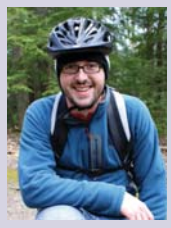
SUMMER SKY— One evening at the end of July when *Lab News* photographer Randy Montoya saw the dark clouds gathering with unusual intensity, he saw the potential for a uniquely dramatic photograph. As darkness descended and the brewing storm came alive in light and sound, Randy was there, set up just in front of the National Museum of Nuclear Science and History. Waiting for his moment, Randy captured this unforgettable image of the museum's iconic Redstone rocket standing boldly in the face of some of the planet's most awesome forces. (Photo by Randy Montoya)

Meet Sandia's new Truman Fellows

Researchers Grey Ballard and John Gamble have been selected as Sandia's 2014 Truman Fellows. They join the ranks of 19 other Fellows who have been appointed since the President Harry S. Truman Fellowship in National Security Science and Engineering was established in 2004. See **page 12.**



Sandia LabNews

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Managed by Sandia Corporation for the National Nuclear Security Administration

Sandia National Laboratories

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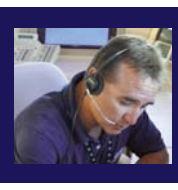


'We're here to protect, enable, and challenge you'

NNSA Acting Administrator Bruce Held visits Sandia

By Nancy Salem

Acting NNSA Administrator Bruce Held said the unique and distinguishing strength of DOE is its scientific brain trust, particularly at the national laboratories. "The brain trust is the core asset of our enterprise and one of the great creations in the history of mankind," he told Sandians on Monday. "We're not here to micromanage. We need to make you reach and stretch, and take chances."

NNSA ACTING ADMINISTRATOR Bruce Held at Sandia on August 5. (Photo by Randy Montoya)

Held said scientists should not be criticized when a project isn't successful. "We want you to push the envelope, and in doing so there will be some failures," he said. What should be emphasized, he explained, is the impact of returns on technical investments and of lessons learned from working on big challenges.

Held said an emphasis on maximizing the percent ratio for success can force scientists to take on smaller challenges. He said that's not the best approach. "What the nation really needs you to do is take on massive, big projects,

(Continued on page 4)

'If Sandia fails, the deterrent fails'

NNSA DP chief Don Cook on Sandia's role in weapon modernization efforts

By Neal Singer

Sounding occasionally like a proselytizer at an unusual revival meeting, NNSA Deputy Administrator of Defense Programs Don Cook returned to Sandia to raise awareness and enthusiasm for NNSA's effort to modernize and simplify the US nuclear weapons stockpile.

The warmly greeted Cook, who as a Sandian once led major programs at Z and MESA, reassured a packed house on July 24 at the Steve Schiff Auditorium of the importance of Sandia to NNSA's sustainment and modernization plans. These include designing interoperable and adaptable warhead components to reduce the number of weapons needed for deterrence.

"In aggregate, these technical challenges exceed anything the Labs has been called upon to do in the past 20 years," Cook said.

NNSA DEFENSE PROGRAMS chief Don Cook at Sandia. (Photo by Randy Montoya)

He added that while Lawrence Livermore and Los Alamos national laboratories

(Continued on page 4)

Hydrogen ignition

Hydrogen fuel cell electric vehicles could be coming to a showroom near you in just a few years. Many automotive manufacturers are turning to hydrogen as an alternate transportation fuel, with initial commercialization expected soon. Story on **page 3.**

Tech Showcase

Sandia will again take its cutting-edge research and technology to the community at a daylong event on Sept. 10 at the Embassy Suites in Albuquerque. The Sandia Research & Technology Showcase is free and open to the public. Story on **page 9.**

Chem/bio detectors

Sandia scientists are thinking small, building on decades of sensor work to invent a new generation of tiny detectors with a wide range of applications that can sniff out everything from explosives and biotoxins to smuggled humans. See the story on **page 11.**

That's that

My mother, whose home is in the Washington, D.C., area, has been visiting us for the summer and she's gotten right into the swing of things. When she arrived, all we could talk about was the drought. Coming from a part of the country where that's usually not an issue, her first impression was probably that we were maybe a bit OCD-ish on the subject. It wasn't long, though, before she was scanning the horizon right along with us, squinting, reading the clouds like tea leaves, muttering, "Looks like it could rain." And finally, it did. And did. And did. And instead of talking about the drought, we talked about flash floods and power outages and that dreaded "H" word: humidity.

I knew my mom had really arrived as a New Mexican when I overheard her side of a telephone conversation with my sister. It went something like this: "Mostly sitting out on the front porch watching it rain." And: "We drove over to the arroyo to see how much water was in it." And: "The mountain really looks socked in; we may drive up into the clouds." I can just hear my sister on the other end of the line: "Okaaayyyy."

A pretty exciting place, New Mexico.

* * *

As long as I'm talking about family, let me tell you about my son's latest adventures in New Zealand, where's he's a grad student in Wellington.

Jim and a friend had a house on a bluff on the edge of town, nothing fancy but the terrific views were included in the price. Well, it so happens that on one particular evening Jim was en route back to Welly after doing a presentation at a conference in Seoul. His friend Bridget was home alone. Along about 3:30 in the morning, a neighbor started pounding frantically on the door: "You have to get out! Get out now! The cliff is collapsing." Alarmed and understandably confused and disoriented — she had been in a deep sleep at this point — Bridget didn't even have time to grab her shoes. But she escaped in one piece and got to a shelter while emergency responders kept people out of the area. Bridget was able to reach Jim while he was at a layover in Singapore, told him what was going on and not to worry in case he heard anything in the media. (He would likely be checking the Wellington newspaper on his iPad during his layover, after all.)

Daylight revealed that two neighboring houses were literally perched over the edge of the cliff; a mudslide had washed away half their foundations. Jim and Bridget's house was right at the edge but still intact. Given the precarious nature of the situation, safety officials wouldn't let them back in to get their stuff. In the meantime, the house had settled and split right down the middle, leaving a gap in the roof that allowed New Zealand's ample winter rainfall to get in, ruining most of the furniture.

Well, after a couple of weeks in a shelter, they found a new house, a neat little place right on the waterfront on the outskirts of town down near Cook Strait, which separates the North Island and South Island. They were pretty excited and began to think that maybe everything had worked out for the best after all. They were all set to move in when a huge freak hurricane-sized storm blew in from a direction that storms *never* come from. It washed out the road in front of their house, first time that had happened in living memory. Finally, the winds subsided, the waters retreated, and the road got patched up and made passable again. They moved in and just loved the place.

And everything was fine . . . until the earthquakes struck, the biggest one measuring 6.5 magnitude, with a focal point in — yes — Cook Strait. Jim's first message to us was subject-lined: Safe and Sound. He reported that he and Bridget were shaken up, but otherwise fine. Now, Jim reassures us that they have their evacuation bags packed, one in the house and one in the car and their tsunami warning radio has fresh batteries in it.

We're not too worried; Jim is the soul of prudence in these things. When all is said and done, you have to figure they're either the luckiest people in Wellington, or the unluckiest. Luckiest, I think.

I just wonder, though, if, come summer down there, he and Bridget are prepared for the plague of locusts that are bound to descend.

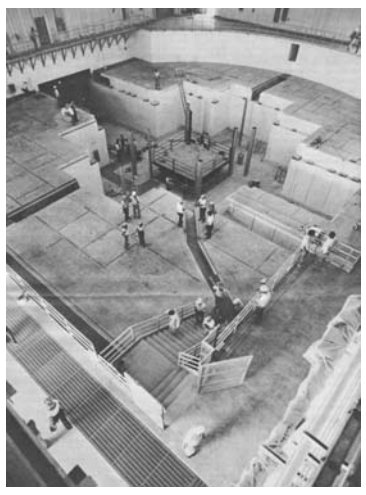
See you next time.

— Bill Murphy (505-845-0845, MS 1468, wtmurph@sandia.gov)

VANTAGE POINT — on the roof of Bldg. 912 at Livermore Laboratory provides J. G. Harter (8221) with a view of the excavation for the new wing of the building. When completed the addition will connect the present wings of the building, forming a quadrangle.

50 years ago . . . Work on the new addition to Bldg. 912 at Livermore Laboratory is scheduled to be completed next May. When completed, the two-story, 23,600 sq. ft. wing will principally provide additional engineering office and laboratory space. It will be built of reinforced concrete frame construction with masonry curtain walls.

40 years ago . . . Two patents for Sandia inventions were granted to the AEC that cover methods of strain biasing a ferroelectric electrooptic ceramic plate. The strain bias produces birefringence with relatively low voltages applied across the plate thickness. Cecil Land and Willis Smith (both 5113) have produced strain bias by purely electrical means under one of the patents. Poling and switching produces strains in the ceramic plate which, in turn, produces birefringence — hence the term self-strain bias. A further modification of the method to induce strain bias in the ceramic was the basis for the second patent. Birefringence in the ceramic can be achieved easily with both of the new methods with controllable and repeatable results.



30 years ago . . . Someday this giant tri-level space in Bldg. 983 will house a world-class accelerator, the largest of its type in the world. Called PBFA-II (for Particle Beam Fusion Accelerator, second version), it will deliver (for a few billionths of a second) some 50 times the world's electrical generating capability.

20 years ago . . . An artificial heart with a steady power source could spell the difference between life and death for patients awaiting heart transplants in the future. Temporary artificial hearts and ventricular assist devices are still a few years off, says Jim Freese of Storage Batteries Dept. 25225, but the design and testing of these devices and their potential power supplies is already under way.

10 years ago . . . Success has been the name of the game for the Explosives Destruction System (EDS), which wrapped up development testing of a new larger system in the United Kingdom this summer with the remarkable accomplishment of completing every test on its originally planned date during the five-month-long deployment. One of the other three systems built by Sandia to dispose of aging munitions was used to destroy 15 mortar shells containing mustard agent that were recovered at the Spring Valley subdivision of Washington, D.C. The Army is expanding the original mission of the EDS to include nonexplosively configured munitions and deployments not only to public sites, but also to military bases where nonstockpile munitions are stored.

