SANDIA LAB NEWS
PUBLISHED SINCE 1949
Vol. 76, No. 21, Oct. 31, 2024

MAKING HISTORY SHAPING THE FUTURE — 75th Anniversary Issue

Detecting battery failures quicker

BATTERY EXPERIMENTS — Sandia's Alex Bates and Loraine Torres-Castro talk about positioning a battery that's undergoing testing at the Battery Abuse Testing Lab. Their research on electric vehicle batteries aims to detect battery failures more quickly. **Photo by Craig Fritz**

Sandia working to improve safety of electric vehicle batteries

By **Kenny Vigil**

Batteries in electric vehicles can fail quickly, sometimes catching fire without much warning. Sandia is working to detect these failures early and provide sufficient warning time to vehicle occupants.

While electric vehicles have systems to detect performance issues with lithium-ion batteries, these systems are not focused on imminent safety concerns. "The nature of battery fires can vary widely, depending on the failure mode. Some batteries self-heat for hours, while others are abrupt and aggressive," said Alex Bates, a member of Sandia's battery safety group. "The battery starts heating uncontrollably, ultimately resulting in a fire."

— CONTINUED ON PAGE 4

Sandia's heritage in Advanced Simulation and Computing

The transformative national security impact of early parallel computers

By **Shelby Owens**

How do you ensure the safety, security and reliability of nuclear weapons without testing?

That was the question the U.S. needed to answer quickly after the 1991 signing of the Strategic Arms Reduction Treaty and the subsequent testing moratorium that accompanied the beginning of negotiations for a Comprehensive Test Ban Treaty.

After the September 1992 Divider test, the U.S. ceased all nuclear explosive testing, ending decades of reliance on the combination of theory, complex experiments and live atmospheric, underground and underwater nuclear testing.

— CONTINUED ON PAGE 6

ASCI RED — Pictured in a photo from 2000, Red was a massively parallel computing system deployed by Sandia and Intel Corp. in 1996 to support the Accelerated Simulation and Computing Initiative program. It was the first computer to reach 1 teraflops computation and the first system in ASCI. **Photo from the Lab News archives**

SANDIA LABNEWS
PUBLISHED SINCE 1949
Managed by NTESS LLC for the National Nuclear Security Administration

Sandia National Laboratories

Albuquerque, New Mexico 87185-1468
Livermore, California 94550-0969
Tonopah, Nevada | Kauai, Hawaii
Amarillo, Texas | Carlsbad, New Mexico | Washington, D.C.

Katherine Beherec, Editor kgbeher@sandia.gov
Ray Johnson, Production rbjohns@sandia.gov
Craig Fritz, Photographer cvfritz@sandia.gov
Michael Langley, California Contact mlangle@sandia.gov

CONTRIBUTORS

Michelle Fleming (milepost photos, 505-844-4902),
Neal Singer (505-846-7078), **Kristen Meub** (505-845-7215),
Troy Rummler (505-284-1056), **Meagan Brace** (505-844-0499),
Mollie Rappe (505-288-6123), **Skyler Swezy** (505-850-2063),
Kim Vallez Quintana (505-264-1886), **Kenneth Vigil** (505-537-1528),
Luke Frank (505-844-2020), **Michael Baker** (505-284-1085)
Maggie Krajewski (mkrajew@sandia.gov),
Valerie Alba (vnalba@sandia.gov), **Lea Blevins** (lsblevi@sandia.gov)

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Published on alternate Thursdays by Internal, Digital and Executive Communications, MS 1468

LAB NEWS ONLINE: sandia.gov/LabNews

TABLE of CONTENTS

 continued on page 4
 continued on page 6

EDITOR'S NOTE: Please send your comments and suggestions for stories or for improving the paper. If you have a column (500-800 words) or an idea to submit, contact the Lab News editor at labnews@sandia.gov.

Cooperative Monitoring Center turns 30

Anniversary celebration highlights impact of science diplomacy on global security

By **Kristen Reynolds**

Sandia's Cooperative Monitoring Center celebrated its 30th anniversary on Sept. 12 at the Center for Global Security and Cooperation. The event drew more than 140 guests representing NNSA, the U.S. Department of State, non-governmental organizations, academia and international partners from across the globe.

"Thirty years ago, the visionaries who founded the CMC recognized the profound potential of cooperative monitoring to address some of the world's most pressing security challenges," Managing Director Amir Mohagheghi said in his opening remarks. "They understood that through technical collaboration and transparency, we could build a safer and more secure world."

GLOBAL CONNECTIONS — From left, NNSA's Kasia Mendelsohn catches up with Nisreen AL-Hmoud and Iyad Aldasouqi from the Royal Scientific Society of Jordan. **Photo by Bret Latter**

The CMC draws on Sandia's scientific and technological expertise to build bridges between countries and inform regional and international policymaking around global security. This practice is called "science diplomacy," a recent term and the topic of the keynote speech by Ambassador Shirin Tahir-Kheli, who served as a national security adviser to three U.S. presidents. "Science enables diplomacy by underpinning confidence in technical matters and thus is invaluable," the ambassador said.

The daylong event featured panels on the center's past, present, and future and included perspectives of its founders, longtime sponsors and partners, and the next generation of thinkers and leaders. Panelists included Princess Sumaya bint El Hassan, president of Jordan's Royal Scientific Society; Mallory Stewart, assistant secretary for the U.S. Bureau of Arms Control, Deterrence, and Stability; Jooho Whang, president and CEO of Korea Hydro & Nuclear Power; Yongsoo Hwang, professor at KEPCO International Nuclear Graduate School; and Kasia Mendelsohn, principal assistant deputy administrator for Defense Nuclear Nonproliferation at the NNSA.

Devised in the wake of the Soviet Union's dissolution and the beginning of nuclear stockpile stewardship, the CMC was a novel concept. Emerging regional issues heightened the need for arms control, nonproliferation and security agreements. The concept was to build trust and foster cooperation on a global scale by sharing knowledge of nuclear monitoring technologies with other nations.

IDEA EXCHANGE — Panelist Jooho Whang, president and CEO of Korea Hydro & Nuclear Power, takes questions from the audience. **Photo by Bret Latter**

"There were all these regions where there seemed to be political will to move toward agreements," CMC co-founder Arian Pregenzer said. "Those agreements would be nothing if they weren't implemented — and that meant technology." In 1994, NNSA, with support from the Department of State, funded and launched the center with early focus on the Middle East, Southeast Asia and Northeast Asia.

Upon opening, the center's six staffers began hosting technical and policy experts from Middle Eastern academic, government and military circles. As part of the Middle East peace process, discussions focused on monitoring and verification challenges related to arms control and regional security. Outside of Washington, D.C., these meetings were more relaxed, recalled panelist Mike Yaffe, who was then a Department of State foreign affairs officer concentrating on Middle East peace negotiations. Training workshops, technical collaborations and Track II, or unofficial diplomatic, meetings ensued.

The center originally occupied a strip mall outside the Eubank gate because there was no easy mechanism for hosting foreign visitors from sensitive countries on the military base. Joining virtually, former Sandia Deputy Laboratories Director Dori Ellis recalled her fostering of the International Security programs and the CMC as one of the most challenging and impactful initiatives of her career. When the International Programs building, later renamed to the Center for Global Security and Cooperation, was constructed outside the military installation in 2004, Ellis was there to cut the ribbon.

Early center successes included a cooperative monitoring experiment at border crossings between India and Pakistan. Justine Johannes, associate Laboratories director of Global Security, said this work was a major contributor to Sandia's current border security portfolio. Sandia sponsored the establishment of two sister Cooperative Monitoring Centers — one in Jordan in

A SHARED VISION — From left, Cooperative Monitoring Center staff and panel speakers Chuck Kosak, Sue Caskey, Mike Yaffe, Kent Biringer, Cassie Gale, Justin Olmstead, Farnaz Alimehri, Hannah Haegeland, Ambassador Shirin Tahir-Kheli, Noelle Camp, Arian Pregenzer, Chris Cutrone, Justine Johannes, David Cooper, Rodney Wilson, Jana Wattenberg, Dave Sandison, Monte Mallin, Jason Bolles and Amir Mohagheghi. **Photo by Adriane Littlefield**

2004 and another in the United Arab Emirates in 2012, which began educating the first generation of nuclear enterprise professionals in the Gulf region. These organizations are known today, respectively, as the Chemical, Biological, Radiological, and Nuclear Threat Reduction Office located within the Royal Scientific Society, and the Gulf Nuclear Energy Infrastructure Institute.

Princess Sumaya addressed the anniversary audience in a video message from Jordan. "Ladies and gentlemen, my colleagues and I at the Royal Scientific Society of Jordan are immensely proud of our long partnership with so many of you here today. Through our rich and embedded partnership with Sandia and its network, we have greatly enhanced our ability to deal with the most pressing existential challenges to our region." The video depicts many who were present at the anniversary and illustrates their longtime collaboration.

