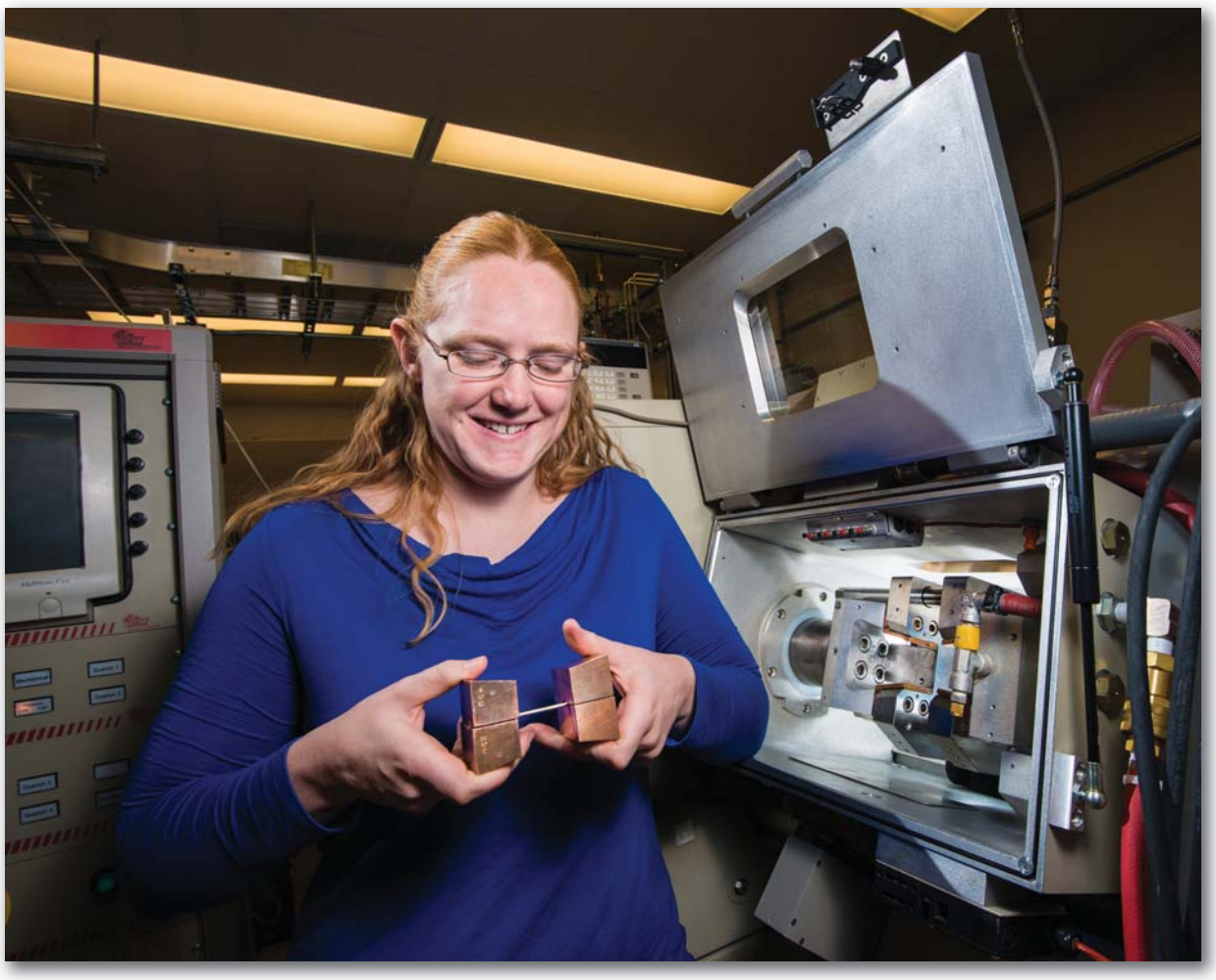
Lisa's experiments indicated it was important to model two softening mechanisms, recovery and recrystallization. Recovery occurs first within a microstructure when material is heated to soften it. By measuring the hardness and the amount of recrystallization after each heat treatment, Arthur and Lisa identified how much softening was due to recovery.

"It was important to model both softening mechanisms because we were seeing microstructures that contained no new recrystallized grains, but which had changed properties from the initial deformed material," Lisa says. "By failing to include the effects of recovery, our model couldn't predict why the properties weren't the same as the initial deformed material. Adding in recovery allowed us to account for the changed properties in microstructures with no recrystallization."

She described the work in a poster, "Design of a Heat Treatment to Soften Stainless Steel Tubing," presented at Sandia's winter 2012 Post-Doctoral Technical Showcase.

Solution required baseline for model

The team first developed a baseline for the model. Lisa performed heat experiments on the steel tubing since she didn't know the conditions under which it was manufactured. That effort required "a lot of shipping tubing around the country for various heat treatments," she recalled.



LISA DEIBLER (1819) HOLDS A TUBING SPECIMEN in a grip, ready to load it into the thermal-mechanical experimental system behind her. Lisa of Sandia/New Mexico and Arthur Brown (8259) of Sandia/California worked together to develop a simulation for an annealing process to soften tubing that was too hard for the requirements of the job. (Photo by Randy Montoya)

She put tubing samples in Sandia's thermal-mechanical experimental system at various temperatures for different lengths of time. Then she had the tubing sectioned, polished, and etched, and analyzed the images to see how much the microstructures had recrystallized. Arthur fit her data with the model to simulate different heat treatments.