SUPPRESSION — Dave Cole and Gilbert Gonzalez (both 15322) ready the fragment suppression system that protects the chamber from damage from explosive charges used to open the sealed bottles or munitions so the agent can be neutralized in the chamber.

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Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corp., for the US Department of Energy's National Nuclear Security Administration.

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), Tim Deshler (844-2502), Jim Danneskiold, manager (844-0587)

Lab News fax **505/844-0645**
Classified ads **505/844-4902**

Published on alternate Fridays by Media Relations and Communications Dept. 3601, MS 1468

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in the Turbulent Combustion Lab

Capturing the moment of hydrogen ignition

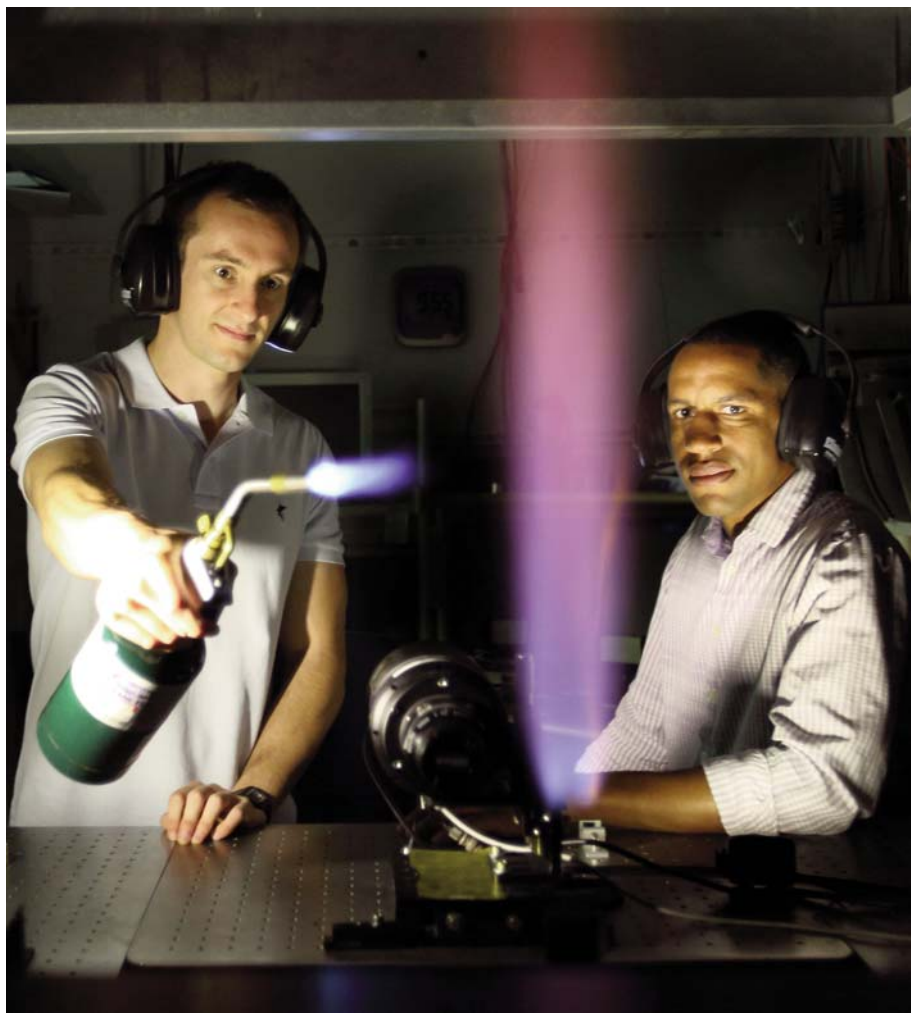
By Patti Koning

Hydrogen fuel cell electric vehicles could be coming to a showroom near you in just a few years. Many automotive manufacturers are turning to hydrogen as an alternate transportation fuel, with initial commercialization expected soon.

For these zero-emission vehicles, a fuel cell converts hydrogen and ambient air into electricity to run an electric motor. Unlike conventional battery electric cars, however, hydrogen fuel cell vehicles can be rapidly fueled (~3-5 minutes) at existing gas stations once appropriate infrastructure upgrades are in place. The state of California is leading in the national deployment of commercial hydrogen refueling stations with a plan to have 68 public fueling stations in place by 2015.

A principal challenge to the widespread adoption of hydrogen infrastructure is the lack of quantifiable data on its safety envelope and worries about additional risk from hydrogen. Using advanced laser-based diagnostics and imaging capabilities in the Turbulent Combustion Lab (TCL), Isaac Ekoto (8367) and Adam Ruggles (8351) are working to provide that quantifiable data to accelerate the development of hydrogen fuel infrastructure.

"The use of hydrogen as a fuel presents some new challenges because of its unique storage requirements," says Isaac. "To achieve sufficient energy density for relevant transportation uses, it needs to be stored at extremely low temperatures or under very high pressure, so an unintended release will behave differently than gasoline."



PLAYING WITH FIRE — Adam Ruggles (8351) and Isaac Ekoto (8367) pinpoint the ignition boundary from an unintended release of high-pressure hydrogen gas. Their research provides a scientific basis for establishing separation distances for hydrogen infrastructure. (Photo by Dino Vournas)

Hydrogen does have certain added safety benefits. The high diffusion rate and buoyant nature means that leaks quickly dissipate into the atmosphere and move rapidly away from the source.

Sandia CaliforniaNews

To assure regulatory officials, local fire marshals, fuel suppliers, and the public at large that hydrogen refueling is safe for consumer use, the risk to personnel and bystanders must be quantified and reduced to an acceptable level. Such a task requires validated methods to assess the potential harm from credible failure modes and a good understanding of effective mitigation measures to control any associated hazards.

Understanding ignition probability

Until recently, most methods used to analyze hydrogen infrastructure safety were adapted from those used for natural gas and industrial environments without much regard to the unique properties of hydrogen. This approach has often resulted in overly conservative rules and requirements that make infrastructure adoption prohibitive in densely populated areas.

To understand the thinking behind the specification of separation distances, one must consider the necessary sequence that results in a catastrophic event — essentially, a fire or explosion initiated by an unintended hydrogen release. First, the gas must be released from its containment system in sufficient quantities to create a hazard. A flammable mixture must then come into contact with an ignition source and ignite. Ignition, however, is not enough; the flame must be able to sustain itself long enough for a hazard to develop. Each process has its own specific probability that is dictated strongly by physical layout and system operation.

Isaac and Adam have examined well-characterized hydrogen jets in the TCL to address the need for suitable analysis tools for large-scale hydrogen storage safety and to better understand potential hazards from unintended releases.

They are able to recreate representative hydrogen leaks using custom burners and a laser spark apparatus to pinpoint ignition at various locations within the release plume. These capabilities enable statistical characterization of the release plume and insight into phenomenological processes during ignition and transition to sustained flame light-up.

To ensure the controlled laboratory experiments preserve relevant flow physics expected from releases from compressed storage, Adam recently designed a high source pressure hydrogen jet and integrated it into the lab. The ability to study realistic release scenarios using state-of-the-art measurement tools distinguishes the TCL from similar labs around the world.

"It's very easy to study an atmospheric hydrogen jet to understand the fundamentals, but in any real-world release scenario, the stored hydrogen is going to be under extreme pressure or at a very low temperature," says Isaac. "The next step in this lab is to add the capability to test hydrogen at those low temperatures."

In a recent experiment, they attempted to spark ignite a hydrogen jet at numerous locations. "We can record whether the mixture ignites and whether ignition leads to a sustained flame or is simply extinguished," says Adam.

The diagnostics enable the researchers to freeze a moment in time and visualize the distribution of the flammable range. From their results, Adam and Isaac have been able to identify the ignition probability for all locations of a given unintended hydrogen release. Their methods represent a tremendous technical advance over the current method used to establish separation distances for hydrogen, the lower flammable limit (LFL) determined from mean concentration boundaries. For hydrogen, the LFL is about 4 percent.

Grossly excessive safety distances

"Basing hydrogen separation on the LFL leads to safety distances that are grossly excessive. Yes, the flammable limit of hydrogen is much wider, but at what point is there a true hazard? Right now, we can predict the probability of ignition with much more specificity over the old methods based on LFL," says Adam.

In establishing safety distances for a hydrogen fueling station, the probability of a sustained flame developing is the key metric, not ignition probability. "The hazards of a leak only occur when ignition has transitioned to a sustained flame," he adds. "If you only consider ignition probability, you end up with distances that are quite large and can inhibit the development of stations in crowded areas. But if you consider the lower probability of sustained flame development, the distances shrink even further. This provides a technical case for building stations with a smaller footprint without compromising safety."

Isaac and Adam are working to develop validated methods for predicting flame light-up transition.

Hydrogen fueling stations for light-duty vehicles are just one application for this research. Another growing area of hydrogen utilization is in the materials handling sector through the use of hydrogen fuel cell-powered forklifts. In a separate project, Isaac and recently retired Sandian Bill Houf (8365) examined the risks and potential impact of an accidental release inside a warehouse.

"The codes and standards for how much refueling you could do indoors were based on floor layout, overall volume, and the ventilation system. Essentially, if you had a certain level of active ventilation, you could refuel as much as you wanted," Isaac says.

Some surprising results

After testing different scenarios they came up with some surprising results. "We found a critical period after a release of about five seconds up to a minute in which the hydrogen was above the LFL before it diffused out," says Isaac. "If the released gas came into contact with an ignition source within that window, things went bad quickly no matter what kind of ventilation system was in place." This work has already had an impact on the codes governing hydrogen fuel cell use in warehouses.

The researchers are working with several different codes and standards communities, including the International Organization for Standardization (ISO), International Fire Code (IFC), and National Fire Protection Association (NFPA). Adam and Isaac have performed targeted experiments to answer specific questions, from which they ultimately plan to develop a toolkit that couples release/ignition behavior and hazard modeling with quantitative risk analysis tools that determine failure frequencies.

"The idea is to develop a toolkit that the operator can use to minimize risk as they design a system or facility like a hydrogen fueling station or a pipeline," says Isaac. "Each setup is unique, so rather than give specific parameters, the toolkit will enable operators to optimize their design using risk reduction strategies." With sufficient funding, they hope to have a beta version ready within two years.