The anniversary's Future of the CMC panel focused on the current multipolar, geostrategic environment and the many threats to global security. Distinguished panelists from the NNSA, Department of State and U.S. Naval War College emphasized the importance of cooperative engagement to counter discord and mistrust. "The CMC has established its core capabilities," Mendelsohn said. "These capabilities will allow CMC to address future challenges — whatever they may be."

Today, the CMC is globally recognized for convening roundtables on global security issues and exploring options to address them. Panelist and Sandia historian Justin Olmstead described the center as "thought leaders who drive innovation."

"The key differentiation between the CMC and think tanks is that they are doers, not just thinkers," Justin said.

Current global security studies conducted by the center address alternative geopolitical futures for tomorrow's nuclear age and a framework for evaluating the risk landscape of emerging disruptive technologies.

"The challenges we face today are complex and multifaceted, but the spirit of cooperation and innovation that defines the CMC will continue to guide us," Amir said. "Together, we will harness the power of technology and collaboration to contribute to a safer world."

For more information on the CMC's current work; Virtual Research Scholar program; speaker series; and Technology, Training, and Demonstration Area, visit cmc.sandia.gov.

EV batteries

CONTINUED FROM PAGE 1

Current measurements in battery management systems capture temperature and voltage, but these are lagging indicators of safety issues. This means a warning may not appear until it's too late — when the battery is about to catch fire or is already on fire.

"We're focused on extending the warning time," said Loraine Torres-Castro, Sandia's battery safety lead. "Our aim is for the diagnostic system to provide an early warning, allowing time to park safely and exit the vehicle." She added that the ultimate goal is to integrate this warning system into the car's dashboard.

The BATLab

To achieve this, Loraine and her team have been testing commercial off-the-shelf diagnostics on single cells and battery packs at the Battery Abuse Testing Laboratory.

SWIFTER FAILURE DETECTIONS — Sandia's Genaro Quintana prepares a battery for testing in a vault at the Battery Abuse Testing Lab. Sandia's research on detecting battery failures sooner in electric vehicles was published in the Journal of the Electrochemical Society. **Photo by Craig Fritz**

"Our objective is to benchmark commercially available solutions for different failures that exhibit varying responses and require tailored diagnostics," Loraine said. "One size does not fit all. We seek to identify specific tools that can provide early warnings for particular failure conditions, battery chemistries and cell engineering."

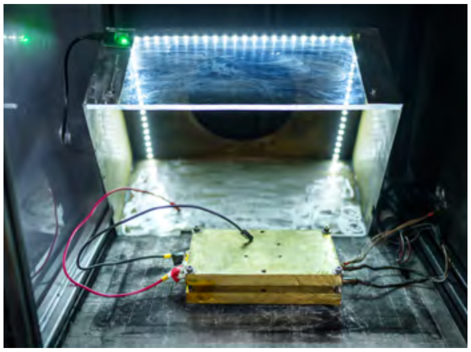
Sandia is uniquely positioned to do this work, not only because of the BATLab. As Loraine said, "We have broad expertise on our team. We understand material science, electrochemistry, engineering and, most importantly, how and why batteries fail."

A paper published earlier this year in the Journal of the Electrochemical Society describing Sandia's research has gained significant attention. "It's important work. Industry is interested in this space. It's still wide open," Alex said. "This manuscript has largely started the conversation, or at least pushed it to the forefront of battery safety for electric vehicles."

The paper highlighted techniques used to detect failure markers and has implications beyond batteries for electric vehicles. "We're working with an organization in South Korea to evaluate the potential use of this technique in grid energy storage systems. We're talking about large batteries," Loraine said.

Next steps

Loraine and Alex agree there's a lot more work to do on electric vehicle battery failure detection. "The next phase is understanding the limitations and applying machine learning algorithms to datasets," Alex said. "We need other methods to examine the signal and ensure that it's fast, accurate and not a false positive."



TEST TIME — A battery is ready for testing in a vault, which includes several layers of shielding and concrete walls, at Sandia's Battery Abuse Testing Lab. Sandia scientists are working to identify methods to detect failures in electric vehicle batteries before the batteries catch fire. **Photo by Craig Fritz**

Another focus area is advancing sensor technology to the point that the sensors issue more than warnings. "These tools can also activate mitigation measures. For instance, upon receiving a warning the system could trigger the thermal management system of the battery to start cooling it down," Loraine said.

As a next step, Sandia will have battery packs from electric vehicles in the lab. The cells will be disassembled and tested at different scales to check the limitations of the current diagnostics on the market.

"It's very exciting to be at the forefront of practical battery safety, where our work will extend beyond the lab," Loraine said.

Alex added, "We're always excited about the science."

Smart Labs completes successful pilot

By **Diana Hackenburg**

Sandia has completed a pilot of the Smart Labs program in Building 897 at the Albuquerque site, aiming to make the laboratories safer, more energy efficient and ultimately better equipped to support our scientists — and our mission.

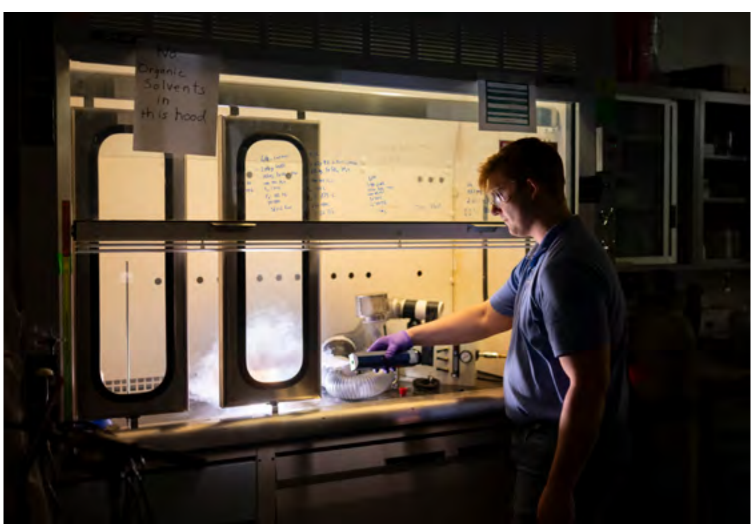
"Smart Labs helps us design spaces based on the specific hazards facing the scientists, while also reducing costs and energy usage," said João Oliveira, Sandia's Smart Labs coordinator.

João led the multidisciplinary pilot team of engineers, industrial hygienists and construction crewmembers. Together, they worked to improve ventilation in 897 by capping unused exhaust hoods, retrofitting existing fume hoods and replacing inefficient laminar hoods.

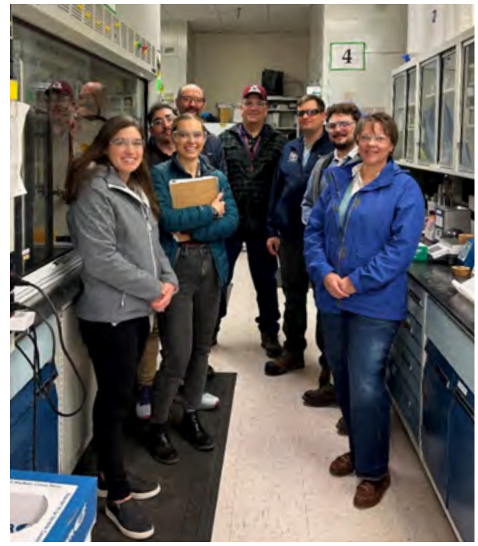
Piloting a team approach

One of nine "clone" buildings designed using similar principles, the team chose Building 897 for the pilot because of its close resemblance to other spaces and its large size — it houses more than 60 lab spaces — provided many opportunities for improvement.

The Smart Labs process starts by assessing laboratory practices and procedures for possible hazards. Sandia then engaged a consultant to translate those assessments into a list of more than 40 specific projects.



EFFICIENT UPGRADE — As part of the Smart Labs initiative, 3Flow contractor Walker Smith tests fume hoods in building 897 after they are retrofitted to save energy. **Photo by Craig Fritz**



TEAM EFFORT — Smart Labs for National Labs coordinators visited a laboratory in Building 897 in March 2024 to learn more about Sandia's fume-hood retrofit kits. **Photo courtesy of João Oliveira**

The team presented those ideas in a town hall with Building 897 occupants and began consulting with individual laboratories to gauge their needs, interest and availability.

"Initially, people had a lot of questions," said Roberto Armijo, Smart Labs lead mechanical engineer. "But when you start digging in, the program makes a lot of sense."

Once a laboratory agreed to participate, the next step was to identify hazards that could affect the construction team. Environment, Safety and Health Coordinator Fernanda Garavito worked with the Material, Physical and Chemical Sciences Center labs in Building 897 to conduct job site hazard evaluations.