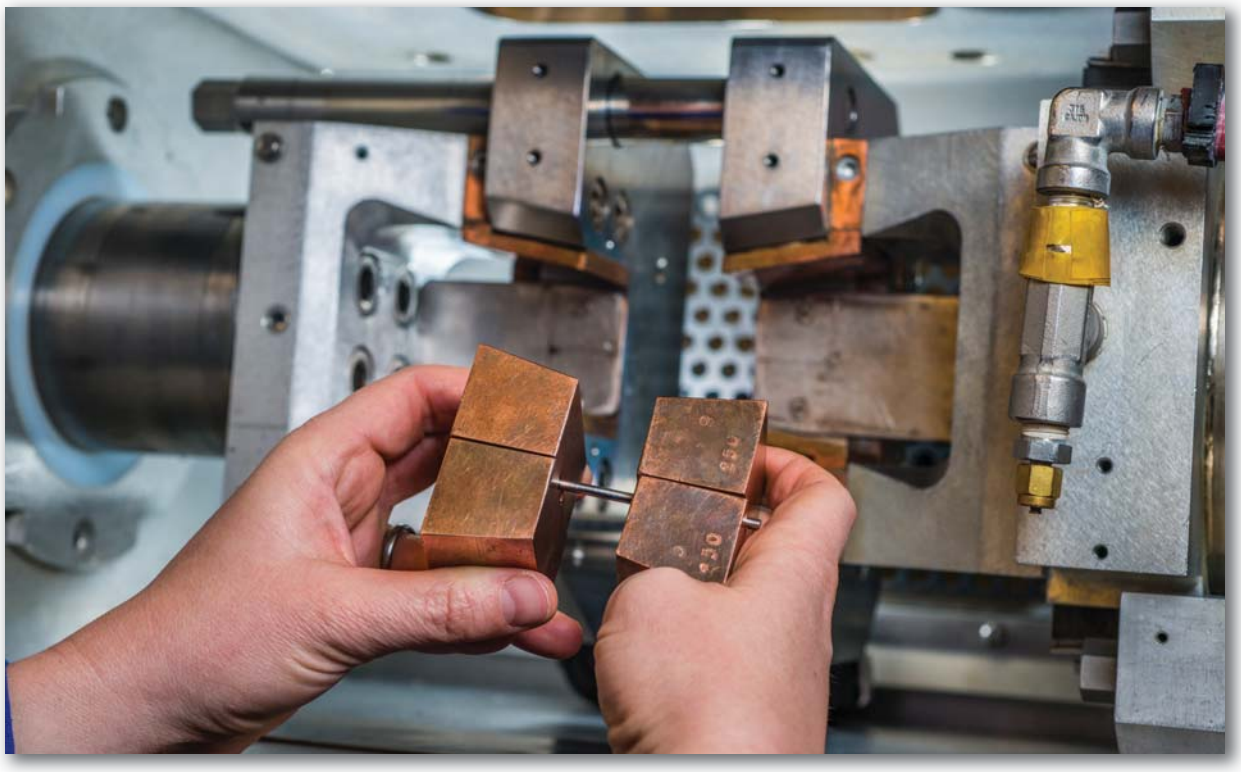
The simulation also required knowing something about the furnace where the tubing would be softened. Heating a furnace quickly tends to overshoot the desired temperature, so the team used the model to determine whether it was better to heat the furnace quickly or slowly raise it to the correct temperature, Lisa says. Once Arthur identified the optimal rate of increase and other factors, KCP technicians filled a furnace with tubing and measured the temperature at several locations inside. Arthur then ran those profiles through the model, which allowed him to predict the impact of temperature variations on the tubing's final properties.

Looking ahead

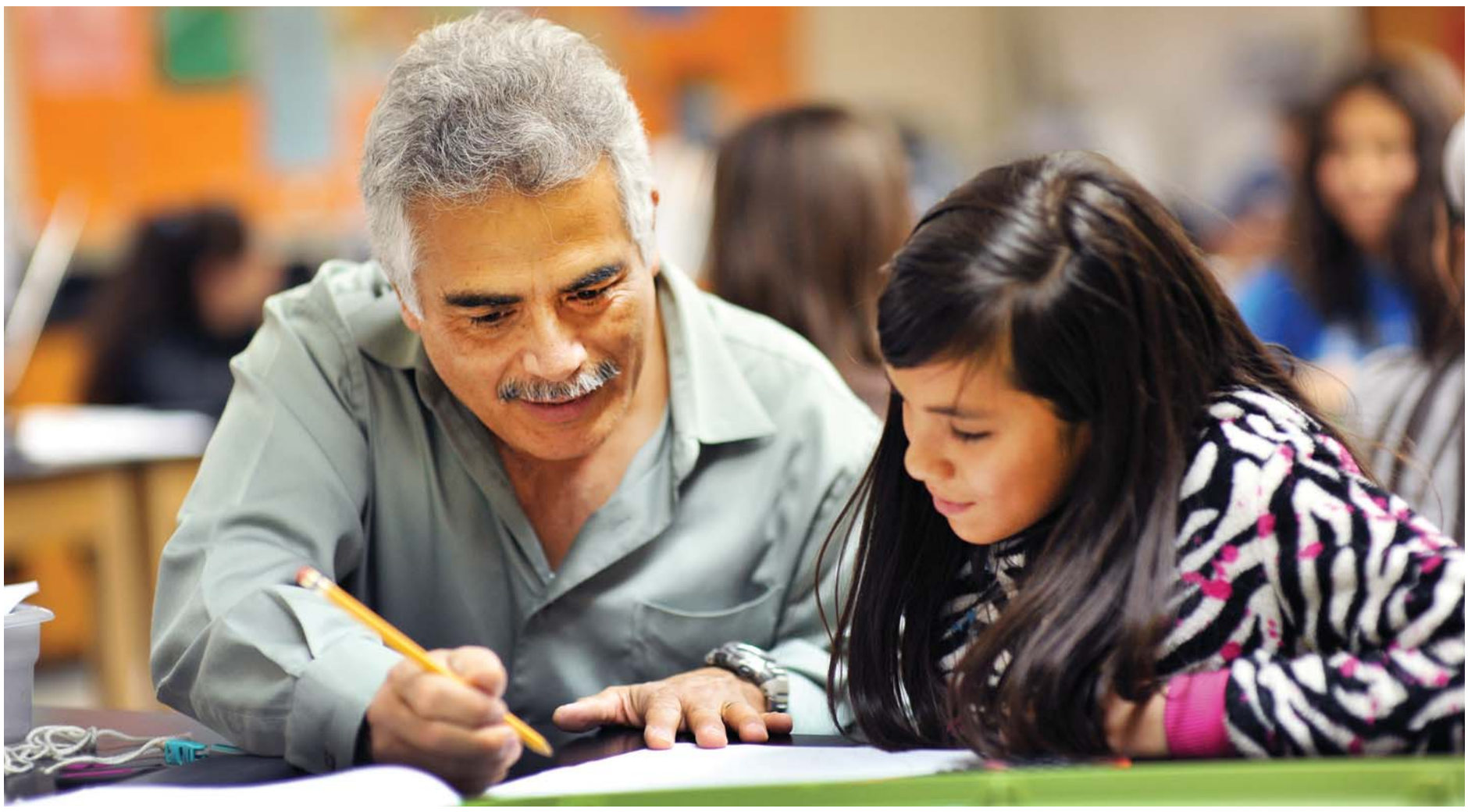
The researchers want the model to handle both forging and welding because in some ways the two processes work against one another. Forging steel gives it a strong microstructure, but welding adds heat that can destroy those properties. "So if you were able to model that process, that would provide a lot more confidence in the overall modeling that their parts aren't going to fail," Lisa says.