They also have begun conducting experiments on other fuels like liquid natural gas to refine the understanding of the flammable envelope. "When we started this research 10 years ago, the understanding of hydrogen was way behind other gases. But now, despite its limited use, our understanding of hydrogen has advanced far beyond what we know about other gases because of this targeted effort," says Isaac. "Everything we do here in the Turbulent Combustion Lab with hydrogen can be done with other gases."

He and Adam feel as if they've just scratched the surface in studying hydrogen releases. Right now the TCL has a simple setup, with an unimpeded vertical jet. "We'd like to do different orientations and with barriers. It's not likely a release will come from a perfectly concentric circle — most cracks are elongated and we don't know how that changes the release," says Adam. "We want to keep taking this one step closer to what could happen in the real world, outside of a lab."

As Adam and Isaac push toward a better understanding of the true hazards of hydrogen leaks, they are adding to Sandia's vast body of knowledge and experience when it comes to high-pressure hydrogen systems.

"This effort demonstrates how Sandia's expertise in combustion science, laser diagnostics, risk assessments, and high-pressure hydrogen science and engineering, is uniquely leveraged to remove barriers to a clean and secure transportation energy future" says Daniel Dedrick (8367), Sandia's hydrogen and fuel cells program manager.

Held: 'What you do is of inestimable value to the security and well-being of the United States'

(Continued from page 1)

do them well, and change the world."

Held visited Sandia/New Mexico on Monday and spoke at an all-hands meeting of workforce members and Sandia Field Office employees at the Steve Schiff Auditorium. He is a former clandestine operations officer of the Central Intelligence Agency who retired and joined Sandia as chief of counterintelligence.

NNSA Acting Administrator Bruce Held during an all hands meeting at Sandia. (Photo by Randy Montoya)

He returned to the federal government in December 2009 as director of DOE's Office of Intelligence and Counterintelligence. In June he became associate deputy Energy secretary and acting NNSA administrator.

President Obama on Aug. 1 nominated retired Air Force Lt. Gen. Frank G. Klotz as DOE undersecretary for nuclear security and NNSA administrator. Held said he will remain in his acting role until Klotz is confirmed in six to eight weeks. He will then revert to his job as associate deputy Energy secretary, focusing on governance.

Held said he accepted the job offer from Energy Secretary Ernest Moniz on the condition he could tackle governance issues and be liaison to the DOE advisory panel in Congress.

He said his first order of business was to address a safety culture survey that revealed a communication gap between the NNSA leadership and workforce. "People didn't feel appreciated. Dealing with this was my first, second, and third priorities," he said. "We will reach out to the entire community, take the pulse, touch people, and see what we can be doing."

He said most important is to say thank-you to workers.

"What the nation really needs you to do is take on massive, big projects, do them well, and change the world."

NNSA Acting Administrator Bruce Held

"What you do is of inestimable value to the security and well-being of the United States," he said. "We never say thank-you enough. We know what you do and really appreciate it."

Held said his governance goal will be to tell the laboratories' story in a more compelling way. "We're here to protect, enable, and challenge you," he said. "That's important governance for the long-term health of the enterprise."

Held said he and Moniz are strong supporters of Laboratory Directed Research & Development, or LDRD. "We want to encourage the labs to think big," he said.

Held was introduced to the audience by Sandia President and Laboratories Director Paul Hommert, who said Held has been an advocate for the Labs at DOE. "The Laboratory has benefited, and he will carry forward that emphasis," Paul said.

In closing the meeting, Paul said Held is taking on important issues. "We stand ready to work with you in your current and future positions," Paul said. "We're confident we can mutually move to a higher place in supporting the country."

Don Cook

(Continued from page 1)

each touch part of separate systems in the stockpile, Sandia is responsible for the non-nuclear systems in all the warheads in the stockpile.

"If Sandia fails," Cook said bluntly, "the deterrent fails."

The all-hands nuclear weapons meeting was sponsored by Jerry McDowell, executive VP (2), who said in his introduction, "In terms of the nuclear weapons program, in pace and substance these are exciting times we haven't seen since the 1980s."

Cook went on to discuss the history, morality, politics, and technology of the subject to validate his call to commitment to improve the state of the stockpile.

"We've dropped the Cold War stockpile by more than 80 percent," he said, indicating data presented on a Powerpoint slide. "We've gone from 30,000 in 1967 (a few years after the Cuban Missile Crisis) to 5,113 nuclear weapons as of the last public figures, which was Sept. 30, 2009. This is the smallest stockpile than at any time since the Eisenhower administration. And it could go down another 30 percent, the President said in a speech, because we've developed a hedge against technical failure.

"So don't believe people who say our stockpile is still at Cold War levels."

But, Cook said, "We also have the oldest deterrent we've ever had, 26 years and climbing. It will peak beyond 40 years of age unless we take action to fully implement the life extension plans."

"We want our deterrent to stay relevant, to assure our allies and deter our enemies — and we have them out there today.

"Sandia will provide the technical leadership in design, development, and qualification of non-nuclear components for the entirety of the US nuclear stockpile," he said. "Eighty percent of the stockpile is undergoing life extension today. We want to replace four independent ballistic systems with three having interoperable warheads.

"This is a significant departure from previous plans which laid out a like-for-like replacement of weapons as they age," he said.

The work, he said, "requires strong leveraging of designs across all nuclear weapons systems.

"Other nations could read this as we're getting ready for war. We're not doing that. We're getting ready for a sustained peace. That can only come with safe, secure, and effective nuclear weapons."

Said Cook of work expected to extend over 25 years and more, "For Sandia thinking, you have the rare pleasure of knowing what the future looks like.

"Drive your actions, drive your thoughts, and drive your collegiality to pull together across all aspects of Sandia to change the deterrent," he summed up. "Keep your eyes on the target. We have the entire stockpile to sustain. The key to keeping it small is our faith in and commitment to the modernization and sustainment strategy we've created. And we have to modernize the stockpile with transparency, so our adversaries can read about it and see we're actually doing it, and the nations who count on us can see it, too."

Rick Ambrose assumes post as chairman of Sandia Corp. Board of Directors

Sandia President and Labs Director Paul Hommert, right, joins Lockheed Martin President and CEO Marillyn Hewson as she congratulates Richard Ambrose, executive vice president of Lockheed Martin Space Systems, as the new chairman of the Sandia Corp. Board of Directors.

Hewson served as chairman of the Sandia board from 2010-2013, a responsibility she has handed off to Ambrose since becoming Lockheed Martin CEO on Jan. 1.

Space Systems, a core Lockheed Martin business area, is an $8 billion enterprise that employs approximately 15,000 people. The company provides advanced technology systems for national security, civil, and commercial customers. Space Systems' portfolio also includes Sandia National Laboratories.

During his 33-year career in defense and aerospace, including 13 years at Lockheed Martin, Ambrose has led a significant number of programs in support of military, commercial, and national security missions. Previously, he was president of Lockheed Martin Information Systems & Global Solutions-National, directing a 6,500-person organization serving the US intelligence community and international partners.

During a 30-year career with Lockheed Martin, Hewson held a variety of increasingly responsible executive positions prior to becoming the corporation's president and CEO.

Hewson was selected by *Fortune* magazine as one of the "50 Most Powerful Women in Business" in 2010, 2011, and 2012 and was named by *Forbes* as one of the "World's 100 Most Powerful Women" in 2013.

(Photo by Randy Montoya)

A wide-ranging mission

Tonopah Test Range provides indispensable support to nation's nuclear deterrent

Story by Bill Murphy

Photos by Jim Galli
*except where noted

2 hours till sunup. Lights are moving across the range.

In this vast alluvial plain, stretching out like an inland sea in the heart of Nevada's basin-and-range country, distances are hard to gauge. But the lights move: 5 miles away? 10? Sandia's Tonopah Test Range sprawls across Cactus Flat, the landscape perfectly suited to the gigantic scale of TTR's mission. Things happen here, often as not, at supersonic speed over hundreds of square miles.

LOW PRESSURE sodium lights cast an eerie glow on Radar 3 in the pre-dawn darkness. (Photo by Ron Pearson)

Operators in pickup trucks and vans move into place in the pre-dawn darkness, taking up positions at an array of radar installations, telemetry stations, telescopes, and cinetheodolites, optical tracking instruments that live in the small domed structures that dot the landscape. The cinetheodolites are specialized telescopes with integrated cameras designed to record visual data and TSPI — time/space position information.

One by one, the lights stop moving, the closer ones first. Stations are coming online for the test ahead.

A coyote, not in any particular hurry, lopes across the road, caught in the headlights of an approaching vehicle. On the range, though, the sense of urgency among the TTR team is palpable. Today is game day; today the team will be collecting data for two tests in support of the nation's nuclear weapon enterprise.

* * *

WHEN YOU DRIVE UP TO TTR FROM LAS VEGAS, you go through the small town of Tonopah, from which the test range gets its name. On the surrounding hillsides, you can still see signs of active mining operations, though the mines aren't nearly the mainstay they were 100 years ago. Today, activities at TTR form the town's economic anchor, or a big part of it, anyway.

On the way out of Tonopah, as you head for the range that's still 40-some miles away, you can't help but notice the sign that warns: "NEXT GAS — 163 MILES."

This place is remote, and that's the point. As then-corporate historian Leland Johnson wrote in his history of the range in 1996:

"Tonopah Test Range in Nevada provided an isolated place . . . to test ballistics and non-nuclear features of atomic weapons. It served this and allied purposes well for nearly 40 years [as of 1996], contributing immeasurably to a peaceful conclusion to the long arms race remembered as the Cold War."

In the 17 years since Johnson wrote those words, TTR has continued to deliver on that basic mission. It still supports the nation's nuclear weapon enterprise and has expanded its scope to conduct test work for other agencies and customers that need to take advantage of its unique combination of capabilities and remote location.

* * *

A HALF A STATE AWAY IN THE PREDAWN DARKNESS, two US Air Force F-15Es are being fitted with today's test units, called joint test assemblies, or JTAs. In these tests, there's a synergy between the Air Force and the TTR flight test staff. The Air Force pilots flying these missions had met the day before with TTR test director Rick Scarine and his team. Rick briefed the pilots on the mission profile, test requirements and critical objectives, safety procedures, and various go/no-go parameters.

