



# Major milestone reached for key weapons component



*Sandia's work is helping modernize the U.S. nuclear deterrent*

By **Kenny Vigil**

**S**andia and the Kansas City National Security Campus completed a crucial weapons component development milestone, prior to full rate production.

The Mark 21 Replacement Fuze interfaces with the W87-0 warhead for deployment onto the Minuteman III and, eventually, the Sentinel Intercontinental Ballistic Missile.

The first production unit of the replacement fuze was approved through the NNSA's rigorous Quality Assurance Inspection Procedure in March.

The Mark 21 fuze, an integrated assembly of Sandia-designed logic and sensing devices directs the warhead to initiate

**SIGNIFICANT MILESTONE** — Sandia tests a prototype of the Mark 21 fuze to ensure it meets requirements and specifications. The first production unit of the fuze, which will be installed in a weapons system, was approved in March.

Photo courtesy of Sandia

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# 1.15 billion artificial neurons arrive at Sandia

*Setting up house for brain-based computing*

By **Neal Singer**

**I**n a groundbreaking stride toward the future of computing, early this year, Sandia researchers welcomed the arrival of an extraordinary brain-based computing system called Hala Point. Packed with a staggering 1.15 billion artificial neurons — believed to be the biggest brain-based computing system in the world — and cleverly confined within a container roughly the size of a microwave oven, this technological marvel made its journey from its birthplace at Intel Corp. in Portland, Oregon, to Albuquerque.

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**NEW ARRIVAL** — Computing researchers William Chapman, Brad Theilman, Craig Vineyard and Mark Plagge, left to right, check out the new Loihi 2 system upon delivery from Intel Corp. to Sandia on Feb. 1.

Photo by Craig Fritz


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# Sandia participates in voluntary review of nuclear security



By **Kenny Vigil**

**S**andia is demonstrating to the world how serious the United States is about protecting nuclear material. For the second time, the U.S. voluntarily participated in the International Atomic Energy Agency's International Physical Protection Advisory Service mission, which included a stop at Sandia.

International nuclear security experts from nine countries participated in the advisory mission. The goal was to review how the host country — in this case, the U.S. — is implementing international legal instruments and consensus recommendations for protecting nuclear material and facilities. The instrument is the Convention on the Physical Protection of Nuclear Material and its Amendment, which 135 countries have agreed to follow.

As part of the Feb. 26 to March 8 mission, four of nine advisory service members visited Sandia.

**INTERNATIONAL PARTNERSHIP** — Members of the International Atomic Energy Agency visit Sandia's Pulsed Reactor Critical Experiments Facility. The visit was part of a voluntary mission to see how the U.S. protects nuclear facilities and materials.

**Photo by Bret Latter**

“This was a diplomatic effort and a great collaboration,” said Anita Romero, an engineering program and project lead who works in Global Security at Sandia. “It allowed Sandia to demonstrate how the U.S. is protecting nuclear material and facilities, while getting feedback on areas where we can strengthen nuclear security.”

Anita said about 70 employees from Global Security, Safeguards and Security, Cyber Security, Emergency Management and Nuclear Facility Operations spent about a year planning and preparing for the visit. Sandia staff from various divisions who do not often get to work together provided input, developed materials, briefed mission members and traveled to Maryland to contribute to the mission.

## A long history

Sandia’s relationship with the International Atomic Energy Agency dates to the 1970s. On behalf of NNSA, Sandia hosts the agency’s flagship international training course on physical protection of nuclear materials and facilities. More than 1,000 international participants have come through Sandia’s doors for the training since it started in the late 1970s.

“Sandia has a long history of working in the nuclear security field,” said Joe Sandoval, a Sandia technical adviser who helped DOE and NNSA prepare for the mission. “This mission was an important White House initiative based on commitments made during the 2010 and 2016 Nuclear Security Summits. The White House and Congress are very interested in the results.”

Most of the mission was held at DOE in Maryland, and it focused on DOE’s legal and regulatory framework for protecting nuclear material. The mission required the collaboration and coordination of nine offices across DOE and NNSA.

## Sandia visit

Out of nearly 200 DOE and NNSA sites in the country, DOE selected Sandia to demonstrate how the legal and regulatory framework for protecting nuclear material is implemented.

“This shows that Sandia takes nuclear security seriously,” Joe said, referring to DOE’s selection of Sandia.



**VOLUNTARY SECURITY VISIT** — Sandia’s Billy Martin, center in green, leads international security experts on a visit to the Pulsed Reactor Critical Experiments Facility. The stop at Sandia was part of a larger voluntary visit examining DOE and NNSA regulations for protecting nuclear facilities and material.

Photo by Bret Latte

The trip to Sandia included opening remarks from DOE, NNSA and Sandia Field Office representatives, and Deputy Labs Director David Gibson.

“Our roots trace back to the Manhattan Project. We are excited to showcase the Laboratories and the work we do, as we celebrate Sandia’s 75th Anniversary,” David said.

Tapani Hack, one of four International Atomic Energy Agency members who visited Sandia, said he was impressed with the number of Sandians participating in the mission. He said it showed the Labs’ commitment to the agency’s mission and nuclear security.

## A culture of security

Sandia’s Safeguards and Security Center played a key role in the mission and preparing for the visit to Sandia. Each day, Safeguards and Security is responsible for protecting Sandia’s people, information, facilities and materials in accordance with DOE and NNSA requirements.

“This mission highlighted the incredible work Sandia performs and revealed a constant commitment to a culture of security,” said Deion D’Arco, who works in Safeguards and Security.

Safeguards and Security led the effort to complete over 130 self-assessment line

items to prepare for questions or topics to be reviewed during the visit to Sandia. Additionally, the center coordinated the development of over 160 slides, which Sandia managers used to brief the mission members. Externally, Sandia also partnered closely with DOE and NNSA.

“The opportunity to collaborate with DOE and NNSA representatives, from all levels, has been incredible,” said Paulette Solis, a manager in Safeguards and Security. “These individuals provided monthslong support and coordination in advance of the mission.”

## Sandia Pulsed Reactor Critical Experiments Facility

During a walkthrough of the Sandia Pulsed Reactor Critical Experiments Facility, Sandians showed how security measures are implemented.

“We had a short time to demonstrate to mission members — at a very broad level — how we protect nuclear material and facilities,” Anita said. “A lot of our focus in preparing for this mission was coordinating to make this as smooth and easy for the mission members to see as much as possible in a short timeframe.”

Work at the facility focuses on nuclear assembly critical experiments and gathering data that assists in benchmarking

computer models for various nuclear processes like fuel fabrication and waste storage.

“Though benchmark experiments are at the core of the mission for the facility, our team also provides hands-on engineer and supervisor training to teach proper work practices for fissionable material as part of NNSA’s Nuclear Criticality Safety Program,” said Billy Martin, manager of nuclear facility operations.

Following the walkthrough of the facility, mission members shifted their focus to discussions. Topics included how security at Sandia is managed, how Sandia implements a strong security culture and what measures are implemented to protect the nuclear material and facilities Sandia possesses.

At the conclusion of the visit, the International Physical Protection Advisory

Service team noted that it was impressed with the thoroughness and clarity of documentation Sandia provided, as well as the effective delivery of the briefings.

### Exit meeting

After the Sandia visit, the four mission members went back to Maryland, joining the other five members. They spent time working on a draft mission report and briefing for the exit meeting. Sandians were on hand to answer questions and provide clarification to the mission members as they prepared for the exit meeting.

Samantha Flores, director of Safeguards and Security, gave closing remarks on behalf of Sandia and thanked members of the International Atomic Energy Agency.