"If they need to modify or remove a fume hood, for example, we must remove the chemicals and decontaminate the equipment to ensure the crew won't be exposed when touching surfaces," Fernanda said.

With safety plans in place, Sandia's in-house construction team could finally start making upgrades — but not before coordinating with each lab to prevent scheduling conflicts. "We did not want to interrupt any mission work," said Berna Otero, construction manager for the pilot.

"We interfaced with the lab owners and construction team to make sure they were on the same page, and we met weekly to go through the schedule and discuss our progress," Berna said.

João identified communication as the project's biggest challenge. "One of the lessons learned was that we need to engage people up front in understanding what we can do through the program and its benefits."

Reaping the benefits

First and foremost among those benefits are the safety improvements that came from retrofitting existing fume hoods. The team also removed unused fume hoods and laminar flow hoods.

"Laminar flow hoods are designed to protect your materials," Fernanda said. "Fume hoods prevent air from going out towards the worker, decreasing exposure." A future goal for some of the labs in 897 is to replace the removed laminar flow hoods with the relocated fume hoods.

For Laboratory Support Technologist Dave Rademacher, removing an unused laminar flow hood reclaimed useful workspace for his lab's chemical analysis and materials characterization research. "The construction team also started preparing the lab for a full hood that will allow us to do even more chemistry," Dave said.

Dave added that the individual lab projects will help with the building's larger ventilation system, too. "When the system is overused, all the hoods kick off." Now, the building has a much lower ventilation load, gaining back capacity that can be allocated to future projects.

João said that Smart Labs has already saved Sandia $64,000 in energy costs and reduced our carbon footprint by an amount equivalent to the annual electricity usage of 14 homes. The program also saved individual labs money by paying for the removal of unused fume hoods and then giving them to other labs in need of new equipment.

Further savings came from collaborating with Roberto on the engineering designs and with Sandia's newly formed in-house construction team. "This project gave the construction team the opportunity to show what they are capable of, and they did a really good job," Berna said.

Next steps

In addition to completing more ventilation assessments — including for buildings at the California site — the team has incorporated Smart Labs guidelines into the standards manual that regulates design, construction, operation and maintenance of all Sandia facilities.

Those guidelines are being used to design Sandia's first fully Smart Labs-compliant laboratory, but funding remains a challenge. The pilot program received money from Sandia's Reinvestment in Utility Savings program, which reinvests savings from renegotiated utility rates into energy projects.

João anticipates more opportunities for the Smart Labs program in the future as Sandia strives to achieve net-zero greenhouse gas emissions by 2050. "We are trying to change the culture, right? Smart Labs has succeeded in making lab users more aware of Sandia's sustainability efforts and what they can do to help."

Advanced computing

CONTINUED FROM PAGE 1

Approaching this new age in nuclear weapons, the nation needed to ensure that its weapons were maintained with confidence in the reliability, performance and safety of the stockpile.

Without testing, the nation turned to computer simulation, technology that was still emerging. This led the DOE to create the Accelerated Simulation and Computing Initiative in 1995, now known as the NNSA Advanced Simulation and Computing program.

'What had never been done before'

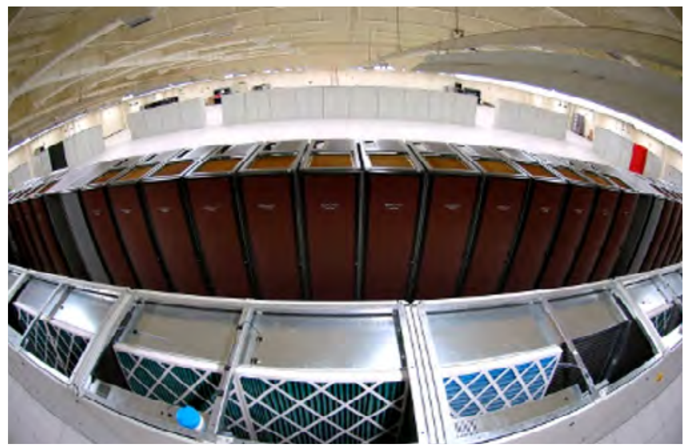
Victor Reis, then Assistant Secretary for Defense Programs, believed the DOE's strength was in the defense program labs: Los Alamos, Lawrence Livermore and Sandia national laboratories. He pulled together the directors of the labs, their weapons leadership, DOD leaders and others inside and outside the federal government to plan a radically different approach to ensuring that confidence.

At the first ASCI workshop in 1994, Reis delivered a call to action.

"We have a 10-year window; if we do not have sufficient computer simulation capabilities by then, we will need to go back to testing and that will probably not be an option. We must succeed. The laboratories will need to change to being experiment- and computer-driven, rather than test-driven as in the past."

To accomplish everything the initiative set out to do required three key components. The defense program laboratories, industry and academia would need to work together.

With a history of competition, it was imperative that Sandia, Lawrence Livermore and Los Alamos labs committed to ASCI, a collaboration that its executive committee called "One Program – Three Laboratories."



ASC RED STORM — When the Accelerated Simulation and Computing Initiative Red reached the end of its operational life in 2006, Sandia used the experience to replace it with a system with a similar design philosophy. ASC Red Storm was built in collaboration with Cray Inc. and used AMD Opteron processors. **Photo courtesy of Jim Laros**

Accurate simulation of the physics at the core of nuclear weapons behavior required a deep understanding of both nuclear physics and more fundamental high-energy physics, fields that demanded expertise from the labs and academia.

By 1994, the laboratories had worked closely with industry to design and develop the most modern and powerful computers in existence, but broader contributions were needed in the development of new technologies for highly specialized capabilities.

The success of ASCI relied on deliberate partnerships that eventually changed the world of high-performance computing.

"Because we were under so much pressure, we needed to bring the best ideas together, partners were key to an impactful start for ASCI," said Thuc Hoang, current director of the NNSA ASC program, who also was one of the first federal staff managers of ASCI at its creation.

Sandia's 'scientific novelty' becomes the foundation

Through an early collaboration with nCube Corporation in the 1980s, Sandia researchers demonstrated the value of massively parallel computers. In fact, Sandians Robert Benner, John Gustafson and Gary Montry won the first Gordon Bell Prize in 1987 running a simulation on the nCUBE 10, capable of 1.9 gigaflops, or 1.9 billion floating point operations per second.

Massively parallel computers require hundreds or thousands of computer processors working in parallel to solve large and complex problems very rapidly.

"Ed Barsis, a director at Sandia during

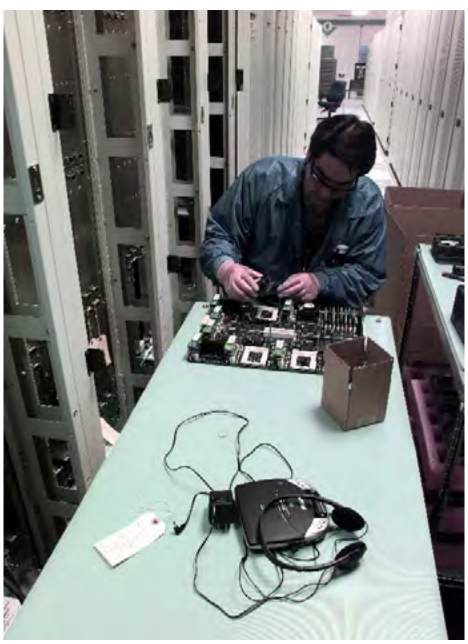
this time, took a huge risk on parallel computing. The technology was challenged, even internally, as not a lot of people had faith in it. It was new and unproven," said Grant Heffelfinger, a retired Sandia director and computational researcher during this period.

Another early computational researcher, Climate Security Center Director Rob Leland, said, "It was an exciting time. Sandia had a major breakthrough in technology as the nation was looking for a eureka moment. This was truly a time of great innovation that was well timed to meet the needs of ASCI."

First big ASCI success

In 1994, another Sandia-led team that included researchers from the University of New Mexico and Intel Corp. won a second Gordon Bell prize for their work in parallel computing. Within a month of the award, Sandia and Intel set the world computational speed record at 280 gigaflops.

"Ed Barsis saw that by applying their new parallel computing technology, it was possible to solve signature problems LANL and LLNL were facing in designing nuclear explosive packages. This insight was used as a bargaining chip for Sandia's inclusion in the ASCI program," said Heffelfinger.



THE MOTHERBOARD — In a 1999 photo, a technician installs a processor on the Accelerated Simulation and Computing Initiative Red motherboard. **Photo from the Lab News archives**

In 1996, Sandia ASCI Red came on line and became the first major success of the program. It was the first machine to exceed a trillion flops, or 1,000 gigaflops, and the experience gained from ASCI Red contributed to more than a decade of U.S. leadership in supercomputing. The machine displayed incredible scalability, applying thousands of processors with great efficiency, an elusive and highly prized goal in early supercomputers.