This morning, game day, the first parameter — the weather — looks good: The test missions will fly.

With the sun just lighting up the eastern horizon, the two F-15s taxi to the runway, perform their final checks, and the throttles move forward into afterburner. The pilots are ready to head north into the invisible web of data-collecting instruments scanning the skies above TTR.

* * *

MORNING COMES EARLY AT THE TEST RANGE. At a quarter to 5 visitors and observers for today's tests gather in a parking lot at the Man Camp, a facility notable enough to warrant its own section header in TTR's Wikipedia entry.

The Man Camp accommodations are a notch above spartan: Think that not-bad mom-and-pop place you might stay in for $35 a night along a rustic stretch of Old Rte. 66 in rural Oklahoma. In fact, that's what the Man Camp costs: $35 a night, cash only. The chow hall, too, is a cash-only operation, $7 a meal. This morning, with the test clock ticking, everyone with a specific job to do gets in a quick breakfast and then races off to their duty stations while the entourage of visitors heads the few miles over to the range control tower, the nerve center for all flight tests at TTR.

When the visitors arrive, staying discreetly out of the way, Rick and his range controllers are at their places in the fourth-floor mission control building, a facility that

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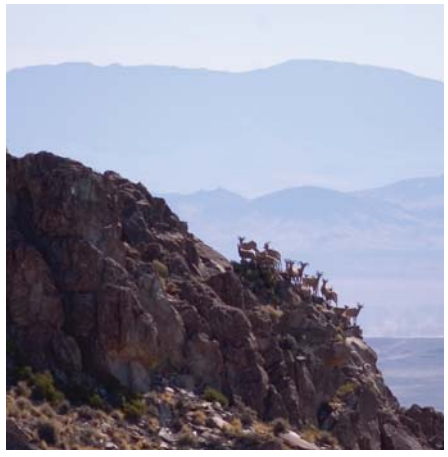
MISSION CONTROL — TTR's 4-story command post with telemetry antennas in the foreground. The range's TM systems have had major upgrades recently, readying them for B61 LEP work.


ACROSS the Test Range's vast expanses, abandoned mines dot the landscape, which supports substantial herds of wild horses, bighorn sheep, and all manner of desert flora and fauna.

'Be advised, tomorrow's tests will be loud'

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looks like an air traffic control tower at a small regional airport. This isn't the deck of the *Enterprise*. It's strictly utilitarian, with a striking mix of old technology and new. Nothing fancy, in other words, but as sophisticated as it needs to be to get the job done.

Rick pulses his team: Communications? Radar? Weather? Airspace? Cameras? Telemetry? Neutron detectors? Everything looks good. The wind is calm — a very good thing — the sky is clear, and the sun is coming up. Word in the tower is that the aircraft are airborne and approaching fast.

The mission control center is in contact with the pilots. It's all good. These are people who know what they're doing, do it well, and have done it often. There are decades of collective experience on this range, backed up by half a century of collective memory, reinforced by a nearly flawless legacy of mission success. The "tyranny of success" — measuring up to the mighty deeds of the past — may put a burden on the TTR team, but it's one they welcome. As TTR Range Manager Brian Adkins puts it, "We continue to succeed despite the many obstacles and challenges we face on every test."

* * *

PREPARATIONS FOR TODAY'S TEST began some two months earlier. Rick, who's been test director for nine years, says that "60 days out we interface with the customer, who specs out the requirements." Based on that input, Rick and his team configure the range to best meet the requirements of the particular test.

"We establish the camera array, the radar array, coordinating with Glen Watts, who coordinates the camera/cinetheodolite team, and Karl Hess, who coordinates radar. We get with the computer guys for neutron detection; get together with the telemetry guys."

THE NAVARRO RESEARCH AND ENGINEERING contractors who provide maintenance and operations services at TTR don different hats during tests, becoming instrument operators. When Kenny Merlino, above, isn't fabricating something in the iron works shop for the field test engineers, he can be found operating cinetheodolite MC-4

While the team leads are Sandia staff members, many of the operators of the various data-gathering instruments are drawn from TTR's contractor support personnel, mostly from Navarro Research and Engineering Inc. The Navarro team members, many of whom live in Tonopah and bus in to the site every day, carry out TTR's maintenance and operations functions. They are electricians, plumbers, carpenters, mechanics, painters — except when they're not: On test days and when they're practicing for tests, they put on different hats, operating radar units, cinetheodolites, becoming part of recovery teams. They have been described by Brian as "absolutely indispensable; we literally could not operate this range without them."

* * *

ON THE AFTERNOON BEFORE THE TESTS, Brian conducts an all-hands mission briefing to cover the final test requirements, schedule, range safety, and expectations. As team members and visitors file into the conference room in TTR's admin building, Brian greets a lot of folks by name and gets acquainted with various visitors.

At TTR, visitors come with the territory; every test has them. This week, members of the teams that designed the JTAs, their sensors, and instrumentation, are on hand, folks from centers 2100, 2900, and 8100 in California. As today's primary customers, they have a lot invested in the success of the test flights.

Brian mentions to the assembled team that later in the evening Sandia Chief Weapon Engineer and Div. 2000 VP Bruce Walker is scheduled to arrive, along with Infrastructure and Operations Div. 4000 VP Mike Hazen and members of their respective teams.

The VPs want to observe the important JTA tests, of course, but even more important, Bruce and Mike want to evaluate the condition of the site facilities, which aren't what they were two decades ago. The fact is, given uncertainties about the range's mission in the post-Cold War era, TTR has not received the level of investment required to upgrade and modernize many of its critical systems, infrastructure, and facilities over the past few years.

Now, with Sandia's weapon work ramping up, primarily in support of the B61 LEP — and with it a new era of increased demand for what TTR has to offer — the two VPs want to see for themselves what must be done to ensure the range receives the support it needs to meet the challenges that lie ahead.

* * *

ON EVERY CHAIR IN THE BRIEFING ROOM, there is a set of sound-muffling headphones, the kind you sometimes see shooters wear at target ranges.

Brian begins: "Be advised, tomorrow's tests will be loud," explaining that the flight profiles stipulate JTA releases at supersonic speed. And that means sonic booms.

Brian, who also wears the hat of overall range safety officer, tells his team he wants everyone "to go home tomorrow with the same number of fingers, toes, and eyes that you came to work with." He adds that TTR's safety record is superb and he is determined that it stay that way.

"Be safe and be smart," he emphasizes, reminding the team that in the expansive range crisscrossed by roads, some paved and some not, "the biggest hazard is driving."

After additional points on safety — clearly a priority here — Brian begins to describe the tests. The team has done the thorough range operational check-outs and mission rehearsals, so this briefing is probably not breaking news, but everyone still pays attention. Everybody in the room wants to make sure there's not

Continued on next page

> *"Tonopah provides the range and support required to execute these tests. They work many things, including scheduling of the airspace, responsibility for the safety and security of executing the test, collection and processing of test data (including radar and optical tracking of the aircraft and JTA, telemetry data), recovery of the JTA, storage and shipment of the JTA post-test . . . the list goes on. They did an outstanding job in this test."*
>
> **— Bryan Struve, B61 Flight System Evaluation Engineer, test engineer for B61-3 March 26, 2013, annual Stockpile Flight Test**

VPs come away from TTR impressed

On game day, after the tests have been completed and the test units recovered, Div. 2000 VP and Chief Weapon Engineer Bruce Walker and Infrastructure and Operations Div. 4000 VP Mike Hazen do a walk-around tour of the main TTR facilities. The two executives get briefings — and wish lists — from building owners and occupants who are clearly glad to have some one-on-one time with the VPs. Several identify potential single-point-of-failure situations where if a system were to fail, the whole range would be adversely affected.

Mike's point man for TTR facilities issues, Mark Coffing, accompanies the VPs on the walk-around. He confers frequently with Mike about how various facilities issues might be addressed. Mark is quite familiar with the challenges at TTR; he has been a frequent visitor, playing a key role in helping advance the slow but steady improvement of facilities on the range over the past couple of years. Mark is also the lead to help develop a facility recapitalization plan that will span multiple fiscal years and provide a more modern and robust working environment at this remote location. Now, with the VPs engaged, there is optimism that the improvements can be more than incremental, a little less slow and a little steadier.

GLEN WATTS briefs VPs Mike Hazen (in black shirt) and Bruce Walker at one of TTR's telescope installations.

After the walk-around, Bruce conducts an all-hands meeting for the TTR team, which is part of his Div. 2000 workforce.

"I am continually impressed with the can-do attitude and service to the nation" embodied at TTR, he tells them. "The esprit de corps is refreshing."

He says the personnel at the range "are doing a tremendous job with limited resources" and pledges to see that new investments keep the range viable for the demanding years ahead.

"We definitely need Tonopah; we'll be doing an ever-increasing amount of testing as the B61 LEP moves forward," he says.

'Every test is different. That's field test. That's Tonopah.'

(Continued from preceding page)

something they've missed or overlooked or forgotten.

As the clock ticks down to tomorrow's tests, many of those in the briefing room are running through their assigned roles, maybe thinking of some theme and variation of Shepherd's Prayer, named for astronaut Alan Shepherd: "Dear Lord, please don't let me foul up." Or words to that effect.

* * *

TOMORROW'S TEST, Brian explains, is a combined surveillance test and a developmental test: One unit, a B61-3 pulled directly from the nation's legacy stockpile, is being tested — without its nuclear components, but with a special instrumentation and sensor package added — as part of Sandia's annual stockpile surveillance program. The flight test program is an essential piece of the larger surveillance program, which also includes system-level lab testing and component testing. Taken together, surveillance test data provide the information needed to support decisions about the stockpile throughout the weapon life cycle.

This first JTA unit will be dropped from an F-15E flying straight and level at high speed several thousand feet above ground level. Its parachute will immediately open, lowering it relatively slowly to a recovery point on a dry lakebed. During its flight, an onboard recorder stores data about the functions and status of various components in the device. The TTR team captures radar, TSPI data, and a video record of the event. The flight recorder will be recovered later and its data analyzed.