“Your nuclear security expertise is invaluable. Sandia is always seeking ways to continuously improve, and we welcome

your recommendations or suggestions for bolstering our existing security systems and structures,” Samantha said.

Mission members focused the exit meeting on recommendations, suggestions and good practices for protecting nuclear facilities and materials, based on what they observed during their visit.

A draft mission report was provided to DOE at the conclusion of the mission, and a final report is expected to be delivered to the U.S. in the next couple of months.

“It has been a huge privilege to be a part of this team. Seeing the results of months and months of work come together into this report is hugely gratifying,” said Sondra Spence, a manager in Sandia’s global security. “This mission has truly enabled Sandia to come together and demonstrate our strong history and commitment to global nuclear security.” 

## Mark 21 Fuze

CONTINUED FROM PAGE 1

firing sequences at the correct point in targeting parameters. The Mark 21 Fuze Replacement Program is a partnership between the NNSA and the U.S. Air Force.

“Sandia’s role is to deliver a fuze that meets the Air Force’s requirements. Completing the first production unit is a visible milestone in maintaining a credible deterrent,” said Brad Boswell, a director in Sandia’s nuclear deterrence modernization program. “It demonstrates that we are providing the necessary capability for the U.S. nuclear deterrent into the future.”

### Designing the fuze

As the lead design agency of the Mark 21 Fuze, Sandia was responsible for incorporating Air Force requirements into a form, fit and functional package that interfaces with the Mk21 aeroshell, MMIII missile and W87-0 warhead. Work began in 2011.

“The early engineering work takes a lot of time. While some of it is done in parallel, much of the work must be sequential,” said Bob Oetken, a former program manager for the fuze program.

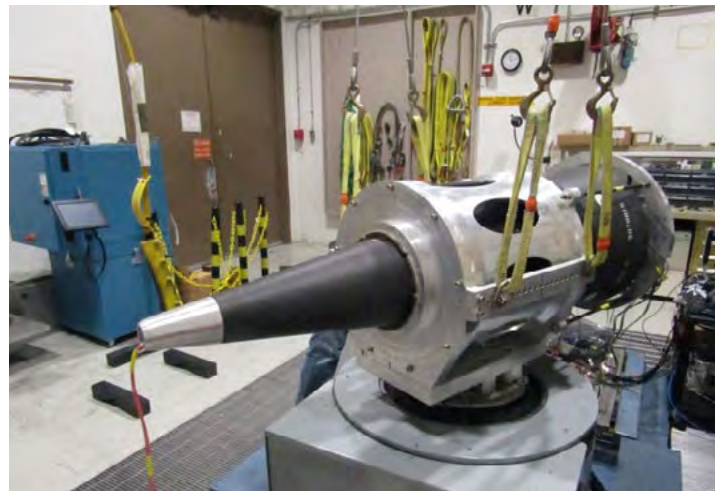
“We’re doing a very specific job that requires, in many cases, custom parts.”

Sandia worked closely with the Kansas City National Security Campus to ensure the design was producible and delivered on schedule. While the Kansas City National Security Campus is producing and assembling the fuze, Sandia is manufacturing some of the parts.

### Fuze qualification

Before production of the fuze began, a significant amount of time was spent qualifying the design, which ensures the design meets Air Force specifications. It includes analysis through testing and other engineering tools to ensure the fuze will function as intended.

“Qualification involves significant resources and time. We are in a very



**COLLABORATIVE EFFORT** — Sandia is the lead design agency for the Mark 21 Fuze. The program is a collaborative effort with NNSA, the Kansas City National Security Campus and the U.S. Air Force.

Photo courtesy of Sandia

rigorous business. Some of the qualification is used to verify that we are meeting requirements and took as long as three years from concept to delivery,” Bob said.

The program has conducted numerous tests, including environmental, ground and flight tests, to ensure the fuze withstands multiple difficult environments, such as acceleration, vibration and thermal environments expected during missile launch and ballistic reentry.

## Stockpile assessment

Now that the fuze is in full rate production, Sandia's responsibilities shift. "As the design agency, Sandia is responsible for the component until the weapon is retired. Sandia is accountable for ensuring that the weapon with the fuze attached is safe, secure and reliable," Brad said.

As part of the stockpile assessment, Sandia will conduct monitoring through


processes such as modeling and simulation and flight and ground testing to ensure the fuze continues to work as intended.

## Partnering for great results

Completing the first production unit of the Mark 21 fuze is the culmination of more than a decade of work and collaboration, not just at Sandia, but by NNSA and the DOD.

"This first production unit marks a

significant milestone not just for Sandia but the broader nuclear security enterprise, particularly our partners at the Kansas City National Security Campus," Brad said.

"While we stop to recognize this achievement, we must also acknowledge this is the start of the next phase of our partnership as we work to meet key production milestones to deliver the quantity of fuzes needed to meet the needs of the stockpile." 

## Artificial neurons

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The system's purpose is to provide Sandia and NNSA research teams with the tools to realize brain-based computing on a large scale. At a smaller scale, the neuromorphic method has already demonstrated greater speed, accuracy and lower energy costs than conventional computing in several labs, including [one at Sandia](#).

Compared with the system of 50 million artificial neurons received by Sandia from Intel three years earlier, dubbed Pohoiki Springs, the new system is 10-times faster, 15-times denser and has increased from 128,000 circuits on a single chip to 1 million.

The work is funded by NNSA's Advanced Simulation and Computing program. The NNSA is a semiautonomous DOE agency responsible for the management and security of the nation's nuclear weapons, nuclear nonproliferation, and naval reactor programs, as well as

responding to nuclear and radiological emergencies in the U.S. and abroad.

"We believe this new level of experimentation — the start, we hope, of large-scale neuromorphic computing — will help create a brain-based system with unrivaled ability to process, respond to and learn from real-life data," Sandia lead researcher Craig Vineyard said of the latest arrival.

"Our colleagues at Sandia have consistently applied our Loihi hardware in ways we never imagined, and we look forward to their research with Hala Point leading to breakthroughs in the scale, speed and efficiency of many impactful computing problems," said Mike Davies, director of the Neuromorphic Computing Lab at Intel Labs.



**BIGGER, BETTER BRAIN** — Computing researcher Brad Theilman takes a closer look at the new Loihi 2 system. **Photo by Craig Fritz**

Hawaiian location, Hala Point.

"Since a system of this scale hasn't existed before, we've been developing algorithms to efficiently use it," Craig said.

While his group is interested in problems involving large-scale physics, chemistry and the environment, he says the technique has the potential to be disruptive at multiple scales.

"On the one hand, we're looking at science codes, physics computations. Can we model large processes in more detail? What about device design or climate models with better-defined resolution?" This means, Craig said, creating applications that can use the full system.

