

LOS ALAMOS NATIONAL LABORATORY ♦ WINTER 2025

NATIONAL ★ SECURITY SCIENCE

THE NEVADA ISSUE



Clouds and craters:

Historic nuclear testing data informs the modern stockpile.



Big booms: Explosive experiments at the Kappa West firing site.



Answers from

underground: Subcritical experiments ensure reliable nuclear weapons.



From fission

to function: The National Criticality Experiments Research Center.



+ PLUS:

A nuclear test director recalls the Cold War

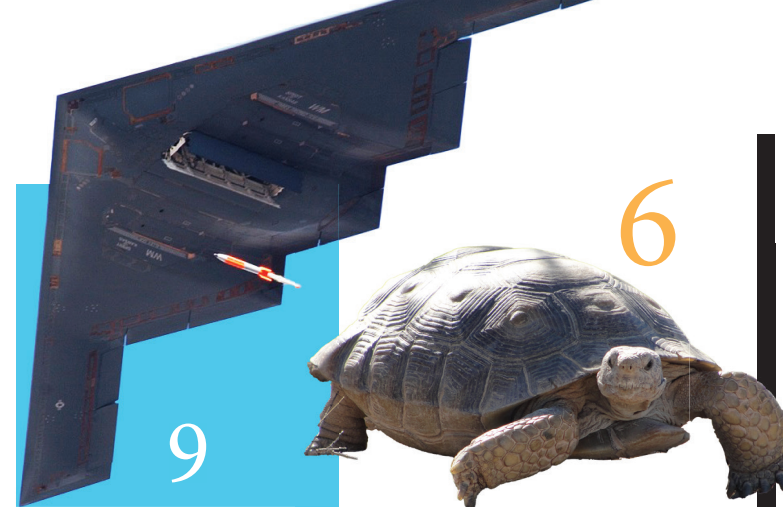
Scientists contain radiation in nuclear experiments

Mock weapons are put to the test at Tonopah Test Range

PHOTOBOMB

Earlier this year, approximately 50 employees from Los Alamos National Laboratory visited the Trinity site on White Sands Missile Range in southern New Mexico. Ground zero of Trinity—marked by a stone obelisk—is where Los Alamos scientists detonated the world's first nuclear device on July 16, 1945, 80 years ago.

A new episode of the *National Security Science* podcast captures audio from the visit and explores the historical significance of the site's remaining structures and artifacts. Scan the QR code below to listen. ★



IN THIS ISSUE

- 2 Letters: The Nevada issue** The work performed by Los Alamos National Laboratory at the Nevada National Security Sites (NNSS) helps maintain the credibility of the U.S. nuclear deterrent and reinforces a commitment to global security.
- 6 Abstracts: Notes and news from around the Lab** Testing at Tonopah, ignition innovation, evaluating earthquakes, and more.

FEATURES

- 14 Clouds and craters**
The 928 nuclear tests that occurred in Nevada continue to inform the modern stockpile.
+ Test director Ron Cosimi remembers
- 30 Big booms**
The Los Alamos team at Kappa West, a remote firing site in the Nevada desert, handles large explosive experiments.
- 36 Answers from underground**
Subcritical experiments below the Nevada desert ensure reliable nuclear weapons.
+ The machines behind the mission
+ Chronology of a subcrit
+ A critical crew
+ Hold everything: containment science
+ Sphere of influence: a new confinement vessel
- 52 From fission to function** Scientists conduct experiments at the National Criticality Experiments Research Center.
+ Going critical
- 64 Analysis: Working together to get the job done** Roger Rocha leads NNSS in collaboration with Los Alamos and others.
- 66 Being essential: Desert diagnostics**
For more than four decades, Tom Sandoval has supported nuclear weapons and nonproliferation experiments at NNSS.
- 68 Accolades: The distinguished achievements of Los Alamos employees**
- 69 Looking back: 68 years ago**
On August 7, 1957, Los Alamos scientists conducted the Stokes test to evaluate blast and heat effects on aerial vehicles.

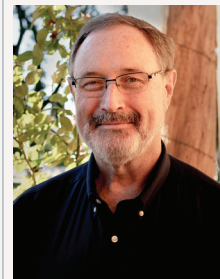
About the cover:
A global security experiment—a 1-ton chemical explosion at the Kappa West firing site—is captured through the window of the wooden Apple House, which still stands at the Nevada National Security Sites (NNSS) after being subjected to the 1955 Apple 2 nuclear test. To learn more about nuclear testing at NNSS, see p. 14. To learn more about Kappa West, see p. 30. Photo: Reed Poderis/NNSS ★

THE NEVADA ISSUE

The work performed by Los Alamos National Laboratory at the Nevada National Security Sites helps maintain the credibility of the U.S. nuclear deterrent and reinforces a commitment to global security.

BY DON HAYNES

SENIOR DIRECTOR, NEVADA PROGRAMS OFFICE



As you'll read throughout this issue of *National Security Science*, Los Alamos National Laboratory plays a vital role in supporting national security through its work at the Nevada National Security Sites (NNSS), a Rhode Island-sized venue located about an hour northwest of Las Vegas. The collaborative efforts between Los Alamos and NNSS

are essential for ensuring the safety, security, and effectiveness of the United States' nuclear deterrent, while advancing scientific understanding and innovation critical to national and global security.

NNSS, formerly the Nevada Test Site, is perhaps best known as the location for 928 nuclear tests—100 in the atmosphere and 828 underground—between 1951 and 1992 (p. 14). Although the United States no longer conducts such tests, scientists still use the data from these detonations to validate and improve computational models used in the Stockpile Stewardship Program—the effort to ensure the safety, security, and reliability of the nation's nuclear arsenal.

In the absence of full-scale nuclear testing, experiments at NNSS are essential for science-based stockpile stewardship, as NNSS is the only place in the country where scientists can work with special nuclear material and high explosives at weapons-relevant scales. Earlier in my career, I spent considerable time running simulation codes and learned firsthand how easily they can yield incorrect results. The most effective way to prevent this is to rigorously constrain the models with high-quality experimental data. Additionally, in complex systems like nuclear weapons, emergent phenomena—arising from the interplay of numerous interacting components—are both possible and potentially consequential. Only by performing integral experiments can we ensure that unforeseen behaviors don't compromise our understanding. Minimizing extrapolation is critical; the closer our experiments are to real-world conditions, the more confidence we can have in our results.

Subcritical experiments are an important source of stockpile stewardship data—and confidence. These experiments, which use special nuclear material, are designed by scientists at Los Alamos or Livermore national laboratories and conducted in special confinement vessels in the Principal Underground Laboratory for Subcritical Experimentation (PULSE), a maze of tunnels 1,000 feet below the desert floor. Subcrits, as they're called, do not produce a self-sustaining chain of fission reactions, yet they are crucial for predicting the performance of nuclear weapons components and materials. Read more about PULSE and various subcrit capabilities on p. 36.

In addition to subcrits, Los Alamos scientists design and execute many other types of experiments that take advantage of NNSS's unique infrastructure. The Big Explosives Experimental Facility, for example, does exactly what its name implies—big (think thousands of pounds), open-air conventional



■ Haynes holds a beryllium-reflected plutonium (BeRP) ball at NCERC.

high-explosives experiments. Sophisticated diagnostics capture data in support of stockpile stewardship. Learn more on p. 30.

Global security—specifically, nuclear nonproliferation—research is a major driver of Los Alamos' work at NNSS. Much of this research takes place deep inside P Tunnel, which comprises four miles of mined corridors beneath a mesa. The nonnuclear explosive experimentation conducted inside P Tunnel provides data to enable the detection of underground low-yield nuclear tests and other nuclear weapons development activities.

Finally, the National Criticality Experiments Research Center (NCERC, p. 52) is a Los Alamos-operated facility at NNSS that supports a variety of nuclear security missions, including nuclear criticality safety research and training, nuclear emergency response, nuclear nonproliferation, and support for other government agencies requiring hands-on access to significant quantities of nuclear material in numerous configurations.

Of course, none of the work at Nevada is possible without a dedicated and skilled workforce. Some Los Alamos employees work at NNSS permanently, while others come and go as their work necessitates. All of them—including Tom Sandoval, who is profiled on p. 66—are mission-focused and committed to serving the nation. They work seamlessly with others from across the nuclear security enterprise, including the team from Mission Support and Test Services (MSTS), the contractor that operates NNSS. MSTS is led by Roger Rocha, who you will meet on p. 64.

As the senior director for the Lab's Nevada Programs Office—the organization that coordinates Los Alamos work at NNSS (p. 7)—I'm one of those people who is back and forth between New Mexico and Nevada all the time. Yet as familiar as NNSS has become, every time I arrive, I am struck anew by the power of the site—its rich history, current contributions, and promising future. I hope this issue of *National Security Science* helps you appreciate the significance of NNSS. Using these nearly 1,360 square miles, we sustain confidence in our deterrent and advance our commitment to global security. ★

MASTHEAD

EDITOR Whitney Spivey

ART DIRECTOR Brenda Fleming

WRITERS Jake Bartman, Jill Gibson, Ian Laird

COPY EDITOR Anne Jones

3D ARTIST Margaret Doebbling

PHOTOGRAPHERS

Lee Anne Dillingham, Ethan Frogget,

Porter McLeod, Ignacio Perez,

David Woodfin

EDITORIAL ADVISOR Kimberly Scott

CONTRIBUTORS Avery Arena, Don Haynes

National Security Science (NSS) highlights work in the Weapons and other national security programs at Los Alamos National Laboratory. NSS is unclassified and supported by the office of the deputy Laboratory director for Weapons. Current and archived magazine articles are available at m.lanl.gov/magazine. Unless otherwise credited, all images in the magazine belong to Los Alamos National Laboratory.

To subscribe, email magazine@lanl.gov, or call 505-667-4106.

LA-UR-25-29791

Los Alamos National Laboratory, an equal opportunity employer, is operated by Triad National Security, LLC, for the National Nuclear Security Administration for the U.S. Department of Energy under contract B9233218CNA000001.

NSS STAFF SPOTLIGHT



In May 2025, NSS writer Jake Bartman visited NCERC at the Nevada National Security Sites in Nevada. At NCERC, researchers use critical assembly machines such as Godiva IV (pictured) to conduct experiments with special nuclear material that can't be completed anywhere else in the United States. For more about NCERC, see p. 52. ★

WARNING

January 11, 1951

From this day forward the U. S. Atomic Energy Commission has been authorized to use part of the Las Vegas Bombing and Gunnery Range for test work necessary to the atomic weapons development program.

Test activities will include experimental nuclear detonations for the development of atomic bombs – so-called “A-Bombs” – carried out under controlled conditions.

Tests will be conducted on a routine basis for an indefinite period.

NO PUBLIC ANNOUNCEMENT OF THE TIME OF ANY TEST WILL BE MADE

Unauthorized persons who pass inside the limits of the Las Vegas Bombing and Gunnery Range may be subject to injury from or as a result of the AEC test activities.

Health and safety authorities have determined that no danger from or as a result of AEC test activities may be expected outside the limits of the Las Vegas Bombing and Gunnery Range. All necessary precautions, including radiological surveys and patrolling of the surrounding territory, will be undertaken to insure that safety conditions are maintained.

Full security restrictions of the Atomic Energy Act will apply to the work in this area.

■ The U.S. Atomic Energy Commission distributed this flyer across the Las Vegas Bombing and Gunnery Range on January 11, 1951. Sixteen days later, on January 27, the Able nuclear test was executed above the Frenchman Flat area of the range (now the Nevada National Security Sites). Designed by scientists at Los Alamos Scientific Laboratory (now Los Alamos National Laboratory), the test device was dropped from a U.S. Air Force B-50 bomber and detonated with a yield of 1 kiloton. Learn more about such tests on p. 14. ★

RALPH P. JOHNSON, Project Manager
Las Vegas Project Office
U. S. Atomic Energy Commission

NEVADA

AT A GLANCE

A brief overview of the Nevada National Security Sites (NNSS).

MISSION

NNSS supports the stewardship of the nation's nuclear deterrent, provides nuclear and radiological emergency response capabilities and training, and contributes to key nuclear nonproliferation and arms control initiatives.

LOCATION & SIZE

Spanning approximately 1,360 square miles, NNSS is situated in southern Nevada, about 65 miles northwest of Las Vegas. The remote, highly secure site conducts operations outdoors, indoors, in airspace, and underground.

NAMES

Established in 1950, the site has had several names: the Nevada Proving Grounds, the Nevada Test Site, the Nevada National Security Site, and the Nevada National Security Sites. ("Sites" is a nod to nine satellite locations, including one in Los Alamos, see p. 7.)

HISTORICAL SIGNIFICANCE

NNSS was the primary location for U.S. nuclear testing during the Cold War. A total of 100 atmospheric tests were conducted, beginning with "Able" on January 27, 1951. The 1963 Limited Test Ban Treaty banned atmospheric testing, which gave way to underground testing. After 828 underground tests, full-scale nuclear testing came to an end in 1992 when the United States entered a testing moratorium that is still in place today.

OPERATION & OVERSIGHT

NNSS is managed and operated by Mission Support and Test Services (MSTS) for the National Nuclear Security Administration, a semi-autonomous agency within the U.S. Department of Energy. Roger Rocha (p. 64) is the president of MSTS.



ECONOMIC IMPACT

The site contributes nearly \$1 billion annually to Nevada's economy and is one of the largest employers in southern Nevada.

Las Vegas

ENVIRONMENTAL STEWARDSHIP

The site is actively involved in environmental management, including groundwater monitoring and remediation efforts to address legacy contamination.



PUBLIC ENGAGEMENT

NNSS offers reservation-only public tours, fostering transparency and education about its missions and history.

RESEARCH & DEVELOPMENT

NNSS houses advanced facilities like the Principal Underground Laboratory for Subcritical Experimentation (PULSE, p. 36) and the Big Explosives Experimental Facility (BEEF, p. 30), supporting cutting-edge scientific research. Experiments at these and other facilities help ensure the safety and reliability of the nuclear stockpile without nuclear testing.

COLLABORATIVE EFFORTS

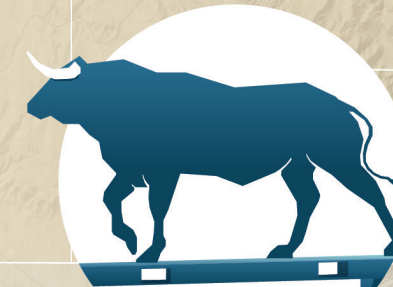
NNSS collaborates with various national laboratories (including Los Alamos), federal agencies, and international partners to advance its security and scientific objectives.

EMERGENCY RESPONSE

NNSS plays a pivotal role in national radiological and nuclear emergency preparedness, offering training and response capabilities.

Schooner crater

Boxcar crater



P Tunnel

Sedan crater

BEEF
Big Explosives
Experimental
Facility

Kappa West

Icecap

Yucca Flat

PULSE
Principal Underground
Laboratory for Subcritical
Experimentation

Apple II house

Divider
ground
zero

DAF
Device
Assembly
Facility

Frenchman
Flat

NCERC
National Criticality
Experiments
Research Center

JASPER
Joint Actinide
Shock Physics
Experimental
Research facility

Rock Valley

Mercury

THE INTERSECTION

Science and culture converge in northern New Mexico—and beyond.



Anyone who plans to drive a vehicle through the Nevada National Security Sites is required to take tortoise training—an online course that teaches drivers what to do if they encounter a desert tortoise crossing the road. The education has undoubtedly helped protect this threatened species. *Photo: Roy C. Averill-Murray*



Los Alamos computing pioneer Peter Lax died May 16 at the age of 99. Lax was the first applied mathematician to win the Abel Prize, which in mathematics is likened to the Nobel Prize. In the 2005 award citation, he was described as “the most versatile mathematician of his generation.” Lax is pictured here (left, leaning against the rock pile) with Enrico Fermi (right) on the summit of Santa Fe Baldy during the Manhattan Project.



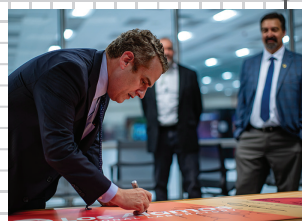
In August, Los Alamos winners of the 2023 and 2024 Defense Programs Awards of Excellence were recognized during a ceremony with U.S. Air Force Brigadier General Michael Walters, principal deputy administrator for Military Application at the National Nuclear Security Administration. Here, Amy Wong accepts the award for the Glovebox Export Control Issue Resolution Team, which quickly resolved export control issues to minimize schedule delays and avoid significant cost increases for fabricating radiological gloveboxes.



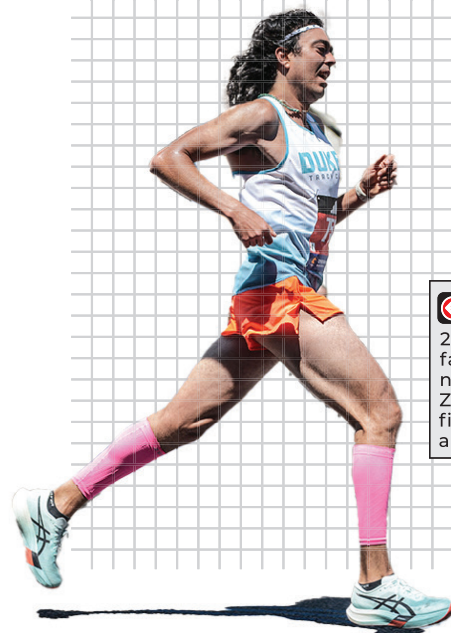
In a recent episode of the *National Security Science* podcast, listeners can experience the preparation, execution, and aftermath of an explosives safety test. Join Lab engineers in the Dynamic Experiments division as they anticipate the outcome—will it be a boom or a bust?



Deputy Secretary of Energy James Danly visited Los Alamos on July 9. Here, he signs a panel for the Venado supercomputer; the same panel was recently signed by Secretary of Energy Chris Wright.



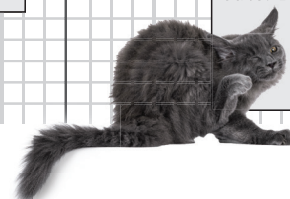
No visit to Las Vegas, Nevada, is complete without a visit to the Atomic Museum, a Smithsonian affiliate that tells the story of U.S. nuclear weapons testing—and the atomic pop culture that emerged alongside it. *Photo: Atomic Museum*



Several Los Alamos employees ran the 2025 Boston marathon; fastest among them was nuclear facilities engineer Zachary Alhamra, who finished 72nd overall with a time of 2:22:57.



Los Alamos employees are used to seeing wildlife—deer, bobcats, sometimes even bears—but employees at the North Las Vegas location of the Nevada National Security Sites experience a different kind of animal encounter: cats. Dozens of feral cats roam the property, often hiding below bushes. “They’ve been there for as long as I can remember,” says one employee. “They aren’t really problematic, and you don’t have to worry about mice.” *Photo: Dreamstime*



SCIENCE

CULTURE

THE NEVADA PROGRAMS OFFICE

The Los Alamos office helps streamline Lab work at the Nevada National Security Sites.

In recent years, Los Alamos National Laboratory’s work at the Nevada National Security Sites (NNSS) has increased—and will continue to increase—considerably. To help manage and coordinate this growth, the Nevada Programs Office (NPO) was established in 2020.

Under the leadership of Los Alamos physicist Don Haynes (p. 2), NPO oversees the execution of Los Alamos weapons and global security work—research and development as well as experimental—at NNSS. From plutonium tests at the Principal Underground Laboratory for Subcritical Experimentation to earthquake studies in Rock Valley, NPO determines what work will be done to meet weapons program needs, establishes milestones, and negotiates funding requirements.

“NPO makes use of the unique environment at NNSS to safely conduct experiments for both the Los Alamos Weapons and Global Security communities,” Haynes explains. “We can do things in Nevada that we simply can’t do anywhere else.” ★



Los Alamos Director Thom Mason (left) talks with Tom Sandoval of the Lab’s Nevada Programs Office in front of the Icecap tower at NNSS. Learn about Sandoval’s career on p. 66.