A side note: Most of the video documentation to this day is still captured on wet film, developed at another location, and then digitized frame-by-frame to perform the data reduction process. That's one of the areas where the capabilities at the range must be upgraded to provide the data more rapidly to the weapons engineers in days instead of weeks.

Interestingly, making the transition to all-digital isn't as straightforward as swapping film cameras for digital ones: In tests comparing the new technology to the old, the TTR data reduction team must painstakingly validate and verify TSPI data between the film and the digital methods. Those variations are being reconciled, though, and over the next couple of years, the range will be digital.

Continuing the pre-mission briefing, Brian explains that the second unit being tested tomorrow is a B61-3 Flight Test Qualification Unit built by and for the B61 JTA Modernization (JTAM) program. This is not a surveillance test; this JTA was never a real weapon. It was designed specifically to test new instrumentation systems for B61 JTAs. This test is vitally important to the larger B61 Life Extension Program effort. Over the next several years, as the B61 LEP advances, there will be a need for a modern high-bandwidth telemetry-based data collection system to provide weapon designers with the most comprehensive flight performance data possible.

The JTAM test is the second of four planned development tests in this series and the first to transmit telemetry. The TTR team is ready, having just upgraded its capacity to capture data at increased speeds and throughput. The upgrade represents a 20-fold increase in capability and a necessary one for the new generation of sensors and instrumentation.

The flight profile for this test is different. The F-15 carrying this unit will release it from low level and high speed, essentially lobbing it in a ballistic trajectory that will end up with it slamming into the earth at hundreds of miles per hour, intentionally putting the unit through one of the most severe environments it is likely to encounter.

Brian, with technical input from Rick, wraps up the mission briefing and tells everyone he'll see them in the morning — early in the morning. After which, most of the Man Camp tenants — visitors and resident Sandians — head for the chow hall for a $7 plate of all-you-can-eat Salisbury steak and mashed potatoes.

* * *

BRIAN SEEMS PERFECTLY SUITED TO HIS ROLE as range manager. It's a big place and he's a big man. One might be inclined to say "a bear of a man" except that would probably embarrass him. There's a nameplate on his desk that says "Brian 'Animal' Adkins," a call sign he picked up during his days as an Air Force officer, flying the A-10 Warthog, F-117 Nighthawk, and MQ-1 Predator. An insight into Brian's management style might be found in another plaque on his desk: "Lack of planning on your part does not constitute an emergency on my part." Put simply, Brian expects everyone to do their jobs and leads his personnel accordingly. At the same time, he follows that age-old principle good leaders seem to embrace by instinct: Check what you expect. Or as former President Ronald Reagan stated, "Trust, but verify."

After spending several days with Brian, you come away pretty sure that he doesn't

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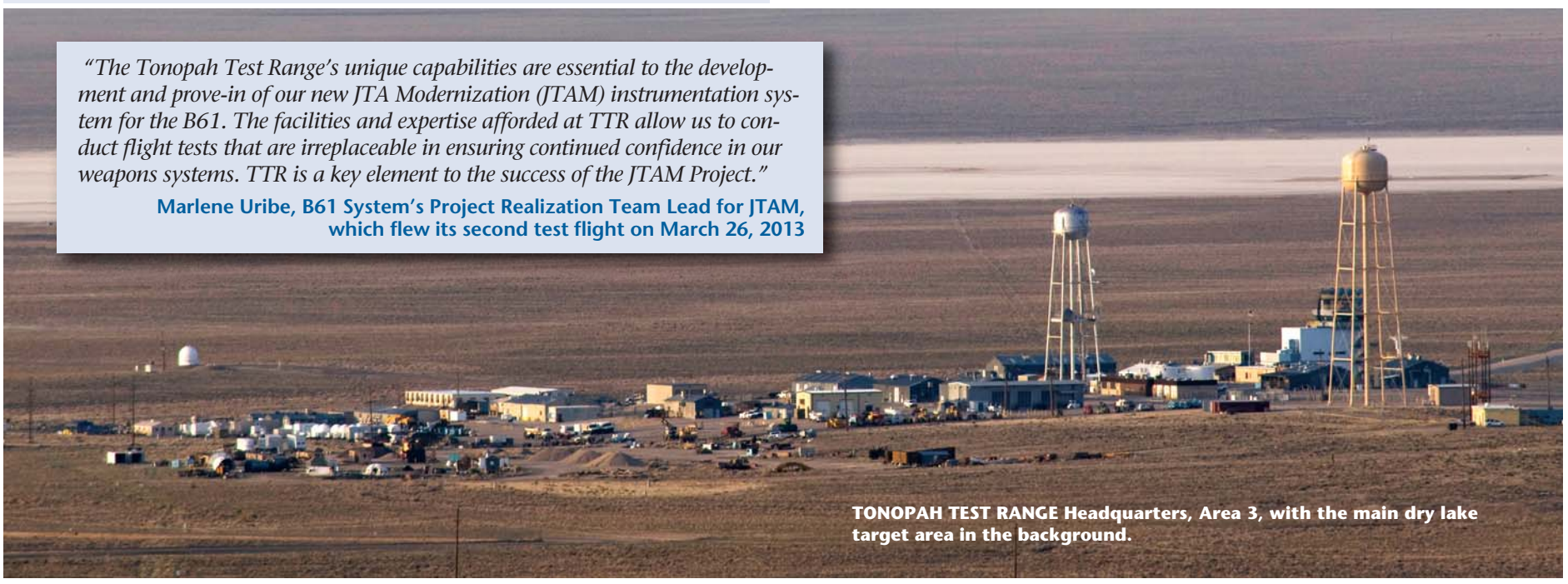
TONOPAH TEST RANGE Manager Brian Adkins oversees a facility with a 50-plus-year legacy of exceptional service in support of the nation's nuclear deterrent.

ANY INTERESTED STAKEHOLDERS wishing to visit Tonopah Test Range should coordinate their visit request well in advance to ensure the visit plan is feasible and your interests can be accommodated. There are personnel limits the range can manage and security requirements, special equipment passes, and area access must be worked well in advance. Due to special security measures, no cameras, iPhones, iPads, or similar devices are permitted.

JTAM flight test achieved many 'firsts'

The flight test of the JTA Modernization (JTAM) FTQU-2 was a notable success for Sandia and for the teams that put the test assembly and its associated systems together. In the wake of the test, Ryan Layton of JTA H-Gear Systems Dept. 8133 described some significant milestones:

The instrumentation system inside the JTA Modernization FTQU-2 proved many firsts for the B61 JTA program. Specifically, this was the first-ever B61 JTA system to transmit data in real-time to the surveillance engineer on the ground and the first-ever JTA flight test to deliver end-event waveforms. Post-flight analysis reveals all features of the FTQU-2 JTA system worked as required. The ground station received data at millions of bits per second both during the 20-plus minute pre-release checkout activities and throughout the flight test drop — this is more than double the data rate of the highest bandwidth system currently fielded by the JTA program. Telemetry also captured all core end-event data, giving surveillance access to all key data months earlier than the legacy system would have. After retrieving the JTA from its post-impact burial, the memory in the on-board recorder revealed the JTAM had not just worked during the impact, it continued to operate while in the ground. That means the mechanical design of the bomb and the flight recorder enabled the electronics to survive a deceleration from the delivery speed to a dead stop in less time than it takes to blink.



"The Tonopah Test Range's unique capabilities are essential to the development and prove-in of our new JTA Modernization (JTAM) instrumentation system for the B61. The facilities and expertise afforded at TTR allow us to conduct flight tests that are irreplaceable in ensuring continued confidence in our weapons systems. TTR is a key element to the success of the JTAM Project."

Marlene Uribe, B61 System's Project Realization Team Lead for JTAM, which flew its second test flight on March 26, 2013

TONOPAH TEST RANGE Headquarters, Area 3, with the main dry lake target area in the background.

'Range is green. Range is green! Cleared to release.'

(Continued from preceding page)

let much fall through the cracks.

Brian's fairly new to the range and to Sandia, coming less than two years ago straight from a stint at Creech Air Force Base, which, among its other functions is the focal base for the Air Force's Predator and Reaper Remotely Piloted Aircraft (RPA) fleet, the Global RPA Command and Control Center (of which Brian was the founding director), and the USAF Unmanned Aerial Vehicle Battlelab.

Brian expresses a special affinity for the Navarro contractor personnel, perhaps because he worked his way through college as a pipefitter and machinist. He understands what the Navarro team does and knows what it takes to do it well. And the Navarro team, he says, is the best he has seen.

Brian likens TTR to "a hidden gem and a national treasure" whose value to the Labs mission is becoming more widely recognized by senior management.

There was a time after the Cold War, Brian noted, when there was serious consideration given to closing the range, as some thought it unnecessary and too costly to sustain. A series of studies over the course of more than a decade, however, concluded time after time that the unique characteristics of the range made it indispensable to stockpile surveillance, weapons development testing, and other projects. If it didn't exist, in other words, it would be necessary to coordinate with other test ranges to fold into their schedules, reducing Sandia's flexibility for weapons program changes. Now, with increased weapons work, there will be an increased demand for flight tests.

Brian knows, though, that the Cold War days of blank checks and a "money-is-no-object" approach to the weapons missions are gone forever. As they should be.

"We have to be accountable. That's what makes us better," he says. "We've got to find efficiencies; we can't work any harder but we must work smarter." Not that the TTR team is exactly profligate. Quite the contrary. Brian goes out of his way to say how impressed he is with how far his team can make a dollar go and how creative his folks are in solving problems with little or no extra money. He says: "I think of what my grandfather used to say: 'We can squeeze a penny until Lincoln screams.'"

Noting that much of the technology at the range dates from 30 and more years ago, he says, "If we could build a more modern infrastructure and network backbone, along with upgraded equipment for some of our functions, it would make a big difference and pay big dividends in the long run."

Expressing his appreciation for his management chain's support, Brian says, "We're getting there, getting to where we need to be for the next decade. My 2900 Center director, Victor Johnson, has been our champion and staunch advocate and has provided valuable guidance. He's empowered us to make good decisions to chart the strategic path for the range. We also get outstanding support from our parent division, as well as the RTBF [NNSA's Readiness in Technical Base and Facilities] and DSW [Directed Stockpile Work] offices to help us meet our ever-increasing requirements. We're here for the long haul."