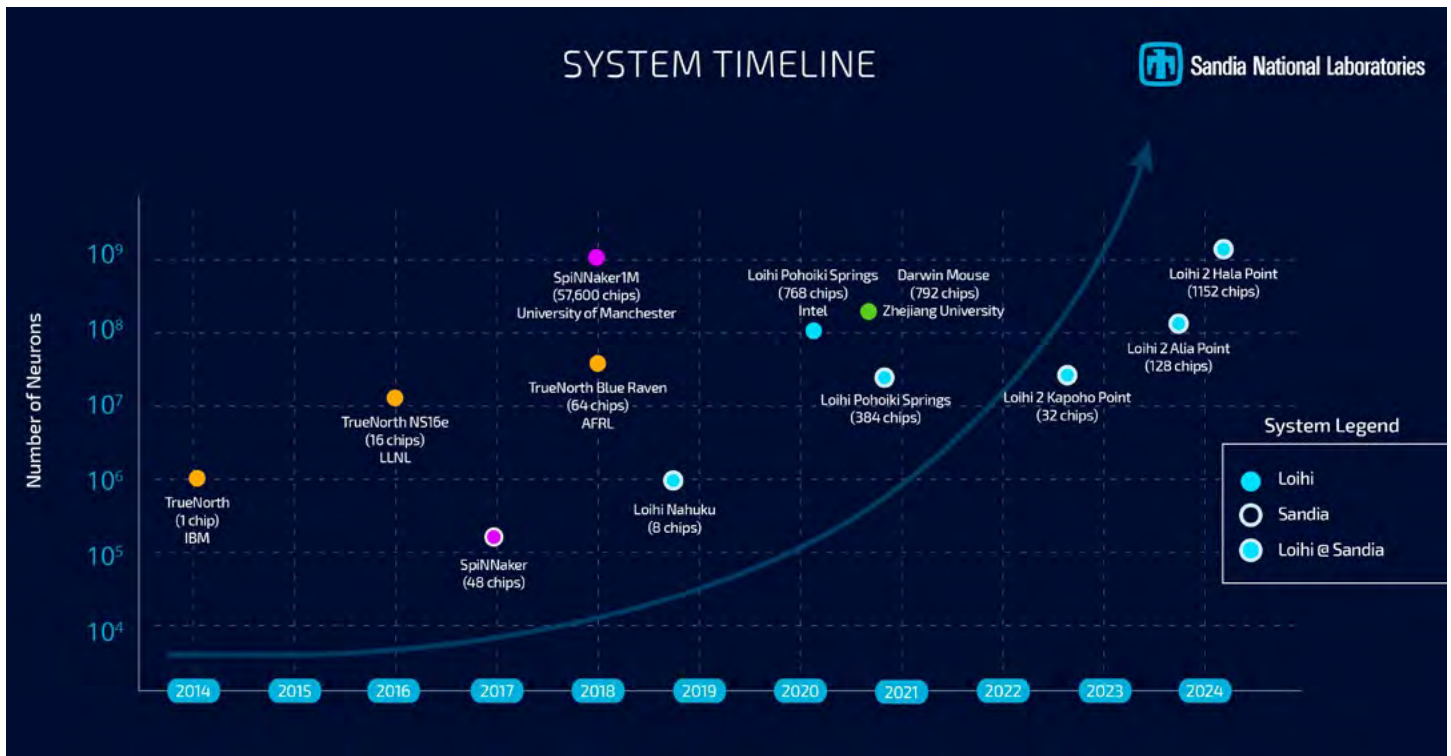
On the middle ground: "We're not looking at global replacements of all traditional processing. It's more a matter of identifying the best approach to a problem. A supercomputer that requires the energy of a small city could function with substantial energy reductions if neuromorphic systems took over subsidiary tasks."

In terms of societal protection, Craig sees smarter soldier gear, better analysis of intelligence operations, better border



**BRAIN-BASED COMPUTING** — 3D render of the motherboard with an AI chipset illuminated from the bottom. **Graphic by Ray Johnson**

The two systems use two generations of research chips, code named Loihi 1 and 2 for the youngest volcano in the Hawaiian Islands. The latest computing system comprises 1,152 Loihi 2 research processors and is named after another



**A DECADE OF RESEARCH** — Sandia has received a groundbreaking brain-based computing system from Intel Corp., boasting 1.15 billion artificial neurons, aiming to advance large-scale, brain-inspired computing. This innovative system, 10-times faster and 15-times denser than its predecessor, holds potential for various applications from scientific simulations to societal enhancements like smarter soldier gear and rapid medical diagnoses. **Graphic by Ray Johnson**

security and quicker response to earthquakes. Medically, he sees more rapid medical diagnosis and less expensive drug discovery.

“We might soon see self-driving cars with neuromorphic technology, lane detection, cell phones with voice recognition, smarter watches and refrigerators, more detailed home security systems. Did the cat run by or is someone in your house?”

### Electrical spike that notifies neurons

The neuromorphic process saves energy and compute time by electrically pulsing only when a synapse in a complex circuit has absorbed enough charge to produce an electrical spike. This process discards useless information — that which doesn’t spike — instead of storing it in distant locations and revisiting it in every calculation. In this manner, neuromorphic computing operates like the brain does, with subgroups of active neurons arranged in parallel circuits, tapped for information as needed, rather than the sequential instructions and remote memory storage involving every possible unit that

characterizes mainstream computing.

Sandia researcher Brad Aimone said, “One of the main differences between brain like computing and regular computers we use today — in both our brains and in neuromorphic computing — is that the computation is spread over many neurons in parallel, rather than long processes in series that are an inescapable part of conventional computing. As a result, the more neurons we have in a neuromorphic system, the more complex a calculation we can perform.

“We see this in real brains. Even the smallest mammal brains have tens of millions of neurons; our brains have around 80 billion. We see it in today’s AI algorithms. Bigger is far better.”

Aimone led a Sandia team to an **international prize** in 2023 for using neuromorphic hardware to suggest solutions to a wide range of problems, including those in heat transfer, medical imaging and finance.

### The mismatch: Like running a race in someone else’s shoes

The most obvious difficulties for

neuromorphic computing today are that its software must either perform through mainstream hardware — a mismatch like running a race in someone else’s shoes — or in neuromorphic hardware typically, though not always, too trivial, and lacking in scale and function to produce notable results.

“It’s clear that brain-based computing functioning through conventional serial hardware hampers the efficiency of neuromorphic programs,” Craig said.

Brad added, “For a long time, we’ve been forced to think about neuromorphic algorithms that are small because neuromorphic hardware is new. I fully believe that the advantage of a neuromorphic computer will best be seen at realistic brain-like scales. With this billion-neuron system, we will have an opportunity to innovate at scale both new artificial intelligence algorithms that may be more efficient and smarter than existing algorithms, and new brain like approaches to existing computer algorithms such as optimization and modeling.”

As Hala Point prepares to experience its newly minted Sandia programs, the future awaits.

# Employees use new benefit for whatever floats their boat

By **Karyn Scott**



**FLOATING HOLIDAY FUN** — Sandian Natasha Hart spends a floating holiday enjoying a high school basketball game during spring break with her daughters Payton, 9, and Skylar, 6.

Photo courtesy of **Natasha Hart**

**B**eginning this year, eligible employees receive two floating holidays, totaling 16 hours, each year in addition to the 11 holidays already observed by Sandia. These floating holidays are part of the new and enhanced employee benefits that were introduced in 2024.

“We care about our employees’ health and well-being, and having a good work-life balance is essential for maintaining one’s overall wellness,” Executive Director and Chief Human Resources Officer Brian Carter said. “Work-life balance continues to come up in our employee engagement surveys as a reason people stay at Sandia. We want that to continue, and through the Lab’s [People & Culture Strategy](#), one of the ways we’re continuing to promote work-life balance is by providing additional time off through our new floating holidays.”

## A successful benefit

More than 2,000 Sandians have already used their floating holiday hours. For

example, more than 400 employees took off part or all day on Monday, Jan. 15, for Martin Luther King Jr. Day.

Additionally, nearly 550 Sandians used floating holiday hours on Monday, Feb. 19, for Presidents Day. Chief of Staff Lindsay Klennert and her children went skiing in Durango that day.

“It was great being able to spend Presidents Day having fun with my kids and celebrating another holiday in addition to our Sandia-observed ones,” Lindsay said.

Germaine Almager-Laughlin, ethics and business conduct officer, also used a floating holiday on Presidents Day.

“My husband and I were able to extend our weekend camping trip an extra day,” Germaine said. “These new floating holidays are a real benefit for employees, and I appreciate having the extra time off.”