In the future, the researchers want to use the model for all kinds of welding at Sandia: laser welding, resistance welding, and gas tungsten arc welding. Types of welding vary in their thermal rates — how fast something is heated.

"Looking at how different heating and cooling rates affect the microstructure during welding would give us valuable information," Lisa says.



READY TO BE LOADED — A tubing specimen is held in Gleeble grips just before it is loaded into a thermal-mechanical tester. Sandia experiments and modeling allowed the rapid design of an annealing process to soften stainless steel tubing. (Photo by Randy Montoya)



Sandians kick off Manos program for Hispanic youth

Story by Stephanie Hobby • Photos by Randy Montoya

Last week, more than 140 Hispanic middle school students embarked on a four-week-long academic adventure designed to encourage students' interest in math, science, and engineering concepts. The Manos program was launched by Sandia's Hispanic Leadership Outreach Committee and Community Involvement Dept. 3652 in partnership with Albuquerque Public Schools. Manos is now in its 23rd year.

Twice a week, after school, students from several area middle schools board buses and head to Rio Grande High School for two-hour workshops. Students select one of seven workshops focused on physics, chemistry, electronics, computer design, robotics, finances, and introduction to engineering. Activities include building and flying rockets, learning what causes fireworks to have different colors and what makes bread rise, circuitry and controlling the flow of electricity, building web pages, building and programming LEGO robots, making money "grow," and building cars and bridges.

Miquelita Carrion (10657) leads the coordination of Manos, and all of the teachers are Sandia employees who volunteer their time. The participating middle schools are Ernie Pyle, Polk, Harrison, Truman, John Adams, and Jimmy Carter.

"We really want to increase the pool of Hispanic students who pursue STEM university degrees by showing students the possibilities and highlighting the accomplishments made by Hispanic professionals," says Javier Ruiz (10657), who helps coordinate the Manos program. "One of our goals is to increase and promote academic excellence for students at the precollege level. We provide hands-on learning experiences to help inspire these young minds, and to see them succeed is very rewarding."

A helping hand when duty calls

Stories by Nancy Salem

Sandia is being considered for the 2013 Secretary of Defense Employer Support Freedom Award, the highest recognition given by the US government to employers for outstanding support of employees serving in the Guard and Reserve. Each year, Guard and Reserve employees, or a family member acting on their behalf, can nominate their employer for the Freedom Award.

ESGR® EMPLOYER SUPPORT OF THE GUARD AND RESERVE

Sandia named a Patriotic Employer

SUPPORT SYSTEM — Sean Christopher, his wife Samantha, and sons Sean Jr. and Samuel (front row, center) are joined by Todd Harrison (front row, second from right, holding the award) and members of Sandia's Military Support Committee, including Jody Thomas (back row, left) and Esther Hernandez, Sandia's chief diversity officer (front row, left). (Photo by Randy Montoya)

The Employer Support of the Guard and Reserves (ESGR) has honored Sandia with its new Patriotic Employer Award. The award recognizes employers who hired a National Guardsman or Reservist in 2012, contributing to lowering the unemployment rate for those members of the military.

Guardsman Sean Christopher was hired last year by Manager Todd Harrison in Physical Security Services Dept. 98. Sean and Todd accepted the award at a Feb. 28 luncheon at the National Guard Armory on Wyoming Boulevard.

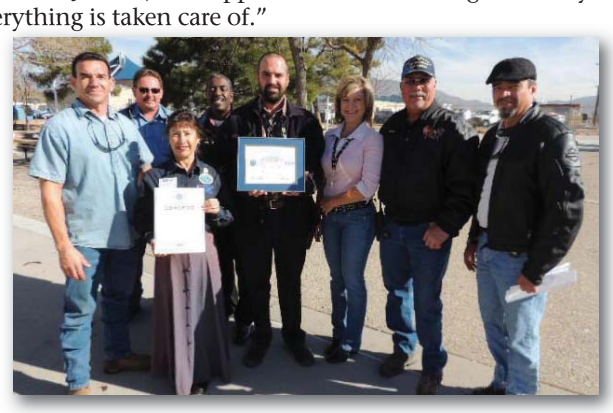
"We are honored to be recognized by the ESGR as a New Mexico Patriotic Employer and are proud to have contributed to reducing the number of unemployed service members in 2012," says Jody Thomas (2995) of Sandia's Military Support Committee. "We value the contributions of the men and women who serve our great country."