* * *

AFTER NINE YEARS AS TTR'S TEST DIRECTOR — not to mention a previous life as an Air Force squadron commander and pilot — Rick Scarine's seen just about everything a test can throw at him.

Now as the aircraft approach, he's thinking well ahead. If the test doesn't come off, the cost to taxpayers probably runs into seven figures, so it's really important to make the right calls — every time.

TEST DIRECTOR Rick Scarine at the helm in TTR's control center. (File photo)

In his mind, Rick is ticking off the factors in play this morning: "We need good TSPI. We have to have perfect radar and telemetry links and we need at least three good cuts from the optical systems [from among the seven cinetheodolites deployed for the test]. I've got to be able to see the release. One limiting factor is that most of the theodolites are still recording the flights on film. And film runs out. So, for that matter, does the fuel on the aircraft. The margins are tight. Maybe there's enough fuel and film to allow for one dry pass, but no more."

Today, everything looks good so far, but Rick knows from long experience that things can change fast.

"On game day," he says, "what are you willing to give up, what can you live without, because something can always go down."

* * *

THE SUN IS CRESTING THE RANGE TO THE EAST. The visitors, including the VPs Bruce Walker and Mike Hazen, follow Brian up to the top floor of the tower to the mission control center. Inside, Rick is juggling the mission priorities and is a cool hand in a hot seat. Around the room, controllers are focused on monitors and instrument screens: radar, communications, video, weather, airspace, telemetry streams. Glitches are resolved, readiness among the far-flung operators confirmed.

A SIMPLE RECOVERY of a test unit from TTR's dry lake target area. On a good day, things are simple.

The conversations are clipped. Focused.

"MC5: Did you get the pulses?"

"Turn that gain all the way down . . ."

"Camera control, up and ready . . ."

And this: "Range is green. Range is green! Cleared to release."

Looking directly into the sun, the visitors can't see it at first, but then, there it is, coming out of the south: the first aircraft, the one tasked to drop the surveillance JTA unit via parachute. From a distance and at a height of several thousand feet, it doesn't appear to be moving that fast, but then the boom hits. It quite literally rattles the glass and shakes the floor of the control tower. The test unit pops out of the aircraft and drifts to the ground. It's all captured on film, on radar, in computer memory.

The second aircraft, maintaining an orbit off to the south, waits for the first flight to complete its mission. Then the pilot gets the clearance to proceed inbound on his test run.

This aircraft, much closer to the ground — just a few hundred feet off the deck — comes screaming into view. Right in front of the control tower the aircraft shoots almost straight up just as another sonic boom washes over the range. The F-15 pilot releases the test unit into a high ballistic arc that ends with the unit burying itself in the dry lakebed, the only marker a big cloud of dust, visibly apparent even several miles away. Everything happens so fast that it's over before you know it. Some cheers go up and some back-slaps. Another successful test in the hopper for TTR.

The second aircraft peels off and away to the south. The Air Force has done its part. The pilots head for home, bidding the range a crisp so long.

As the morning spreads across the range, these "engineers in cowboy boots," as a visitor to TTR, probably an Easterner, once dubbed them — rack up another successful mission. The first impression — later to be confirmed as the data is collected and analyzed — is that the tests went right according to plan. While the TTR team makes it look smooth and polished, the weeks-long preparations, fixes, and test day troubleshooting resemble a duck gliding across a pond while the feet are paddling like crazy underneath the waves — escaping the alligator nipping close behind.

The TTR team still has to recover the JTA units, but that process proves to be routine this time. That's not always the case. There was one test, the account of which has entered the vaults of TTR lore, where a JTA unit buried itself deep in the dry lakebed. Nothing out of the ordinary there. However, in this case, a surprise desert rain storm blew in, promptly flooding the lakebed in a torrential rain of the kind you only see in the desert. That test unit sat in the ground for weeks before the lakebed was dry enough — or at least un-muddy enough — to allow recovery. The team eventually got it out and retrieved all of the on-board recorded data. Needless to say, there's a general consensus that "routine" is better.

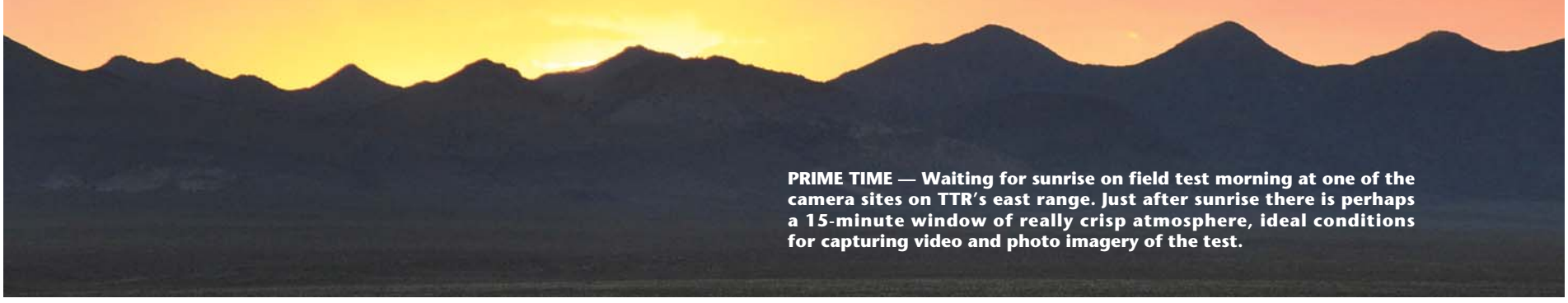
By lunchtime, both flight recorders have been recovered. With these units, and with good video and telemetry, TTR's data reduction experts will be able to provide the customers with what they came to TTR to get: performance metrics on a variety of instruments, components, sensors, and systems in a modern B61 JTA. The good results enable the B-61 LEP program to proceed on schedule.

* * *

TONOPAH TEST RANGE IS ONE OF THOSE PLACES where your impressions are shaped not just by what's in front of you, not just by what you see, but by what you know. And you know that here, for more than 50 years, Sandians have wrestled with really big challenges. Here, in the high desert, here on Cactus Flat, Sandians have provided exceptional service to the nation. History is alive here; you sense it. You sense those who have come before. And you feel the promise. You feel that this team, with its mix of veterans and relative newcomers, is primed and ready to out-do itself. There is a mystique here, tied up with what the test range has been and what it can be.

Brian Adkins captures the essence of the work at the range as "delivering excellence every day, on every test, by every person, because the nation has entrusted us to conduct the flight test missions to ensure the functionality of the national nuclear stockpile."

One engineer explains the allure of TTR in his own way. "I can't imagine working anywhere else,' he says. "What we do is so consequential. It's so important. And every test is different. That's field test. That's Tonopah."



PRIME TIME — Waiting for sunrise on field test morning at one of the camera sites on TTR's east range. Just after sunrise there is perhaps a 15-minute window of really crisp atmosphere, ideal conditions for capturing video and photo imagery of the test.

Outside the fence

Sandia showcase shines a light on research and tech transfer

By Nancy Salem

MAELYN MELVILLE (7931), a technical business development specialist, talks to a 2012 showcase attendee about a Sandia technology available for licensing.

Sandia will again take its cutting-edge research and technology to the community at a daylong event that will also spotlight intellectual property and how to do business with the Labs through licensing, partnership agreements, procurement, and economic development programs.

The second annual Sandia Research & Technology Showcase is Sept. 10 from 8 a.m.-4 p.m. at the Embassy Suites in Albuquerque. The event is free and open to the public.

"This is Sandia's opportunity to highlight our great work in front of a large, interested audience, "says Jackie Kerby Moore, manager of Technology and Economic Development Dept. 7933. "It allows us to share with the community some of the work we do behind the fences."

The showcase will include presentations, panel discussions, posters, and booths. Posters will focus on four broad themes: bioscience, computing and information science, energy and climate, and nanodevices and microsystems. Within each theme, a collection of research projects, technologies, and facilities will be featured, illustrating the range of Sandia's work from early stage research through technology deployment.

ALBUQUERQUE EMERGENCY ROOM physician Scott Forman (left) and Sandia researcher Mark Reece (1831) examine trauma shears developed for Forman's company, Héros. Mark helped Forman engineer the shears through the New Mexico Small Business Assistance Program. Forman will be a speaker at the 2013 Sandia Research & Technology Showcase.

(Photo by Randy Montoya)

The showcase is targeted to local and regional industry and academic partners. The agenda includes an overview of Sandia research and partnerships by Labs Vice President and Chief Technology Officer Julia Phillips. Pete Atherton, senior manager of Industry Partnerships Dept. 7930, will discuss technology transfer. Researchers and licensing executives will talk about available intellectual property (IP) at a panel moderated by Mary Monson, manager of Business Development and IP Management Dept. 7932.

Companies that have partnered with Sandia will talk about achieving business success on a panel moderated by Technology Ventures Corp.'s John Freisinger. Ben Cook (7910), a manager in the CTO Programs Office, will lead a panel on university partnerships and strategies for engagement.

And Jackie will moderate a panel of local leaders who have used Sandia's economic development programs, including the Sandia Science & Technology Park and the New Mexico Small Business Assistance Program.

Researchers and business development specialists will be on hand to discuss the showcased technology. And careers and recruiting staff will be available to answer hiring questions.

JACKIE KERBY MOORE, manager of Technology and Economic Development Dept. 79311, moderated a panel at the 2012 showcase that discussed how to partner with Sandia.

(Photo by Randy Montoya)

The inaugural 2012 showcase had about 400 attendees, including businesspeople from New Mexico, Arizona, California, Colorado, Illinois, Maryland, Massachusetts, Nevada, New York, Texas, and Utah. Representatives came from the University of New Mexico, New Mexico State University, New Mexico Tech, Central New Mexico Community College, and the University of Texas El Paso. The New Mexico congressional delegation also was fully represented.

Jackie says connections were established between Sandians and potential suppliers and partners.