A HIDDEN HUB OF INNOVATION

Los Alamos Operations develops technology for the nuclear security enterprise.

BY WHITNEY SPIVEY

Every day, thousands of Los Alamos National Laboratory employees drive past a brown brick building perched atop a mesa on the eastern edge of Los Alamos County. From the outside, the structure appears modest. But beyond its facade is an expansive center of scientific innovation.

“We have an entire basement that is laboratory space,” says Daniel Clayton, manager of Los Alamos Operations (LAO) for the Nevada National Security Sites (NNSS). “We even have a small accelerator down there.”

Clayton oversees approximately 70 NNSS employees—primarily scientists, engineers, and technologists—based in Los Alamos. “LAO is an applied science and engineering organization engaged in research, analysis, testing, and field operations for Los Alamos National Laboratory, NNSS, and other national labs,” he explains. “We do everything from designing and fabricating ultrafast electro-optic imaging systems to building and fielding fiberoptic temperature and velocity diagnostics on hydrodynamic experiments.”

Steve Sterbenz, a retired Los Alamos scientist who managed LAO prior to Clayton, recalls the organization’s roots. “LAO was established decades ago to support full-scale nuclear tests, which were designed at Los Alamos and executed in Nevada until the 1992 moratorium,” he says. “We are embedded in Los Alamos County to support experiments in Nevada and across the nuclear security enterprise. That was true during the nuclear testing era, and it’s still true today.”

Sterbenz explains that “the engineers, scientists, and technicians at LAO develop and deploy a wide range of



diagnostics used across the enterprise—especially at the NNSS.” For example, a new imaging system for the Cygnus test bed in the NNSS Principal Underground Laboratory for Subcritical Experimentation (PULSE, p. 36) is being developed at LAO, as was the current system that has been in use at Cygnus for many years. LAO engineers are also devising an imaging system for the in-development Scorpius accelerator at PULSE.

According to Clayton, LAO has long been a source of unique capabilities. “There are certain technologies that LAO has developed over decades that the national labs rely on us to provide,” he says. One notable example is the high-speed electronic camera system known as Kraken, which was designed by LAO staff and is currently in use at the Proton Radiography facility at Los Alamos. Kraken cameras will also be deployed in other dynamic experimentation venues, such as PULSE.

“Many people don’t realize the behind-the-scenes work that takes place at LAO,” Clayton says. “We have the people and the know-how to deliver for the stockpile stewardship and stockpile modernization programs.” ★



■ The RV/DC corehole drilling operation was completed in June 2025.



■ RV/DC will detonate chemical explosions within drilled holes nearly 7,000 feet deep. Here, a drilled core awaits analysis.

DESERT SHAKE UP

Scientists study shallow earthquakes to understand how they differ from underground explosions.

BY AVERY ARENA

In 1993, a series of shallow earthquakes occurred in Rock Valley, inside the Nevada Test Site (now the Nevada National Security Sites, NNSS), just northwest of Las Vegas, Nevada. The tremors, which occurred approximately 2 kilometers below the Earth's surface, have since become central to the Rock Valley Direct Comparison (RV/DC) project, an experimental series led by Los Alamos, Livermore, and Sandia national laboratories together with NNSS.

The Rock Valley earthquakes have similar signatures (characteristics) to underground explosions. To further evaluate the seismic differences between natural events (earthquakes) and human-made events (underground explosions), the RV/DC team will compare the earthquakes to scaled chemical explosions. The chemical explosions in RV/DC are anticipated to have similar seismic signals as a low-yield nuclear weapon that could be tested underground.

RV/DC is the third phase of the Source Physics Experiment (SPE), a long-term research and development effort to improve U.S. monitoring capabilities. “The data generated from SPE, a series of well-designed and recorded chemical explosions, contribute to the development and validation of seismo-acoustic modeling codes,” explains Los Alamos geophysicist Cathy Snelson, who is one of the leaders of the effort.

For SPE, chemical explosives of different sizes have been—or will be—detonated in granite, dry alluvium, or dolomite. Scientists then study the effects—including seismo-acoustic waves—to better understand how energy travels underground to determine the size, location, and type of event that has occurred.

Snelson says that SPE, and RV/DC in particular, will provide valuable data for national security applications. “We believe this exciting effort will reveal new insights into discriminating underground explosions from a background of shallow earthquakes,” she says. “In addition to providing novel information about the physics of earthquakes themselves, RV/DC will be the ultimate test of our identification capabilities for low-yield underground nuclear tests.” ★



■ A Los Alamos-designed B61 is flight tested at Tonopah. Photo: SNL

TESTING AT TONOPAH

Mock assemblies of nuclear weapons are put to the test just 160 miles northwest of Las Vegas.

BY IAN LAIRD

U.S. Air Force planes streak across the skies above the Tonopah Test Range (TTR), a remote military installation located about halfway between Reno and Las Vegas, Nevada. The planes support flight tests that help the Department of Defense and National Nuclear Security Administration labs evaluate the pathing, performance, and survivability of nuclear weapon assemblies.

At TTR, flight tests are limited to the two bombs in the U.S. nuclear stockpile: the B61, designed and maintained by Los Alamos National Laboratory, and the B83, managed by Lawrence Livermore National Laboratory. The tests use mock assemblies containing no nuclear material and often no high explosives. A nuclear-capable aircraft releases the test unit over a designated target zone.

Los Alamos research and development engineers Casey Door and Tim Rushenberg are the only full-time members of the B61 flight test team. A significant part of their role involves coordination with military partners, particularly the Air Force. “There are two formal meetings a year, led by Air Force Global Strike Command and Strategic Command,” Door says. “Outside of those, we work to keep those relationships strong.”

These biannual meetings are used to set test schedules and determine airspace availability. Once dates are confirmed, the focus turns to building test assemblies. “Some are low-fidelity,

using surrogate materials,” Door says. “Others are high-fidelity and include nearly every component we can safely use.” Thanks to decades of B61 testing and a large repository of past assemblies, Door and Rushenberg can often develop the right configuration for a specific goal. Their work spans multiple B61 variants, including the recently fielded B61-13.

Combined, Door and Rushenberg take about a dozen trips to TTR annually, with each test spanning about a week. The process includes extensive setup and coordination. On test day, the aircraft performs a communications check followed by dry runs over the target area to ensure the aircraft is meeting the test parameters. Once alignment is verified, a “hot pass” is conducted and the mock weapon is released.

Data collection begins immediately. Instrumentation on the plane and assembly provide live readings, and while that telemetered data can be hard to interpret as it streams in, once analyzed, it helps the team evaluate if the flight and release went as expected. “The live feed comes in fast,” Rushenberg notes. “Sometimes we get what we need right away. Other times, recovery is required to get the necessary data.”

Recovery is mandatory after each test to retrieve materials and prevent contamination. Timing varies—some units are recovered immediately, others during batch trips. The data collected helps evaluate component function and environmental response. According to Door, the team has a high success rate in both test execution and data quality.

One persistent variable is the weather. “We’ve had hurricane-force winds, calm heat, and even snow in June,” Rushenberg says. “One time, we almost didn’t make it out of the valley before the roads closed due to snow. It can get wild.” ★



■ The Spyder 1 rocket takes off from White Sands Missile Range carrying Los Alamos technology and components into space. Photo: WSMR

FINE-TUNING FLIGHT TESTING

Los Alamos scientists send innovative technology soaring.

BY JILL GIBSON

Los Alamos National Laboratory is celebrating advances in flight-testing capabilities following a rocket launch on June 13, 2025. The test launch, part of the Lab's Stockpile Responsiveness Program (SRP), took place at White Sands Missile Range in partnership with commercial launch provider Up Aerospace Inc.

"This test required a hugely collaborative effort," says Jordan Shoemaker, SRP deputy program manager and payload development lead for the launch. "It represents a leap forward in our capability to test new things at low cost and high cadence."

This test marked several firsts for the Laboratory, which has successfully launched innovative payloads on commercial rockets since 2021. Suborbital flight tests allow scientists to determine how weapons technology and components perform in situations relevant to those seen in an intercontinental ballistic missile launch. For this particular launch, scientists deployed a payload of newly developed weapons technology and experimental components.

"This was also the first test of a new thermal protection material, a new integrated telemetry system, and a new additively manufactured titanium flight vehicle built by the Kansas City National Security Campus' New Mexico Operations site," Shoemaker says. (A flight vehicle is the cone on the end of the rocket that holds the payload.)

Cooperative weather conditions contributed to an on-time launch, and multiple data collection teams at different locations optimized data return, according to flight lead Justin McGlown, deputy senior project leader for the Lab's Agile Space program. He notes that the onboard telemetry systems successfully transmitted data during the flight. Following the flight, the payload as well as the data recording systems (similar to an airplane's black box) were recovered, and analysis of the results began.

"The data we receive is invaluable in allowing us to assess performance and make modifications to improve it," McGlown says, adding that what sets the SRP apart is speed and affordability. "This program requires that we work quickly and keep down costs. Historically, launching a payload into space took years—sometimes decades—and hundreds of millions of dollars. This test integrated a new payload into a new vehicle, on a new rocket, including range costs, in just three years start-to-finish, at a significantly lower cost."

Steve Judd, SRP program manager, says several more launches are on the schedule. "We spent several years building this capability, and now we are accelerating the cadence and using this capability to test the art of the possible for the future deterrent." ★



■ On December 8, 1962, after visiting Los Alamos Scientific Laboratory, President John F. Kennedy visited the Nevada Test Site to see the Nuclear Rocket Development Station. Photo: Science History Institute

FROM THE MOJAVE TO MARS

Los Alamos scientists developed and tested nuclear rocket engines at the Nevada Test Site.

BY IAN LAIRD

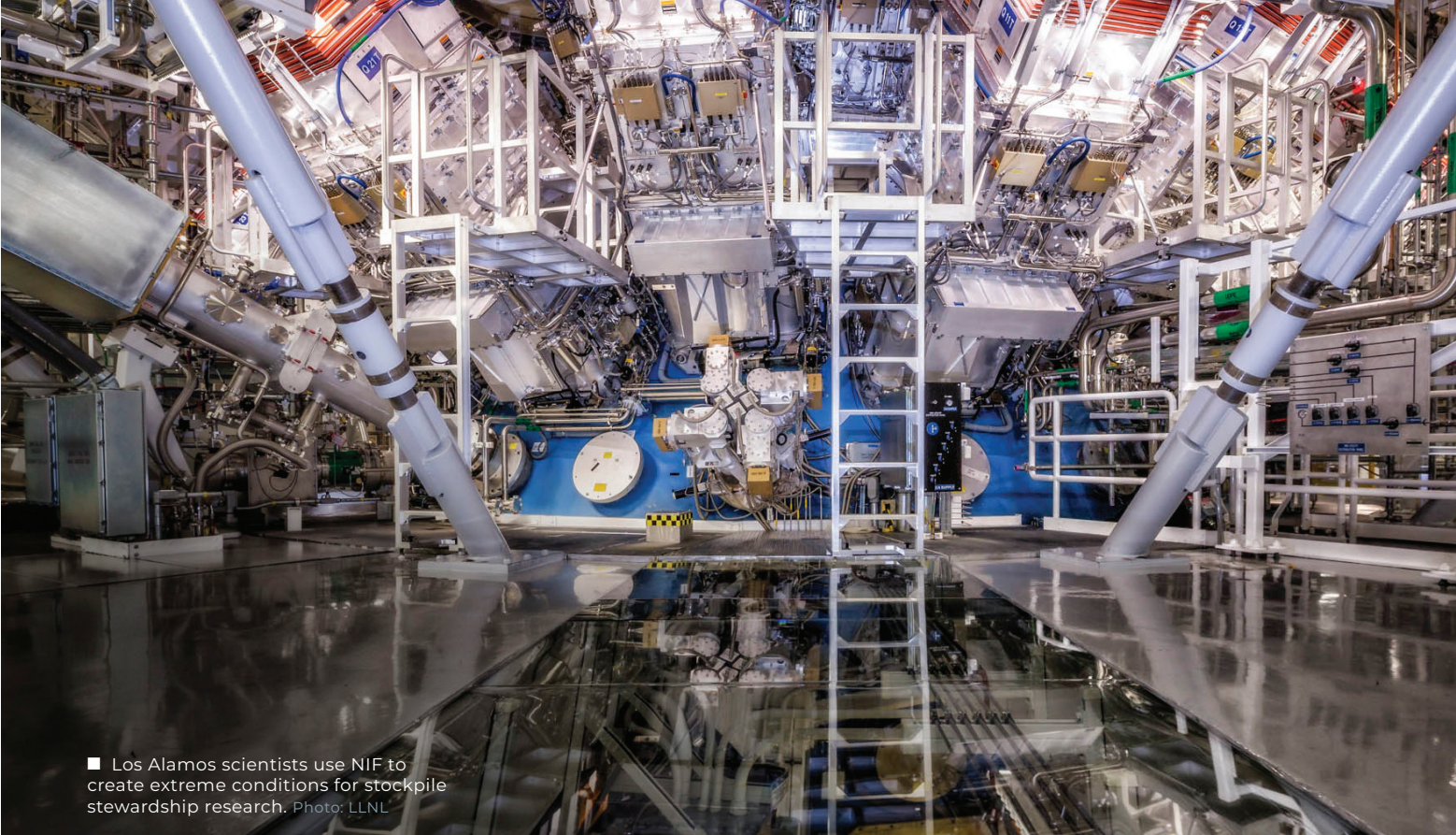
In 1952, Los Alamos Scientific Laboratory successfully tested Ivy Mike, a thermonuclear device, at Enewetak Atoll in the Pacific Ocean. Mike, however, was undeliverable on the conventional rockets and aircraft of the time because of the device's weight (more than 160,000 pounds) and size (the equivalent of a small house). While some scientists worked to reduce the device's size, other scientists embarked on Project Rover, an attempt to develop a nuclear-powered rocket.

The effort coincided with the national space race, and Rover immediately attracted attention and funding—could nuclear propulsion send a man to the moon? To Mars? In a special address to Congress, President John F. Kennedy requested funding to "accelerate development of the Rover nuclear rocket. This gives promise of some day providing a means for even more exciting and ambitious exploration of space, perhaps beyond the moon, perhaps to the very end of the solar system itself."

Much of the science behind Rover took place at Los Alamos (keep in mind that the National Aeronautics and Space Administration didn't exist until 1958) and much of the prototype testing took place at the Nevada Test Site, which had the space (no pun intended), infrastructure, and personnel to safely conduct tests.

Rover's first nine years focused on Kiwi, a nuclear reactor design named for the New Zealand flightless bird, as researchers didn't intend to flight-test these reactors. After successful Kiwi tests, researchers began developing the Phoebus series of reactors, one of which, Phoebus-2A, produced more than 4,000 megawatts of thermal energy in 1968, making it the most powerful nuclear propulsion reactor in the world.

Although Phoebus-2A was never meant to go into space, researchers thought perhaps the prototype reactor could be modified for travel to Mars. That dream fell short due to a lack of funding stemming from shifting priorities and the nation losing interest in space travel. However, Project Rover still had a significant impact on future science. Breakthroughs during the project led to the creation of the modern heat pipe, an essential technology that is ubiquitous in most devices, such as phones and laptops. ★



■ Los Alamos scientists use NIF to create extreme conditions for stockpile stewardship research. Photo: LLNL

COLLABORATION ACHIEVES FUSION IGNITION

A Los Alamos-led experiment paves the way for groundbreaking studies.

BY JILL GIBSON

A team led by Los Alamos National Laboratory in conjunction with Lawrence Livermore National Laboratory has achieved fusion ignition at the National Ignition Facility (NIF) in Livermore, California.

Fusion ignition—the point in a nuclear fusion reaction when more energy is generated than is needed to spark the reaction—allows scientists to study the behavior of materials in conditions that were previously impossible to achieve in a laboratory setting. Livermore first achieved ignition in 2022 and has replicated it several times since then, but this recent achievement opens the door for studying new aspects of physics.

Physicist Joseph Smidt, codirector of the Los Alamos inertial confinement fusion program, says the experiment conducted on June 22, 2025, “shows how well the labs’ designs can create fusion ignition conditions to address key stockpile stewardship questions.” Because fusion ignition conditions are similar to the conditions inside a detonating nuclear weapon, NIF experiments can help weapons scientists understand how materials could behave in weapons.

In NIF fusion experiments, lasers are fired into a gold-coated cylinder called a hohlraum, which is just a few millimeters long and wide. The hohlraum holds a tiny capsule of

deuterium and tritium—the fusion fuel. The lasers hit the inner walls of the hohlraum, creating a uniform bath of x-rays that drives the symmetrical implosion of the inner capsule, resulting in fusion ignition.

The June 22 experiment was the first time ignition was achieved using a hohlraum with “windows” that allow some of the high-flux x-rays to escape. In future experiments, the x-rays will provide a source to test how materials interact with high temperatures and radiation levels, which are both of interest to nuclear weapon scientists. Building on a Livermore hohlraum design, Los Alamos scientists created the windowed hohlraum called THOR (Thinned Hohlraum Optimization for Radflow).

“This experiment marks a critical step in validating high-fidelity simulations and in demonstrating that ignition-scale performance can be achieved even with the THOR platform modifications,” says Los Alamos project series lead Ryan Lester, noting that the challenge in this design was ensuring that adding windows to the hohlraum did not result in significant energy or implosion symmetry loss that would prevent fusion ignition from happening.

“Igniting capsule implosions are incredibly sensitive and any energy loss or perturbation can easily prevent ignition, which would eliminate the generation of the x-ray fluxes we want to use as a source,” says physicist Brian Haines, who helped design the experiment. Haines says now that ignition has been achieved with a THOR design, the next step will be to design experiments that attach to the THOR windows.

“This is a game-changing breakthrough that advances the science of ensuring the reliability of the nation’s nuclear stockpile,” Smidt says. “Hitting this goal illustrates the Lab’s expertise with this complex and exciting platform.” ★



■ Before their visit to the Lab, foreign defense attachés and DIA staff stopped at the Main Gate. Half of the group is pictured here.

DEFENSE ATTACHÉS VISIT THE LABORATORY

Nearly 30 foreign military officers attended the Los Alamos Defense Attaché Orientation Program.

BY WHITNEY SPIVEY

On September 8, Los Alamos National Laboratory’s Center for National Security and International Studies hosted 31 foreign defense attachés and 10 staff members from the Defense Intelligence Agency (DIA). The event was part of the Defense Attaché Orientation Program and marked the first time the program has visited a U.S. national laboratory. The purpose of the unclassified visit was to highlight the Laboratory’s core missions—nuclear deterrence, global security, and space science and technology.

“Deterrence continues to be the cornerstone of U.S. policy—that has not changed and will not change,” Steve Cambone, director of the Lab’s Strategic Assessment and System Analysis Office, told the cohort. “The work we do is essential to maintaining the deterrent to ensure the policy of deterrence is credible.”

Defense attachés are military diplomats—typically high-ranking officers—stationed abroad as liaisons between their host countries

and their own defense establishments. Members of this attaché cohort hailed from 29 countries and are currently based in Washington, D.C. with the DIA.

Deputy Laboratory Director for Science, Technology, and Engineering Pat Fitch kicked off the briefings with a Lab overview. He emphasized how imperative the Laboratory’s work is in the current geopolitical environment.

“If there is a single word to describe this year, it’s urgency,” Fitch said. “Whether it’s operations, mission, or science work, we are trying to go faster.” As an example, Fitch mentioned applying artificial intelligence to a fracture analysis code. “We used AI tools and sped up the code by a factor of 10,000,” he said. “We lost some resolution, but we can do 10,000 simulations in the time it took to do one, and that’s a huge advantage.”

In something of a full-circle moment, Cambone began his “Deterrence in a Challenging World” briefing by explaining that when he was the undersecretary of defense for intelligence in the early 2000s, the U.S. defense attachés reported to him.

“Allies and partners have been and will continue to be important to deterrence policy in the United States,” Cambone said. “We are all better off if the world works in a certain way. To have friendships and partners in building and defending that world is important.” ★



CLOUDS AND CRATERS

BY JILL GIBSON

The 928 nuclear tests that occurred in Nevada before 1992 continue to inform the modern nuclear weapons stockpile.