ESGR is a Department of Defense committee established in 1972 to promote cooperation and understanding between Reserve members and their civilian employees. It is supported by more than 4,900 volunteers in 54 committees nationwide. The Albuquerque office is at the Armory on Wyoming Boulevard N.E.

Supervisor made military leave a breeze

Joshua Konetzni, team lead for Grounds & Roads Dept. 4843, has received a Patriot Award from the New Mexico Employer Support of Guard and Reserve (ESGR) for his encouragement of a staff member's military duty.

"With other employers outside Sandia it was very difficult. Not everybody is helpful when it comes to military leave," says Roy Cain (8433), who nominated his supervisor Joshua for the award. "With Sandia and Joshua, the support is there. When I get military orders I give them to him and everything is taken care of."



JOSH KONETZNI, holding his Patriot Award plaque, is joined by colleagues, left to right, Eric Cain, brother of Roy Cain, who nominated Josh for the award, John Trujillo, Robert Washington, Josh, Edlynn Olivas, Charlie Palacio, and Rick DeLaRosa. In the front is Victoria McCormack, a volunteer with the New Mexico Employer Support of Guard and Reserve organization.

Roy, a heavy-equipment operator in the Facilities group, spent eight years in the US Navy and two in the Army. He came to Sandia in March 2012 and about six months later joined the Air National Guard's 210th Red Horse unit. Red Horse squadrons provide the Air Force heavy repair capability and construction support.

"The unit was just forming in New Mexico and they needed experienced heavy-equipment operators," Roy says. "I helped start a training program and get the unit up and running."

Roy was on leave four months, returning in February. He recently began a short assignment at Kirtland Air Force Base. "The response was surprising to me," Roy says. "I used to be scared to take my orders to my boss. I didn't know if I'd have a job or not. But with Joshua there was no problem whatsoever. He makes sure there is a smooth transition when I come back."

Roy had heard about the Patriot Award, which recognizes supervisors nominated by a Guardsman or Reservist employee for support provided directly to the nominator.

"I had never had an employer worth nominating," Roy says. "I think very highly of Joshua. And Sandia's support of the military makes it possible."

Joshua says the award was unexpected and means a lot to him. "I had never heard of it. It was one of those good things that happen when you're a supervisor," he says. "My grandfather was in the service and I always looked up to him as a role model. Hearing the stories of what he did and how it impacted the country gave me a great appreciation for what service men and women do to make our lives what they are.

"I wish I could do more for the military. Supporting someone like Roy is my way of saying thank you to the people who keep us safe and keep our country going."

Norman, Okla. students headed to National Science Bowl after reigning in Albuquerque

YOUNG SCHOLARS — Students from Gila River Middle School, left, and Native American Community Academy face off in the third annual Intertribal Middle School Science Bowl. A team from Norman, Okla., took top honors and will compete in Washington, D.C., in the National Middle School Science Bowl in late April. (Photos by Randy Montoya)

By Stephanie Hobby

A team of five students from Norman, Okla., took the top prize at the third Annual Intertribal Middle School Science Bowl, held in conjunction with the National American Indian Science and Engineering Fair (NAISEF) in Albuquerque. Twenty teams of middle school students took part in the fast-paced regional competition, which included questions about math, chemistry, physics, and biology. The winning team is now headed to Washington, D.C. to compete in the National Science Bowl on April 25-29.

The NAISEF and EXPO, now in its 26th year, is hosted by AISES, the American Indian Science and Engineering Society. AISES was founded in 1977 to identify and remove barriers to academic success for American Indian students, and substantially increase the representation of American Indians and Alaska Natives in science, technology, engineering, and math fields. The program works with students, professionals, mentors, and leaders and provides a "full circle of support" model, with emphasis on professional development, mentoring, networking, community service, and initiative and awards programs that start with pre-college programs and continue through retirement. More than 200 tribal nations are represented within AISES, which has the support and partnership of corporate, government, academic, and tribal decision makers.

Sandia's American Indian Outreach Committee (AIOC), closely aligned with AISES, was founded in 1979 to recruit and retain more American Indians to Sandia. The mission of AIOC is to stimulate the increase and success of American Indian employees at Sandia and to help young American Indian students explore the pathways of higher education that will lead to rewarding careers at Sandia. AIOC uses various means to accomplish its goals, providing opportunities, mentoring, and support that employees and students need to grow and advance.

AIOC members are instrumental to the success of the NAISEF and EXPO, providing volunteers to serve as judges and moderators. "Our mission is to stimulate and increase the success of Native American students," says Cindy Burnett (35543), an AIOC member who helps coordinate Sandia's participation in the annual event. "AIOC members really care about helping other people, and this event allows us to reach out to students and encourage them to explore pathways to higher education."

Employee death . . .

Brilliant, gifted Carlos Cox lived by his convictions

Carlos Cox, an avid and accomplished mountaineer and member since 2009 of the elite Albuquerque Mountain Rescue team, fell to his death during a climb in the Sandia mountains last Friday.

Carlos (1678), 35, joined the Labs' technical staff as a mechanical engineer in 2010 (he had worked previously as a Sandia contractor). At the time of his death, Carlos was supporting several Z machine-related projects in Tech Area 4.

Colleague Daniel Headley (1678), part of the team that originally brought Carlos on board as a contractor, says "My friendship with him grew over time," revolving mostly around lunchtime, hallway, office, and dinner conversations.