The machine's architecture and software environment were so successful that it operated for a decade, twice the typical lifetime for supercomputers. Sandia's lightweight operating system was a key contributor to the success. When ASCI Red reached the end of its operational life in 2006, it was replaced with Red Storm in 2006, designed by Sandia and built by Cray Inc., with a similar design philosophy.

Red Storm would go on to score many technical program achievements and produce 124 descendants before its retirement in 2012.

"Bill Camp, Sandia's director of computing research in that era, had the vision for Red Storm. He worked closely with computer architects to produce a system that not only met the impossible mission need, but also became a dominant force in the field," Rob said. "Red Storm was among the few fastest machines of its era, and it stood out for its performance on difficult engineering problems like those faced by Sandia. Its influence can be seen in supercomputers today."

One of the machine's notable public impacts was in February 2008, when it was used to bring down a defective satellite. Burnt Frost, as the operation was known, required Red Storm to perform hundreds of impact simulations on an errant satellite.

President George W. Bush was briefed on options, derived from months of Red Storm calculations. The mission successfully brought down the 5,000-pound satellite with a single missile shot.

Bill Camp was recognized with the Seymour Cray Computer Engineering

The early computing days at Sandia

1960s

Early investigation of vector processing

Investment into commercial off-the-shelf computers (COTS)

1970s

CDC 6000 and 7000 first supercomputers

Good scalar processing performance

1980s

CRAY-1 becomes 1st "successful" vector processing machine

1988

Parallel computing

Recognized with a Gordon Bell Award

Development of parallel methods for a 1024-Processor Hypercube

Accomplished on nCUBE 2

1993

Intel Paragon

Sandia's first #1 on top 500 with 143.4 GigaFLOPS

1996

ASCI Red

First major success in ASCI program

First machine to exceed 1 TFLOPS

1997

CPLANT™

First terascale Linux cluster

2006

ASC Red Storm

Prototype for Cray's most successful product line

Graphic by Ray Johnson

ASTRA — Continuing the legacy of high-performance computing at Sandia, the Vanguard program built Astra in 2018. The Astra platform was the first petaflops computer using Arm-based processors.
Photo by Regina Valenzuela

Award in 2016d f "for visionary leadership of the Red Storm project, and for decades of leadership of the HPC community."

The legacy lives in today's ASC program

The ASC Program at Sandia continues to build on its strong legacy as the nation moves to a new era of high-performance computing in support of national security. In 2018, Sandia's Vanguard program successfully deployed Astra, the first petaflops computer using Arm-based microprocessors.

Astra's success has positioned Sandia to continue taking high-risk opportunities in developing emerging leading-edge technologies to prove their viability in the ASC mission — a key component to NNSA's platform strategy.

Astra's success has positioned Sandia to continue taking high-risk opportunities in developing emerging leading-edge technologies to prove their viability in the ASC mission — a key component to NNSA's platform strategy.

"The legacy of the ASC program is a testament to the power of collaboration and innovation," said Jen Gaudioso, Sandia's current ASC program director. "Today, we continue to push the boundaries of computational science, ensuring that our national security remains robust and our technological leadership unchallenged."

The collaboration between industry, academia and the three NNSA labs remains a foundation for the continued success of the ASC program. In addition to nuclear testing simulations and design work for refurbished weapons, the computing, modeling and simulation tools developed through ASC enhance a wide variety of other national security programs to ensure that the U.S. remains at the forefront of technological innovation and nuclear safety.

A deeper dive into ASC

A more comprehensive history of the first 10 years of Advanced Simulation and Computing can be found on Lawrence Livermore's website, in the publication **Delivering Insight**. NNSA's ASC program celebrated its **25th Anniversary** in 2020.

Sandia and AWE sign strategic intent document

By **Jennifer Awe**

The U.S. and U.K. have a rich history of cooperation dating back to the Manhattan Project. Since 1958, the countries have shared ideas, information, materials and equipment within the provisions of the Mutual Defense Agreement.

During a September visit to the United Kingdom's AWE Nuclear Security Technologies, Laura McGill, Sandia's Deputy Labs Director for Nuclear Deterrence, and Mandy Savage, AWE's Executive Director for Engineering, signed an updated Strategic Intent of Collaboration. This document outlines mutually beneficial opportunities for strategically aligned collaborations between Sandia and AWE. It is reviewed and updated regularly to address changes to the agreement or to senior leadership.

Signing the document demonstrates that through enduring collaboration, the risk carried by each organization in delivering its mission is reduced, while readiness to meet emerging threats is enhanced.

STRATEGIC INTENT — Sandia Deputy Labs Director for Nuclear Deterrence Laura McGill, left, and AWE Executive Director for Engineering Mandy Savage, signed a strategic intent document to verify and describe collaboration between the two organizations.
Photo courtesy of AWE Nuclear Security Technologies

Executive excellence

Deb Marchand's trailblazing assignment at NNSA

By **Kristen Meub**

Administrator Jill Hruby leads over 60,000 people at NNSA and throughout the labs, plants and sites of the nuclear security enterprise. For 18 months, Deb Marchand was at her side during a tense and complicated time for the nation. This was the first time an executive assistant from Sandia had served on an off-site extended duty assignment, and Deb went on to receive a Silver Award from NNSA for her service.

In June 2022, Deb stepped into the Forrestal Building in Washington, D.C., for her first day as Hruby's senior executive assistant at NNSA.

She didn't have a computer or calendar access yet, but an urgent challenge already awaited her.

The war in Ukraine started several months earlier, and a man stood in the office, demanding to speak to Hruby about a classified document regarding the besieged country. Hruby wasn't there.

One of Deb's new coworkers said, "Oh yeah, she's in the situation room at the White House."

Deb sprang into action. With years of experience as a senior executive assistant at Sandia, she was no stranger to working in high-pressure situations.

"I knew what to ask him; I knew what Jill would want to know if she was there," Deb said. She called the situation room, pulled Hruby out of the meeting and set up a SCIF, which stands for Sensitive Compartmented Information Facility. That was her first 10 minutes on the job at NNSA.

As the week progressed, Deb began strategically organizing Hruby's calendar. She set up a cadence of meetings and planned how they could quickly pivot to respond to the White House, Secretary of Energy Jennifer Granholm and other urgent requests.

"I put all my skills to use to make her calendar dynamic," Deb said. "Of course, it never worked out that way. As much as we tried to plan, I would turn on the news each morning and start making mental adjustments. I could tell by the tone of the coverage how current events would impact her day."

Going into the assignment, Deb thought she knew what the job would entail. She had been an executive assistant and senior executive assistant to three lab directors, one executive vice president, three vice presidents and one director during her 36-year career at Sandia.

"I couldn't have been more wrong," Deb said. "The most surprising thing was what the job really entailed versus what I had thought it would be and how much a hamburger cost in D.C. — $25 plus!"

She expected the type of work Hruby does as NNSA's leader and the nation's expert on nuclear deterrence and security. More surprising was the amount of international travel for diplomacy and the heavy load of congressional affairs work.

"That's a whole lot of work for someone who is that busy," Deb said. "The pace was pretty numbing."

Planning and preparation

Deb joined a small team supporting Hruby each day: a military liaison, Chief of Staff Steve Ho and some writers. They discussed her upcoming meetings and what she needed to know to be prepared.

"We put briefing materials together for her meetings, including the history and frequency of the meetings, what was discussed last time, the type of meeting — informational or decisional — and data to help inform decision-making," Deb said. "When people would send over an 80-page slide deck for a meeting the next morning, we would put together bullet points and prepare her as much as we could. It's not an easy thing to do."

Every job has its surprises, and Deb embraced them. "When you go on assignment, the job description should really say 'other duties as assigned,'" Deb said.

SILVER AWARD — Deb Marchand received the NNSA Distinguished Service Silver Award for her exemplary and dedicated service during her off-site extended duty assignment working with Administrator Jill Hruby.

Photo by Lonnie Anderson

"One day, I'd get her some water, tea and cold medicine. Another day, it was getting her over to the White House and Pentagon and everything in between. You don't even ask; you just do it. There's no such thing as 'That's not my job' in a small office."

Beyond the day-to-day of calendaring, planning, preparing for the next day and crisis management, Deb and the team ensured Hruby's vision stayed front and center.

"We needed to cast this clear and concise net of what her goals and expectations were," Deb said. "A four-year time period is not a long time to change major organizational thinking."

One way Deb did this was by listening with intent. When she sat in on conversations, she would know when something was going to become actionable. Proactively, she would follow up with the appropriate people, schedule meetings and plan out next steps.