Business Management manager Jac Pier used a floating holiday last month to celebrate his birthday.

“My birthday this year fell on a Thursday right before one of my regularly scheduled 9/80 Fridays off. I had a nice, relaxing day on my birthday and a decent chunk of time off with a four-day weekend. The cool thing about this new benefit is that it gives us the gift of time, which is a precious resource,” he said.

Rate analyst Natasha Hart spent a fun-filled day with her family during spring break by using one of her floating holidays.

“I don’t normally take time off during spring break, but this year I enjoyed a one-day staycation with my family. We stayed overnight in a hotel with a swimming pool for the kids, then woke up and went to Topgolf in the morning, a high school basketball game in the afternoon and then dinner afterwards,” she said. “I got to spend additional time this spring break with my family, and I’m thankful for those extra hours.”

Since the new floating holidays can be used in one-hour increments, manager Lorenzo Stanton has been able to use his extra time off for a variety of activities.

“I used a few of my floating holiday hours to leave work early on Valentine’s Day, run some errands on another day and tack on some additional time to my vacation,” Lorenzo said.

Senior Technical Recruiter Doan Phung used one of her floating holidays to celebrate Lunar New Year in February.

“I’m Vietnamese and the most important holiday in my culture is Lunar New Year. We celebrate it for about a week or more, primarily spending time with family: feasting, attending festivals, handing out red envelopes with money to children and lighting red firecrackers for good luck,” Doan said. “Even though this year’s Lunar New Year started on a Saturday, I was able to extend my celebration by using one of my floating holidays.”

Creative Services manager Rebecca Brock hasn’t used her floating holidays yet, but she knows exactly what she is going to do with them.

“I’m saving my floating holidays for Rosh Hashanah and Yom Kippur in October. Our Jewish holidays change each year with the Hebrew calendar,” Rebecca said. “Previously I had to use vacation time to observe my faith. And although Sandia has always promoted diversity really well, being able to now use holiday hours for my religion’s holy days makes me feel even more included at the workplace. This feels like I belong.”

Regardless of how employees choose to use their new floating holidays, they now have more time off from work to spend resting, recharging and doing the things that matter most to them. [📄](#)

All full-time benefit eligible employees will be awarded 16 floating holiday hours annually in January. Part-time employees are awarded pro-rated hours based on their standard work hours. Represented employees should refer to their collective bargaining agreement for eligibility details.

# Finland delegation tours superfuge



**SUPER TOUR** — Mikko Hautala, center, Finland's ambassador to the U.S., asks questions of Sandia manager Ed Romero during a tour of the superfuge. NNSA hosted a delegation from Finland's Ministry of Foreign Affairs and Ministry of Defense on a tour of the facility last month. **Photo by Craig Fritz**

## Environmental responsibility a priority for Sandia

By **Diana Hackenburg and Dan Ware**

According to Kermit the Frog, it's not always easy being green — but it is safe to say that Sandia takes environmental stewardship seriously.

This Earth Day, Lab News highlights a few of the many programs that help

protect, restore and monitor the world around us. Representatives from each program summarize how they help Sandia achieve its commitment to environmental responsibility and highlight one big accomplishment from the past year.

In addition to these efforts, Sandia engages in research, development and deployment activities that solve the

nation's energy challenges, including **climate change**. Together, these programs ensure Sandia is a good neighbor to our surrounding communities for this and future generations.

### **Ecology program**

The Ecology Program conducts long-term natural resources monitoring and





**SAFER SITES FOR ALL** — Sandia biologists relocated a flock of ducklings and their mother from Sandia's Albuquerque site to the pond at the Tijeras Arroyo Golf Course on Kirtland Air Force Base.

Photos by Isabel Lawrence

provides technical support. In 2023, one of the program's biggest achievements was continuing initiatives to reduce unwanted human-wildlife interactions. Awareness campaigns, simple physical changes to our shared landscape and outreach efforts resulted in a stronger understanding that everyone at the Labs shares in protection of the natural environment.

—Evan Fahy, Environmental Technical Professional with the Ecology Program

## Energy equity and environmental justice

The Energy Equity and Environmental Justice team increases awareness of how these concepts can be incorporated into our work, research and community interactions. Sandia can make a difference for overburdened and underserved communities, and the team works to ensure communities have equitable access to a healthy, sustainable and resilient environment, and the benefits that result from our nation's shift to clean energy.



**JUSTICE FOR ALL** — In addition to co-hosting speakers on topics of energy equity and environmental justice, Sandia also participates in several initiatives designed to create educational opportunities in technical areas for minority students.

Photos by Randy Montoya

Working with Sandia's **Climate Speaker Series**, the team brought several experts in last year to speak on the topic. The Energy Equity and Environmental Justice team also hosts a reading club where staff come together to learn about these concepts by reading and discussing journal articles.

—Myra Blaylock, Energy Equity and Environmental Justice team staff lead

## Energy management

The energy and net-zero programs have developed plans to achieve net-zero greenhouse gas emissions at the Albuquerque, New Mexico, and

Livermore, California, sites, including decarbonizing our energy supply, reducing mission-critical emissions and incorporating sustainability into building renovations. In 2023, Sandia received DOE recognition for **achieving the 50001 Ready designation** and instituting best practices in continuous energy improvement across the two campuses. Achieving this designation requires sites to self-attest to the structure of the ISO 50001 energy management standard and to measure and report energy performance improvement.

—Mary Watson, Energy and Infrastructure Data Management department manager

## Fleet services

As part of the national effort to catalyze American clean energy industries and reduce greenhouse gas emissions, federal fleets must acquire all zero-emission vehicles by 2027 for light-duty and 2035 for medium- and heavy-duty vehicles. Sandia has received 19 zero-emission and plug-in hybrid vehicles that meet the federal sustainability requirement and anticipates receiving 462 more through fiscal year 2030. In anticipation, Fleet Services installed four solar-charging units at the Albuquerque site this past year.



**MORE ENERGY EFFICIENT** — Plumbing contractor Gary Roberts works on the cooling system in Sandia's high-performance computing building, which was used as a benchmark for identifying opportunities for better energy management at the Labs.

Photo by Craig Fritz



**FEWER EMISSIONS** — A Ford F150 Lightning “refuels” at an off-grid solar electric vehicle charging station.

Photo by Justin Teo

Fleet Services is also considering a used tire recycling program. Several audits and assessments have recognized the team’s noteworthy environmental stewardship, including cleanliness and waste management practices at the New Mexico maintenance shop.

—Justin Teo, Fleet manager

## Stormwater

The Stormwater Program oversees compliance with several Environmental Protection Agency National Pollutant Discharge Elimination System permits as part of its larger mission to protect surface water quality at Sandia. Stormwater runoff from the Albuquerque site flows to the Tijeras Arroyo and then to the Rio Grande, which provides habitat for several threatened and endangered species, drinking water for Albuquerque and surrounding communities, and irrigation water to local farms and Pueblo communities. By ensuring potential pollutants are used, stored and disposed of properly to prevent exposure to precipitation and storm runoff, the program helps maintain the quality of this important water resource.

In May 2023, the EPA and New Mexico Environment Department inspected numerous facilities at our Albuquerque site as the final step of a yearlong audit of our municipal stormwater permit. The audit, a first in more than a decade, was a success, reporting that “Sandia has a comprehensive stormwater program and appears to do an excellent job of implementing their stormwater permit.”

—John Kay, Stormwater Program

## Materials sustainability and waste management

The Waste Management and Pollution Prevention Department supports Sandia’s commitment to achieving zero waste every day by helping members of the workforce manage waste products, encouraging reducing, reusing and recycling before disposal. In the last five years, Sandia’s Albuquerque site reduced commercial solid waste by 23% and increased recycling and composting by 45%.