■ An atmospheric nuclear test is viewed from Las Vegas, Nevada, in 1951.
Photo: Nevada Test Site Archive/Atomic Museum



■ Coverage of the 1951 Ranger test series exploded in Las Vegas newspapers. Photo: *Origins of the Nevada Test Site/DOE*

During the 1950s, visitors to Las Vegas, Nevada, would gather on casino balconies to sip atomic-themed cocktails while watching nuclear explosions. These detonations took place approximately 65 miles northwest of the city, and the mushroom clouds were just visible from the Strip. The city became ground zero for atomic culture because of its proximity to the nuclear weapons tests. “It’s like the entire town promoted everything with the atomic bomb exploding,” says retired Los Alamos National Laboratory scientist Glen McDuff. “A nuke was a pretty good show.”

“Mushroom clouds were a tourist attraction,” says Laboratory senior historian Alan Carr. “People were fascinated by everything nuclear. The atomic obsession influenced everything from movies to toys, hairstyles, and architecture.”

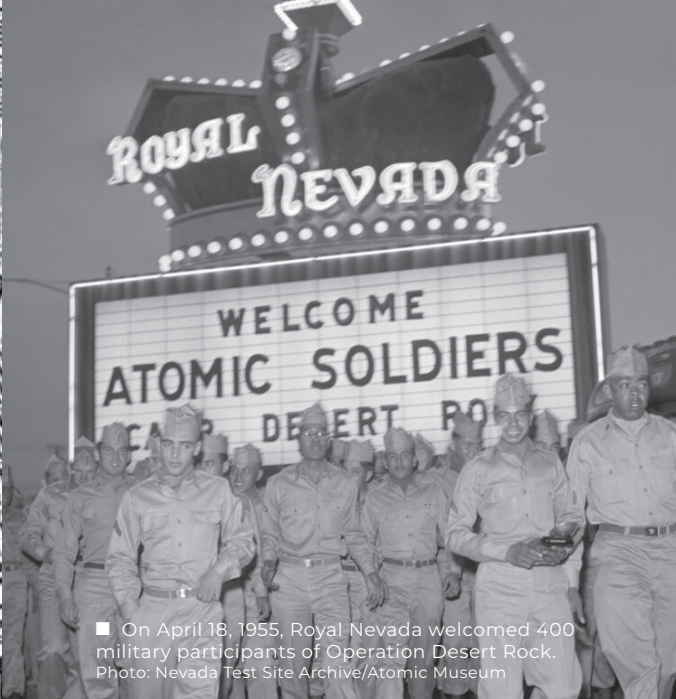
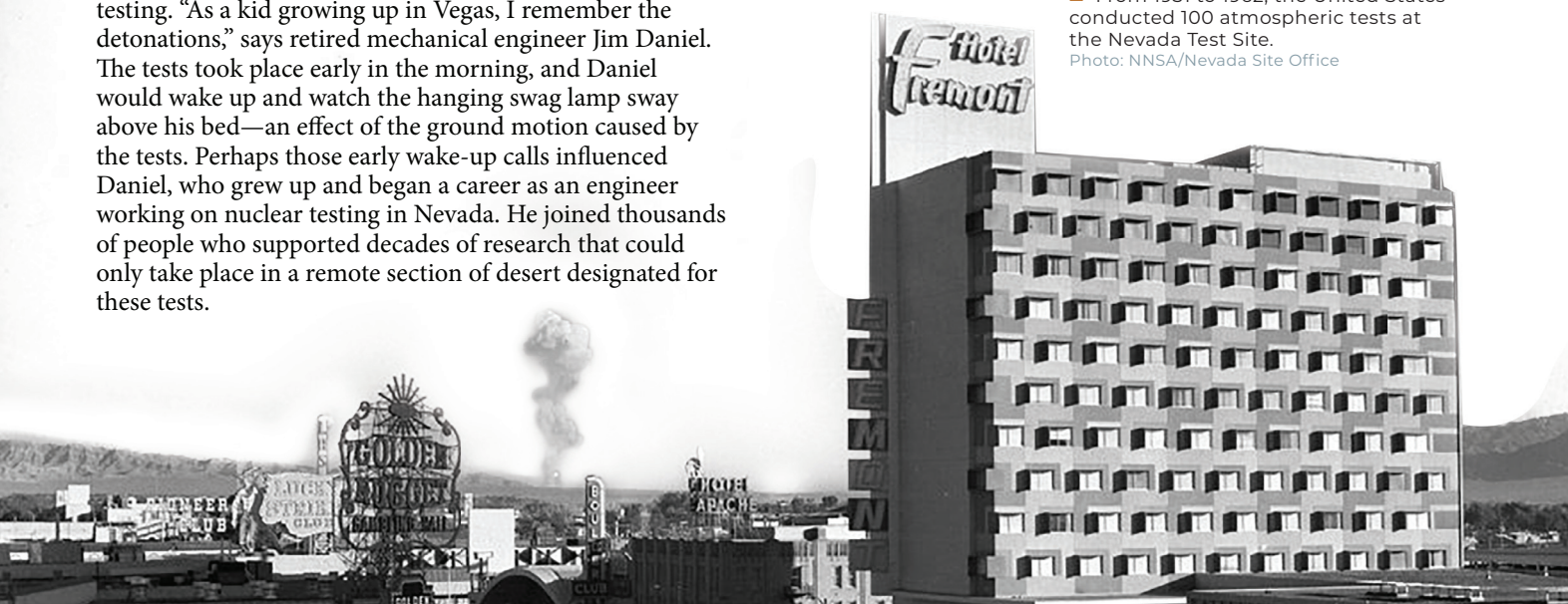
Las Vegas residents quickly became accustomed to the testing. “As a kid growing up in Vegas, I remember the detonations,” says retired mechanical engineer Jim Daniel. The tests took place early in the morning, and Daniel would wake up and watch the hanging swag lamp sway above his bed—an effect of the ground motion caused by the tests. Perhaps those early wake-up calls influenced Daniel, who grew up and began a career as an engineer working on nuclear testing in Nevada. He joined thousands of people who supported decades of research that could only take place in a remote section of desert designated for these tests.

“A nuke was a pretty good show.”

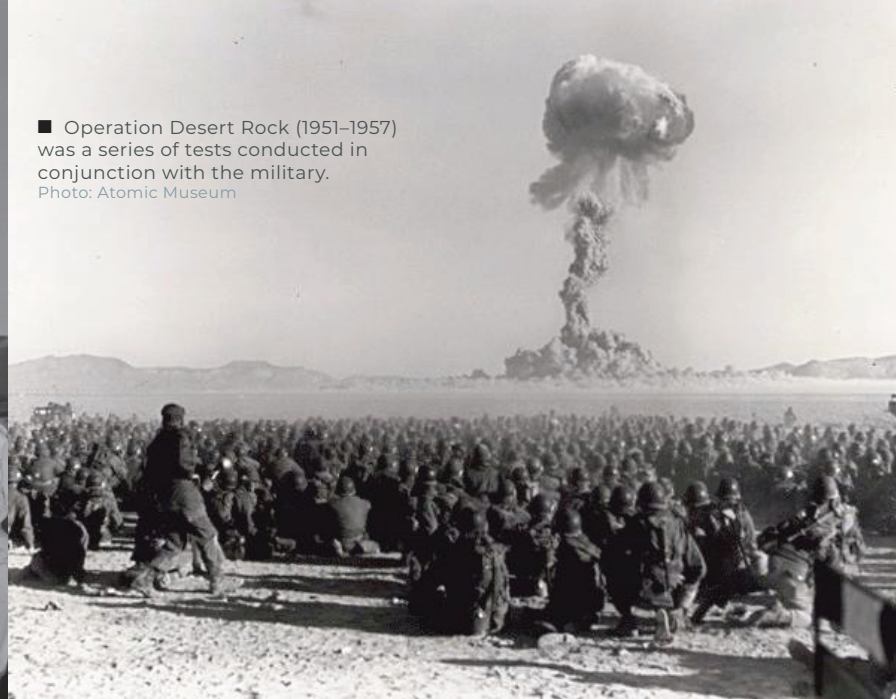
—GLEN McDUFF

From 1951 to 1992, what is now called the Nevada National Security Sites (originally called the Nevada Proving Grounds and then the Nevada Test Site) served as the United States’ primary location for full-scale nuclear testing, which involved detonating actual nuclear devices. During those years, Los Alamos, Lawrence Livermore, and Sandia national laboratories, along with a variety of government entities, conducted 100 atmospheric tests before pivoting in 1963 (when the Limited Test Ban Treaty was signed, prohibiting testing aboveground, in space, and underwater) to underground testing. Between October 1963 and September 1992, 828 underground tests were executed at the site.

■ From 1951 to 1962, the United States conducted 100 atmospheric tests at the Nevada Test Site. Photo: NNSA/Nevada Site Office



■ On April 18, 1955, Royal Nevada welcomed 400 military participants of Operation Desert Rock. Photo: Nevada Test Site Archive/Atomic Museum



■ Operation Desert Rock (1951–1957) was a series of tests conducted in conjunction with the military. Photo: Atomic Museum



■ In 1953, pool-goers at the Hotel Last Frontier in Las Vegas, Nevada, observe the mushroom cloud from Encore, a 27-kiloton nuclear test airdropped from a B-50 bomber. Photo: Getty Images



■ Bus from Mercury to Las Vegas, 1959



■ Mercury, Nevada, 1959



■ Mercury, Nevada



■ Snure's Snack Shack, 1959



■ Mercury, 1959

In 1992, shortly after the Los Alamos–designed Divider test, the United States declared a moratorium on full-scale testing, which was followed by the signing (but not ratification) of the global multilateral Comprehensive Test Ban Treaty (CTBT). Decades later, the United States continues to abide by the CTBT’s “zero-yield” standard, which requires states to refrain from conducting “any test that produces a self-sustaining, supercritical chain reaction of any kind.” Nevertheless, the lessons learned and the data collected during those decades of testing continue to play an integral role in protecting the nation by providing a crucial component for weapons research.

“Nevada quickly became a main character in the history of nuclear weapons testing.”

—ALAN CARR

IN THE BEGINNING

Following the advent of nuclear weapons in the summer of 1945 and the end of World War II shortly thereafter, the United States continued to refine its weapons designs through nuclear testing. Scientists evaluated the performance, yields, effects, and reliability of dozens of types of weapons, including thermonuclear weapons.

Testing initially occurred in the Marshall Islands in the Central Pacific, but as the Cold War with the Soviet Union escalated and North Korea invaded South Korea, prompting U.S. military intervention, American leaders decided a test site within the continental United States would be more secure.

“The Nevada Proving Grounds was the perfect spot,” Carr says. “It was remote, close to Nellis Air Force base, and most of the land was already government owned.”

McDuff agrees that Nevada was the ideal location for testing. “The government wanted a more secure place, and, trust me, the Nevada Test Site is about as secure as you can get. You know, it’s made up of valleys surrounded by tall mountains, and no one lives there.”

Later scientists would learn that the site’s deep water table and geological characteristics (including rock types and volcanic soil) also created stable conditions for underground testing. “That was serendipitous,” Carr says.

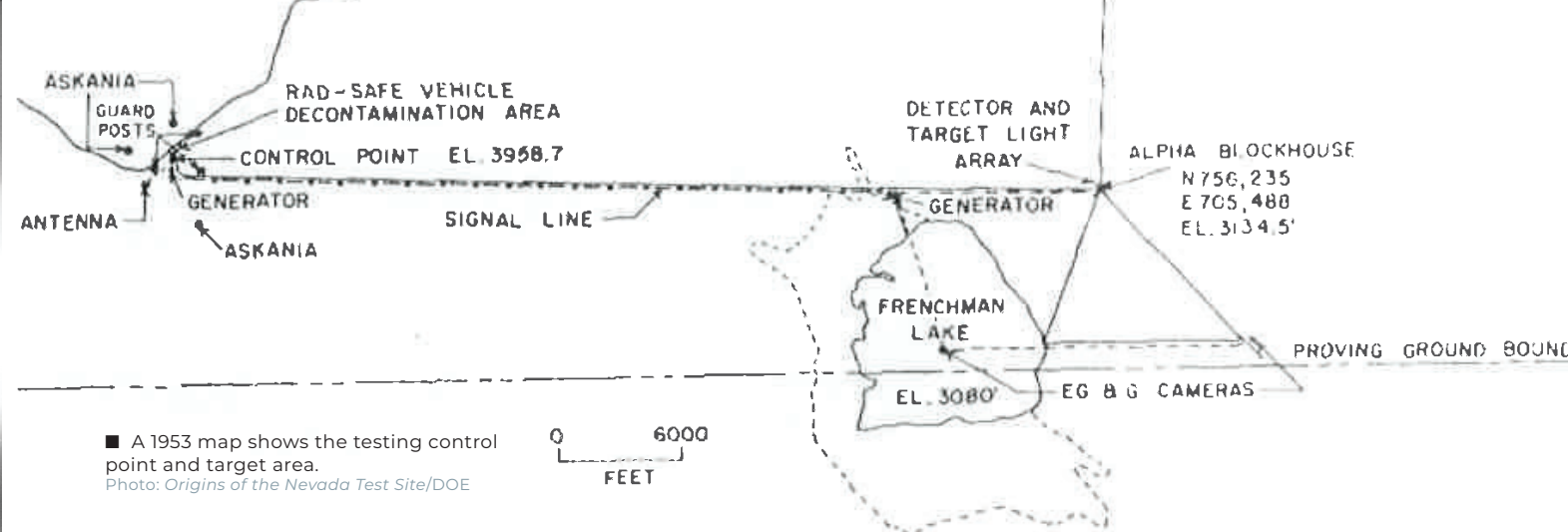
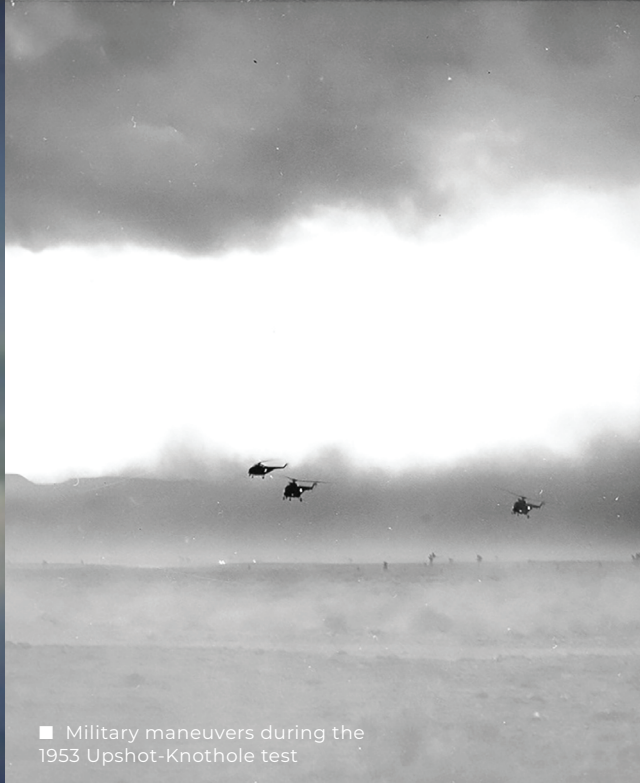
In December 1950, President Harry Truman authorized the establishment of a portion of the Las Vegas Bombing and Gunnery Range (renaming it the Nevada Proving Grounds) as the primary location for nuclear testing. Testing began just weeks later. “Nevada quickly became a main character in the history of nuclear weapons testing, and the significance of the site continues to this day,” Carr says.



■ Mercury cafeteria, 1959



■ Sleeping on the bus from Mercury to Las Vegas, 1959



■ Operation Ranger, the first test series in Nevada, took place in 1951.

■ Military maneuvers during the 1953 Upshot-Knothole test

■ A 1953 map shows the testing control point and target area.
Photo: *Origins of the Nevada Test Site*/DOE



■ Buster-Charlie test, 1951



■ Operation Hardtack II-Santa Fe, 1958



■ VIPs and reporters gather at News Nob to witness an atmospheric nuclear test.

THE HEIGHT OF TESTING

For former Los Alamos test director Ron Cosimi, underground testing in Nevada formed a significant part of his career. “Nevada was my second home,” Cosimi says. “We were so busy that we would finish one test and immediately start on the next.” Cosimi and other Laboratory scientists would fly from New Mexico to Nevada on Monday mornings and fly home on Friday nights. During the week, the scientists lived in dormitories. In addition to the people staying onsite, another 11,000 commuters showed up each morning. “Everyone was important—the electricians, the pipefitters, the ironworkers. It was a huge operation, and everyone had a job to do,” Cosimi says.

Despite its remote location, the test site proved to be relatively easy to access because of the popularity of Las Vegas. “This is a city that ran 24/7 with flights coming in daily, both from Los Alamos and Livermore—thousands of people going through every day,” Los Alamos historian emeritus Roger Meade says. “You had as many as 60 buses, big buses, that just went back and forth from Vegas up to the test site because so many people who worked there lived in Vegas. So, you had this huge community.”

At the site, a government-created town called Mercury served as operational headquarters. “At the peak of nuclear testing in the 1950s and ’60s, Mercury was one of the larger towns in Nevada,” Carr says. “They had a bowling alley, swimming pool,

“Everyone was important—the electricians, the pipefitters, the ironworkers. It was a huge operation, and everyone had a job to do.”

—RON COSIMI



■ Los Alamos control room at the Nevada Test Site



■ Plumbbob-Fizeau, 1957

cafeteria, and a steakhouse. Many scientists spent weeks and even months of the year at the site.”

Cosimi says spending so much time together in such a remote place created a sense of camaraderie. “We missed our families, but we had a bond.” Although his schedule was grueling and he describes the work as often stressful, Cosimi says he and his colleagues had great passion for the work. He speaks fondly of the time he spent in Nevada, frequently telling stories about the friendships forged at the site. Although many of Cosimi’s tales feature practical jokes, he took his job seriously. “Our work was of vital importance to the safety of the nation,” he says. That work continues to support nuclear weapons research today.

BUILDING ON THE PAST

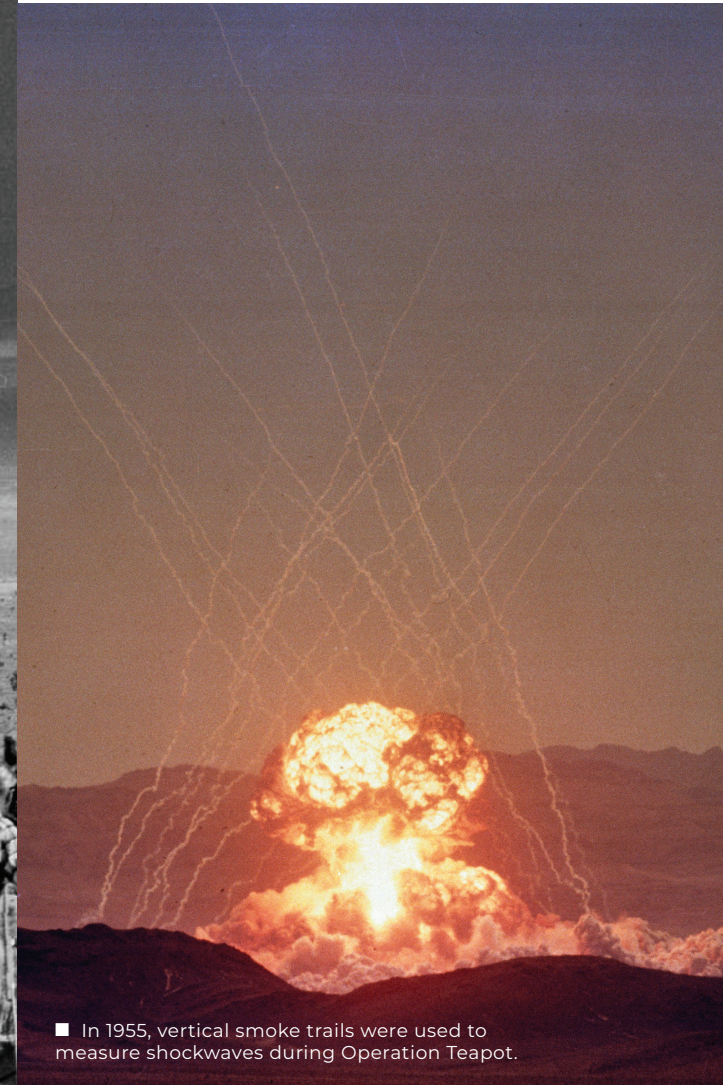
Mary Hockaday, a now-retired Los Alamos physicist, fielded diagnostics on underground nuclear tests. “It was very exciting and nerve-racking. You worked months and months to get this one shot, a nanosecond to get the data. It was the ultimate final exam.”