"We deeply enjoyed talking about the deepest things. We spent a great deal of time discussing life, death, politics, religion, family, marriage, and whatever else we stumbled upon. Carlos' refusal to take a quick answer always challenged me to think through my beliefs and I am grateful to God for the time I spent with him. He was my beloved friend and I miss him."

Carlos' manager, Finis Long (1678), recalls his colleague as a critical member of the Dept. 1678 team. "Carlos wasn't just a great thinker and problem-solver, he was also extremely creative and his designs are a testament to his engineering abilities. He took on assignments with great enthusiasm and always saw a chance to engineer safety, cost, and function into every assignment.

"It was always a pleasure to stop and talk to Carlos about work or about his hobbies. His outlook was always to do his best at whatever he did. Losing Carlos is a huge loss to me, both personally and professionally, and it's a loss to Area 4 and Sandia as well."

While his professional accomplishments were significant and his technical insights invaluable, it was the way Carlos touched people at the simplest human level that will be most remembered among his colleagues. Says Joanne Wistor, "Carlos was a wonderful person to be around, always cheerful. He liked to bake bread; we were always sharing recipes. I will miss him terribly."

CARLOS COX was instrumental in assisting in the design and assembly of a target chamber currently being used at the Ion Beam Laboratory (IBL) for neutron detector efficiency calibrations. These detectors are fielded regularly on experiments at the Z facility. In the photo here, Carlos examines the beam line at IBL where the target chamber would eventually be mounted. (Photo by Ruth Smelser, 1677)

Carlos collaborated frequently with Kurt Tomlinson designing Z machine targets. Kurt, a General Atomics engineer working as a DOE contractor assigned to Sandia's pulsed power program, says, "Typically, Carlos and I would attempt to come up with a target design that fulfilled the physicists' requirements while being as simple and inexpensive as possible.

"Carlos was really a great guy," Kurt continues. "He was always very upbeat and enthusiastic. I liked his sense of humor, too. His death is definitely a great loss to the world. Carlos was a great human being."

AN AVID MOUNTAINEER, Carlos Cox participated in numerous life-saving operations as a member of Albuquerque Mountain Rescue before succumbing to a climbing accident in the Sandias. (Photo by Ben Goddard, Albuquerque Mountain Rescue)

How good was Carlos at his job? Dept. 1671 Manager Bill Stygar is unequivocal in his admiration: "Carlos Cox was a world-class mechanical engineer and a key and critical member of the Z Science Operations team. He was a great intellect, brilliant and hard-working, and we could always count on him to develop creative and novel solutions to complex and difficult problems.

"Carlos was invariably gracious and polite, and always ready and willing to help; he was a pleasure to work with. We will all miss him immensely."

Away from work, Carlos was a man of many interests, especially climbing. As friend and colleague Bill Scherzinger (1678) recalls, "Carlos Cox was an avid mountaineer and an active team member with Albuquerque Mountain Rescue since 2009. He served the community in numerous wilderness search and rescue missions in New Mexico, including the Sandia Mountains. His compassion and dedication to the rescue community continues a long tradition held by Sandia employees who have volunteered in New Mexico Mountain Rescue. He will be greatly missed by the search and rescue community and by Albuquerque Mountain Rescue."

Leslie Simmons (0421), who met Carlos through her husband, a member of Albuquerque Mountain Rescue, mourns his passing but celebrates his life.

"Carlos and his wife Kiki didn't care about 'stuff,'" says Leslie. "They loved the people in their lives and lived by their convictions. I remember one hot July, on Carlos' birthday, how sweaty he and my 2 ½-year-old daughter got playing soccer in his living room! That same day, Carlos showed her how to play his drum set, and ended the party with salsa dancing."

Christina Acosta, the Office Administrative Assistant for departments 1678 and 1679, cherished Carlos' human side. Her thoughts probably express the views of all who worked with him. "Carlos was such a pleasure to work with," she says, "always so humble and giving. It was a blessing to have known him." *— Bill Murphy*

No-bomb fertilizer

(Continued from page 1)

dener since I was 8. We had five acres in Las Cruces with the problems of calcareous soils that are very similar to those in the Middle East. I know something about commercial farming."

He also knew the chemistry of IEDs from years of training soldiers how to deal with them.

Ammonium nitrate has an Achilles heel from a terrorist's perspective. The ammonium ion is weakly attached to the nitrate ion. They hang onto each other, but the right chemical reaction can easily pull them apart. Kevin reasoned you could separate the ions by adding a compound they would rather cling to, called a metathesis reaction. "It would change into something else at the molecular level," Kevin says.

He tried several materials including iron sulfate, a readily available compound that steel foundries throw away by the tons. When mixed with ammonium nitrate, the iron ion "grabs" the nitrate and the ammonium ion takes the sulfate ion. Iron sulfate becomes iron nitrate and ammonium nitrate becomes ammonium sulfate. This reaction occurs if people attempt to alter the fertilizer to make it detonable when mixed with a fuel.

"The ions would rather be with different partners," Kevin says. "The iron looks at the ammonium nitrate and says, 'Can I have your nitrate rather than my sulfate?' and the ammonium nitrate says, 'I like sulfate, so I'll trade you.'"

Ammonium sulfate and iron nitrate are not detonable, even when mixed with a fuel. "It's a different compound," says Kevin, who completed work on the formula in late 2012. "At the chemical level it's a great fertilizer but does not detonate."

Chemical engineer Vicki Chavez (6633) ran a small-scale proof-of-concept of the reaction, and validated it. "We were able to prove that there was little to no ammonium nitrate left in the resulting process," she says. "It was very cool. We looked at pure ammonium nitrate and pure ammonium sulfate. The resulting sample looked more like ammonium sulfate."

Kevin says iron sulfate in fertilizer adds iron and acidifies soil. "It does good things for soil health. It takes alkaline soil and makes it more neutral, closer to an ideal pH level," he says. "The closer you get a neutral pH, the more crops grow. Crop yield would improve significantly.