"The planning for this year's event is going well. We are thrilled with the enthusiasm shown by Sandia's principal investigators who are participating and pleased to be highlighting their work," Jackie says. "We hope to increase partnerships as a result."

In addition to Sandia, sponsors include the New Mexico Manufacturing Extension Partnership, Sandia Laboratory Federal Credit Union, the City of Albuquerque, Bernalillo County, Technology Ventures Corp., and the Sandia Science & Technology Park. Online registration is required. For the agenda, more information, and to register, visit www.sstp.org/showcase.

Gen. Wolfenbarger, commander of Air Force Materiel Command, visits Sandia

Gen. Janet Wolfenbarger, commander of Air Force Materiel Command, was in Albuquerque last week to lead the promotion ceremony for Maj. Gen. Sandra Finan, the commander of the Air Force Nuclear Weapons Center (AFNWC), which is headquartered on Kirtland Air Force Base and is part of Materiel Command.

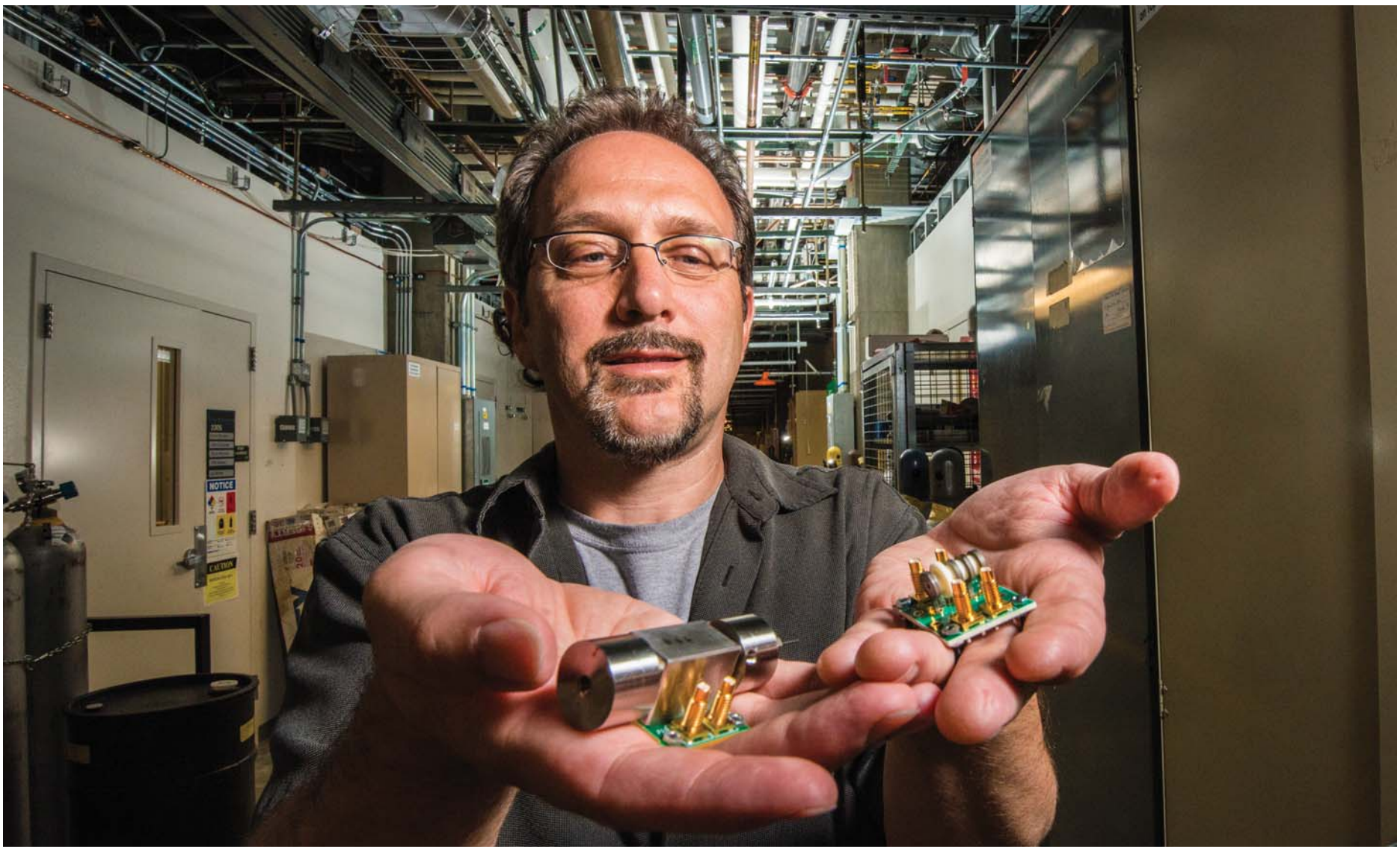
Wolfenbarger had an opportunity for a brief visit to Sandia, including a stop at the Weapons Display Area, where she was briefed on the status of the B61 Life Extension Program and the Mk21 Fuze, programs of particular relevance to the Air Force.

Wolfenbarger also had time for a quick tour of the MESA fabrication facility (photo at left) to gain an appreciation of the underlying infrastructure supporting those programs. Joining Wolfenbarger on the MESA tour were, from left, David Sandison, senior manager of MESA Microfabrication Dept. 1740; Sandia President and Laboratories Director Paul Hommert; and Science and Technology Div. 1000 VP Duane Dimos.

On her visit to Sandia, Wolfenbarger was accompanied by Wayne Brasure, executive director of the AFNWC, and Col. Tom Miller, commander of the 377th Air Base Wing and KAFB base commander.

(Photo by Randy Montoya)

Researching new detectors for chemical, biological threats



RON MANGINELL AND COLLEAGUES are developing new miniature pulsed-discharge ionization detectors — mini-PDIDs — like those Ron is holding here. The tiny devices have broadened the scope of chemical targets for Sandia's microanalytical detection technology to toxic industrial chemicals, biological volatiles, greenhouse gases, and more. (Photo by Randy Montoya)

By Sue Major Holmes • Photo by Randy Montoya

Sandia scientists are thinking small, building on decades of sensor work to invent tiny detectors that can sniff out everything from explosives and biotoxins to smuggled humans.

The military needs to find low concentrations of chemicals, such as those used in roadside bombs or chemical warfare agents, before they hurt anyone, says Ron Manginell (1716). Soldiers often use detectors in less-than-ideal situations, looking for dangerous substances from among a rich miasma of diesel fumes, smoke, and dust. They also carry detectors into the field, where instruments must be portable, rugged, reliable, and easy to use. In addition, inspectors at checkpoints and border crossings that check large numbers of containers lack automated ways to find people or contraband.

In the late 1990s, Sandia developed a simple-to-use handheld chemical detector for the military, the MicroChemLab. Ever since, Sandia has improved such microfluidics- and microelectromechanical (MEMS) systems-based instruments that identify chemicals based on gas chromatography, or GC, and resonator-style instruments such as surface acoustic wave (SAW) detectors.

Detection world needs new instruments

Ron says SAW-based instruments will continue to be extremely important. But the world of detection also needs new instruments that can find compounds such as carbon dioxide, chemical signals unique to humans, or the volatile signatures of pathogens and diseases in livestock and humans.

Ron led a project to develop such a detector and couple it with a GC. Together, they identify vapors by "sniffing" volatile organic compounds (VOCs). The prototype of the new detector, a miniature pulsed-discharge ionization detector, or mini-PDID, is about 1 inch by 1 inch by 2 inches, can be coupled with micro-GCs, and can run for nine hours on a charge of helium.

Experiments have shown the mini-PDID can detect explosives-related compounds, pesticides, and toxic industrial compounds. "These are nasty things," Ron says. The detector also homes in on signatures of human odors and bacteria, light gases such as carbon monoxide and carbon dioxide, and a broad range of organic compounds.

"We now have new detectors, like the PDID, with higher sensitivity and broader applicability that would integrate well with the SAW and micro-GCs to provide both sensitivity, the ability to detect a few molecules of a given compound, and selectivity, the ability to distinguish compounds from one another," Ron says. A miniaturized vapor detection unit and subsidiary electronics could fit in a format no larger than a cell phone, he says.

A detector for human cargo

The universal detection capabilities of the mini-PDID are allowing researchers to look at vapor detection of bacteria, an approach aimed at bringing biological and chemical detection into a small, common platform, Ron says. He highlighted the work, funded by Sandia's Laboratory Directed Research and Development program, in a presentation at last fall's International Breath Analysis meeting in Sonoma, Calif. *The Journal of Breath Research* published a paper by the team in July.

Part of the project demonstrated the possibility of a VOC-based detector for humans.

"People are brought across the border for many reasons, sometimes for a better life, sometimes for malevolent reasons" that could involve drug, weapons, or explosives smuggling, Ron says.

Current commercial detectors to find human cargo are about the size of a large shoebox, minus the electronics to operate them. Thus, Ron's team saw promise for a miniature vapor-based detector for what he calls "indications of human presence."

In other words, sweat.

No other animal has one component of human sweat called hexenoic acid. The action of bacteria on sweat excreted by human glands results in that distinct *eau de locker room* smell — what's really a byproduct of bacterial metabolism, or a bacterial VOC.

The project proved the miniature detector could find hexenoic acid at the parts-per-billion level.

So Sandia researchers, wondering whether the technique could detect other bacteria, tested it on the VOC signatures of *Microbacteria bovis* and *Microbacteria tuberculosis*. *M.bovis* causes TB in livestock and can cause TB in humans; *M.tuberculosis* causes TB in humans. The bacteria produce four unusual compounds not made by other bacteria that infect humans, and the mini-PDID approach can detect those markers at the same concentration or comparable to or better than current methods, Ron says.

Sandia, in collaboration with the University of California, Davis, has submitted a proposal to the US Department of Agriculture to use the approach on *E.coli* in soil and water to see whether it can differentiate between toxin-producing *E.coli* and more benign varieties, Ron says.

Further development sought

The proof of concept works for biological detection, and Sandia is seeking funds to develop software and mathematics for pattern recognition for specific targets, he says. It will be several years before the technology could be ripe for tech transfer, he says.