Hockaday says that years of testing in Nevada set the stage for future experiments. “If you look at how we are doing experiments now, and you think about the protocols and infrastructure we use, you will discover that we continue to exercise many of the things we learned to do during the years of full-scale testing. The concept of dry runs, timing, diagnostics, having a test director, the roles and

■ Members of the Marine Atomic Exercise Brigade
Photo: Atomic Museum



■ Operation Teapot-Wasp Prime, 1955



■ In 1955, vertical smoke trails were used to measure shockwaves during Operation Teapot.



■ Upshot-Knothole-Grable, 1953



“The archived data we obtained through those decades of testing is so important. I’m very proud to have played a part in that.”

—MARY HOCKADAY

responsibilities, the questions we address—that framework was developed during full-scale testing.”

When the testing moratorium went into place, Hockaday pivoted and applied the skills she had developed in the Nevada desert to new types of experiments, including subcritical experiments (p. 36). “How we do business today has roots in that past,” she says.

Another important takeaway from the past is the tremendous amount of useful data the tests generated. Today, that data is used to validate computer codes that scientists use to design new devices, maintain the existing stockpile, and study nuclear weapons effects.

“Our nuclear test database is priceless,” Hockaday says. “The archived data we obtained through those decades of testing is so important. I’m very proud to have played a part in that.”

Hockaday explains that weapons designers hone their skills by using the archived data to make calculations. Scientists who attend the Lab’s Theoretical Institute for Thermonuclear and Nuclear Studies (TITANS), which is often referred to as a graduate program in nuclear weapons, use that data to advance their knowledge and familiarity with the science and tools necessary for maintaining the nation’s nuclear weapons.

“That data allows new designers to test their understanding,” Hockaday says. “It’s still the final exam.”

But the information from those decades of explosions does more than test physicists’ understanding. It underpins and informs a significant portion of Los Alamos scientists’ current work. Physicist Rachel Smullen describes the decades of testing data as “an immeasurably valuable resource for physicists today. The data is absolutely crucial to validating our computer codes. They ensure our calculations and predictions are correct.”

Physicist Jessica Thrussell agrees. “That testing data provides confidence and forms the foundation for everything we do,” she says. “If my code models a historic underground test well, I am more confident in its predictions for new designs.”

■ Large bits were used to drill holes for underground testing.



■ Workers drag diagnostic cables in preparation for a 1967 underground test.



■ The test rack (left) was connected to diagnostic trailers (right) by hundreds of cables. Photo: Atomic Museum



■ Control point, 1988



■ Subsidence craters dot the landscape.



■ Hundreds of miles of cables transmitted data from underground tests to recording instruments.



■ Operation Mandrel-Planer, 1969



■ Testing preparation. Photo: Atomic Museum



■ The tower remains from Icecap, a structure built in 1992 for a test that was canceled when the testing moratorium went into place.

IN THE ARCHIVES

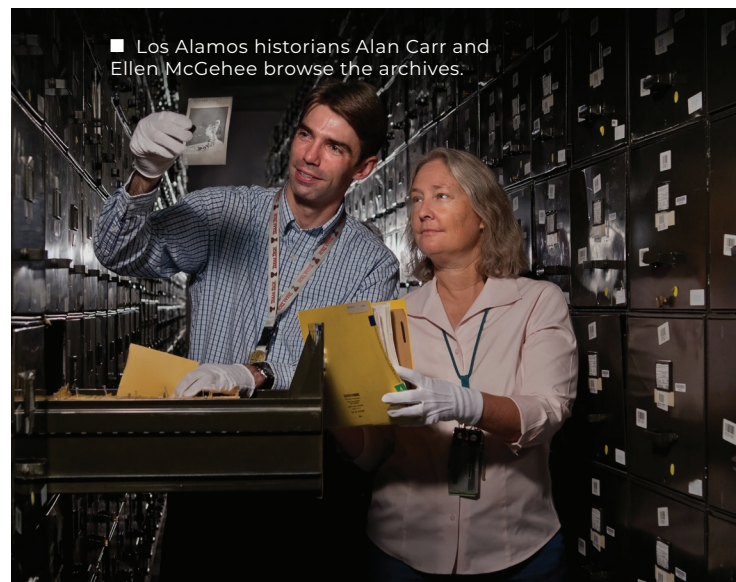
The librarians, historians, knowledge managers, and archivists who work at the National Security Research Center (NSRC), the Laboratory's classified library, are prepared to tackle all manner of weapons testing questions. "We answer about 1,500 researcher requests a year ranging from 'What type of cables did this system use?' to 'What documents exist about this test?'" explains Collections Management Team Leader Patty Templeton. "We have more than 10 million resources, including film, photographs, oral histories, drawings, and technical reports. We are working toward making it all digitally accessible."

Smullen says she often turns to the NSRC for data. "They do a great job of archive diving and have found me everything from engineering drawings to physicists' handwritten notebooks with hundreds of pages of thoughts, ideas, and calculations." Smullen notes that everything she learns helps improve computer modeling to predict outcomes and performance. "Even when we explore new device designs, those designs have a strong basis in test history. We rely on this data to improve our understanding of how things work and to explore what we can create for the future," she says. Digitizing historic material and creating searchable repositories plays an important role in connecting scientists to answers, according to Templeton. "We are building scalable artificial intelligence-enabled searching and indexing solutions for today's researchers who are solving tomorrow's problems."

Recently, the NSRC's Multimedia Digitization Services and Research Librarian teams created a collection in the Lab's unclassified video library that pairs historic weapons effects videos and the related reports describing the experiments.

"The combination of the videos and the reports is incredibly valuable," says Tim Goorley, chief scientist for nuclear weapons effects. "Together, they allow us to quantify the blast pressures, winds, and thermal radiation that the planes, vehicles, buildings, and many other things experienced, and the resulting damage." Goorley also says these resources provide necessary details for using the extensive historic test data to validate the Lab's modern high-fidelity computer codes used to provide high confidence analyses to the National Nuclear Security Administration and the Department of Defense.

Templeton notes that digitized video and film provide unique insights. "Moving images convey techniques, timing, and the situational conditions of how things worked (or didn't work) in real time."



■ Los Alamos historians Alan Carr and Ellen McGehee browse the archives.

“The information collected during those tests provides the United States with the great advantage of real-world data. We stand on the past.”

—ALAN CARR

PRESERVING THE LEGACY

Although visitors to Las Vegas no longer gather on casino balconies to sip atomic-themed cocktails while watching nuclear explosions, they can visit the Atomic Testing Museum, a Smithsonian affiliate in Las Vegas, to learn about this period in U.S. history.

Meanwhile, scientists at Los Alamos continue to use testing data to ensure America's nuclear deterrent meets current and future needs. "The information collected during those tests provides the United States with the great advantage of real-world data," Carr says. "We stand on the past." ★



■ Cosimi was the test director for 14 nuclear tests.

RON COSIMI REMEMBERS

A former nuclear testing director reflects on U.S.–Soviet relations during the Cold War.

BY JAKE BARTMAN

Ron Cosimi, who in November 1989 was one of the test directors for Los Alamos National Laboratory’s nuclear testing program, was in his first-ever meeting with the Soviet Union’s nuclear testing delegation when events took a dramatic turn.

“In the middle of the meeting, someone came in and whispered in the Soviet delegation leader’s ear, and his face went white,” Cosimi remembers. “And the Soviet leader said, ‘Break.’ So, we took a break, and we were sitting in the meeting room, wondering what was wrong. I asked someone, ‘Is he sick? What’s going on?’ Finally, someone came in and said, ‘You won’t believe what’s on TV.’”

It turned out that during the meeting, the Berlin Wall had fallen—a development that showed the Soviet Union’s weakness and marked the beginning of the end of the Cold War (the Soviet Union dissolved two years later). “The meeting went a lot

faster after that,” Cosimi says. “I think the Soviets had orders to get back home.”

Cosimi’s career at Los Alamos spanned most of the Cold War: He joined the Laboratory in 1965 and retired in 1998. An engineer by training, Cosimi supported some 80 Los Alamos–led full-scale tests of nuclear devices, acting as the Laboratory’s test director for 14 of those tests. Beyond being scientific achievements in their own right, these tests supported the development of nuclear weapons that shaped how the Soviet Union viewed the United States (and vice versa).

According to Cosimi, J Division—the Los Alamos division that planned and executed nuclear tests at the Nevada Test Site (now the Nevada National Security Sites)—focused more on the specifics of its work than on how that work affected the broader Cold War. But the sense that nuclear testing played a key role in the nation’s nuclear weapons development and, by extension, in the United States’ competition with the Soviet Union, fostered a sense of purpose. “We thought of ourselves as warriors,” Cosimi says. “J Division was like an army. Whatever you did, you depended on your coworkers, just like in a military unit.”



■ Cosimi (right) still travels regularly to the Nevada National Security Sites, where he leads tours and shares his knowledge of the United States’ nuclear testing.

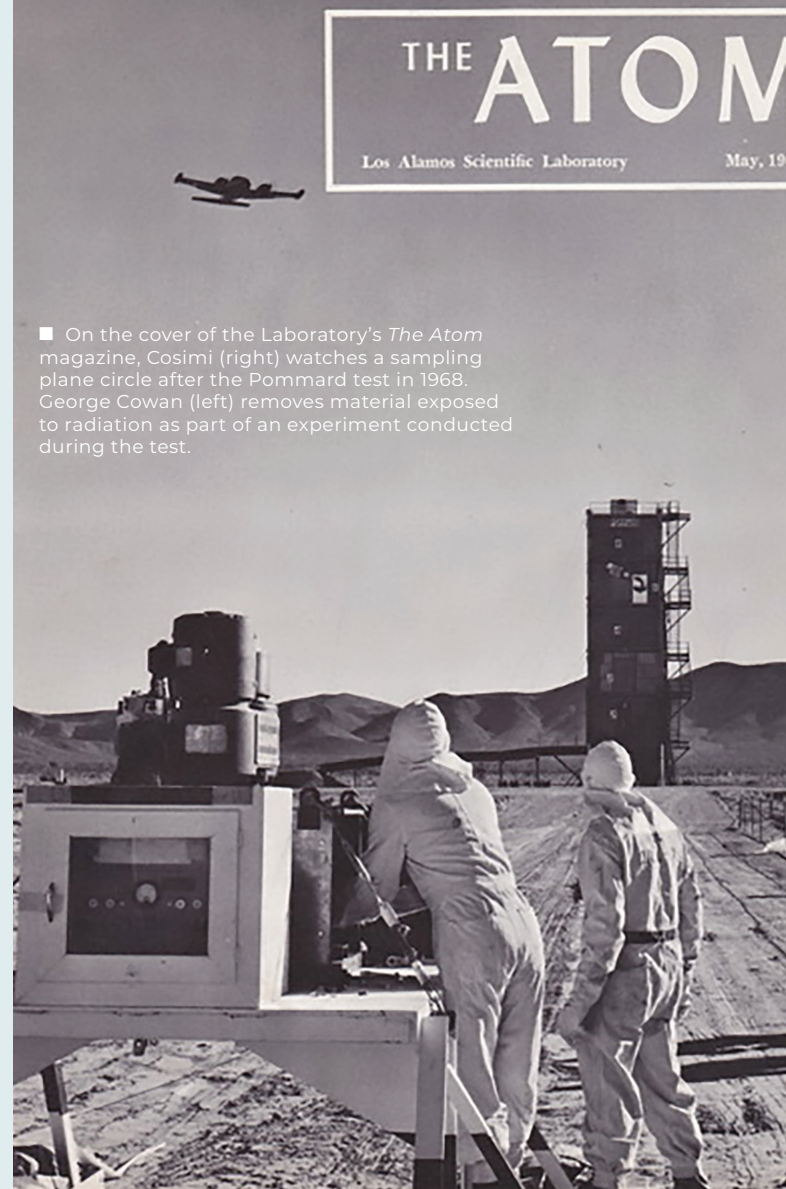
Relations between the United States and the Soviet Union thawed in the mid-1980s. In 1987, the United States and the Soviet Union began working together to develop diagnostic techniques that would allow them to ensure that neither country’s nuclear tests exceeded the 150-kiloton yield limit established by the Threshold Test Ban Treaty (TTBT). This effort culminated in the Joint Verification Experiment, which saw two nuclear tests—one in the Soviet Union and one in the United States—carried out collaboratively.

Per the TTBT, either country could send representatives to observe the other’s nuclear tests (which was why Cosimi went along with the U.S. delegation to meet with Russian leaders on a number of occasions between 1989 and 1991). These meetings were focused on preparing for a Los Alamos test called Junction, which took place in Nevada in March 1992. Cosimi recalls hosting Russian scientists for the Junction test. Originally skeptical of each other’s motives, relations between the Russian and American scientists warmed to such an extent that after several weeks, members of the Russian delegation even began to work alongside the Americans to prepare the test.

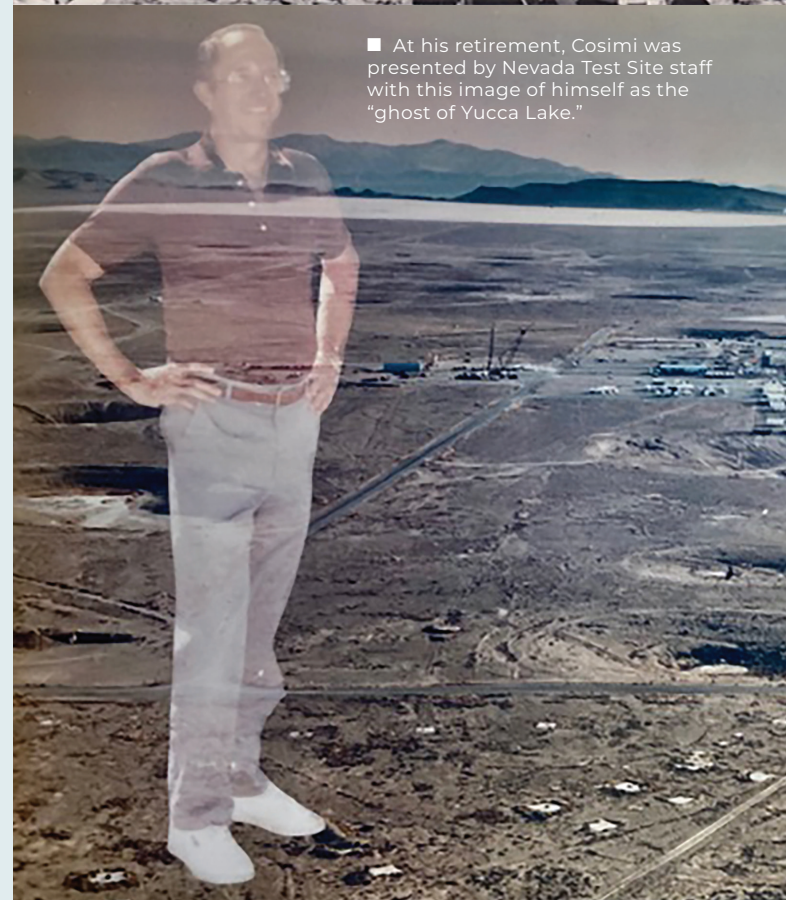
In the fall of 1992, nearly a year after the Cold War’s end, Cosimi was leading preparations for several nuclear tests when President George H. W. Bush declared a 90-day moratorium on testing. When it became clear that this moratorium would last longer than 90 days (the moratorium remains in effect today), Cosimi spearheaded the development of the Laboratory’s subcritical testing program (p. 36).

Today, Cosimi travels frequently to Nevada to tour Laboratory employees and others around the onetime center of the nation’s nuclear testing program. Cosimi says that the amount of activity at facilities such as the Principal Underground Laboratory for Subcritical Experimentation, where Los Alamos conducts subcritical tests and is assembling the Scorpis accelerator, reminds him of the heyday of the testing era.

“It’s like a city down there now,” Cosimi says. “It looks just like it used to during testing.” But, he adds, “I do still miss the testing days.” ★



■ On the cover of the Laboratory’s *The Atom* magazine, Cosimi (right) watches a sampling plane circle after the Pommard test in 1968. George Cowan (left) removes material exposed to radiation as part of an experiment conducted during the test.



■ At his retirement, Cosimi was presented by Nevada Test Site staff with this image of himself as the “ghost of Yucca Lake.”

BY IAN LAIRD

BIG BOOMS

The Los Alamos National Laboratory team at Kappa West, a remote firing site in the Nevada desert, handles large explosive experiments.

■ As many as 50,000 pounds of explosives can be detonated at Kappa West.



■ Cameras at Kappa West frequently capture experiments reflected in mirrors, which allows the cameras to record safely while avoiding direct exposure to detonations.

“Five...four...three...two...one.”

For the second time today, Alex Tafoya’s countdown crackles across handheld radios spread through a cluster of trailers in the heart of the Nevada National Security Sites (NNSS). At zero, in the distance, a fireball emerges against the desert backdrop as more than 560 pounds of explosives detonate.

Seconds later, the sound arrives—sharp, resonant, and chest-thumping. The fireball is gone, replaced by a rising cloud of dust and smoke.

“That was a pretty good one,” murmurs Art Villalobos, his eyes fixed on the dissipating plume. The leader of Los Alamos National Laboratory’s Integrated Weapons Experiments Nevada Operations group, Villalobos has worked for more than 40 years at NNSS, and he knows explosions. Today’s high-explosives (HE) “shots” at Kappa West, part of the Big Explosives Experimental Facility (BEEF) at NNSS, are two of hundreds that Villalobos has overseen.

Nearby, technologist Matthew Teel checks cameras designed to capture the detonation at up to half a million frames per second. Today’s shots will yield no formal data—the purpose is to destroy sensitive parts—but for Teel, it’s practice with his instruments.

The evolution of BEEF

So, what leads up to this chest-thumping explosion? BEEF’s roots stretch back to the 1950s, when its earth-

covered bunkers supported imaging of atmospheric nuclear tests. After atmospheric testing came to an end in 1963, BEEF was largely unused until the mid-1990s, when Lawrence Livermore National Laboratory, constrained by California’s suburban sprawl, turned to Nevada for HE work.

However, by the 2010s, activity had waned again. That’s when Los Alamos stepped in. Tom Sandoval (p. 66), then the Los Alamos group leader for Focused Experiments, spearheaded the effort to establish Kappa West in a legacy radiological zone adjacent to BEEF’s original footprint. “BEEF had power, it was flat, it had a bunker,” Sandoval says. “I could do large shots of depleted uranium. My clearance circle was 6,200 feet, and I could fire 2,500 pounds of fragment-producing shots.”

What began as three people working at Kappa West is now a 26-member team that continues to grow. The team members—all Lab employees—support not only Los Alamos programs but also the Department of Defense, the Federal Bureau of Investigation, and other federal customers.

The work is diverse: dismantling classified parts, testing blast effects, modeling shrapnel dispersal, and supporting global monitoring efforts. Customers often commit to multiyear campaigns, keeping the calendar full a year in advance.