"And iron-containing fertilizer added to the soil would be taken up in crops and help fight anemia and other iron deficiencies in people who eat them."

The soil in Afghanistan is alkaline with a high pH, and could benefit from an ammonium nitrate/iron sulfate fertilizer, Kevin says. "What they use now, ammonium nitrate with calcium carbonate — which makes soil more alkaline — doesn't make sense," he says.

Danger to soldiers

Sandia could have patented the formula but opted to waive ownership rights for humanitarian reasons.

"One of Sandia's priorities is deploying the technologies that result from our research for the public good," says Pete Atherton, senior manager of Industry Partnerships Dept. 7930. "In this case, we believe that making it freely accessible and disseminating it as widely as possible was the best way to accomplish this mission."

Replacing ammonium nitrate with a non-detonable fertilizer in Afghanistan and other parts of the world will not happen overnight, Kevin says. Ammonium nitrate is produced in huge plants in many locations. "It's easy to get in large quantities," he says. "The sheer volume of ammonium nitrate is gigantic."

But he says there are some thoughts on how to get the non-detonable formula into the marketplace. "We could give the formula to a neutral party and let them work with the Afghanis, Pakistanis, and others," he says. "They could set up side-by-side demonstrations to see which fertilizer works better. Prove it to them gradually."

"It does good things for soil health. It takes alkaline soil and makes it more neutral, closer to an ideal pH level. The closer you get a neutral pH, the more crops grow. Crop yield would improve significantly."
— Researcher Kevin Fleming

Kevin says his sense of urgency in tackling the issue came from looking into the eyes of hundreds of soldiers he trained in anti-IED tactics. "Explosive Ordnance Disposal techs see a lot of IEDs, and about one third of them will die, be maimed, or injured by IEDs before getting through their tours, and most from ammonium nitrate-based explosives," he says.

At a meeting last year in Crystal City, Va., Kevin sat next to an ex-Marine who had lost both legs trying to find IEDs. "He had a metal detector, but some bombs are chemically initiated with no metal parts. He stepped on a non-metal trigger and set off a blast that took off both legs. He became a double amputee in milliseconds. So when I sit next to him and see the aftermath of an IED, I have to think of any way possible to keep stuff like this from happening."

Sandia's safety journey

(Continued from page 1)

Sandia recognizes these concerns and has initiated actions to address them, effective line implementation has not been achieved. Sandia needs to identify and understand the aggregate causes of the recent events (e.g., Halon cylinder, fume hood, etc.) in order to identify and address underlying safety concerns."

The report continues, "Sandia management has not addressed long-standing, systemic issues in Assurance, Environment, Safety and Health (ES&H), and Quality. Though Sandia has undertaken numerous initiatives, significant improvement in these areas has not been demonstrated."

A marathon, not a sprint

"Sandia's safety culture — its progress — is a journey," says Mike Hazen, VP of Infrastructure Operations Div. 4000. "Most folks think it's something you can change overnight. It is not. It's a marathon, not a sprint."

Mike became the Div. 4000 VP in the fall of 2007. The following year a rocket sled motor ignited prematurely and an employee was hurt, suffering a broken leg and severe burns.

"Looking back, the sled track accident was a low point in our safety journey. It was a watershed, a wake-up event. It was horrible, but at the same time we've worked hard at the evolution of our safety culture because of it," Mike says. "That culture is maturing rapidly and now with the implementation of Engineered Safety with truly engaged leadership, we are seeing results."

"When leadership does the right thing and makes the tough decision, even if it might impact schedule or cost in the short run, then the safety culture will improve."
— Sid Gutierrez, Chief of Safety

After a two-year suspension due to the accident, Sandia re-started operations of the sled track and recently conducted a successful, full-scale test — the first of its kind since the 2008 accident (see related article on **page 1**).

"But what if post-accident the sled track had been permanently shut down?" Mike asks. "Or, what about the possibility that you or a co-worker might not go home in the same safe condition in which you arrived at work due to the consequences of hazardous behavior?"

That is Paul Hommert's tough, bottom-line message about the importance of Engineered Safety as Sandia's critical next step in its safety journey.

Engineered Safety, in Paul's words, "uses a principle-based approach for designing safe operational systems by identifying potential failures and aiming to prevent them or by mitigating consequences when failures do occur."

Its interconnected elements include people, procedures, facilities, equipment, and the hazards inherent in them and the work to which they are applied. Engineered Safety values technical understanding, critical thinking, and due diligence by viewing safety in a system engineering context, appropriate for an R&D laboratory: a system where safety is part of the design intent.

"This is not another initiative, or something ES&H is rolling out. Engineered Safety is an improvement in our safety journey and something the line developed and owns," says Mike.

Leading by example

Under Paul's direction as Sandia's safety leader, the Labs has made a practice of examining lessons learned, understanding feedback others have provided, and combining these with new approaches that place a higher value on safety in Sandia's culture.

Mike says a key message is that Sandia's safety culture is only as good as the activities leaders deliver and model by walking through workspaces, focusing on people first and demonstrating safety values.

"Safety is now part of mission success — it's how we define success beyond delivering the product. Safety is becoming an instinctual part of our daily Sandia culture," he says.

Sandia's character as a learning organization means that workers and managers think through what might go wrong and design systems that make such consequences less likely, or design systems that may eliminate them entirely.

Case studies of successes in the two-year Engineered Safety pilot program, written or recorded on video, are part of this first year of implementation, including an online repository of design documentation and other resources, along with contact information for mentors who have successfully implemented Engineered Safety activities.

Mike says he already has seen a change in safety attitude among all workers.