Service to the nation

Shortly before Deb returned to Sandia, Hruby and the team held a going-away party and presented Deb with the NNSA Distinguished Service Silver Award for exemplary and dedicated service. The award said: "In recognition of your exemplary, dedicated service to the National Nuclear Security Administration as a trusted member of the Administrator's team. Your superb support to the Administrator, management skills, professionalism and grace under pressure have ensured smooth, organized Front Office operations. Your commitment to excellence has furthered NNSA's critical missions to deliver the nuclear stockpile, counter threats of nuclear terrorism and proliferation, and power the nuclear Navy."

"I wasn't expecting it; I cried," Deb said. "I had only seen them given out for technical work, not administrative. To be honored at that level was huge, knowing they recognized that administrative work is just as important as technical work. It was the proudest moment of my career."

Back at Sandia, Deb works as a quality assurance specialist, assisting the Sandia board of managers' missions committee, handling logistics for the nuclear deterrence advisory board and working on a new pilot project, the Nuclear Deterrence Assignee Academy, to help others considering an off-site assignment.

"I appreciate Sandia and my husband, also a Sandia employee, for their support," Deb said. "It was an amazing experience to see things from the customer perspective. It gave me that much more depth in how I'm able to anticipate needs. Because I know what's going on behind the scenes, I can read the room better. It's an opportunity I wouldn't have changed for the world."

She hopes to inspire other administrative professionals and let them know that through their expertise and skills, they have an important impact on the Labs and the nation.

MAKING HISTORY SHAPING THE FUTURE

The history of WIPP

A 6-year project that turned into 25

By **Kim Vallez Quintana**

In 1975, the nation asked Sandia to investigate the possibility of building a repository in New Mexico for the disposal of radioactive transuranic defense waste. Little did those assigned to the project know that the task would absorb most of their careers and become one of the most controversial and important projects in U.S. history.

The purpose

The Waste Isolation Pilot Plant, or WIPP, was created at the direction of the federal government. The necessity for a repository grew with nuclear research, nuclear power production and the nuclear defense program that began with the Manhattan Project. While nuclear waste was piling up during the Cold War, no solution to safely storing and disposing of it had been found. In Los Alamos, radioactive and toxic materials were dumped into canyons, according to a DOE report: Closing the Circle: The Department of Energy and Environmental Management 1942-1994. Sandia needed to do something no one else had managed to do before. To this day, WIPP is the only U.S. deep geologic repository for the disposal of defense-related transuranic waste.

A monumental task

"We were, in retrospect, a small, somewhat naive group of Sandians that first began work on the WIPP project in 1975," remembers Wendell Weart, known as the "Sultan of Salt" for his contributions to the project. "I was involved in WIPP for at least 30 years. I think everyone from Sandia who worked on the project felt like it was the thing to do for the nation."

Sandia's team started with about a dozen people but over the years grew to nearly 170. Weart, who died on Sept. 26, worked longer on the project than anyone else. In a phone interview last year, he spoke passionately about what it took to get WIPP open.

"It's something that took a very dedicated team of Sandians working much longer than they expected. Working on WIPP is not a one-person effort; it takes a team, and I had that team," Weart said.

Site challenges

Sandia inherited the WIPP project and a proposed site from Oak Ridge National Laboratory. The site was the pure salt of the Salado Formation in the Los Medanos area, about 25 miles east of Carlsbad, New Mexico. While the plan was to bury the waste 1,500 to 3,000 feet deep, it didn't take the Sandia team long to determine that the site was geologically unsuitable. After drilling the first borehole in 1975, the Sandia team discovered unexpected geology: steeply dipping salt beds and brine that presented serious obstacles.

That drilling almost turned deadly. Brine, containing a heavy concentration of hydrogen sulfide, came gushing out of a borehole. Sandian Tom Lawes, who was working nearby, inhaled the gas. There was no medical oxygen on-site but Lawes had the shrewdness to direct his coworkers to the welding truck where oxygen was stored, ultimately saving his own life.

Source

Much of the historical information in this story that accompanied the generous descriptions by Wendell Weart came from a Sandia history of WIPP published in 1999: **Sandia and the Waste Isolation Pilot Plant 1974-1999**, by Carl J. Mora (SAND99-1482).

THE FUTURE SITE OF WIPP — The first exploratory borehole was drilled at the current site of WIPP in 1976 near the center of the Delaware Basin, 7 miles from the original site.
Photo from a report by Carl J. Mora

The team decided it had to start from scratch and search for a new site. This would be one of the biggest challenges for the Sandia team, led by supervisor Les Hill and geologist Dennis Powers. From that point, the team grew rapidly. After more than a year of investigation, research and exploration, the team settled on a new site seven miles from the original — in the center of the Delaware Basin.

Facility design and environmental impacts

After abandoning the first site, the team also had to abandon the initial facility design and start over. This effort, led by Leo Scully, would prove challenging and time-consuming. Simultaneously, a group led by Sandian Mel Merritt studied the site's environmental impact.

It was not an easy task, Weart said. "They had to be able to show that this facility would be safe and protect the waste for 10,000 years. The way to approach that was through calculation."

The team released its new conceptual design in 1979 and its environmental impact statement in October 1980.

Political challenges

With the project came much opposition. Not only did they have to convince the government WIPP was safe, but they also had to convince the American people. The community of Carlsbad was mostly supportive, eager to secure jobs to replace the waning potash industry. However, the idea of storing nuclear waste triggered opposition in New Mexico and elsewhere. About 1,500 people showed up for three days of DOE public meetings in April 1978 in Carlsbad, Albuquerque and Santa Fe — some to learn more, others to share their fears. Subsequent meetings over the next decade also drew crowds.

The concerns raised publicly by politicians in Washington, D.C., and New Mexico failed to reassure Americans. In 1980, President Carter signed a bill authorizing the construction of WIPP but made it clear he was not endorsing this approach to nuclear waste disposal. That bill quickly was met by a lawsuit from New Mexico Attorney General Jeff Bingaman, who asked a district court to halt work on WIPP to "vindicate rights guaranteed to the state of New Mexico." The state was fighting for a voice in what would happen at WIPP, even though it was a federal project. The fight dragged on for many years, as did other fights over what type of waste should be stored at WIPP, how it should be regulated and whether it should be drilled at all.

During this time, there were repeated changes in those overseeing the project, and with each new face, there was a new perspective as to what WIPP should look like and what its purpose should be. Despite the decades-long yo-yo effect, the Sandia team remained determined to see it through.

Construction

In September 1981, the team began drilling the first two shafts at WIPP for research and testing. That decision was not welcomed by some.

"With tombstones and picket signs, dozens of people demonstrated at the Albuquerque WIPP headquarters. Twenty-one activists and eight media representatives were arrested when they attempted to enter the buffer zone near the site," the Albuquerque Journal reported.

It would be another two years before the political unrest would ease and DOE officially approved full construction. It was then, in September 1983, that DOE invited the media to visit the site.

Eric McCrossen, an editorial writer for the Albuquerque Journal, described his experience: "Once you have toured the Waste Isolation Pilot Project under construction, it is difficult to understand the controversy that has surrounded it and it is easier to believe the support the project appears to have from area residents."

THE GEOLOGY OF WIPP — From left, Les Hill, Steven Lambert, Dennis Powers and Sue-Ellen Shaffer review a just-published geological characterization report on WIPP in 1978.
Photo from a report by Carl J. Mora

THE BUILDING BEGINS — The WIPP site under construction in 1985.
Photo by Randy Montoya

The home stretch

By 1984, enough of the site was complete to begin underground experiments to test the potential environmental effects of the waste repository.

"We had long been doing laboratory experiments to understand the nature of the facility, but we also had to be in the site to test how the salt rock would interact with the waste. That continued for a long time," Weart said.

This testing was required to satisfy requirements from the Environmental

ENDURING THE TEST OF TIME — The TRUPACT-II containers built in the 1980s are the same containers in use today.
Photo by Randy Montoya

A TEST OF ENDURANCE — A TRUPACT-II container conditioned to minus 20 degrees Fahrenheit drops 30 feet onto a steel puncture bar multiple times at Sandia's Coyote Canyon test facility in 1989. **Photo by Randy Montoya**

Protection Agency, the designated regulator of WIPP.

During that time, Sandia environmental testing crews conducted experiments to help perfect the TRUPACT-II containers in which transuranic waste was to be transported. Each weighed 12,750 pounds empty and was designed to carry 14 55-gallon drums. Testing included dropping the containers 30 feet onto a steel plate and puncture bar, burning them in a jet fuel pool fire at 1,424 degrees Fahrenheit for 30 minutes and then submersing them under 50 feet of water.

Other Sandia groups were essential players in the lengthy technical efforts required to ensure WIPP's readiness to accept waste.

In an interview in a 1989 edition of Lab News, around the time that site characterization was completed, Weart expressed confidence that WIPP was safe but recognized the Labs had more to do.