“We can pretty much do anything done at Los Alamos,” says Villalobos, noting that explosive tests are conducted

frequently at the Laboratory. “But Kappa West lets us go bigger.” The site’s remoteness is an asset. Unlike Los Alamos, where wildfire closures or population proximity limit operations, Kappa West provides flexibility. “We don’t face the same constraints,” Villalobos says. “We’re approved for 5,000 pounds of explosives now and we can scale to 50,000 with additional approvals. That’s why demand keeps climbing.”

A day in the field

Reaching Kappa West requires a 45-minute drive north from NNSS’s main entrance. On shot days, the team gathers in a trailer for a safety brief. Today’s work continues a series of weapon dismantlement and disposition (WDD) shots, in which the goal is to reduce classified parts to unrecognizable fragments.

Tafoya, as firing site leader, coordinates and executes the experiments. Fielding coordinator Lewis “Trey” Allen III manages the explosives and the classified inventory. Teel runs cameras, assisted by Kaleb Howard, who has expertise in optical networks and diagnostic communications. Mechanical engineer Justin Cole and electrical engineer

“We have enough experience where we know what explosives materials need to be used and how much.”

—ART VILLALOBOS

Aaron Rogall are both in training to become HE handlers. Deputy group leader Ryan McCombe oversees operations together with Villalobos. With roles clarified, the team disperses and gets to work.

■ Preparations for an experiment are underway at Kappa West.





■ Art Villalobos leads the Integrated Weapons Experiments Nevada Operations group—a Los Alamos group that is based at NNSS.

At the firing site, the ground is pockmarked from past detonations. There are three towers of concrete barriers, which have been stacked 20 feet high and bolted together with steel plates. The barriers are equipped with pulley systems that enable some assemblies to be lifted as high as 14 feet off the ground.

Tafoya and Allen prepare sealed metal assemblies containing classified components slated for destruction. The team wraps each assembly with detonating cords, a process that is quick, practiced, and laced with camaraderie. “Most of them have been here at least five or six years,” Villalobos notes. “Everyone’s trained to do everything, so we can adapt as needed.”

Meanwhile, Teel positions his cameras—one of which captures 500,000 frames per second—behind concrete shields, mirrors angled to capture the blast. He knows the risks—shrapnel often threatens delicate optics. Still, each shot is a chance to refine his methods. “I love WDDs,” he says. “They let me test setups without risking critical data.”



■ Members of the Integrated Weapons Experiments Nevada Operations group prepare for a detonation.



■ An explosive device is suspended above the firing site.

Dismantle and dispose

Sitting at the firing console, Tafoya confirms with access control that the firing point is vacant. He inserts a key, counts down, and triggers the explosion, which is inaudible from inside the bunkers.

After a few minutes, team members head back to the firing point to assess the damage and prepare for the second shot to further destroy the assemblies, which have cracked and broken into pieces. These pieces are placed into three 55-gallon drums along with depleted uranium that is also designated for destruction. The contents are layered with explosives. “We have enough experience where we know what explosives materials need to be used and how much,” Villalobos says. “For experiments where we need data, we will do calculations beforehand, so we know exactly how to position things, but it’s not as precise for WDDs.”

The full drums are wrapped with detonating cords, and the site is vacated once more. However, this time, “We will stand outside,” says Villalobos, positioning himself about a mile-and-a-half away but with a clear view of the firing site. “It should be cool.”

Indeed, 563 pounds of explosives detonating is loud and powerful. A fresh crater marks the ground, surrounded by chunks of warped metal. Some pieces have flown meters away. After determining that the site is safe for reentry, Tafoya holds up a jagged fragment that is still warm from the explosion. Although it will take some time to assess the damage, the drums appear to be sufficiently destroyed.

Not everything went to plan, however. Sun glare washed out one camera’s footage. Another camera got knocked askew by the explosive shock wave and was left facing the wall of the camera shelter. But for Teel, these are valuable failures. “We learn what goes wrong before it really matters,” he says.

Each misstep refines future experiments, where capturing data is paramount. “You see something new every time,” Villalobos says. “That’s the beauty of it. New technology, new systems, new customers—it keeps you motivated.” ★

■ The Integrated Weapons Experiments Nevada Operations group—part of the Laboratory’s J Division—plans, fields, and executes dynamic high-explosive experiments at NNSS.



■ Nearly 1,000 feet underground inside the Principal Underground Laboratory for Subcritical Experimentation (PULSE), scientists conduct experiments to obtain technical information about the U.S. nuclear weapons stockpile. Photo: NNSS

ANSWERS FROM UNDERGROUND

Subcritical experiments below the Nevada desert ensure reliable nuclear weapons.

BY JILL GIBSON



■ PULSE is busy above and below ground. Photo: NNSS

“On shot day, once everything is a go, I go over to the control room to execute the experiment. We have a two-minute countdown. To me, that’s the most exciting part about being a test director. I hear the countdown continue ... ten, nine, eight, seven. I’m sitting on the edge of my seat thinking, ‘Come on, just a few more seconds. Let’s get this thing off.’ Four, three, two, one, zero time.”

—Don Bourcier, retired Los Alamos group leader, engineer, and subcritical experiment test director

Nearly 1,000 feet below the Nevada desert, scientists and engineers are conducting groundbreaking nuclear weapons research. Subcritical experiments, or “subcrits” for short, play a crucial role in ensuring national security.

“Subcritical experiments are a key part of the science-based Stockpile Stewardship Program, which is the way America ensures that our nuclear weapons are safe, secure, and reliable—without conducting full-scale nuclear weapons tests,” says Don Haynes, senior director of Los Alamos National Laboratory’s Nevada Programs Office. “Los Alamos is leading the national effort to enhance our subcritical experimental capabilities, while at the same time continuing to conduct complex subcritical tests.”

Subcritical experiments allow researchers to evaluate the behavior of nuclear materials (usually plutonium) in combination with high explosives. This configuration mimics the fission stage of a modern nuclear weapon. However, subcrits remain below the threshold of reaching criticality. No critical mass is formed, and no self-sustaining nuclear chain reaction occurs—there is no nuclear explosion.

“In the absence of full-scale testing, subcrits are our only source of ground truth on explosively driven plutonium, which is plutonium that’s compressed by explosives,” says Los Alamos physicist and subcritical experiment diagnostic coordinator Chris Frankle.

Although subcrits don’t create self-sustaining nuclear reactions, in many ways, they harken back to the days

of full-scale nuclear testing (p. 14). Since the 1992 moratorium on full-scale nuclear testing, subcrits have provided valuable data related to weapons design, safety, materials, aging, and more. This information helps scientists determine if America’s nuclear weapons will work as intended. The tests have also bolstered researchers’ understanding of nuclear physics and have provided scientists with data to evaluate new weapons designs.

Because of international treaties and government regulations, subcrits—which are designed by scientists at Los Alamos and Lawrence Livermore national laboratories—are conducted in a subterranean facility at the Nevada National Security Sites (NNSS). The Principal Underground Laboratory for Subcritical Experimentation, or PULSE (formerly known as U1a), is where scientists conduct experiments using explosively driven plutonium in weapons-relevant quantities. Currently, the facility houses one active subcritical test bed (area for experiments), Cygnus. Two more test beds—ZEUS and Scorpius—are under development as part of a modernization and expansion effort called the Enhanced Capabilities for Subcritical Experiments (ECSE) initiative.

“In the absence of full-scale testing, subcrits are our only source of ground truth on explosively driven plutonium.”

— CHRIS FRANKLE

“Subcritical experiments are important to the nation because they provide some of the national security weapons data that the full-scale weapons tests used to give us,” says retired Los Alamos group leader and engineer Don Bourcier, who served as the test director for multiple subcritical experiments. “The national laboratories needed to answer all these questions about the nuclear weapons stockpile. And without full-scale nuclear weapons testing, we had to devise a different methodology to do that. So, we came up with subcritical experiments.”

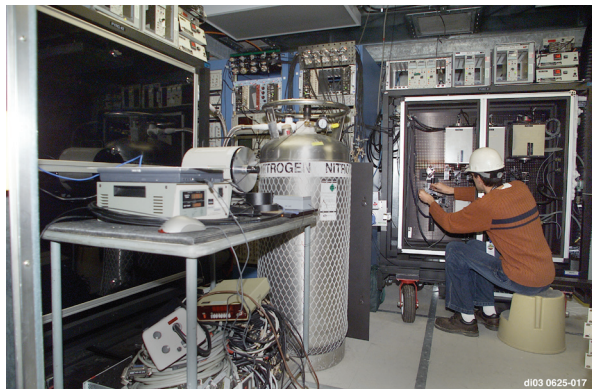


■ A 6-foot vessel is lowered 1,000 feet underground into the PULSE facility.





■ Technicians prepare a 3-foot vessel for the Barolo test series, which was executed in the Cygnus test bed in 2011.



■ Technicians set up measurement equipment for the Armando test series, the first experiment to use Cygnus.



■ Los Alamos physicist David Holtkamp, who worked on numerous subcritical experiments, explains the data measurement and recording devices.



■ On experiment day, personal protective equipment is necessary for some team members.

How it started

The underground facility where subcrits are conducted dates back to 1968, when two shafts were drilled for a proposed underground test. One of those boreholes was named U1a. Scientists canceled the originally planned detonation, but 20 years later, a horizontal tunnel was added for Ledoux, a full-scale nuclear test carried out in 1990. Following the 1992 moratorium on full-scale testing, Ron Cosimi, a Los Alamos engineer and former underground test director, says he suggested repurposing the underground facility, then referred to as U1a, for a new kind of experiment. “We needed a way to continue getting information about the weapons in the stockpile,” Cosimi says. “We had to prove we could do something, and we could learn something.” From there, subcrits were born.

In the 1990s, the U.S. Department of Energy expanded and modernized the U1a facility to house subcrits. Now the sophisticated underground laboratory, which was renamed PULSE in 2024, consists of a maze of horizontal tunnels and alcoves, nearly two miles in length. PULSE is accessed via two vertical shafts through which elevators transport personnel and equipment approximately 1,000 feet down. A third vertical shaft provides ventilation, instrumentation and utility access, and an emergency exit, and a fourth borehole will support power and cooling for Scorpius.

“Nuclear testing was a wonderful tool, but it was also the world’s biggest shortcut.”

— JOSEPH MARTZ

The first subcritical experiments at the facility were conducted in single-use alcoves mined into the walls. After an experiment, the alcove was sealed and filled with grout to prevent the escape of any radioactive material. (Although subcrits do not produce self-sustaining reactions, precautions must be taken whenever working with high explosives and nuclear materials.) That meant that when this type of testing first started, every time scientists conducted a subcrit, they had to start over with a new alcove. “While the data we obtained wasn’t as sophisticated and extensive as today’s standards, we proved we could do this and keep the testing capability alive,” Cosimi says.

Next, scientists conducted “drift downhole tests,” which involved boring a small vertical shaft inside one of the facility’s tunnels, inserting a device into that hole, filling the hole with layers of dirt, gravel, grout, and plugs of concrete, and then detonating the device. “Then we would



■ Emblems from past subcrits capture elements of each test series.

move 20 feet away in the same tunnel and mine another vertical shaft,” Bourcier says.

In 2003, scientists added two pulsed x-ray radiography sources, called Cygnus (p. 45), to the complex. Although originally planned for a single experiment, Cygnus has entered its third decade as a principal diagnostic for subcritical experiments. It uses pulsed power to create medium energy x-rays that pass through the device being tested. The resulting high-resolution images of explosively

driven materials provide information on motion, density changes, implosion symmetry, and more.

Cygnus is located next to a mined space known as a “zero room,” where implosions take place within steel containers called confinement vessels (p. 50) to prevent the release of radiological material. This approach, which continues today, allows the room to be reused for every experiment and ensures that even if a test causes a small leak of radioactive material, the radioactivity will be confined and contained. Following each experiment, the vessels are “entombed”—placed at the end of a tunnel and permanently sealed off from the rest of the facility. This means the machine and the underground research area can be reused.

How it’s going

Los Alamos engineer Joseph Martz explains that “PULSE has revolutionized scientists’ ability to understand and assess how nuclear weapons function—in essence, we’ve built a state-of-the-art plutonium-testing laboratory in a mine.”

Martz’s long tenure at Los Alamos—he started at the Lab during the testing era in the 1980s—provides perspective on how much has changed over the decades. “Nuclear testing was a wonderful tool, but it was also the world’s biggest shortcut,” Martz says. “It meant that we didn’t have to understand all the details of a nuclear weapon and how it functions. We detonated it to see if it worked.”



■ Engineers prepare equipment for the 2021 Red Sage–Nightshade test series.



■ Technicians secure the door before execution of a 2021 Red Sage-Nightshade experiment.

Now, Martz says, with subcrits (and other nonnuclear experiments like those conducted at Los Alamos' Dual-Axis Radiographic Hydrodynamic Test facility and Livermore's National Ignition Facility), scientists obtain the experimental data needed to validate the supercomputer calculations used to model effects from weapons aging, materials changes, new designs, and other aspects that could impact weapons performance. "This stockpile stewardship approach enables weapons designers to make technically sound judgments about a weapon's performance without any new nuclear tests," Martz says.

Today, more than 30 subcritical experiments have been conducted at PULSE, and scientists say the demand for subcritical experiments is growing. Subcrits continue to provide the data used to validate the advanced computer models that predict multiple aspects of weapons, components, and materials performance and weapons and materials aging. "Over the years, our diagnostics have improved exponentially," Bourcier says. "With more advanced diagnostics, we can capture more data points."

Russ Olson, Los Alamos program director for Nevada Weapons Experiments, says numerous factors impact the importance of the subcrit program. "We are dealing with plutonium aging; America's military and strategic needs are changing; we are developing new designs and new manufacturing processes—we will need subcrits to test things and ensure the validity of our computer codes." That's why the subcrit program is expanding. "The whole impetus is to establish new measurement abilities and

to execute subcrits at a higher cadence," Olson says. "We are evaluating new concepts and answering new questions regarding weapons design."

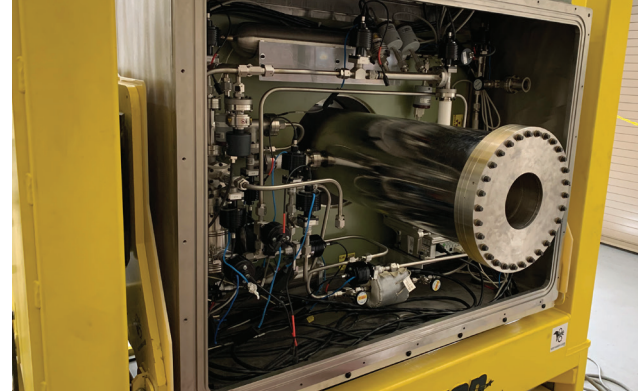
To support these goals, two new subcritical experiment systems are in development. New machines, called ZEUS and Scorpius, will allow researchers to conduct subcritical experiments of different sizes and scales with comprehensive diagnostic coverage. Like Cygnus, the new devices will each have their own dedicated experimental area (or test bed) within the PULSE facility.

Dave Funk, the vice president for ECSE at NNSS, says the concept of developing enhanced subcritical capabilities dates back more than a decade. "In 2014, the nuclear security enterprise established the need to increase understanding about how plutonium behaves in the late stages of an implosion," he says. "These new capabilities will reduce uncertainty, provide greater assurance of reliable performance, and ensure we can get the data we need without returning to full-scale nuclear testing."

ZEUS

Scientists plan for ZEUS, which stands for Z-pinch Experimental Underground System, to be fully operational in the next few years. The machine system will enable researchers to conduct neutron-diagnosed subcritical experiments—using neutrons as probes to learn more about how materials behave under extreme conditions.

Los Alamos physicist John Lestone created calculations for neutron-diagnosed subcrits that paved the way for ZEUS.



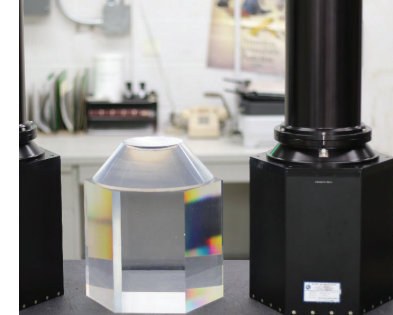
■ ZEUS's Dense Plasma Focus device creates an intensely bright neutron source that allows scientists to diagnose material properties under highly transient conditions.

“ZEUS will allow us to study neutron criticality with real weapons configurations and added complexities.”

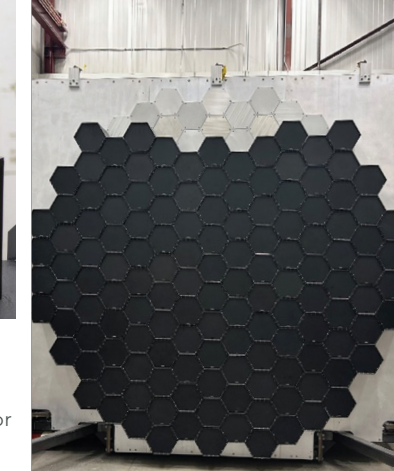
— JOHN LESTONE

“Researchers have envisaged using a neutron-diagnosed concept for decades,” says Lestone, pointing out that technological advances now allow scientists to achieve that goal.

In the ZEUS test bed, a device called a dense plasma focus will compress a deuterium-tritium plasma using a powerful pulsed electrical current. This results in an intense burst of high-energy neutrons that pass through the test device just as it is dynamically compressed using high explosives. The interaction of the neutron pulse



■ In the ZEUS test bed, a transparent scintillator assembly unit (above) fits into a black hexagonal detector, a mosaic of which makes up the detector wall (right). This wall captures gamma rays to measure reactivity.



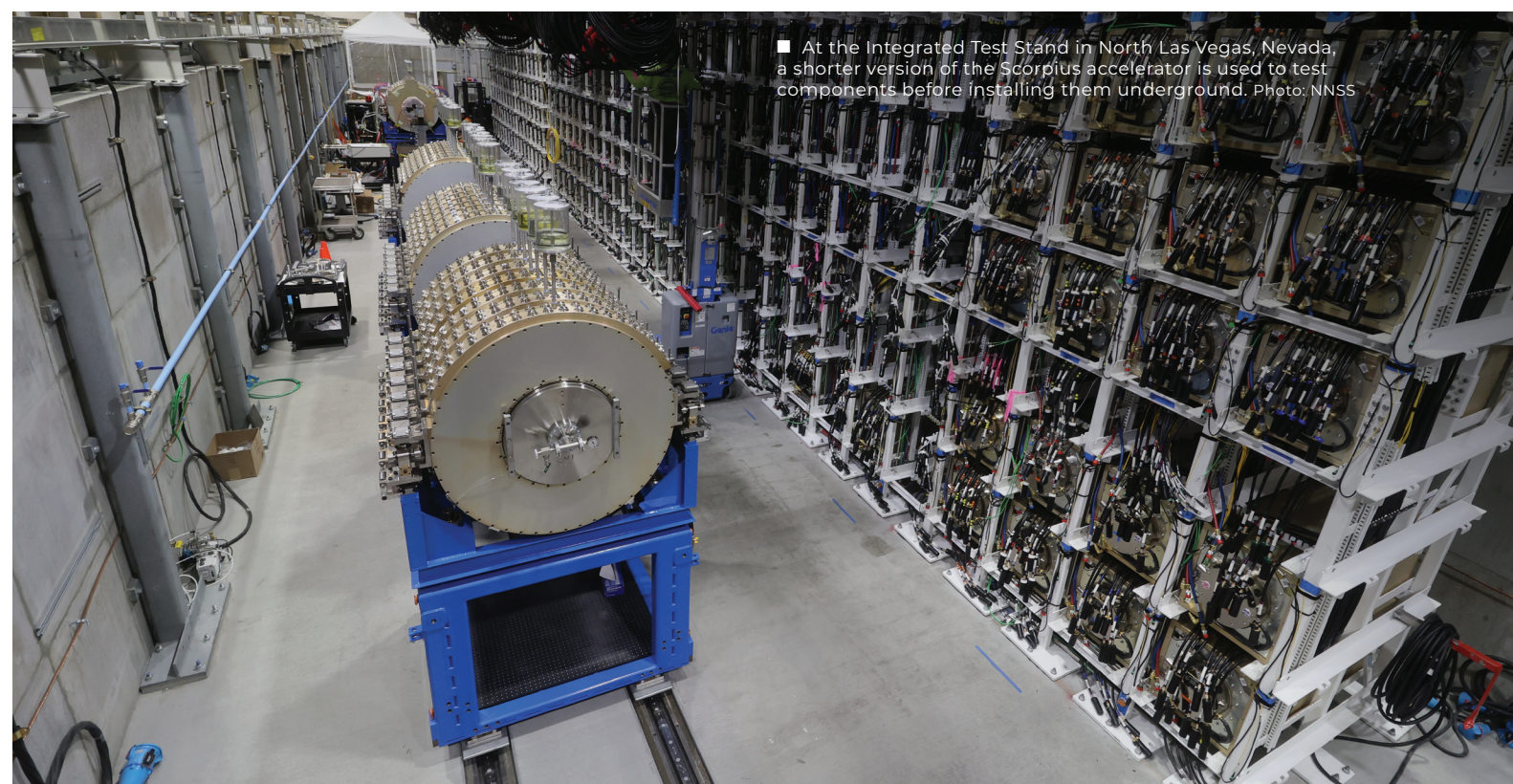
with the test weapon creates fission reactions that emit gamma rays. Those gamma rays are captured by a detector, enabling precise measurement of the reactivity of imploding plutonium. This will allow scientists to measure how close plutonium gets to crossing the threshold for a sustained nuclear reaction as it implodes.