The department also focuses on sustainable acquisition of the materials needed for mission work. Sandia gives preference to products that meet various environmental specifications, such as energy and water efficiency and bio-based or recycled content. In 2023, the department introduced a tool to streamline sustainable product procurement and better track progress toward zero-waste. Subcontractors have already submitted reports for over \$38 million in spending through the tool, which indicates that procurement of compliant bio-based products increased by 114% from the previous fiscal year. Buying bio-based products provides American farmers with an outlet for their crops, increases demand for these environmentally friendly products and decreases the use of petroleum-based materials. Sandia purchased more than \$35 million in registered **Electronic Product Environmental Assessment Tool** electronics, such as cell phones, printers and computers, that meet environmental performance criteria set by the EPA.

—Cary Hamilton, Pollution Prevention, and Kelly Wiese, Materials Sustainability

## Wastewater monitoring

Sandia’s Wastewater Monitoring Program ensures compliance with the six industrial discharge permits and two lagoon permits. The program also makes sure that Sandia activities do not pollute the Rio Grande or nearby watersheds. The team uses automated field monitors



**CLEANER STREAMS** — Stormwater drains from the Labs at the Albuquerque site into a concrete channel that discharges into the Tijeras Arroyo.

Photo by John Kay

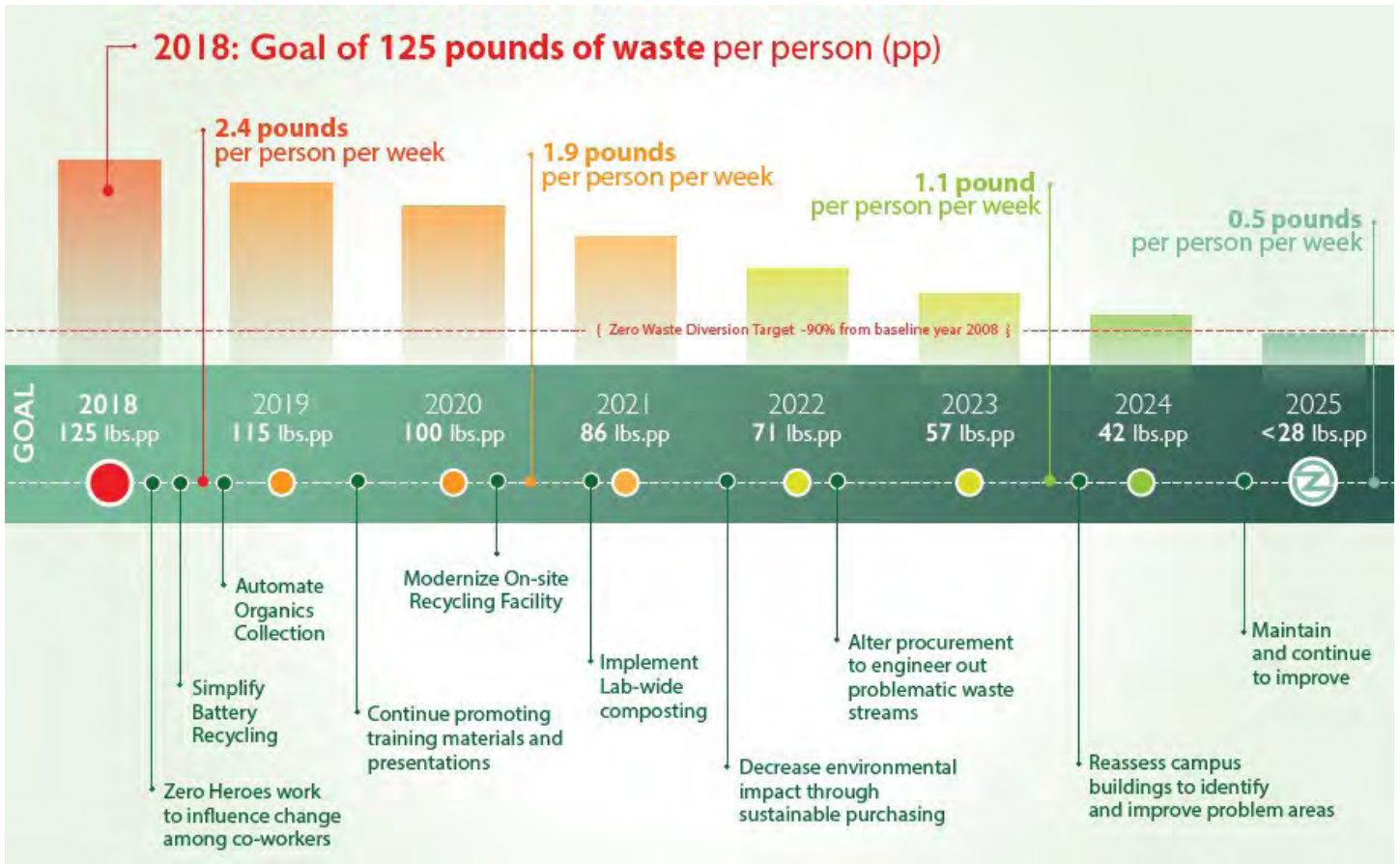


**TESTING WASTEWATER** — Environmental Field Team members collect samples of wastewater for laboratory analysis. The wastewater team conducts independent verification sampling to make sure Sandia meets water quality standards set by the Water Authority. **Photo by Mark Zuverink**

for around-the-clock tracking of water quality parameters like pH, temperature and total flow at sites throughout Sandia’s campus. Wastewater samples are taken periodically to ensure optimal water quality.

As a testament to Sandia’s commitment to excellence in wastewater compliance, the Albuquerque/Bernalillo water authority bestowed Sandia with six pretreatment gold awards in 2023. The awards were given for meeting 100% compliance with all permit requirements, demonstrating a commitment to environmental protection and using industry leading methodologies to track and ensure water quality.