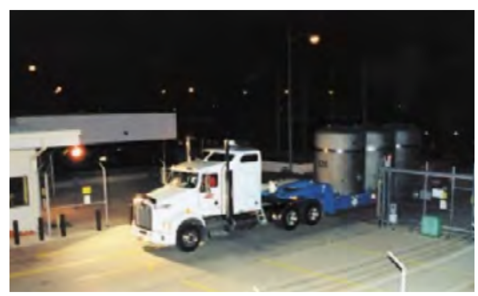
"Proving its safety in quantitative terms would require considerable work for the next few years," Weart said. A few years turned into nine.

A major milestone came Oct. 20, 1992, when President George W. Bush signed a long-debated bill that transferred the 10,000-acre site permanently from the Department of the Interior to DOE. However, the political debates over WIPP perisisted while Sandia continued its work.

Opening Day

Finally, on March 26, 1999, WIPP received its first shipment of transuranic radioactive waste. In the end, the big day wasn't so big. A single truck carrying transuranic waste arrived at the gates of WIPP without incident after a 342-mile journey from Los Alamos National Laboratory. A few anti-WIPP demonstrators showed up in Los Alamos and Santa Fe, but in Carlsbad, only residents welcomed the shipment. New Mexico Rep. Joe Skeen, a supporter of the WIPP project since its inception, made one of the boldest statements of the day, asking, "God almighty, why did it take so long?"

A MONUMENTAL CHALLENGE — Margaret Chu reads one of 21 volumes of the Compliance Certification Application for WIPP.
Photo from a report by Carl J. Mora



OPEN FOR BUSINESS — The first shipments of transuranic waste arrive at WIPP on March 26, 1999. **Photo from a report by Carl J. Mora**

Since that day, WIPP has received more than 13,000 shipments of waste. WIPP drivers have traveled 17 million miles without a serious accident or injury — equal to 35 round trips to the moon. The original TRUPACT-II containers designed

THE SULTAN OF SALT — Wendell Weart examines a chunk of salt at WIPP on opening day March 26, 1999. **Photo by Randy Montoya**

TESTING THROUGH FIRE — A TRUPACT-II container undergoes a fire-test with the goal of surviving 1,475 degrees Fahrenheit for at least 30 minutes without losing vacuum. **Photo from the Lab News archives**

and tested extensively at Sandia are still in use.

A challenging time

Despite its successes, WIPP has experienced setbacks. On Feb. 5, 2014, a salt haul truck caught fire underground. Six workers were treated for smoke inhalation. Nine days later, on Feb. 14, 2014, an air monitor alarm went off, indicating radioactivity in an area near where waste was being stored. These incidents prompted an investigation of safety systems and programs. While it was determined that the radioactivity leak was caused by a drum improperly packed at Los Alamos National Laboratory, the plant shut down for cleaning and improvements, reopening on Jan. 9, 2017.

Looking back

To be part of the building of WIPP is an accomplishment in itself. To work on it for the duration of the project is something entirely different. Wendell Weart is the only person who can claim that distinction. His passion for the project was clear. Even though it brought restless nights and frustrating days, he was proud of what his team accomplished.

"The fact that we succeeded in doing what so many national organizations thought would not be possible showed them that if you are honest with the communities and citizens about what you are doing, you could succeed. WIPP was a beacon to other countries showing that these problems were not without the ability to solve," Weart said.

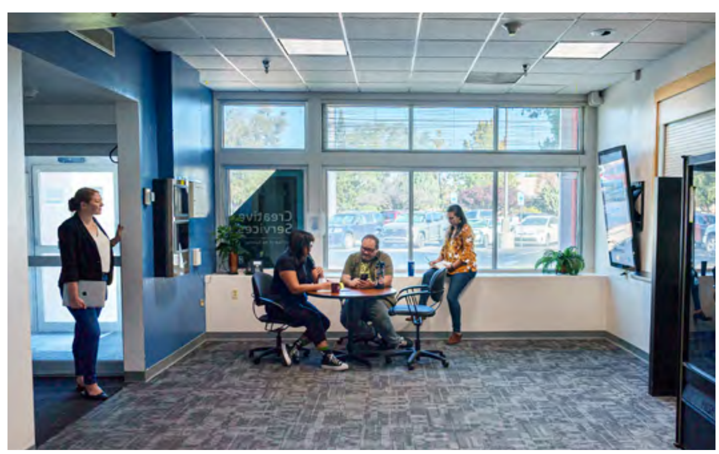
Weart also spoke highly of his team that worked year in and year out to make sure WIPP opened its doors. "Sometimes it didn't feel great because it involved talking with people who didn't want to hear what you were saying, but in the end, by persistence and by what was clearly dedication from all of our people, I think we were able to convince them it was safe. It's a good feeling to think you've managed this problem successfully."

Permit renewed

On June 27, WIPP reached another milestone: the New Mexico Environment Department renewed its operating permit for another decade. The permit includes, among other things, a requirement that WIPP prioritize legacy waste cleanup from Los Alamos National Laboratory.

Sandia continues to serve as the science adviser on long-term storage performance at WIPP, with about 50 total Sandia staff there. Lab News published an **update on work there** two years ago.

Then and now: Creative Services



CREATIVE SPACE — A photo from 1954 depicts the buzzing lobby of the Personnel Building, which housed the Personnel and Employment Department, known as Human Resources today. The building is now occupied by Creative Services. The recent photo shows that the large desks were removed and the area is used as a common space. **Historical photo from the Lab News archives; Recent photo by Craig Fritz**

75th anniversary speaker takes audience “Beyond the Moon”

Los Alamos historian recounts how Project Rover overcame insurmountable technical problems

By **Jim Danneskiold**

The quest to ferry astronauts to Mars and beyond on rockets powered by nuclear reactors offers object lessons both in astounding technical achievement and in the complex political twists and turns that affect important research projects.

That was the conclusion of “Beyond the Moon: The Story of the Rover Program, 1955 to 1973,” part of the 75th Anniversary Speaker Series delivered by Los Alamos National Laboratory senior historian Alan Carr.

The research originated in the quest to deliver a rocket that could propel the early, multi-ton thermonuclear warheads across the globe. Conventional rocketry couldn’t do it, he said.

“This was the origin of our Rover program,” Carr said. “We’re not going to start out trying to get to Mars; we’re going to start out trying to get H-bombs to Moscow,” Carr said.

The program goals, sponsors and funding shifted every few years as the Rover team made steady, if intermittent, progress.

Work began in earnest in 1954 when the Air Force directed Los Alamos and Lawrence Livermore national labs to explore the feasibility of nuclear rocket engines. Within a year, building on the previous decade of basic reactor research, Los Alamos established the Nuclear Rocket Propulsion Division and sponsors seemed pleased, “but things are going to change,” Carr warned.

He then took Sandians on a 90-minute roller-coaster ride up and down the project’s nearly two decades of successes and failures. Carr blended tales of astounding technical breakthroughs and setbacks with accounts of huge shifts in federal priorities from the 1950s on. Ultimately, the letdown after the 1969 moon landing and ever-growing budgets for the Vietnam War and President Lyndon Johnson’s Great Society resulted in Project Rover’s demise with the cancellation of NF-1, the Nuclear Furnace, in January 1973.

High highs and low lows

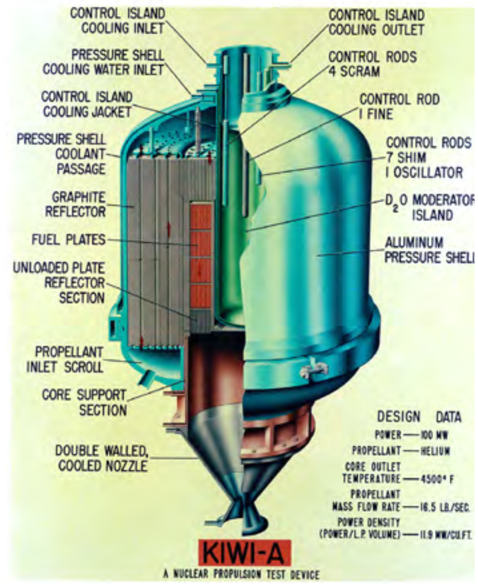
“The Rover program is very much a series of very high highs and very low lows,” Carr said.

Lawrence Livermore branched off to work on Project Pluto, a nuclear ramjet engine, as work at Los Alamos continued. However, by 1956, the breakneck pace of improvements in shrinking the weight of thermonuclear weapons and huge leaps forward in the power of conventional rockets rendered the notion of reactor rockets hurling those early H-bombs at the Soviet Union less practical.

Initially, the Atomic Energy Commission was responsible for nuclear rocket engines while the U.S. Air Force and private industry developed missiles. After the Soviet Union launched Sputnik in October 1957, the project quickly pivoted toward space travel and NASA took over sponsorship.