“ZEUS will allow us to study neutron criticality with real weapons configurations and added complexities,” Lestone says. He stresses that the experiments planned for ZEUS will provide much-needed data about plutonium aging and compression and will show how different materials in weapons devices interact and change during detonation. (For more on ZEUS, see page 45.)

Scorpius

The Scorpius test bed, which is expected to be operational in the early 2030s, will provide detailed images of what happens near the end of a plutonium implosion. Scientists still have questions about this late stage of the process.

“Scorpius will allow us to do an experiment and have immediate confidence,” Michael Furlanetto, Los Alamos senior director for the Advanced Sources and Detectors



■ At the Integrated Test Stand in North Las Vegas, Nevada, a shorter version of the Scorpius accelerator is used to test components before installing them underground. Photo: NNSS



■ This tunnel will house Scorpius. Photo: NNSS

project, says. “With Scorpius, we will know more about plutonium in the relevant conditions than we ever knew. We will have the best radiographic source in the world and will get exquisite data to sustain the stockpile.”

When complete, Scorpius, a 400-foot-long linear induction accelerator, will create a series of four electron pulses that produce a series of images revealing how plutonium behaves during the final parts of implosion. Scientists will be able to use Scorpius to conduct tests on full weapons assemblies. “We will be able to see how everything interacts in a real device,” Furlanetto says.

Building Scorpius requires collaboration between Los Alamos, Sandia, and Lawrence Livermore national laboratories, which are each responsible for different aspects of the accelerator, and NNSS, which prepares the underground facility and infrastructure. “I have to stress the expertise and importance of the other two labs and NNSS,” says Furlanetto. “If any of these four weren’t a part of this project, we would have failed.”

Before installing the accelerator underground, scientists are building a shorter version called the Integrated Test Stand aboveground in North Las Vegas, Nevada. This will allow testing of the key accelerator components before transporting it underground. “One of the challenges is

building an accelerator in chunks that fit on an elevator,” Furlanetto explains. “There are some places where we have less than an inch of clearance, and we are moving 20,000 pounds of equipment at a time.”

Where it’s headed

Work also continues on installing utilities and infrastructure in the underground facility. “Preparing these devices and this facility and doing it all almost 1,000 feet underground requires a complex interplay of people and processes,” Funk says. “It’s a BHAG—a big, hairy, audacious goal—but we’re making progress. We’re putting an accelerator the length of a football field 1,000 feet below the surface of the Earth in a nuclear facility to study plutonium. It’s a BHAG for sure.”

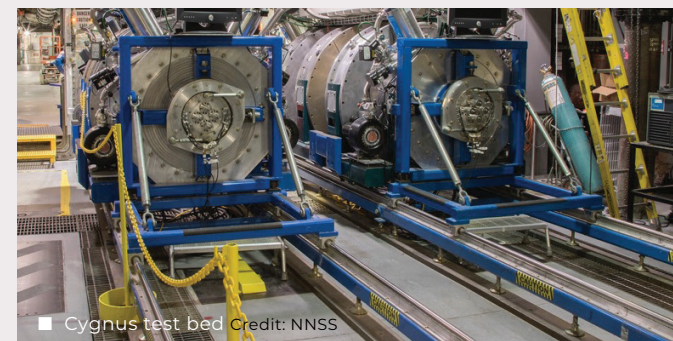
Meanwhile, with the work underway to make ZEUS and Scorpius a reality, subcrits continue to occur at Cygnus. “We are planning tests for all three testing platforms, building the two new test beds, and carrying out subcrits—all at the same time,” Olson says. “Ultimately, we will have three operating test beds, providing three different types of measurements,” he points out. For now, Los Alamos has subcritical experiments scheduled into the year 2032. “It’s a huge effort, but when we push the button and those few microseconds happen, we will get the data we need.” ★

THE MACHINES BEHIND THE MISSION

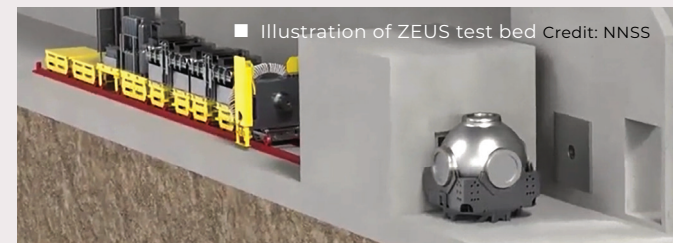
Three devices allow scientists to probe plutonium implosions.

BY JILL GIBSON

Inside the Principal Underground Laboratory for Subcritical Experimentation, Cygnus and two forthcoming machines, ZEUS and Scorpius, offer insights to ensure the safety, security, and reliability of the nation’s nuclear weapons. ★



■ Cygnus test bed Credit: NNSS



■ Illustration of ZEUS test bed Credit: NNSS

ZEUS

WHAT IT DOES:

ZEUS (Z-pinch experimental underground system), which is still in development, will use a dense plasma focus Z-pinch device that provides a short pulse of neutrons. The neutrons trigger fission, allowing scientists to measure the imploding system’s nuclear reactivity—meaning how close it is to sustaining a chain reaction. ZEUS is used in conjunction with a gamma ray detector array.

HOW IT WORKS:

- ▶ Generates a short, high-energy neutron flash. The neutrons strike the plutonium just as it’s compressed, causing the plutonium to fission.
- ▶ Used in conjunction with a device that detects the resulting gamma rays to measure how close the system is to criticality.

WHY IT MATTERS:

ZEUS will measure the subcritical reactivity (how far a system is from criticality) of a nuclear implosion by measuring the decay of fission chains. This dynamic criticality data will be used to further develop and refine the modern predictive physics models used to certify the stockpile.

Cygnus

WHAT IT DOES:

The Cygnus device provides dual-view x-ray images (called radiographs) of explosively driven plutonium implosions.

HOW IT WORKS:

- ▶ Uses pulsed power to fire electron beams into metal targets from two perpendicular angles.
- ▶ High explosives detonate, shocking the plutonium.
- ▶ When the electron beams hit the targets, x-ray bursts are generated.
- ▶ X-rays pass through the shocked plutonium, and x-ray detectors capture a snapshot of the behavior of the material in the early phases of a plutonium implosion. The process is similar to, though much more powerful than, a dental x-ray.

WHY IT MATTERS:

Cygnus provides a way to “see inside” a plutonium implosion. It lets scientists examine how plutonium compresses and helps them evaluate what happens during the early stages of the implosion. Cygnus was first used for a subcritical experiment in 2004 and is still in use today. The device captures snapshots of the plutonium implosion at two points in time, not the full progression of the experiment.

Scorpius

WHAT IT DOES:

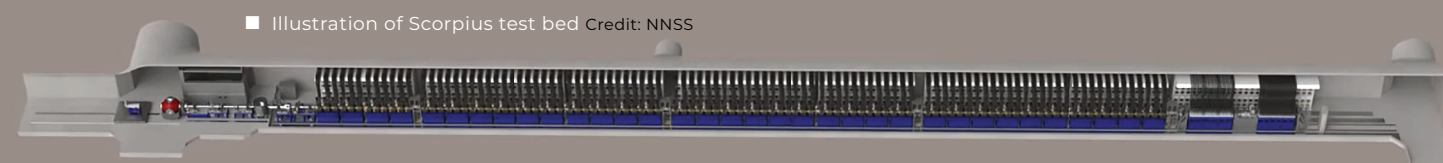
Scorpius, which is still in development, is a high-energy linear accelerator that will take a four-frame “movie” of the later stages of a plutonium implosion when the densities are highest.

HOW IT WORKS:

- ▶ Produces four timed electron pulses, each creating an intense x-ray flash.
- ▶ Creates a series of images that show how plutonium changes over time during the final stage of implosion.
- ▶ Will also create photofission, a type of nuclear fission triggered by high-energy gamma rays, to provide additional information about the subcritical reactivity of the imploded device.

WHY IT MATTERS:

Scorpius will fill the biggest remaining gap in subcritical research by allowing scientists to watch a full implosion unfold and evolve over time—physics no current diagnostic system can fully capture. Scorpius is also energetic enough to conduct tests on complete weapons assemblies.



■ Illustration of Scorpius test bed Credit: NNSS

CHRONOLOGY OF A SUBCRIT

Conducting a subcritical experiment requires many complex steps.

BY JILL GIBSON

Preparing for and executing a subcritical experiment is a complicated process that can take more than five years from beginning to end. Los Alamos National Laboratory defines the subcritical experiments it needs to meet its responsibilities to the Stockpile Stewardship Program, and the Subcritical Experiments Council schedules those experiments for execution at the Nevada National Security Sites' (NNSS) Principal Underground Laboratory for Subcritical Experimentation (PULSE). ★

Here is a simplified look at the steps required to carry out a subcritical experiment:

- Identify the weapons-physics questions involving plutonium that Los Alamos scientists need answered
- Identify what subcritical experiment data will answer those questions
- Design the experiment
- Manufacture the subcritical experiment device and the accompanying equipment
- Develop the diagnostic measurements
- Prepare the PULSE facility
- Test the diagnostic, timing and firing, process control, and other systems
- Transport all parts of the device to NNSS
- Assemble the device at the Device Assembly Facility
- Transport the device to PULSE
- Insert the device into an underground zero room
- Connect the diagnostic measurement systems inside the vessels
- Conduct dry-run tests to ensure all systems are functioning correctly
- Emplace the device inside the confinement vessel
- Connect diagnostic systems from the vessel to the recording systems
- Conduct a final dry run
- Execute the experiment
- Entomb the used vessel
- Analyze data

A CRITICAL CREW

Behind every subcritical experiment is an army of people and years of work.

BY JILL GIBSON

Carrying out a subcritical experiment requires hundreds of people and extensive collaboration and coordination. Every test brings together experts from across the nuclear security enterprise.

At Los Alamos National Laboratory, numerous people work behind the scenes for years leading up to each test series.

Hundreds of scientists, engineers, and technicians design, develop, and manufacture the devices, diagnostics, and experimental platforms for each subcritical test. In Nevada, miners, electricians, pipefitters, inspectors, and many others contribute to building and maintaining the state-of-the-art subterranean facility where subcrits are detonated.

It's difficult to capture the intense time, effort, and expertise that goes into these underground tests in Nevada, but three important roles in each subcrit are the test designer, the test director, and the diagnostic coordinator. The people in these roles can change from test to test, but *National Security Science* was able to sit down with the three people involved in an upcoming subcrit. ★



Meet the designer

Los Alamos physicist **Candace Joggerst** designs weapons primaries—the first stage (which involves fission) of thermonuclear devices. Her goal is to create weapons systems that address specific requirements, function properly, are cost effective, are fast, and are easy to manufacture and produce. “Today’s threat environment is radically different, so we must be ready,” she says.

Joggerst uses high-fidelity computer codes to create her designs, but she needs real-world data to ensure the devices will perform as predicted. That requires testing, which in this case means subcrits. “We can put every other component of a weapon through

its paces, but a subcrit is the only way to push the plutonium in the way a nuclear detonation would. We need this data, and the only way to get it is through subcritical experiments. We have no other opportunity.”

So, when Joggerst was offered the chance to design a subcritical experiment to test one of her primary designs, she quickly replied, “That would be awesome.” Although she has worked on many subcrits, an upcoming test, planned for early 2026 using the Cygnus test bed, will be the first time she has put one of her own designs through its paces. She says no two subcrits are exactly alike. “Every experiment is its own special snowflake.”

For Joggerst, the data will be invaluable. “My job is to answer questions about how the device operates, the impact of aging plutonium, safety and surety, how the systems work together in real life conditions, and more. When it comes to answering questions, there is no substitute for actual data.” She adds that designing an experiment to produce the much-needed answers is challenging. “A nuclear device involves complex, tightly integrated components.

Meet the test director

Los Alamos engineer **Stephen Sintay** spends a great deal of time in Nevada. That’s because Sintay is the test director for a series of subcritical experiments that will kick off in early 2026. He says he’s been preparing for the test series since 2018, and things are moving fast. “There’s lots of momentum,” says Sintay. “I can see that across the project.”

The first in the upcoming series of five subcritical experiments will be executed in the Cygnus test bed, while the other four will take place using ZEUS, which is currently under construction. Three other nonnuclear experiments will be conducted in Los Alamos. These experiments will use surrogate materials that mimic the behavior of nuclear components to prepare for the subcritical tests.

As test director, Sintay is responsible for multiple moving

parts that include everything from getting the facility ready and integrating schedules to preparing the actual device. “One of the test director’s jobs is to demonstrate compliance with all rules and regulations governing a nuclear facility,” Sintay says. He must understand who is responsible for fulfilling compliance elements and providing evidence that requirements have been met.

Sintay describes the actual test day of a subcrit as “very choreographed.” “We will have lots of practice runs, and I will be playing an actual directing role,” he says. “On the day we insert the device into the facility, all the multiple project elements will converge.”

Sintay notes that one of the last things that will happen before the test is executed is connecting the diagnostics. “The team will be hooking hundreds of fibers together and testing every one of them.” Diagnostics preparation

often takes weeks, according to Sintay. “The objective is to get nanosecond precision on every signal.”

Sintay says this series of experiments is crucial. “The series will establish a baseline to characterize how weapons design changes nuclear behavior,” he says. He points out that the ZEUS test bed will allow scientists to evaluate the nuclear performance of plutonium and examine when it achieves criticality.

“This series will generate a data set that will reduce uncertainty and generate new lines of inquiry,” says Sintay, adding, “I’m excited and nervous. The data will be spectacular.”



Meet the diagnostic coordinator

“Diagnosticians are the providers of ground truth,” says Los Alamos physicist **Chris Frankle**. Frankle is the diagnostic coordinator for an upcoming series of subcritical experiments that will take place at PULSE. “Diagnostics is the end of the chain,” Frankle says.

There are about 100 people on Frankle’s diagnostic team, and his work involves collaboration amongst multiple entities. “Once we are underground, you can’t tell which people are from where,” he explains. “We are very much an integrated team.”

Frankle says a typical subcrit may have 10 different diagnostic systems and several hundred channels of incoming data.

“Diagnostics demands a great deal of preparation,” he says. “Part of my job is to be meticulous.”

Frankle’s attention to detail has paid off. He worked on his first subcritical

experiment in 2001 and has developed his expertise over the decades. “You have to be sure when you go into the final countdown that things will work,” he says, adding, “Our track record is very good at returning data.”

Another of Frankle’s roles as diagnostic coordinator is to play referee, because the vessels (p. 50) that confine the experiments and the test beds themselves have a finite amount of room for diagnostic equipment. “Everybody would like to have a spot, but you can only fit so many probes, so ultimately I decide on the best diagnostic suite to meet the requirements of the designers,” he says.

Frankle says in many ways subcrits resemble the full-scale underground tests that once took place in Nevada (p. 14). “There is definite overlap with the types of diagnostics and skillset, but our technology has changed.”

He emphasizes that the main similarity is that subcrits provide real-world data. “Subcrits take away the guesswork and give scientists actual measured data to prove whether their computer codes are correct,” he says. “In diagnostics, our job is to measure performance, to get that information from the test.”





■ Javier Arroyo, Brandon Fresquez, and Eric Moss examine the porthole of the new vessel.



■ Program manager Stephen Ney celebrates the vessel's arrival by signing it.

SPHERE OF INFLUENCE

Los Alamos National Laboratory's first new confinement vessel in 20 years is ready to shape the future of national security.

BY JILL GIBSON

For the first time in two decades, Los Alamos National Laboratory has a new confinement vessel. The vessel, which measures 6 feet in diameter and weighs approximately 14,000 pounds, was fabricated by vendor Westinghouse Government Services (WGS) and arrived at the Lab July 1, 2025.

Confinement vessels are spherical steel containers that scientists use to hold (or confine) exploding material during hydrodynamic and subcritical experiments. Although this new vessel won't be used for conducting experiments, it will be used for many practice and preparation tasks.

"This piece of equipment successfully demonstrates WGS's ability to fabricate vessels that meet our qualification requirements and represents the last step before the first production unit vessel (which will be used in experiments) arrives in 2026," says Brandy Royer, who leads the Dynamic Structure Design, Engineering, and Vessel Operations group.

"This is a big deal," says Mark Crawford, division leader for Integrated Weapons Experiments. "It marks a major milestone in supporting experiments at the Dual-Axis Radiographic

Hydrodynamic Test (DARHT) facility and the Principal Underground Laboratory for Subcritical Experimentation (PULSE) at the Nevada National Security Sites." Crawford notes that Los Alamos serves as the design agency for all confinement vessels used in the nuclear enterprise.

Los Alamos scientists first came up with the idea of conducting nuclear and nonnuclear explosives tests inside steel containers during the Manhattan Project. Years later, the Lab began using the same approach for experiments at DARHT and PULSE. The spherical steel containers keep radioactive materials and flying fragments safely inside while portholes allow scientists to insert multiple diagnostic probes to gather data. "This new vessel design will allow us to leverage higher-fidelity diagnostics and will allow us to forge new capabilities," says subcritical vessel team lead Jason Cardon.

At DARHT, where two linear-induction accelerators produce high-powered x-ray images of materials that implode at more than 2.5 miles per second, experiments do not contain special nuclear material (highly enriched uranium or weapons-grade plutonium), so the vessels can be cleaned and reused. Since the Lab's last procurement of vessels in 2004, the same seven vessels have been reused for DARHT experiments. Scientists have used each vessel for 14 or 15 experiments, Royer says.

Meanwhile, the vessels for subcritical experiments (p. 48) can only be used once. After each test, the used vessels are sealed off, or entombed, in underground chambers.

In 2019, as the nuclear enterprise began increasing the pace of experiments and started building the ZEUS and Scorpius test beds (p. 45) for subcritical experiments, the need for new vessels became evident. But finding contractors who could manufacture the containers was no easy task.

"We faced a certain amount of atrophy in the manufacturing industry and had to find a way to collaborate to grow," Royer says. "Our engineering team had an amazing way of finding paths to move forward during the challenges we faced," she adds.

Every aspect of the vessel, from the complex design, to the materials used and the welds holding it together, had to meet stringent specifications. The matte gray container is made of 2.5-inch-thick high-strength low-alloy steel, which has higher strength and toughness but lower weight than carbon steel. "I have a 2,500-page document stating this vessel meets our requirements," says program manager Stephen Ney, who celebrated the vessel's arrival by signing it.

Across the top of the vessel, Ney's scrawl reads, "We're glad you're here." ★

■ The Dynamic Structure Design, Engineering, and Vessel Operations group welcomes the vessel to the Laboratory.