—Mark Zuverink, Environmental Compliance and Monitoring

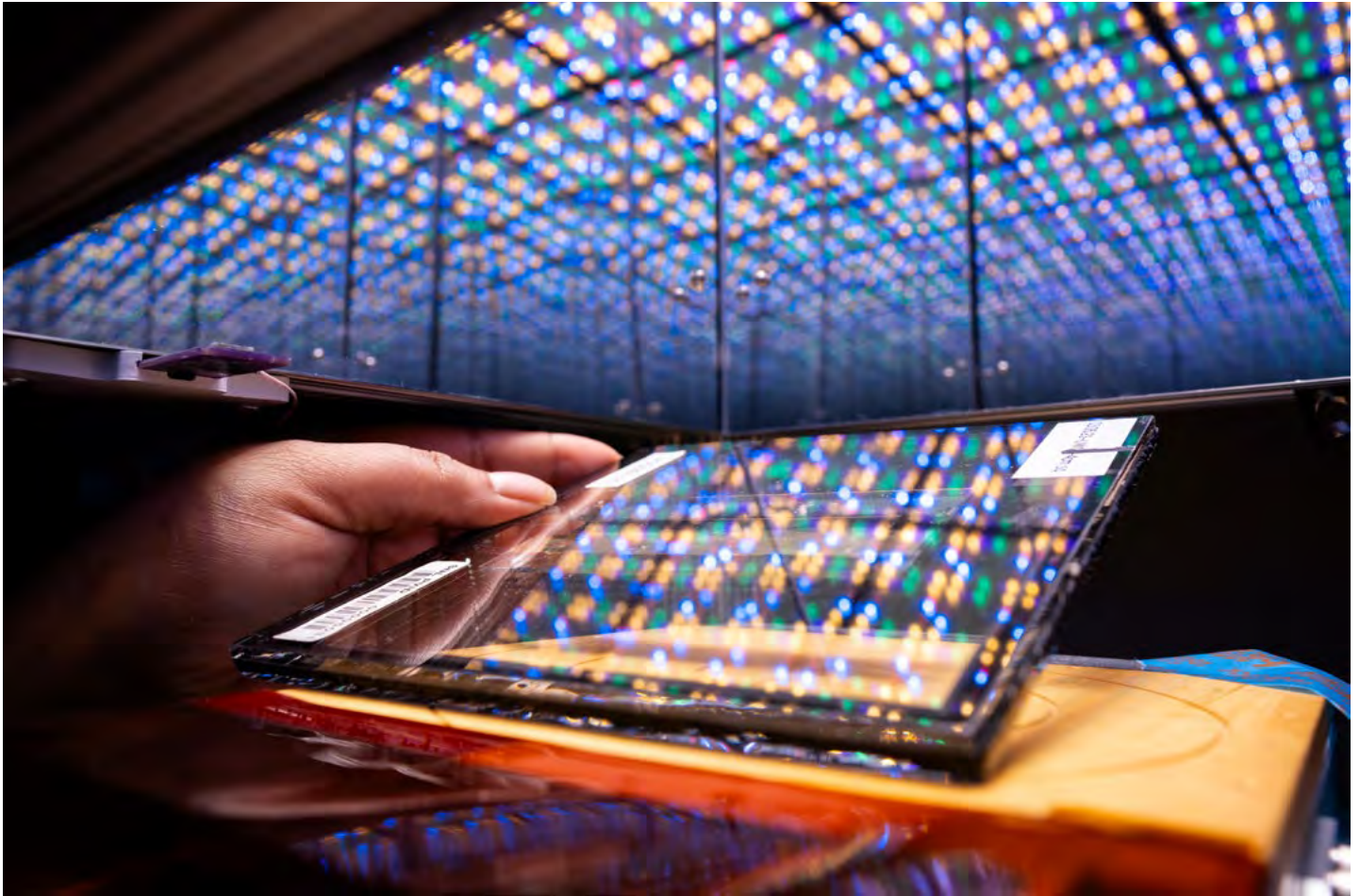


**LESS WASTE** — In the past five years, Sandia has cut the amount of waste it creates per person in half to 1.1 pound per person per week in 2023.

Graphic by Michael Vittitow; Data provided by Samuel McCord

# Earth Month around the Labs

Photos by **Craig Fritz**



**SHINE BRIGHT** — Scientist Angelique Montgomery places a perovskite module in a solar simulator of LED lights to simulate the sun with a flash of light at the Photovoltaic System Evaluation Laboratory.



**ALL HANDS ON DECK** — A group at the National Solar Thermal Test Facility cleans all the heliostats with a power washer, scrubbers and squeegees the morning before a critical test in an attempt to maximize the sun's heat on Dec. 4.



**PV PICK UP** — Technologists William Snyder, left, and Kevin Santistevan move a photovoltaic module for testing at the Photovoltaic System Evaluation Laboratory on Aug. 2.

# Sandia microgrid expert named IEEE Fellow

By **Mollie Rappe**

**S**andia electrical engineer Michael Ropp has been named a Fellow of the Institute of Electrical and Electronics Engineers, one of the world's largest technical professional organizations.

Michael's research focuses on developing algorithms to improve the **resiliency of the electrical grid**, particularly with the addition of many sources of renewable energy such as rooftop solar panels and wind turbines. One source of resiliency, and technical challenges, is the ability to form small "islands" of power around hospitals, water treatment plants and other critical infrastructure, called microgrids, if the main grid goes down.

IEEE Fellow is the highest grade of membership, and fewer than 0.1% of IEEE voting members can be selected as fellows each year after a rigorous evaluation process. Michael was nominated by one of his graduate advisers for his work on an issue that can occur with wind and solar plants where they can accidentally separate themselves from the rest of the electrical grid. This is called unintentional islanding, and Michael's graduate work on detecting this issue is used as the foundation for the unintentional islanding

prevention in 75% of inverters on the grid today, Michael said.

"An IEEE Fellow is kind of like a lifetime achievement award, so it is a huge honor," Michael said. "I'm extremely humbled and grateful to be a part of that community now. There's just an enormous list of people to thank, and I hope they all know who they are."

Also, Michael is quite proud of his work as an early pioneer studying the use of time-synchronized voltage measurements, or synchrophasors, for unintentional islanding detection. Using physics theory, computer simulations, laboratory experiments and field tests, Michael and the rest of the **Solar Energy Grid Integration Systems** team showed that synchrophasors work. So far, the cost of high-speed communication systems and GPS has hindered industrial adoption, but Michael hopes their time will come.


Michael received his bachelor's degree in music from the University of Nebraska-Lincoln in 1991. He received his master's and doctoral degrees in electrical engineering from Georgia Tech in 1996 and 1998, respectively. Michael has been a member of IEEE since 1998.

Michael enjoys both playing and writing music and hiking and exploring the Southwest with his family.



**NEWEST FELLOW** — Sandia electrical engineer Michael Ropp has been recognized by the Institute of Electrical and Electronics Engineers for his work improving the resiliency of the electric grid.

Photo by **Craig Fritz**

"There are two ingredients that need to come together for innovations that make a big difference," Michael said. "One is you need to have a deep knowledge of the problem and the physical workings of possible solutions. You've got to understand the physics well. Two is you need to have a dedicated block of time to think. It takes time; innovation is not something you can just schedule." 

## From nose cones to molten salts

*National Solar Thermal Test Facility plays important role in multiple missions*

By **Mollie Rappe**

**W**hat do steam, salt and sand have in common? All three have been studied by researchers at the National Solar Thermal Test Facility in their quest to shed light on innovative ways to harness concentrated sunlight for utility-scale electricity.

**Commissioned in July 1978**, the

NSTTF has played a vital role in the development of concentrating solar power technologies and served as a testing ground for aerospace and defense applications, areas it continues to advance today.

Its development was prompted by the OPEC oil embargo of 1973 and was inspired by early solar dish testing in White Cliffs, Australia, and legends of **Archimedes' heat ray**, said Ken Armijo, a concentrating solar power researcher at Sandia and project leader of a **digital concentrating solar power archive**.

"The NSTTF has a unique place in Sandia's history," said Margaret Gordon, manager of the concentrating solar technologies group. "We've hosted so many

visitors — U.S. presidents, secretaries of energy, congresspeople — and been able to emphasize the engineering expertise that exists at Sandia, not just the NSTTF but the Labs as a whole. We are the scientists and engineers who make things work, not just for renewable energy but for defense and other applications."

Over the years, the NSTTF has been involved in testing solar dishes, parabolic troughs to concentrate sunlight into a line, as well as the very visible 200-foot-tall





**FIRST LIGHT** — In 1978, Sandia staff and dignitaries gathered for the commissioning of the National Solar Thermal Test Facility. For more than 45 years, the facility has led the way in solar energy commercialization and research and aerospace materials testing.

Photo from the Sandia archives

power tower with a field of more than 200 mirrored heliostats, Ken said. Researchers found that while the initial cost of a power tower and heliostat field was greater, over the lifetime of a plant, the leveled cost of electricity was lower than the more modular forms of concentrating solar power, he added.

## Steam and salt

In the early years, researchers focused on concentrating sunlight on an array of metal tubes containing water, so that the heat from the sun could turn the water into steam, which in turn could spin a turbine to generate electricity. Until 1985, Sandia's power tower produced up to five megawatts of energy for the grid using this method and a generator salvaged from the USS Norfolk, a post-World War II warship, Ken said.