Carr recounted the rapid changes during that period, as the goal of creating a nuclear Intercontinental Ballistic Missile went away and Project Rover was “rebranded” for space travel. He quoted former Los Alamos Director Norris Bradbury: “It (Sputnik) rescued the nuclear rocket program, although we didn’t really have one.”

Starting with development of the KIWI-A and KIWI-B reactors, Rover researchers built a test stand in Jackass Flats at the Nevada Test Site, ran the first full-scale test of KIWI-A in July 1959 — 70 megawatts for five minutes — and quickly learned that they faced a big technical challenge in protecting the reactor’s graphite core from damage by the hydrogen fuel.



INSIDE THE KIWI — A schematic cutaway shows the components of KIWI-A, the first in the series of prototype nuclear rockets.

Illustration courtesy of Los Alamos National Laboratory National Security Research Center

TEST PREPARATIONS — In a photo from 1962, researchers from the Los Alamos Nuclear Rocket Propulsion Division at the Nevada Test Site prepare for a test of the KIWI-B4A, termed a revolutionary, compact and efficient design.

Illustration courtesy of Los Alamos National Laboratory National Security Research Center

Still, by any engineering measure, the KIWI series rapidly proved the feasibility of something that seemed well-nigh impossible at first glance.

"That is mind-blowing to me," Carr said. "You have gone from talking about it to a test in a year and a half."

Rocket tests and weapons tests

Testing continued on variants of both reactors for a few years, with some successes and multiple accidents. The only constant seemed to be budget woes, especially after the nuclear weapons testing moratorium ended in April 1962, as funds began flowing from Jackass Flats back to Frenchman's Flat.

"(The Russians) set off 57 devices over the next 65 days," Carr said, recounting nonstop nuclear tests by the U.S. and Russia before, during and after the Cuban missile crisis. "This is, arguably, the most dangerous moment in human history."

Then came another one of those high highs, Carr said. President Kennedy announced the goal of putting men on the moon, and support for nuclear rockets blasted off again in the belief they could push the U.S. ahead in the space race into missions beyond the moon.

The pace of testing increased in the mode of two steps forward for each one back — "limited success; marginal progress," Carr said — until, finally, in August 1964, KIWI B4-E ran for eight minutes at 900 megawatts, a spectacular success. With high hopes, the all-powerful inventors of acronyms at the lab dubbed the future flightworthy reactor engine NERVA — the Nuclear Engine for Rocket Vehicle Application.

But just as a future launch looked likely, other budget priorities won out and the flight program formally ended in early 1964.

"Rover became an R&D project, a program without a specific mission," Carr said.

In an aside, he told Sandians how Albuquerque played a big role in Rover, and in the early nuclear weapons program. A Duke City railroad car manufacturer, American Car and Foundry, had the responsibility of building not only the complex reactors that needed to withstand incredible temperatures, but also some of the key components for the first full-scale thermonuclear weapon.

"We don't want to forget ACF, a partner of ours way back in the day," he said.

"We called them up and said, 'Can you fabricate a nuclear weapon for us, a device, in the Pacific,' and they put the Mike device together," Carr said. "We called them up again and said, 'What about building some nuclear rocket engine parts together as well?'"

Phoebus fires

But that now mission-less Rover program continued with tests of the Phoebus series of prototype reactor rocket engines. The first fired for 10 minutes at 1,090 megawatts in June 1965, then 1,500 megawatts for 30 minutes in February 1967 and, finally, 4,080 megawatts with Phoebus 2A during a 12-minute run on June 26, 1968. A later test version, Peewee, the "pocket rocket," reached 4,500 degrees Farenheit and proof of principle that it could be adapted for space missions.

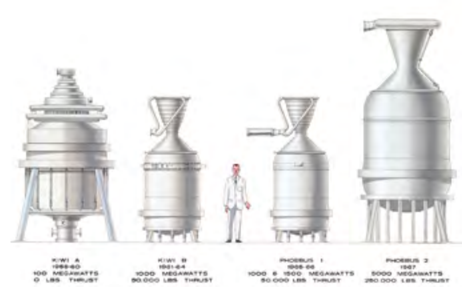
Carr said most modern nuclear power plants operate at roughly one-quarter of the power demonstrated in those 1968 experiments and are many times larger.

"The Phoebus 2A was the most powerful reactor ever built," Carr said. "You could power 8.5 million toasters," he said.

In fact, Phoebus was 30% more powerful than the biggest chemical rocket engine SpaceX has devised, nearly six decades later. See video of Phoebus testing here.

FLAME ON — In one of the most successful early tests, the KIWI B4-E produced 900 megawatts for eight minutes in August 1964.
Illustration courtesy of Los Alamos National Laboratory National Security Research Center

POWER TO SPARE — Testing of the nuclear rocket prototypes reached its zenith in 1968 with Phoebus-2A, roughly four times more powerful than a modern nuclear reactor but far more compact. Its successor, Peewee, achieved temperatures of 4,500 degrees Farenheit and tests showed its potential for space travel.
Photo courtesy of Los Alamos National Laboratory National Security Research Center



PREPARING TO LAUNCH — Nuclear rocket progress, 1958-1968, shown to scale to illustrate how compact the reactors were.
Illustration courtesy of Los Alamos National Laboratory National Security Research Center

In the aftermath of Project Rover, some of the researchers took what they had learned into the suite of energy programs that experienced rapid growth at Los Alamos and Sandia during the 1970s.

However, Carr said the most wide-reaching result of Rover, barring a revival one day of a nuclear rocket to take man beyond the moon, is Rover scientist George Grover's humble heat pipe, adapted by NASA to manage the huge temperature fluctuations in satellites.

The heat pipe was the most significant of many spinoff technologies, found in phones, computers and numerous other devices used every day, Carr said.

"Why doesn't your cell phone melt in your hand?" he asked. "This ubiquitous technology that we all have — multiple heat pipes in our lives . . . It all started out with this program."

Watch a recording of Carr's talk in Sandia's Digital Media Library.

Make no mistake

For 30 years, Sandia's Dennis Roach piloted commercial aircraft safety program

By **Luke Frank**

Imagine in the early days of a new job, fresh out of college, your manager asks you to take on a colossal task of global consequence — developing a program at Sandia to ensure the airworthiness of commercial aircraft, independent of the airline industry and supported by the Federal Aviation Administration.

Dennis Roach, a newly minted aerospace engineer at Sandia, was just easing into his role in the Labs' modal analysis group analyzing structural dynamics tests.

"I happened to cross paths with the manager who hired me," he said. "He was attempting to stand up an airworthiness assurance program and asked for my help."

Sandia had already earned national recognition for ensuring the reliability of high-consequence systems and critical assemblies across multiple disciplines, Roach said. Recognizing this, the Federal Aviation Administration approached the Labs to help ensure the long-term safety of commercial aircraft. Thus, the Federal Aviation Administration Airworthiness Assurance Center, or AANC, operated by Sandia took flight.

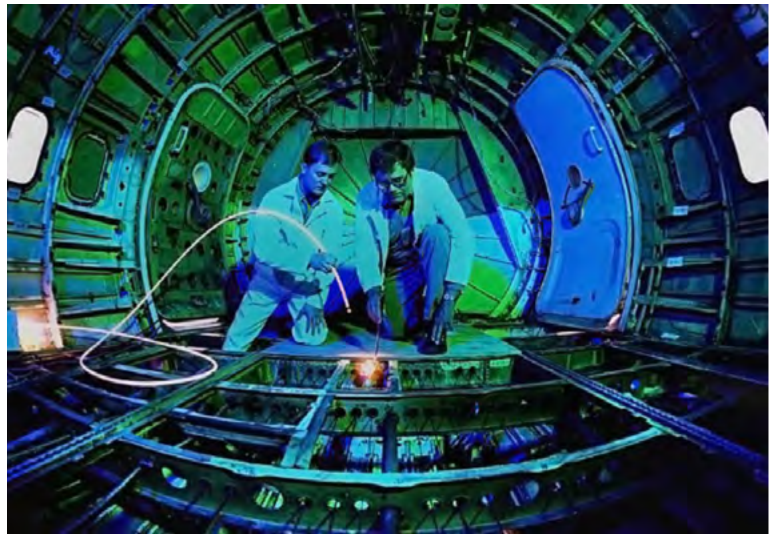
Tinker tot

Growing up in a small town in Upstate New York with three older sisters, Roach was influenced early on by his father, a chemical and materials engineer. "Just watching and listening to him talk about his work probably started my interest in engineering," he said.

As a kid, he enjoyed building things with Tinker Toys and erector sets. Then, as sports became a bigger part of his life, his bicycle turned into his primary mode of transportation for baseball and basketball games and hanging out with friends.