"We're more productive if we're safer. People are engaging others about safety — whether it's about activity-level work or speaking with someone about biking across campus without a helmet. People are responding by saying 'thank you' rather than feeling they're being challenged," adds Mike.

Sid Gutierrez, director and Chief of Safety (4100), and co-lead of the Engineered Safety Implementation Team with Charles Barbour, director, Research & Development Science & Engineering (1000), points to a number of daily safety enhancements that demonstrate this workforce shift. They include use of the LiveSafe website, the slips and falls awareness program, the new training simulator for slippery conditions, and a new focus on reducing stress and overexertion.

"But the most important change involves leadership expectations and actions. The staff is looking to more than just what their leaders say; they want to see what their leaders do," Sid says. "When leadership does the right thing and makes the tough decision, even if it might impact schedule or cost in the short run, then the safety culture will improve."

Moving away from a 'hero culture'

He says leadership needs to move away from Sandia's hero culture of 'deliver no matter what' as the measure of success. "We are only successful in completing the mission if we do so without injury to personnel and without harm to the environment," Sid says.

Mike and Sid emphasize that Sandia workers must consistently implement three key behaviors at all levels to build a strong safety culture:

1. Take personal responsibility and commit to "Do the Right Thing" at all times. Decision-making must be risk-informed and thoughtful, with "Safety Always."

2. Be unrelenting safety advocates, constantly challenging assumptions and eternally vigilant, seeking to identify and eliminate or mitigate all hazards. Always questioning. Constantly learning. Always trying to get better.

3. Treat failures that result from human error as learning opportunities, but address intentional at-risk behaviors and reckless behaviors with discipline. The consequences must be proportional to the at-risk or reckless behavior, not the outcome of the event. We must create a "Just Culture."

"We have a lab full of people who want to do the right thing. We have to make it as easy as possible for them to do it."
— Div. 4000 VP Mike Hazen

Sandia can be proud of how far it has come, but it still has a way to go, says Mike.

"We have a lab full of people who want to do the right thing. We have to make it as easy as possible for them to do it. Engineered Safety means people at all levels truly demonstrating these corporate values. What improves performance is people wanting to improve performance, and being encouraged and enabled to do so," he says.

More information about Engineered Safety and "Just Culture" will be provided in a variety of ways to the entire workforce during the coming months. An upcoming issue of *Lab News* will feature the positive impact these approaches are having on Sandia's safety journey, and provide more information about the Engineered Safety Implementation Plan's online and mentoring resources.

Events along Sandia's safety journey

"When I reflect on our performance, I'm reminded that we have had quite a few recent injuries at Sandia during normal, planned work. We have also experienced some incidents that had the potential for serious injury. Yet we were fortunate; nobody was injured. However, one thing is certain: We cannot rely on luck when it comes to safety. The Halon and lithium incidents stand out in that regard. The first led to the suspension of activities, failure analyses, and supplemental causal analyses. The second led to detailed safety assessments, and both events led to many lessons learned. Furthermore, in some respects, we have plateaued in our safety performance. Some may consider this situation adequate. However, I don't, and you shouldn't."

Excerpts from video by Paul Hommert, Sandia President, and Laboratories Director and Chief Safety Officer, December, 2012

• 2005 — A DuPont study identified the overall Sandia safety culture as an issue, while acknowledging the difficulty R&D cultures have adhering strictly to required processes.

• 2006 — Environment, Safety & Health (ES&H) funding increased for Sandia to help address Laboratories' safety issues.

• 2007 — 10 CFR 851 implemented — a new federal rule requiring DOE contractors to develop and execute project management plans.

• 2008 — DOE's Office of Environment, Safety & Health Evaluations (HS-64) issued 24 findings related to implementation of Feedback & Improvement requirements for Sandia's ES&H program.

• Oct. 6, 2008 — Rocket Sled Test Accident. A rocket motor ignited prematurely while employees were preparing an AIII rocket sled test at the 10,000-foot sled track (Area III), resulting in a Type-B Accident. One individual sustained a compound fracture of the femur and first- and second-degree burns on hands and arms.

• Oct. 7, 2010 — Workers who sort and repackage hazardous wastes at the Radioactive and Mixed Waste Management Facility received the results of surface wipe samples that showed the presence of surface beryllium contamination in an earlier repackaging job. Beryllium is a toxic metal that can cause a chronic lung disease when inhaled.

• 2010 — Sandia introduces innovative Engineered Safety Model for approximately 50 pilot programs at the Laboratories.

• July 21, 2011 — An employee was performing tests on a one-inch-long lithium battery that ruptured, and a metal fragment hit the employee's leg.

• December 2011 — Small fire at Z machine, Bldg. 983 Hi-Bay.

• Aug. 26, 2011 — Lithium fire at the Plasma Materials Test Facility. During initial preparations to conduct an experiment, molten lithium made contact with water, causing an over-pressurization and small fire in a vacuum test chamber.

• September 2011 — Lithium-Thionyl Chloride Battery event.

• January 2012 — Fire at Kauai Test Facility.

• February 2012 — Inappropriate storage and transportation of explosive materials, live detonator.

• June 20, 2012 — Halon pressurized gas cylinder was moved and left in the sun by clean-up crews. It heated up, leaked, and the pressure imbalance propelled the 94-pound cylinder 515 feet, damaging asphalt and a parked vehicle.

• October 26, 2012 — Lithium ion battery fire occurred during overcharge testing at the Explosive Components Facility, Bldg. 905, resulting in fire damage to test equipment, lighting, electrical wiring, the gas scrubber, and ventilation system.

Deployed for good

Sandia nurse earns national honor for work with women veterans, children

By Nancy Salem

Michelle Racicot was a high school grad itching to leave home when she enlisted in the military in 1997. She ended her service 13 years later, transformed into an Army nurse who saved lives on the battlefields of Iraq and Afghanistan.