In 1981, Sandia worked with the company Rocketdyne to design and build a 300-foot-tall power tower with a 360-degree heliostat field in Barstow, California, called Solar One. Solar One produced 10 megawatts of electricity from 1982 to 1986.

Transitioning in 1986, the NSTTF switched its research focus from steam to molten nitrate salts. Molten salt — salt that is heated to approximately 1,000 degrees Fahrenheit so it flows like a liquid — can hold a lot more heat than steam and can be stored in tanks to allow a power plant to continue to produce power at night or during cloudy periods, Ken said. However, molten salt is quite corrosive, **requiring pipes, valves and seals** to be made from non-corrosive materials that also can

withstand the heat. Conversely, if the salt gets too cool, it freezes and can really gum up the works, he added.

“We were one of the powerhouses of molten salt research for two decades,” Ken said. “Sandia and Plataforma Solar de Almeria in Spain were the places to do molten salt research for CSP.”

Collaborating with the Southern California Edison Company in 1995, the second-largest electric utility in the nation at the time, Sandia converted Solar One to molten

salt using the lessons learned from the NSTTF. **Solar Two** operated from 1996 to 1999, produced 10 megawatts of electricity annually and could store hot salt for up to three hours.

Sandia's expertise in molten salt continues to this day with the world's largest molten salt test loop, Ken said. This series of three loops is constructed from 6-inch pipes and can test molten nitrate salts from 570 to 1,085 degrees Fahrenheit. Innovations and improvements from this facility are used at dozens of molten-salt-based **concentrating solar power plants** around the world as well as molten-salt-based advanced nuclear reactors, he added.

## Aerospace materials testing

Since 1979, the NSTTF has been a vital hub for testing aerospace materials for NASA, the DOD and private industry, Ken said.

The facility can replicate the intense heat of reentering the atmosphere, while being a more cost-effective method of testing materials and subsystems than an **Arc jet**, Ken said. Arc jet testing costs \$100,000 per shot, while testing on the power tower costs \$21,000 per day, he said.

The various NSTTF labs have been involved in testing **space shuttle tiles, sensors** and communication systems to see if they would work during reentry. The facilities have also been involved testing nose cones for space shuttles and planes, and **aerospace materials'** resilience to rapid temperature changes.

The power tower and heliostat field



**VERY IMPORTANT VISIT** — President George W. Bush visited the National Solar Thermal Test Facility on Aug. 5, 2005, to sign the Energy Policy Act of 2005. From left, Sen. Jeff Bingaman, Secretary of Energy Samuel Bodman, Labs Director Tom Hunter, Bush and Sen. Pete Domenici.

Photo by Randy Montoya

can produce light intensities up to 3,500 suns. The solar furnace, a fixed solar dish, can produce light intensities up to 10,000 suns, resulting in temperatures up to 5,400 degrees Fahrenheit, Ken said. The NSTTF also has a high-intensity solar simulator that allows for continuous, long-term testing of materials.

Additionally, the test bay 140 feet up on the power tower has a wind tunnel capable of mimicking the conditions of Mach 0.3. Ken added he would like to get funding to build a Mach 1 or Mach 5 wind tunnel on top of the tower to replicate even better the intense conditions of reentry.

Testing materials for aerospace applications continues to this day. Researchers from Johns Hopkins University Applied Physics Laboratory tested heat-shield materials for possible solar-powered rockets on the power tower in 2022. In 2023, NASA tested materials at the tower for the Mars Sample Return mission.

## Sand like particles

From 2013 to 2018, Sandia researchers led by Cliff Ho explored the potential of **sand like particles** in collecting heat from concentrated sunlight. Unlike molten salt, cold particles flow just as well as hot particles and can be stored for long periods of time. Also, the **dark, ceramic particles** can reach temperatures of 1,800 degrees Fahrenheit or hotter, compared to molten salt's 1,000 degrees. Higher temperatures mean better heat-to-electricity conversion.

Particles require different systems than water or liquid salt to transport and imbue them with heat from concentrated sunlight.



**HOT STUFF** — In a photo from 2022, a lead technologist at Sandia’s National Solar Thermal Test Facility assesses damage to some aerospace heat-shield materials after on-sun testing.  
**Photo by Craig Fritz**

Therefore, much of the effort to design and test a **falling-particle receiver** that produced a smooth curtain of particles was focused on mitigating conversion and transportation risks.

In 2021, the falling-particle receiver efforts were recognized by DOE, with the team receiving \$25 million to build a **third-generation concentrating solar power pilot plant** to pave the way for widespread commercialization. The Sandia team hopes to show that the plant can heat particles above 1,300 degrees Fahrenheit, store them for at least six hours, and produce 500 kilowatts of power through integration with a **supercritical carbon dioxide Brayton cycle**.

Construction of the particle pilot plant tower should be complete by June 2024,

with equipment installation and testing in the subsequent months. While based in New Mexico, the particle pilot plant project involves academic and industry collaborators from across the world.

### The future of concentrating solar power

“There are three main areas where we think solar thermal technologies have the ability to grow in the future,” Margaret said. “The first is industrial process heat, using this high-quality, high-temperature heat that particle-based technologies can produce to replace natural gas and other fossil fuels for industrial processes like making cement or making transportation fuels. The second is in long-duration energy storage. Thermal energy storage is inherent to concentrating solar systems. The third one is around large-scale electricity production. The grid needs some amount of steady electricity generation, and CSP, nuclear power and geothermal energy are the best carbon-free sources for this ‘baseload’ power.”

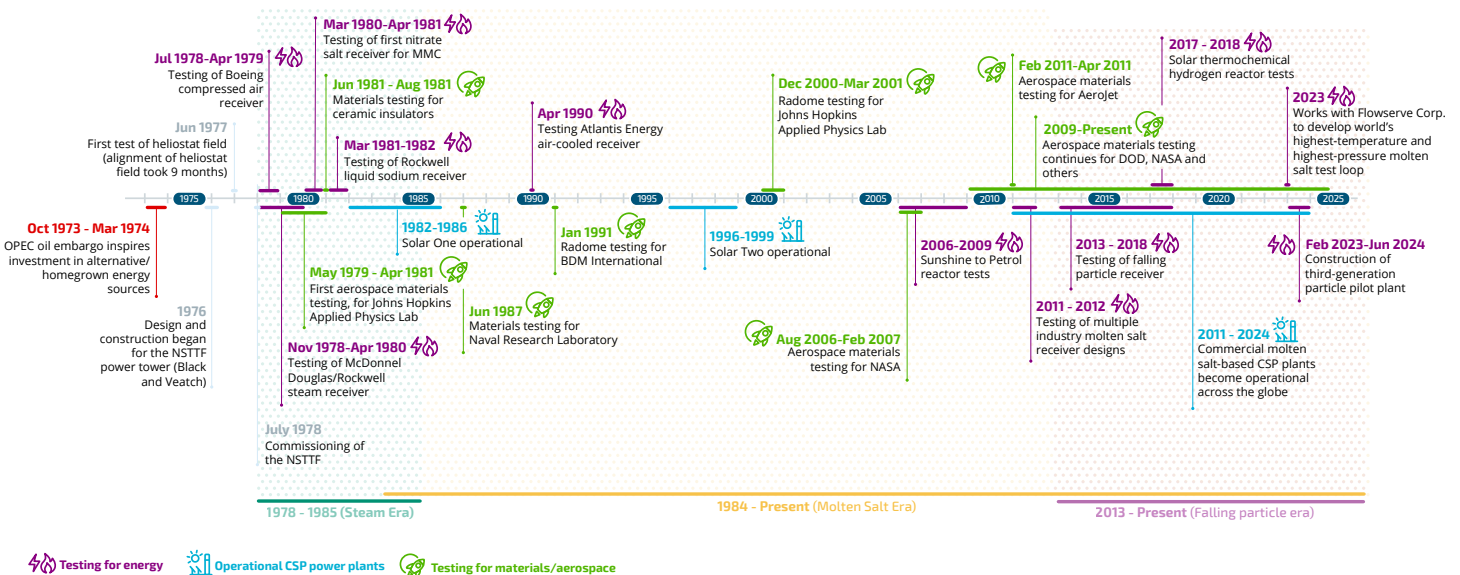
Sandia researchers are **collaborating with private companies** to explore concentrating solar thermal energy for making clinker, a key component in cement, while also capturing the carbon dioxide produced as part of the chemical process, Margaret said. Using electricity, which could come from other green

sources, poses a significant challenge for reaching the very high temperatures needed for the process.