The technology also needs engineering innovations, such as a tiny low-volume, high-flow-rate valve that can operate under high pressure, Ron says. In addition, researchers are looking for funds to further develop the mini-PDID and make it even smaller. Ron wants to reduce the housing to the size of a AAA battery, and ultimately to MEMS size — typically devices measuring between 20 micrometers to a millimeter. For comparison, a human hair averages 70 micrometers in diameter.

In general, Sandia's chemical detection instruments work by collecting and concentrating a sample of air, separating the chemicals using a GC, and finding the targeted ones through selective detection.

Ron likens the GC to a racetrack for chemicals. Compounds in a mixture all enter the race at the same time, but various compounds get to the finish line at different times based on how they interact with the GC. The passage of time also helps indicate what a compound is since compounds separate at different rates, he says.

The microGC system can filter out common interfering agents such as water in the form of humidity, and detected compounds at sub-parts per billion concentrations in 6 seconds to 2 minutes in lab and field tests, Ron says.

Sandia's microGC system approach is more compact and faster than commercial GC units and can be operated by non-experts. It also eliminates the need for a mass spectrometer, which detects chemicals by measuring the relative concentrations of atoms and molecules. Eliminating a mass spectrometer removes the need for vacuum pumps, which are too big and costly for broad field use.

Principal Investigator Ron Manginell thanks colleagues on the technical team who have contributed to the research. They include: Matt Moorman (1716), Achyuthan Komandoor (1714), Curt Mowry (1819), Adam Pimentel (1819), Mike Mangan (1725), Amy Allen (1819), Bryan Carson (8622), and Elizabeth Schares. Ron also cites the support of management, including Dianna Blair (6830), W. Kent Schubert (1718), Larry Stotts (1716), and Wahid Hermina (1710). He also thanks the LDRD program for its support.

2014 Truman Fellows promise to help advance Sandia's computational capabilities

By Bill Murphy

President Harry S. Truman Fellowship
in National Security Science and Engineering

Researchers Grey Ballard and John Gamble have been selected as Sandia's 2014 Truman Fellows. They join the ranks of 19 other Fellows who have been appointed since the President Harry S. Truman Fellowship in National Security Science and Engineering was established in 2004. Because the fellowships are three-year assignments, five Truman Fellows are still doing research at Sandia as part of their fellowship. Additionally, 10 other Truman Fellows subsequently joined the Labs' technical staff upon completion of their fellowship assignments, seven of whom are still researchers at Sandia.

Grey, who earned his doctorate in computer science from the University of California-Berkeley, will be working in Informatics and Systems Assessments Dept. 8966. His manager will be Susanna Gordon and his mentor is Tammy Kolda. John, who earned his doctorate in physics from the University of Wisconsin-Madison, will be working in Advanced Device Technologies Dept. 1425. His manager will be John Aidun and his mentor will be Rick Muller. Both Grey and John are scheduled to begin their Truman fellowships this month.

Sandia Chief Technology Officer (CTO) and Div. 7000 VP Julia Phillips says, "Again this year, Sandia received outstanding research proposals from numerous individuals competing for the prestigious Truman Fellowship. This year, we offered the most interviews of any other year, signifying that applications from outstanding candidates are on the rise.

"After a very challenging deliberation process, the Truman Selection Committee recommended two individuals for the Truman Fellowship. We look forward to great results from the game-changing research proposed by Grey Ballard and John Gamble. We are confident that their research will help us advance our work in areas of fundamental importance to our research foundations and mission areas."

Grey earned a B.S. in mathematics and computer science from Wake Forest University and an M.A. in mathematics from the same school. At UC-Berkeley, his doctoral thesis was titled, "Avoiding Communication in Dense Linear Algebra." He is the recipient of many awards for his academic achievements and was honored as the Edwin G. Wilson Male Student Athlete of the Year at Wake Forest for excellence in both academics and athletics. He is the lead author on a number of journal papers and his work has been highlighted in numerous conference proceedings. Among other professional work experience, Grey was a graduate student intern at Sandia between 2010 and 2012.

The Truman Fellowships are three-year appointments. Candidates are expected to have solved a major scientific or engineering problem in their thesis work or have provided a new approach or insight to a major problem, as evidenced by a recognized impact in their field. The program fosters creativity and stimulates exploration of forefront science and technology and high-risk, potentially high-value R&D. A panel of nine senior scientists and engineers reviews and ranks each application, interviews finalists, and makes a hiring recommendation to the CTO, 7000.

This year's panelists were: Dave Chandler (8300, chairman), Cynthia Phillips (1465), Joe Michael (1819), Philip Kegelmeyer (8900), Ed Cole (1000), Tan Thai (5630), Phil Dreike (5710), John Dec (8300), and Michael Desjarlais (1600).

Sandia's University Research Office (7911) and Human Resources (3554 and 3555) teamed more than eight years ago to create the Truman Fellowship Program and develop the processes necessary to implement the prestigious position.

Current Truman Fellows: Carlee Ashley, Matt Eichenfield, Kevin Carlberg, Paul Schmit, and Christina Ting.

John earned a B.A. is physics and mathematics from the College of Wooster in Ohio and an M.S. in physics from the University of Wisconsin-Madison. His doctoral thesis, also at UW-Madison, was titled "Quantum Effects in Semiconductor Nanostructures." John, who spent the summer of 2007 as a research assistant at Los Alamos National Laboratory, was the recipient of a National Science Foundation Graduate Research Fellowship and earned several awards for his academic achievements while at the College of Wooster. He was chosen as one of two commencement speakers for his graduating class in 2008. John is lead author or co-author on numerous published technical papers and has presented his work at conferences both in the US and overseas.

The Truman Fellowship selection committee found much to praise in the research proposals by Grey and John.

Regarding Grey's work, the committee wrote, "Grey proposes to develop a computer-aided search for a tensor decomposition that will provide better scaling (exponent less than 2.81) than Strassen. If successful, this improved matrix multiplication algorithm would speed the solution of many large numerical problems of interest to Sandia and the larger world of computational simulation. The second part of Grey's proposal is to continue his work on communication-avoiding linear algebra methods in which he will analyze how current algorithms are likely to scale to future exascale computers and contribute communication-avoiding algorithms to the Trilinos library."

Of John's proposed work at Sandia, the committee noted that "He will carefully study the results of his atomic-level simulations to develop general constraints for a higher-level simulation. He will move from 2D to 3D, verifying the code performs correctly on randomly generated disorder instances, and validating the code vs. physical experiments. The final step is to use his validated 3D model to optimize the design of a qubit, also with computational and experimental validation. His proposed research could make a critical contribution to the development of a scalable silicon-based quantum qubit."

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The *Lab News* recently asked Grey and John to describe the work they intend to pursue at Sandia. Here's what they had to say:

Grey Ballard — "Numerical simulation has emerged as the 'third pillar' of science along with theory and experimentation. With increasingly powerful computational resources (both hardware and software), scientists are able to simulate physical phenomena that would otherwise be too expensive, too dangerous, too time-consuming, or simply impossible to observe. However, harnessing the full capabilities of current and future computers is an ongoing challenge, and the size and quality of simulations are limited by the computational time required.

GREY BALLARD

"In my research at Sandia, I'm interested in improving fundamental computations — those used by a wide range of computational scientists — so that they return accurate solutions more quickly, allowing scientists to work more interactively with their data, solve larger problems, and increase the quality of their simulations. Sandia is already a leader in this field of scientific computing, with numerous projects innovating new approaches for solving the hardest problems as well as developing and maintaining widely used software libraries. I hope to contribute to some of Sandia's ongoing projects, including working with Mike Heroux and the Trilinos project. I'll also be working with Tammy Kolda on a project to use computer-aided search to discover new and dramatically faster algorithms for matrix multiplication, one of the most fundamental computations.

"I was attracted to Sandia primarily by its people — the chance to work with the best researchers in the field — and its focus on applying advances in computational research to bigger and better science. Working at Sandia, I'm confident that my research will have a positive impact both on Sandians and on the broader scientific community."

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John Gamble — "Quantum information technology has the potential to revolutionize the computation landscape in ways that advances in conventional computers cannot. Since the 1990s researchers have known of code-breaking, simulation, and other quantum algorithms of critical importance that run fundamentally faster than all their known classical counterparts. Despite this, the largest fully controllable quantum computer demonstrated to date has just 14 quantum bits — a far cry from the billions of bits found in the memories of contemporary computer systems.

"One of the most important obstacles to scaling up quantum computers is the characterization and mitigation of disorder, which if left unchecked easily spoils the delicate physics that gives quantum computers their greater power in the first place. At Sandia, my research will focus on dealing with disorder in semiconductor-based quantum computers. The main challenge in studying this topic is disorder's inherent randomness. To probe its impact on devices, I will develop and apply numerical simulations that capture its essential physics while being efficient enough to collect high-quality statistics. By working with researchers in Sandia's substantial quantum computing effort, my goal is to use these simulations to develop the disorder-resistant devices necessary for scale-up to be feasible.

JOHN GAMBLE

"For these types of simulations to produce informative and useful results, tight collaboration between theory and experiment is critical. Sandia has this key element, and taken together with its in-house computing and fab capabilities, was the clear winner for me to start my post-PhD career. It's an exciting time to be working on quantum computing with prospects for scale-up on the horizon. I'm thrilled to join a world-class organization and team, and to be able to push forward toward useful, practical quantum information technology."

President Harry S. Truman Fellowship
in National Security Science and Engineering

Sandia seeks applicants for FY15 Truman Fellowship

Truman Fellowship: Sandia is seeking applicants for the FY15 Truman Fellowship. Candidates must have been awarded a doctorate within the past three years or complete doctoral requirements prior to the start of their appointment in October 2014. Additionally, they should have solved a major scientific or engineering problem, as evidenced by a recognized impact in their field. Candidates must be seeking their first national laboratory appointment (pre-post-doc internships excluded) and have the ability to obtain and maintain a DOE Q clearance. A grade point average of 3.5 undergraduate and 3.7 graduate is preferred. Please announce the fellowship availability at professional society meetings or university recruiting events and encourage qualified individuals to apply.

Application deadline is Nov. 1.

For more information, see the Truman Fellowship website (http://go.usa.gov/jPfh) or contact Yolanda Moreno (7911) at 284-2106.