■ At the National Criticality Experiments Research Center (NCERC), researcher Charlie Kiehne uses a coordinate-measuring machine to evaluate a highly enriched uranium hemispherical shell.

FROM FISSION TO FUNCTION

At the National Criticality Experiments Research Center, scientists conduct innovative experiments that can't be completed anywhere else.

By Jake Bartman



■ Nuclear facilities engineer Nick Rench solders cables for use in NCERC's Control Room 2, which was upgraded in 2024.

In 2021, Paul Blumberg, who began his career on a nuclear-powered submarine before working for the better part of three decades in facility management at Los Alamos National Laboratory, was asked to take a job at the Nevada National Security Sites in Nevada. Blumberg had expected to finish his career in northern New Mexico, but out of a sense of duty, he agreed to temporarily help lead a Los Alamos group that conducts experimental work at the National Criticality Experiments Research Center (NCERC), which the Laboratory operates in Nevada.

Blumberg's first visit to NCERC changed his mind about ending his career in New Mexico. "I flew out to Nevada on a Sunday, got a tour on Monday, and then on Tuesday, I saw a criticality experiment," he says. Blumberg watched from a control room as NCERC staff used a remotely operated machine to bring pieces of nuclear material millimeter by millimeter closer together, monitoring the experiment via a video feed. Although one couldn't tell just by watching that the material had gone critical—reached the point at which the splitting, or fissioning, of atomic nuclei became self-sustaining—the control room's instruments indicated that criticality had been achieved.

During his decades in the Navy and in management, Blumberg had never witnessed a critical reaction firsthand, which made the NCERC experiment a singular experience. "I couldn't believe it," Blumberg says. "I was like, 'I'm never leaving.'"

Decades ago, a lot of people could do criticality work. But over time, the ability to conduct simulations improved and the cost of security went up, so the facilities that did these kinds of experiments started to go away. ”

—JESSON HUTCHINSON

NCERC is the only place in the United States where researchers carry out general-purpose criticality experiments. Nuclear materials react in many configurations—in reactors and weapons, for example—which makes understanding these reactions key to a breadth of scientific and engineering

endeavors. Los Alamos researchers have conducted criticality research since the Manhattan Project—the World War II-era effort to build the world's first nuclear weapons. Today, criticality experiments are completed with specialized machines that are called critical assemblies, which are, in effect, very small nuclear reactors.

Unlike nuclear reactors that are used to generate power, the energy released through nuclear fission during NCERC experiments is very small. Moreover, by carefully controlling the conditions under which criticality is achieved, NCERC staff ensure that experiments never come close to the kinds of reactions that take place inside nuclear weapons. Criticality experiments also differ from the subcritical experiments conducted at Nevada's Principal Underground Laboratory for Subcritical Experimentation (PULSE, p. 36) in that during subcritical experiments, the nuclear material never achieves criticality (although at PULSE, unlike NCERC, experiments can use high explosives to simulate nuclear weapon assemblies).

Beyond criticality research, NCERC plays a unique role in training criticality safety personnel—that

is, personnel who analyze processes involving nuclear material to prevent the material from going critical—and others who study or work with nuclear material. As Blumberg notes, many nuclear engineers go their entire careers without ever seeing nuclear material achieve criticality, which is one reason that witnessing a criticality experiment at NCERC can be so impactful. The unique expertise of NCERC's staff is why the facility is also one of a few places in the country that produces radiation test objects—subcritical assemblies of nuclear material used

for testing radiation detectors, which are used to test detectors and train personnel to locate nuclear material or determine its composition.

Today, at a time when companies are investing heavily in new kinds of nuclear power reactors to support technologies such as artificial intelligence (AI) and when Los Alamos is ramping up its production of plutonium pits (the cores of nuclear weapons), NCERC is carrying out more training and more research than ever. NCERC staff are meeting this need by using innovative techniques

to design and execute criticality experiments, furnishing data to support national security now and into the future.

A legacy of criticality research

In the aftermath of World War II, two fatal accidents at Los Alamos set the stage for NCERC's approach to criticality research.

The first accident, in August 1945, occurred when physicist Harry Daghljan dropped a tungsten carbide brick onto an experiment he was building around a plutonium sphere, creating a supercritical reaction that emitted a burst of radiation. Daghljan died 25 days later. Although the Laboratory implemented new safety protocols and relocated its criticality research to an isolated canyon site, a second accident occurred less than a year afterward when, during an experimental demonstration involving a plutonium sphere, a screwdriver used by physicist Louis Slotin to lift a beryllium tamper slipped, creating a supercritical reaction that led to Slotin's death nine days afterward.

After the Slotin accident, the Laboratory implemented even stricter safety measures for criticality experiments. Chief among these measures was the cessation of criticality experiments conducted by hand. Instead, future experiments would rely on remotely controlled machines stationed inside concrete-reinforced buildings. The facility that was built for these experiments, the Los Alamos Critical Experiments Facility (LACEF), conducted its first experiment in 1947.

The earliest experiments at LACEF were designed to answer questions about nuclear weapon design—to ensure, for instance, that weapon designs based on the Fat Man bomb, which was detonated over Nagasaki near the end of World War II, wouldn't accidentally achieve criticality while in storage or transit. In the half-century that followed, experiments at LACEF addressed other weapons-related questions as well as questions about nuclear power reactors, naval nuclear propulsion, and the fundamental properties of nuclear materials such as uranium and plutonium. By the early 2000s,

■ In the 1950s, scientists built an unreflected, or bare, uranium reactor and named it Godiva after the legendary Lady Godiva, who famously rode unclothed through 11th-century Coventry. Its successor, Godiva IV, keeps the name alive.





■ Originally constructed to support underground nuclear weapons tests, the Device Assembly Facility at the Nevada National Security Sites now houses NCERC and other programs that conduct important national security research.

when the National Nuclear Security Administration (NNSA) decided to relocate criticality experiments from Los Alamos to Nevada, LACEF had become an important resource for programs like NNSA's Nuclear Criticality Safety Program and Nuclear Emergency Response Program.

The move to Nevada

Between 2004 and 2011, Los Alamos' criticality research capability was relocated to the Nevada National Security Sites. The decision to move this research was made for several reasons. LACEF was located in a canyon, which was beneficial from a safety perspective but made the site expensive to defend from evolving security threats. Moreover, criticality experiments, which previously had been conducted at laboratories and facilities across the country, had dwindled such that only one facility, which would become NCERC, was needed for them.

"Decades ago, a lot of people could do criticality work," says Jesson Hutchinson, NCERC's chief scientist. "But over time,

the ability to conduct simulations improved and the cost of security went up, so the facilities that did these kinds of experiments started to go away." Centralizing criticality experiments in a single location was a way to reduce costs and increase the efficiency of research designed to answer ongoing questions related to nuclear weapons and power, materials science, and more.

In Nevada, NCERC was established inside an existing building called the Device Assembly Facility (DAF) that was originally constructed to host the assembly and disassembly of underground nuclear test devices. When a moratorium on underground testing went into effect in 1992, the facility was no longer needed to support nuclear testing. However, the location of the DAF—far away from the public, in the interior of the Nevada National Security Sites—and the DAF's robust security made the facility an excellent place to store, and conduct research with, a large inventory of special nuclear materials—that is, nuclear materials

such as uranium and plutonium that could be used in weapons. Altogether, NCERC stores hundreds of kilograms of special nuclear material.

The DAF comprises a series of individual steel-reinforced concrete buildings designed with features, such as blast doors and high-efficiency particulate air-filter ventilation systems, that are intended to mitigate the risk of explosions and radiological contamination. NCERC contains two "high bays" for subcritical measurements, storage vaults, and a counting laboratory. NCERC also uses two "cells" inside the facility that contain a total of four experimental machines (also known as critical assemblies) that are separated from operators by blast doors and thick concrete walls. These machines allow researchers to investigate special nuclear materials in different ways (p. 62). "NCERC is the only place in the country, and possibly the world, where you can do these kinds of experiments with highly enriched uranium and plutonium," Hutchinson says.

Understanding nuclear materials

In the past few years, researchers at NCERC have conducted innovative experiments to answer vital questions about plutonium. Plutonium is arguably the most complex element in the world, which is why, more than eight decades after the element's discovery, researchers still don't fully understand how plutonium behaves under certain conditions. Experiments at NCERC aim to produce data that could fill in gaps in this understanding and support applications such as nuclear weapons production and nuclear reactor design.

One important NCERC project related to plutonium, the Chlorine Worth Study, was conducted in 2021. The goal of this research was to understand how chlorine absorbs neutrons—a subject relevant to the aqueous chloride process that allows for the extraction of plutonium and americium from waste produced during plutonium pit production.

During this process, plutonium-bearing salt mixtures are dissolved in a chlorine-bearing solution to extract and purify the plutonium. However, without understanding how chlorine absorbs neutrons, it is difficult to determine exactly how much nuclear material can be safely contained in an aqueous chloride solution at a given time. To prevent a criticality accident, operators had to err on the side of caution, incorporating less plutonium into the solution than would be possible if chlorine's neutron-absorbing characteristics were better validated.

Plutonium-bearing solutions are difficult to handle and study in part because the concentrations of nuclear material can be challenging to measure. Rather than use solutions for the Chlorine Worth Study, researchers developed a combination of plutonium plates and a plastic (polyvinyl chloride) to simulate plutonium solutions. These materials were arranged in

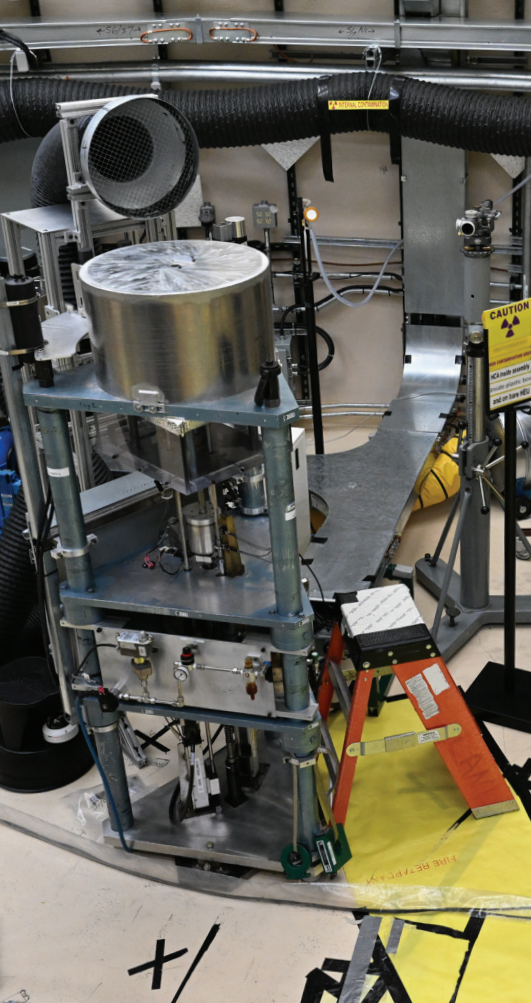
“NCERC is the only place in the country, and possibly the world, where you can do these kinds of experiments with highly enriched uranium and plutonium.”

—JESSON HUTCHINSON

three configurations designed to mimic different plutonium solution concentrations. Using NCERC's Planet critical assembly machine, which has a platform that can be raised and lowered to bring different parts of an experimental configuration together and achieve criticality, researchers were able to simulate conditions in the aqueous processing line and acquire valuable data to support pit production at the Laboratory.



■ Nuclear facilities engineer Edmund Quarshie and safety basis analyst Rachel Ehler inventory and prepare highly enriched uranium "pancake" plates.



■ NCERC's Godiva IV critical assembly can induce prompt fission reactions, yielding sudden, intense bursts of radiation. In 2024, Godiva IV was used to test criticality accident alarm systems (shown above). For more on NCERC's critical assemblies, see p. 62.

“Solution limits in Los Alamos’ Plutonium Facility have been a bottleneck in the production line,” says Theresa Cutler, a researcher at NCERC who co-led the study. “The Chlorine Worth Study was important as a way to potentially help increase those limits.”

A complementary project called TEX-Cl (Thermal/Epithermal eXperiments—Chlorine) was conducted in 2024. Where the Chlorine Worth Study used plutonium, TEX-Cl used highly enriched uranium (uranium consisting of more than 20 percent U-235) as the fuel. Conducted in collaboration with Lawrence Livermore National Laboratory, TEX-Cl supported uranium processing at the Y-12 National Security Complex in Tennessee, demonstrating how research at NCERC supports laboratories and production facilities throughout the nuclear security enterprise.

Optimizing with AI and ML

To design the configurations of nuclear and nonnuclear materials used in criticality experiments at NCERC, researchers have historically used tools such as Los Alamos’ Monte Carlo N-Particle simulation code to study proposed configurations. Recent projects at NCERC have augmented this approach by using AI and machine-learning (ML) techniques to advance experimental design.

For the EUCLID (Experiments Underpinned by Computational Learning for Improvements in Nuclear Data) project, researchers at Los Alamos first used ML techniques to seek out areas where errors could be hiding in nuclear data libraries—large collections of data about all known isotopes that include attributes such as neutron and proton cross sections, fission properties, and more that are the product of decades of research around the world. Next, the researchers used AI to help design criticality experiments that could help determine what combination of data was more likely to be correct. By designing two different experimental configurations, researchers were able to develop experiments that probed specific types of nuclear data (such as neutron scattering or nuclear absorption).

A second project, PARADIGM (PARallel Approach of Differential and InteGral Measurements), built on EUCLID’s approach. For PARADIGM, researchers used ML to locate gaps in data libraries related to plutonium’s intermediate energy range. Cutler explains that when a special nuclear material such as plutonium-239 reaches criticality, it emits high-energy neutrons that then slow down into low-energy neutrons. “Neutrons are born fast, but they die slow,” Cutler says. “Between those points, you have the intermediate range.”

Criticality research has tended to focus on understanding plutonium’s high- or low-energy ranges, leaving data gaps in the intermediate range. One reason for this is that it is challenging to consistently slow neutrons down just the right amount and to measure them when they are in the intermediate energy range. “It’s difficult to build experiments

that are sensitive to the intermediate energy range, and it’s hard to develop the nuclear theory that’s sensitive to it,” Cutler says. “We had to ask, ‘How do you design an experiment around those neutrons if there’s no way to generate them at that energy level?’”

Using AI and ML, the PARADIGM team determined that copper was an optimal material to use in experimental assemblies that would probe plutonium’s intermediate energy range. By surrounding the plutonium with copper and other materials, and by bringing the plutonium to criticality, it was possible to maximize the chance of causing fission in just the right energy range. Researchers then used AI to evaluate many possible experimental configurations, considering qualities that included the materials’ composition, thickness, shape, and more. Ultimately, the researchers selected two configurations for experiments at NCERC, which were conducted in early 2025.

In addition to experiments at NCERC, the PARADIGM team is conducting complementary research at the Los Alamos Neutron Science Center (LANSCE)—a kilometer-long particle accelerator in New Mexico—to gather information about copper that will help reduce the uncertainty of the experimental data. The work at LANSCE, which takes advantage of a recent upgrade to the facility that allows researchers to target materials in the intermediate energy range, will help characterize copper’s cross sections—

“Solution limits in Los Alamos’ Plutonium Facility have been a bottleneck in the production line. The Chlorine Worth Study was important as a way to potentially help increase those limits.”

—THERESA CUTLER



■ Jesson Hutchinson, NCERC's chief scientist, inserts a resistance temperature detector (which measures temperature by tracking changes in electrical resistance) into a highly enriched uranium hemishell.

that is, copper’s propensity to scatter or capture neutrons.

“Criticality experiments are very expensive, and we want to get the most value for the cost,” Hutchinson says. “The old-fashioned way to do this research might involve doing an experiment, only to realize 20 years later that you need to redo the experiment in order to answer certain questions. Now, we’re trying to get the best value by optimizing these experiments.”

Cutler says that the use of AI/ML at NCERC points toward promising future applications. “These days, there’s a lot of research that’s using AI and ML,” she says. “At NCERC, we’re not just using ML for the sake of using ML. We’re using it to meet a need.”

The Deimos test bed

In the past half decade, interest in nuclear power has grown among industry, policymakers, and the public. Part of that interest is because of the

proposed development of advanced nuclear reactors such as microreactors, which could be smaller and safer than traditional light-water reactors.

Many proposed advanced reactors would use fuels such as high-assay low-enriched uranium (HALEU), which has a higher concentration of the uranium-235 isotope than is found in the low-enriched uranium used in traditional power reactors (HALEU contains up to 20 percent U-235 versus up to 5 percent in low-enriched uranium). In the United States, HALEU has never been used in a commercial power reactor, and the fuel must be better understood before advanced reactors can be licensed and deployed.

A newly developed NCERC capability called Deimos, which came online in 2024, could play a key role in addressing some of the questions that must be answered to help bring a new generation of reactors into service. Deimos comprises a specially

machined graphite core that can contain nuclear fuel in diverse configurations. Using NCERC’s Comet critical assembly machine, this core can be raised into a second, larger portion composed primarily of graphite and beryllium as well as additional nuclear fuel, causing the fuel to achieve criticality.

The Deimos test bed allows researchers to investigate a breadth of phenomena relevant to nuclear reactor design. Developing Deimos involved overcoming many engineering challenges from how to machine the graphite (which is very brittle) into the needed shape to how to accommodate the DAF’s ceiling height, which constrained the test bed’s size.

The first Deimos experiments, which were completed in fall 2024, involved tri-structural isotropic fuel (TRISO)—HALEU encased within layers of ceramic and other materials that prevent fission products from dispersing throughout a reactor system. In February 2025, a series of



■ NCERC's Control Room 2 was upgraded in 2024 with new, state-of-the-art equipment.

experiments on Deimos were the first U.S. experiments involving HALEU in more than 20 years. These experiments provided important data relevant to criticality safety that supported Kairos Power, which is developing an advanced reactor that would use TRISO fuel. For example, one set of Deimos experiments involved incorporating steel into the test bed to simulate accidents that could conceivably occur while TRISO fuel was being transported, and another used polyethylene to simulate the accidental incursion of water into a reactor.

Throughout this research, the team demonstrated Deimos' flexibility and its potential to support future projects. "The goal was to prove that Deimos wasn't just a one-time experiment, but something that could be taken apart and reassembled for follow-up experiments," says Cutler, who co-led Deimos. Other experiments are already planned for Deimos, including ones that will support the ZiaCore project—a microreactor design that is being designed at Los Alamos—and Westinghouse, which is seeking data for its proposed eVinci microreactor.

Training and RTOs

The expertise of NCERC's staff and the facility's extensive inventory of nuclear material are why, in addition to conducting criticality experiments, NCERC routinely hosts classes for the Department of Energy's (DOE's) Nuclear Criticality Safety Program, which conducts research and training to support the criticality safety community.

(The Nuclear Criticality Safety Program is NCERC's primary sponsor.)

Another training program at NCERC is for members of DOE's Nuclear Emergency Support Team (NEST). NEST is composed of technical experts from across the DOE complex who support a range of programs related to nuclear emergency response—everything from countering improvised nuclear devices and "dirty bombs" to providing preventative nuclear and radiological detection (such as monitoring the Super Bowl for radiological threats) and emergency response (such as the 2011 Fukushima nuclear accident).

To support such diverse missions, NEST responders must understand

the specialized detectors that they use to scan for or measure radiation. At NCERC, NEST responders have a unique opportunity to see these tools in action. One way in which trainees gain familiarity with detectors involves the use of radiation test objects (RTOs). RTOs are subcritical configurations of special nuclear material that are hand built at NCERC, and NEST responders' tools can detect the material in RTOs and other such objects. "Almost all of the detectors that NEST responders use are present at NCERC, and they're able to train with those," says NCERC researcher George McKenzie. "There's just no substitute for hands-on training."

RTOs have uses beyond training, including benchmark experiments (which provide data to support nuclear data libraries and thereby validate computational models,

■ NCERC researcher Rene Sanchez handles HALEU fuel during the Deimos project.



among other things) and detector testing. At NCERC, RTOs have also supported experiments in areas ranging from nonproliferation and treaty verification to safeguards, emergency response, and more.