Sandia scientists are studying how to use solar thermal chemistry to make green fuels such as **ammonia**, hydrogen and syngas in a renewable way, she said. Researchers have also looked at the **environmental, benefits and taste improvements** of replacing natural gas or propane with solar power for roasting foodstuffs.

While some existing concentrating solar power plants have enough **thermal energy storage** to last overnight, Sandia computer modeling of particle-based solar power has shown the potential for next-generation plants to store more than 100 hours of heat in a cost-effective manner, Margaret said. This breakthrough could be used to meet electricity demands when the sun isn’t shining and the wind isn’t blowing, greatly increasing the resiliency and reliability of the national grid.

“We think that the particle pilot plant is going to do for particles what Solar Two did for molten salt,” Margaret said. “The engineering that Sandia did for Solar Two and molten salt exists in all molten salt plants around the world. Proving out base technologies and reducing risks associated with those components — we think can do the same thing for particles.”



**ERAS OF RESEARCH** — A timeline illustrating the many ways research at the National Solar Thermal Test Facility has impacted the nation.

**Illustration by Ray Johnson**

# Statistician seeks to understand climate change through variable relationships

By **Sarah Jewel Johnson**

Climate change is a confusing maze of inputs and outputs. Katherine Goode spends her days trying to make the variable chaos behave.

Katherine is a research and development statistician at Sandia currently supporting the **CLDERA Grand Challenge**. She is part of a large research team working to understand climate change mitigation strategies and their potential downstream effects. Katherine lends her statistical expertise to create novel algorithms that identify patterns and relationships in inputs and variables that climate scientists believe are related.

“I’m working with observational data collected by satellites to try to understand how different climate variables are related to some sort of climate event. It’s not an easy problem, but it’s a really interesting challenge trying to understand those relationships,” Katherine said.

Machine-learning models relate inputs and outputs to predict future outcomes. Katherine applies machine learning to better understand the negative impacts of climate change, causes and potential outcomes of future mitigation techniques — such as climate geoengineering to slow the rate of change.

“We have this really complex climate system, but we try to understand if a climate change mitigation strategy was taken, how one variable may affect another variable which will affect another variable,” Katherine said. “One of the mitigation strategies we are studying is stratospheric aerosol injections, where aerosols would be injected into the stratosphere with the intention of deflecting the sun’s rays. We would like to understand how a change in the amount of aerosols relates to temperature changes.”

## Statistical relationships

For Katherine, the quest to explain variable relationships is nothing new. She graduated with a doctorate from Iowa State University in 2021 and started as a Sandia intern in 2019. Her dissertation explored

the mathematical relationships between the inputs and the predictions that come out of black-box machine-learning models.

“Machine learning models are powerful tools for making predictions, but the mathematical complexity of the algorithms makes it difficult to understand how the inputs relate to the outputs. Hence the term ‘black-box models’. I work to develop techniques that provide transparency to these models. For example, if we build a model to predict temperature given the quantity of aerosols and other climate variables, how does the model make use of the aerosols for prediction,” Katherine says.

Katherine’s passion to mitigate climate change stems from her love of nature and her desire to prevent potentially catastrophic consequences in the future.

“People are developing possible mitigation strategies for dealing with climate change that could have negative downstream consequences that we still don’t fully understand. If one nation chooses to use a mitigation strategy, it could negatively affect another nation. At Sandia, we’re well positioned with individuals with varied backgrounds to solve complicated problems like this,” Katherine said.

## Making connections

Because of the complicated and complex nature of both climate change and quantitative data, Katherine doesn’t hesitate to reach out to peers and constantly reads literature on diverse application spaces for statistical techniques. While she rarely has an opportunity to discuss her work with the public, Katherine takes time at conferences and events to network with researchers and fellow statisticians.



**VIEW FROM THE TOP** — In her spare time, Katherine enjoys a wide range of outdoor activities in New Mexico, such as skiing in the Sandia Mountains.


Photo courtesy of Katherine Goode

“I go to a lot of conferences, and I think that’s a place I can really talk about the application space,” shares Katherine. “There aren’t a lot of great techniques that already exist that can just be directly applied to the type of climate data that’s being worked with — which is huge amounts of data — or that can be used to address the questions that individuals have, but that’s what makes it interesting. You get to be really creative and think about how we could go about using existing tools and adapting them to work with this particular situation.”

So, what does the world look like in the future according to Katherine?

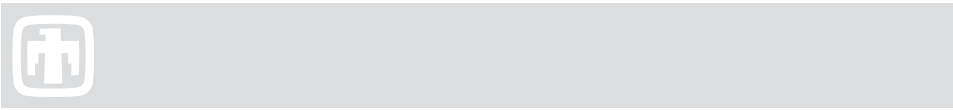
Twenty years from now, we could have a better understanding of climate change and be able to spend more time addressing other threats to national security. We could have algorithms to explain the unexplainable. But we will still need to adapt.

“I feel like we’re going to have to continue taking what we’ve learned from our current research process and I’m sure new issues will arise that we haven’t foreseen. Climate mitigation is such a meaningful place to be doing work, but it’s still a newer area of research. It’s a new application space. It’s challenging but we’ve got to overcome the hurdles,” Katherine said.

We’re going to have to learn from the present to predict the future — even when the variables don’t always behave. 



# Mileposts



Dan Bozman 40



Amy Tapia 35



David Hensinger 30



Jeremy Cottle 25



Kristy M. Kaneshiro 25



Steve Wimpy 25



Shawn Colborg 20



Melissa Garner 20



Sean Harris 20



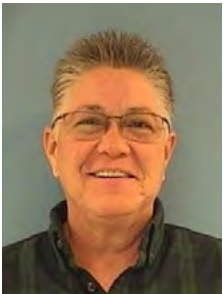
George Hoskison 20



Derek Lamma 20



Steven Neff 20



Carla Weatherred 20



Kasimir Gabert 15



Michelle Kuehner 15



Walen Mickey 15



Cher Rigby 15

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# Kauai volunteers repaint Boys and Girls Club

By **Michael Bejarano** and  
**Ryan Flanagan**



**FRESH PAINT** — Sandians Tory Daligcon, left, and Joannell Cabral fill a bucket with paint. The Boys and Girls Club hosts after-school activities to support children at low or no cost to their families. The clubhouse is a welcoming and comfortable space for children to play, do homework and participate in academic programs.



**NEW HEIGHTS** — Sandians Rilen Bayot, top, and Katie Jurney paint a hallway in the clubhouse of the Waimea branch of the Boy and Girls Club. A group from the Sandia Kauai Test Facility spent a day painting the clubhouse, which serves children from elementary to high school.



**GROUP PROJECT** — A large group of Sandia employees and local Wolverine contractors from the Kauai Test Facility pose outside of the Waimea branch of the Boys and Girls Club. The group repainted the interior of the clubhouse.