Today, Michelle (3331) is a family nurse practitioner at Sandia with strong ties to her first career. She's vice executive director of American Women Veterans (AWV), a national organization that advocates on behalf of servicewomen, veterans, and their families. She's also vice chairwoman of Cuidando Los Niños, an Albuquerque nonprofit committed to ending child homelessness. She educates legislators and community members on homelessness, post-traumatic stress disorder (PTSD), women in combat, and health disparities.

"My plate is probably too full," she laughs. "But I love everything I do. It's just who I am."

Michelle was one of 14 women recognized on March 19 by first lady Michelle Obama as Champions of Change. The event, which took place at the White House during Women's History Month, honored women veterans who have made a major impact on the nation's communities, businesses, and schools. Hundreds were nominated for the award.

The first lady spoke to the group on behalf of her Joining Forces initiative, which helps veterans and military families receive benefits, support, and respect.

"You are the leaders in our businesses and schools in our communities," she told the honorees. "You're mothers raising your kids with that same sense of honor that defines your own lives every single day. You're volunteers in your neighborhoods, on the PTA, your houses of worship, always finding ways to keep lifting folks up.

"Long after you stop serving this country, you don't stop serving it after you hang up your uniforms. And that's something that we say all the time about our veterans. It's important for the nation to understand that you all keep working."

NURSE PRACTITIONER MICHELLE RACICOT (3331) says she learns something new every day in her job at Sandia. "The medical team here is amazing," she says. (Photo by Randy Montoya)

A tough transition

Michelle does interviews and speeches for AWV on such topics as women in combat, PTSD, and how women change status from active duty to veteran. "Women have restraints when we transition into those roles," she says. "We have been in combat. We are leaders, but sometimes we aren't noticed because we're still able to manage a family and social responsibilities."

Michelle says a big problem for women veterans is that people often don't see them as veterans. "We don't wear a hat or a pin," she says. "We transition and still manage homes, children, jobs, and make sure everything is running smoothly. People don't realize that I am a veteran, too. I have been in combat. We have the same issues, but we look different. "

Through AWV, Michelle organizes an annual Veteran's Day parade that encourages women veterans to march with family members. "As an organization we believe in family," she says.

For Cuidando los Niños, Michelle works in advocacy and outreach. "We talk to leaders and explain homelessness, health issues, lack of resources, and struggles these individuals experience," she says.

She organizes events including the Youth Creating Change Film Festival that features public service announcements about homelessness in New Mexico by middle and high school students. "The students involved in the film festival are amazing," Michelle says. "If we can get them to be the voice of change so early, they will be a huge influence later in life."

An RN and an officer

Michelle grew up in Tijeras and graduated in 1997 from Manzano High School in Albuquerque. "I wanted to get away so I joined the Army," she says. Through Army training she became a medic and a licensed practical nurse while stationed in Fort Lewis, Wash.

The Army awarded Michelle a Green-to-Gold Scholarship that sent her to college to become an officer. She earned a bachelor's degree in nursing from Pacific Lutheran University. "I became a registered nurse and an Army officer," she says.

Michelle was stationed in Germany on a hospital surgical floor taking care of wounded soldiers from Operation Iraqi Freedom and Operation Enduring Freedom. Hurricane Katrina brought her to New Orleans in 2005 and deployment with the Army's 21st Combat Support Hospital (CSH). She returned to Germany briefly then was deployed with the 21st CSH to Iraq for 12 months in 2006-2007.

She completed Army trauma training at Brooke Army Medical Center in San Antonio, Texas, a Level 1 Trauma Center and part of the US Army Medical Command. She was deployed to Afghanistan for nine months with a Forward Surgical Team, working in tents near combat zones.

"I worked in Logar Province doing trauma care, then set up another Forward Surgical Team in the Ghazni Province," she says. "I enjoy teaching, so instructing medics on how to evaluate trauma patients and triage was easy. Army medics are the most amazing people you could ever work with."

Michelle worked through rocket and mortar attacks, often sleeping in the trauma bay with a radio in hand. "There are times when you are scared, but the crazy thing is you're more scared for your patients," she says. "You're more anxious to save patients' lives. That's the most important thing."

She did dismounted ground patrols, not routine for a nurse, meeting Afghan citizens and helping out in orphanages. "I loved what I was doing but knew I needed to get a master's degree," she says. "I left the Army in April 2010."

Thirteen years after saying good-bye to her family, Michelle returned to Albuquerque to get a master's at the University of New Mexico (UNM) and become a nurse practitioner. "I missed a lot being away from my family, things like my sister's graduation," she says. "I wanted to spend time with them."

She graduated from UNM in May and joined Sandia as a contractor in January. "This has been the best two months ever," she says. "I work in urgent care and health maintenance. Sandia has great programs and is very progressive on health issues. I can learn so much from the physicians here, and the patients are great. It's a perfect match."

Michelle's manager, AnnaMarie DeCoste (3331), says Michelle is enthusiastic about patient care and eager to learn more as a healthcare provider. "She not only cares about patients but equally cares about her community," says AnnaMarie, who nominated Michelle for the Champions of Change honor. "Michelle is a young woman who wants to make a difference and she is definitely making a difference in our community. I'm very proud to have her as part of our staff."

Michelle says community service brings her many rewards. "You can always give to your community," she says. "At the end of the day you're changing people's lives."

Michelle says one of the best moments of her life came during the first AWV parade. "A woman came up to me and said, 'I'm a veteran, too.' And I thought that's why we need to do this. We're veterans not just one day, but every day of the year."

NURSE AND ARMY OFFICER MICHELLE RACICOT mingled with Afghan children while on ground patrol in 2009. "I met people and helped open a women's center," she says. "The Army encourages community service." (Photo courtesy of Michelle Racicot)