"We lived on our bikes and were grateful for the independence that came with them," Roach recalled. What does a burgeoning engineer do with such a prized gift of freedom? "We started taking our bikes apart and customizing them and then we built go-karts and minibikes."

His eagerness for creating continued into building model airplanes and aerospace science fair projects in high school. "I began developing an interest in aircraft and the space program," he said.



LOOKING FOR FATIGUE — Dennis Roach and Ken Harmon examine the inside of a Boeing 707 for long-term structural fatigue in a photo from 2021. Nondestructive techniques allow inspectors to assess the integrity of aircraft structures without disassembly. **Photo by Randy Montoya**

IN-FLIGHT EMERGENCY — Passengers evacuate Aloha Airlines flight 243 after its successful emergency landing on Maui. Sandia's Airworthiness Assurance Center program was driven by the 1988 Aloha accident. **Photo courtesy of Honolulu Star-Advertiser**

Southbound

Tired of New York winters, Roach enrolled at Georgia Tech, attracted by its aerospace engineering work-study co-op program, which alternated semesters of learning with applying engineering principles. It didn't hurt that these jobs also helped him pay his tuition. "The co-op program took five years to complete, but the experience was invaluable," he said. "I worked at the Naval Air Facility, Boeing Aerospace, and later at the Johnson Space Center, while earning an advanced degree at the University of Texas."

At Boeing, Roach analyzed and solved hardware issues for aircraft coming through the assembly line: if there was a problem, he and his crew got the call. At Johnson Space Center, his work focused on finite element modeling, primarily for spacecraft payloads.

He also spent a summer between undergraduate and graduate school at the National Aerospace Lab in the Netherlands, conducting modeling analyses and experimental work as part of a research assistantship. "That job was another formative experience for me," Roach said. "It allowed me to work with people from a different country, take some risks, try new things, and be independent in research and development."

Landing at Sandia

As he approached graduation, Sandia Labs was actively recruiting at the University of Texas with a compelling pitch.

"I wanted to do something more general coming out of school," Roach said. "The size and structure of Sandia seemed right. There was the diversity of programs, allowing me to move within the Labs — like going to a different company without actually moving, which was very attractive to me."

Although he had decided against going into aviation after graduating, it was serendipitous that he landed right back in the aircraft industry as part of Sandia's new AANC. In the early stages, the center consisted of Roach and his manager, Pat Walter, but they had access to allied expertise at the Labs.

"One of the appealing aspects of this program was the 'work-for-others' design, demonstrating that Sandia Labs was a national resource for addressing a wide array of engineering challenges," Roach said. "We used our expertise across the board, and showed time and again that we could assemble the right team to achieve our goals."

The program was also driven by the 1988 Aloha accident, a flight between Hilo and Honolulu, during which the upper portion of the forward fuselage broke free at 24,000 feet. Miraculously, but tragically, only a flight attendant perished.

The U.S. National Transportation Safety Board's investigation concluded that the accident was caused by metal fatigue exacerbated by crevice corrosion. "We began researching widespread fatigue damage and small crack detection in aircraft," Roach said, "leading to several programs that advanced nondestructive inspection principles, or NDI, to improve damage detection during aircraft maintenance."

Roach, with support from matrixed Sandia experts, began statistically establishing NDI performance standards. "There are two sides to the equation," he said. "There's the damage tolerance analysis, which assesses how much damage an aircraft can withstand and still operate safely, and then there's the NDI performance, which established how small of a flaw can be detected. If the damage tolerance determines an aircraft can withstand a 0.1-inch crack, but an inspector cannot find a crack until it's 0.25-inch long, there's a problem. We ensured the statistical performance of aging materials was compatible with the probability of detection."

Next, Roach and the team evaluated aircraft maintenance inspectors in the field and their performance with different pieces of detection equipment. This led to human-factor studies and procedural changes, resulting in improved aircraft maintenance work.

Eventually, the work expanded to include electrical systems, advanced materials, propulsion systems, landing gear, aircraft certification, regulatory measures and more. Basically, the team covered all aspects of airworthiness assurance.

STRUCTURAL HEALTH MONITORING — In a photo from 2021, Senior Scientist Dennis Roach, center, works inside the cabin of a B737 testbed, installing and acquiring data from Structural Health Monitoring sensors with Sandia mechanical engineers Stephen Neidigk, left, and Tom Rice. **Photo by Randy Montoya**

Be the change

"One of the things I really liked about the center was that we worked across the industry," Roach said. "For most of our projects, our teams included airlines and aircraft manufacturers from around the world — Boeing, Airbus, Embraer — as well as maintenance and repair organizations, universities, the FAA and regulators in foreign countries."

Roach spoke proudly of the program's numerous accomplishments, many of which revolutionized the aircraft industry.

737 AIRCRAFT TESTBED — A 737-200 aircraft, circa 1968, which experienced 50,000 flight cycles in its lifetime and then served as a full-scale testbed for numerous inspection development programs at the Airworthiness Assurance Center hangar facility that Sandia operated at the Albuquerque International Sunport. **Photo by Randy Montoya**

Spin-offs, investigations and innovation

Some projects of note, including spin-off programs for other industries, include:

Accident investigations: The center supported accident investigations for TWA800, Swiss Air111, American Airline587 and several rotorcraft accidents. All programs resulted in the introduction of enhanced inspection methods for critical components.

Space shuttle program: After the space shuttle Columbia accident, the center worked on NASA's Return to Flight program to develop an inspection system to certify each space shuttle before launch.

Syncrude Canada and Exxon Mobil oil exploration: Composite expertise gained from aviation programs was used to produce new repair methods for high-cycle oil recovery equipment.

Monitoring bridge health: Expertise from the center's airplane safety research was applied to monitor the health of bridges.

Robotic inspection of wind blades: The center's expertise in nondestructive inspection was applied to develop a robotic inspection system to monitor the integrity of the blades on wind turbines.

Aircraft designs for tomorrow: In its work to deploy advanced aircraft maintenance technology and new materials, the Airworthiness Assurance Center teamed with more than 300 companies and government organizations and conducted strategic partnership projects in 10 countries.

By **Kristen Meub**

"We created and managed hundreds of programs," he said. "One was an advanced repair method using bonding composite or laminates on aircraft, rather than riveted metallic-patch repairs, which can create extra holes and crack-initiation sites. Bonding offers better load transfer, and composites don't corrode. Ultimately, we got it introduced into the Boeing manuals."

The center also introduced onboard sensors to create a smart aircraft that automatically alerts maintenance personnel where an aircraft needs attention, whether structural or mechanical. And the center was called upon by NASA to help develop an inspection method to ensure the integrity of heat shields prior to each mission following the Space Shuttle Columbia disaster. "Many of our concepts and technologies were adopted by the mining, wind energy and automotive industries as well," Roach said.

As the aviation industry moved to embrace composite materials in aircraft manufacturing, so did AANC. In the early 2000s, the center began analyzing manufacturing processes and studying problems with weak bonds. What's the impact effect of a hailstorm, or ground equipment if driven into the side of the aircraft? What are the deteriorating effects of porosity when a part is made? These progressive programs enabled the center to maintain its relevancy and longevity.

Eastbound

In 2021, the center was brought in-house by the Federal Aviation Administration Tech Center in Atlantic City, New Jersey, after a 30-year run at Sandia. Roach saw it coming with changes in focus and funding.

"I wanted to see the center gracefully handed off, and we had it in a position where it could be operated elsewhere," he said. "We loaded up four transporters of assets, shipped them out and closed the hangar facility."

Looking back, the secrets to success became very clear to Roach. Search out and immerse yourself in important work you love and surround yourself with people smarter than you. "In my 35-plus years at Sandia, I was very blessed to have achieved both," he said.

"I'm very grateful to have been part of the airworthiness assurance program," he added. "We had extraordinarily detailed teams that left no stone unturned. It was important, challenging work filled with innovative thinkers."

Roach remains active in airworthiness assurance, enjoying part-time consulting work and keeping in touch with his engineering colleagues around the world.

Mileposts


Raymond Byrne 35


Richard Hunt 35

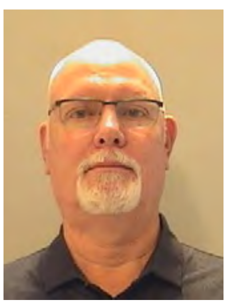

Michael Bawden 25

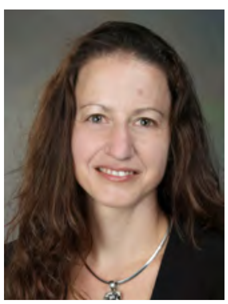

Ron Espinoza 25


Carrie Devonshire 20


James Rivera 20


Yuan-Yu Jau 15


Tom Rodgers 15


Natasha Schwartzwald 15

Retirees


Randy Schunk 35