Looking to the future

Recent upgrades to equipment at NCERC are supporting the facility's mission. In the past few years, the control rooms that allow NCERC staff to operate criticality research remotely were completely upgraded. These new control rooms will enable reliable operation for a decade or more.

To support future research at NCERC, with Laboratory-Directed Research and Development funding, McKenzie, Hutchinson, and other NCERC researchers are developing a design for a proposed new critical assembly machine—the first such design to be completed in more than three decades. "Over the years, there have been many thousands, or possibly millions, of simulations run on data from Jezebel," Hutchinson says, referring to a predecessor critical assembly machine that generated important data about plutonium. "But Jezebel no longer exists, so we can't get new data from it."

The proposed new assembly, called Lilith, would provide another method to validate plutonium data at a time when demand for this data continues to grow. Lilith is being designed to endure for the next hundred years, providing important information about plutonium aging.

NCERC's staffing ensures that the Center is well positioned for the future, says Blumberg, who today remains the deputy leader of the NCERC Facility Operations (FO) group. Blumberg notes that when he came to the Center in 2021, NCERC-FO had less than half the staff it needed (partly because of the COVID-19 pandemic, which had led some staff to seek jobs elsewhere or that could be performed remotely). Hiring NCERC staff can be challenging: Because of the extensive radiological training and security checks that NCERC staff must undergo, it can take up to three years to onboard each new staff member.



■ NCERC conducts classes for nuclear criticality safety experts, Nuclear Emergency Support Team members, and others. Here, instructor Kelsey Amundson (left) guides a student during an experiment.

Today, however, NCERC-FO has a full complement of 14 staff members to support operations. Meanwhile, the team that designs and conducts NCERC's critical experiments, which comprises researchers from the Laboratory's Advanced Nuclear Technology group (part of the Nuclear Engineering and Nonproliferation division), is growing to deliver important experimental data at an increasing pace. Joetta Goda, who leads NCERC's Critical Experiments Team, says that the team—which began with a staff of four researchers who came to NCERC from LACEF—has grown threefold over the years.

"We still have a ways to go to meet the increasing requests for experiments, measurements, and training," Goda says, noting that the Critical Experiments Team brings students to NCERC to

help cultivate the next generation of researchers. "The student pipeline is very important. Almost all of our crew members, me included, began as students or interns of some sort."

Blumberg says that improved communication between researchers, facility staff, and the broader nuclear security enterprise have helped bring a sense of purpose and mission to a facility that is being called upon to support an ever-expanding portfolio of experimental work.

"When people talk about capabilities, they tend to talk about equipment, but people are really the capabilities," Hutchinson says. "One way to sustain and develop that capability is to keep pushing the envelope. The goal is to always keep moving forward." ★

GOING CRITICAL

Decades after their creation, the four critical assemblies at the National Criticality Experiments Research Center continue to enable vital research.

BY JAKE BARTMAN

The National Criticality Experiments Research Center (NCERC), which Los Alamos National Laboratory operates at the Nevada National Security Sites, is the only place in the United States where researchers conduct general-purpose criticality experiments. These experiments involve configuring pieces of nuclear material—uranium or plutonium, for example—in such a way that the material achieves criticality (undergoes a self-sustaining nuclear chain reaction).

To conduct criticality experiments, researchers use four machines, which are called critical assemblies: Comet, Flattop, Godiva IV, and Planet. These critical assemblies were built by Los Alamos and used for decades at the Los Alamos Critical Experiments Facility (LACEF) before being relocated to NCERC in the 2000s. Over the years, the machines have been refurbished and updated, and more recently, each critical assembly was outfitted with modern digital controls. Researchers at NCERC are exploring how additional assemblies could be added to NCERC in the future (p. 52).

Taken together, the four machines at NCERC constitute the largest collection of critical assemblies in the western hemisphere. Read on to learn how, decades after they were created, NCERC’s critical assemblies continue to support a broad range of national security-related research. ★



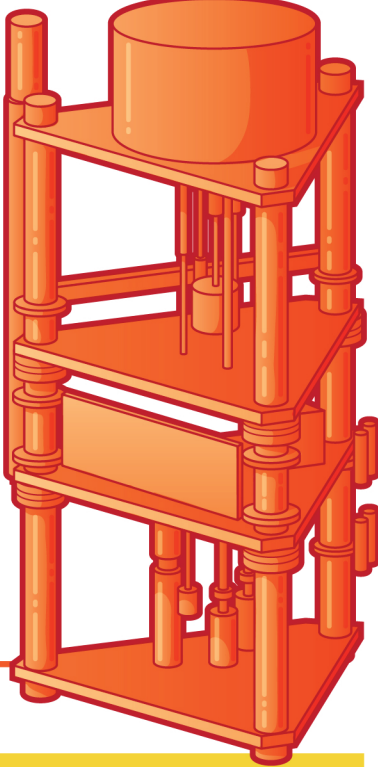
The Godiva critical assembly in 1965. Godiva was a predecessor of Godiva IV, which was built in 1967 and remains in use at NCERC today.

Godiva IV

GODIVA IV IS THE LATEST IN A SERIES OF URANIUM “BURST” ASSEMBLIES BUILT AT LACEF—assemblies designed to create prompt fission reactions that yield sudden, intense bursts of neutrons and gamma rays. Godiva IV’s predecessor, a machine called Lady Godiva, was named after the historical noblewoman who, according to legend, rode naked through her city’s streets (the critical assembly’s name related to the fact that its nuclear material was “bare,” or un-reflected).

Godiva IV was built in 1967 and comprises a fixed core, three highly enriched uranium rods, and a uranium “safety block,” which are brought together to induce criticality. The heat produced by the reaction makes components in the assembly expand, creating a shock wave that causes a magnet in the safety block to release and separates the nuclear material, stopping the reaction automatically.

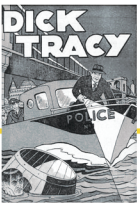
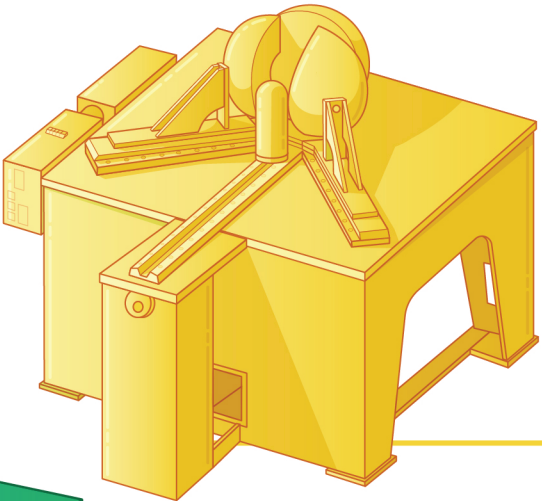
Over the decades, Godiva IV has been used to acquire data for dosimetry studies, materials science, fundamental neutron science, and more. Recently, Godiva IV was used to test criticality accident alarm systems. ■



Flattop

FLATTOP ENTERED SERVICE IN 1958 AND IS NAMED AFTER ONE OF THE VILLAINS IN CHESTER GOULD’S DICK TRACY COMIC STRIP. Unlike Comet, which brings together two subcritical masses of special nuclear material to achieve criticality, Flattop uses a preassembled core (comprising either two hemispheres of highly enriched uranium or two hemispheres of plutonium) that achieves criticality when several natural uranium reflectors are moved inward, directing stray neutrons back into the core. The simple geometry of this design was intentional, allowing researchers to conduct one- or two-dimensional simulations of Flattop experiments.

Although Flattop’s fixed geometry limits the types of experiments that can be conducted with the assembly, the machine provides an important way to validate nuclear data and to irradiate small material samples and foils. Over the decades, Flattop has been used for many benchmark experiments, providing measurements for nuclear data libraries. Flattop is also regularly used to train criticality safety experts and others who attend classes at NCERC. ■



Comet

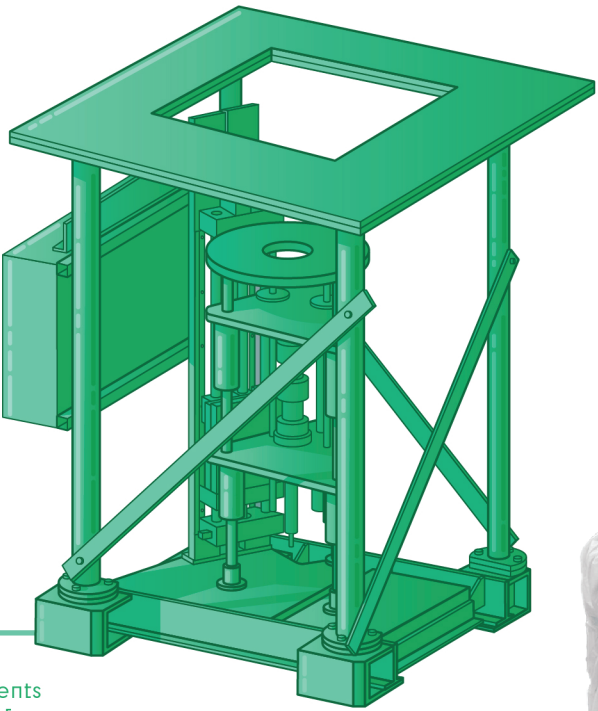
BUILT BY RESEARCHERS AT LACEF IN THE 1950S, the Comet critical assembly was originally named “Haley’s Comet” after its designer, Jano Haley. Comet is a heavy-duty vertical lift assembly that comprises a movable lower platform and a stationary upper platform. Subcritical configurations of nuclear material and reflectors can be arranged on both the upper and lower parts of the assembly, and when these parts are brought together, a critical mass is achieved.

Over the decades, Comet has been used for a breadth of experiments. Among the first was 1952’s Jemima Critical Assemblies, which used highly enriched uranium in the form of “Jemima plates” (so called because of the plates’ resemblance to pancakes).

This experiment led to an accidental prompt critical reaction, which produced a sudden and intense burst of neutrons. The accident revealed a need for a machine designed to produce prompt critical reactions, leading to the creation of the Lady Godiva critical assembly (see opposite page).

Comet was completely refurbished in the 1990s to support the heavier assemblies needed for certain kinds of experiments. More recently, Comet was used for the PARADIGM (PARallel Approach of Differential and InteGrAl Measurements) and Deimos projects (p. 52). ■

NCERC researchers assemble the Deimos testbed. Deimos is enabling novel experiments that support the design and qualification of advanced nuclear reactors.

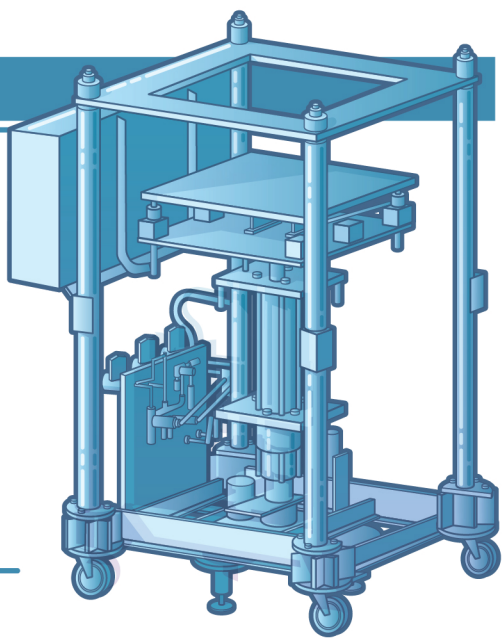


Planet

PLANET WAS BUILT AT LACEF IN THE 1980S AS AN ADDITION TO COMET. Like Comet, the critical assembly consists of a movable lower platform and a stationary upper portion that allow for subcritical masses of special nuclear material to be brought together, yielding criticality. Planet’s upper platform can support smaller amounts of material than can Comet (2,000 pounds for Planet versus 22,000 pounds for Comet), but the wider opening at its center can accommodate different experimental configurations.

Like Comet, Planet enables a broad range of criticality experiments that, over the decades, have provided information about nuclear criticality safety and the critical masses of materials such as uranium, plutonium, and neptunium. Planet was recently used for the EUCLID (Experiments Underpinned by Computational Learning for Improvements in Nuclear Data) project (p. 52). ■

Jesson Hutchinson, NCERC’s chief scientist, assembles EUCLID.





■ Rocha (far right) speaks to NNSS employees before entering P Tunnel at NNSS. P Tunnel provides a safe, secure, controlled, and remote underground test bed for high-hazard high-explosive experiments.

WORKING TOGETHER TO GET THE JOB DONE

On its 75th anniversary, Mission Support and Test Services President Roger Rocha leads the Nevada National Security Sites into the future in partnership with Los Alamos and others.

BY WHITNEY SPIVEY



In December 2024, Roger Rocha became the president of Mission Support and Test Services (MSTS), the management and operating (M&O) contractor for the Nevada National Security Sites (NNSS). “MSTS was awarded the M&O contract in 2017, and we are proud to be part of the NNSS’ latest historic chapter in pioneering nuclear weapons science, global

and homeland security, and environmental programs for our nation,” Rocha explains. “With leading professionals in STEM, craft, operations and business support, more than 3,400 MSTS employees champion our national security mission at our 10 locations spanning the United States.”

Rocha sat down with *National Security Science* to discuss his career, how NNSS partners with Los Alamos National Laboratory, and what’s on the horizon for NNSS, which celebrates its 75th anniversary this year.

How does Los Alamos interface with MSTS?

MSTS runs the NNSS as a user facility. Users are collectively referred to as Nevada Enterprise Partners, and Los Alamos is one of them. Los Alamos performs program execution—such as subcritical experiments (p. 36) and high-explosive operations (p. 30)—and MSTS leadership and technical staff work closely alongside our Los Alamos colleagues, participating in meetings and supporting scientific experiments at the Sites and at the Los Alamos campus. This partnership provides us with insight and understanding to support current Los Alamos stockpile stewardship program needs and anticipate future needs. MSTS also provides Los Alamos with a group that assists with all diagnostics associated with the program work.

You spent 25 years at Lawrence Livermore National Laboratory; how has your time at Livermore informed how you interface with the national labs today?

My time at Livermore provided me with a deep understanding of the mission, culture, and technical complexity that define the National Nuclear Security Administration (NNSA) and its national laboratory system. I learned a lot at Livermore, especially about high-hazard facilities and high-hazard operations, which both fell under my umbrella. I had the opportunity to work across a range of interdisciplinary teams, bridging science, engineering, and national security priorities. That experience helped me build a strong foundation in collaborative problem-solving, system-level thinking, and mission-focused innovation. It also taught me the value of execution—at the end of the day it’s about working together to get the job done for NNSA.

Like Los Alamos, Livermore is a high-performing environment that teaches the importance and value of building trust and partnerships. I’ve developed longstanding professional relationships with colleagues at Los Alamos and other labs, which have helped foster open communication and alignment on the shared goals of our NNSA mission.

Ultimately, my lab experience was an excellent foundation for a career at NNSS, where I started working in 2020 as the chief operating officer and in the vice president role. In my current position, I continue to work closely and collaboratively with the national laboratories to build the stockpile stewardship program of the future with scientific excellence.

MSTS and Los Alamos collaborate in many ways, but what are some of the partnerships you are most proud of?

There have been many tremendously successful and insightful collaborations between NNSS and LANL, so many that it’s hard to choose just a few to highlight. NNSS’ science-based stockpile certification assets have enabled 30 years of stockpile certification without underground testing, and Los Alamos has partnered with us for so much of it: subcritical experiments at PULSE, programmatic nuclear materials studies and aging, nuclear materials testing, high-explosives testing at BEEF,

and programmatic waste disposal. Some top-of-mind examples include data delivery for Los Alamos experiments at PULSE and the advancement of the understanding of ejecta diagnostics.

As we look to the future, what are some exciting collaboration opportunities between MSTS and Los Alamos?

Neutron-diagnosed subcritical experiments and the Scorpius accelerator are tremendous opportunities. I’m excited by both the scope of the collaboration required between NNSS and our partners at the national labs, as well as the science behind the projects themselves. The new subcritical experiment test beds we’re developing at PULSE will set the stage for the next 30 years of stockpile certification and enable a host of new experiments, from which we will gather new data, from which we will develop new experiments, and so on. The continuous technological innovation achieved through partnerships like the one we enjoy with Los Alamos helps us exceed stated mission needs and come up with new ideas and concepts that we translate into unique, mature diagnostic capabilities and data processing tools.

This year is our 75th anniversary, and the future of the NNSS is bright. I am very excited about the unique capabilities that the NNSS provides the NNSA, and we are positioned to deliver on our missions. ★



■ Rocha (center) visits P Tunnel. Roughly 900 feet below a mesa, P Tunnel encompasses four miles of horizontal mined space and features multiple test beds that support the research, development, and evaluation of technical solutions that strengthen current and future nuclear nonproliferation capabilities.



■ Nevada Programs Office Senior Director Don Haynes (above left) and Sandoval stand at ground zero of Divider, the last nuclear test before the current testing moratorium.

■ Below: Sandoval helped establish the Kappa West firing site at BEEF.



DESERT DIAGNOSTICS

For more than four decades, Tom Sandoval has supported nuclear weapons and nonproliferation experiments at the Nevada National Security Sites.

BY WHITNEY SPIVEY

Growing up in Santa Fe, New Mexico, Tom Sandoval was only vaguely aware of the mysterious town of Los Alamos, about 35 miles northwest. “I had relatives who’d been guards there,” he says. Home to Los Alamos Scientific Laboratory, the entire community of Los Alamos was closed to the public from 1943 to 1957. All residents and visitors entered and exited through security checkpoints.

By 1983, however, Los Alamos had long been open to the public, the Lab had been renamed Los Alamos National Laboratory, and Sandoval—newly married and recently out of the Air Force—was looking for work. A family friend encouraged him to apply for a technician position with EG&G, the company that operated the Nevada Test Site (now the Nevada National Security Sites, or NNSS), just north of Las Vegas. Sandoval landed the job, which was based at EG&G’s Los Alamos office, and in early 1984, he began assembling circuit boards and working with fast-framing and streak cameras to record data from underground nuclear tests designed by Los Alamos and conducted at the test site.

THE TESTING DAYS

Sandoval traveled to the test site for the first time in late 1984 and rented a bed in a dormitory for 50 cents a night. He recalls the energy of Mercury, a hub of activity located just inside the site’s southern border. “Mercury had a pool, a bowling alley, and a steak house,” he says. “The test site was rocking back then.”

All that activity was in support of nuclear testing. In the throes of the Cold War, the United States was rapidly developing its nuclear arsenal, and one of the ways that the country’s weapons labs—Los Alamos and Lawrence Livermore—fine-tuned their weapons designs was through nuclear testing. Initially, these tests happened aboveground (mostly at the Nevada Test Site or over the Pacific Ocean), but when the Limited Test Ban Treaty was signed in 1963, testing moved underground, primarily at the Nevada Test Site. The first test that Sandoval supported was Correo, which was detonated on August 2, 1984.

An underground nuclear test began aboveground—with the construction of a towering “rack,” roughly four stories tall. This rack held both the nuclear device and an array of diagnostic instruments designed to capture data from the detonation. Sandoval spent his days climbing the rack’s stairs, installing diagnostics. “I was a lot skinnier back then,” he jokes.

Once ready, the rack was lowered into a vertical shaft up to 3,000 feet deep. The hole was then “contained”—backfilled with rock and soil to prevent radioactive gases from escaping (p. 48). The only elements emerging from the shaft were long cables connecting the diagnostics to recording trailers on the surface.

By the late 1980s, Sandoval was working with a cutting-edge diagnostic system called CORRTX (Continuous Reflectometry for Radius versus Time Experiments). “It’s fancy time domain reflectometry,” he explains. “You send an electrical pulse down a cable, and when it reaches the end, it reflects. That tells you the cable length, and from that, you can derive the explosion’s yield.”

Sandoval built CORRTX systems at Los Alamos and deployed them in Nevada. The data from CORRTX was so valuable that soon Sandoval was installing CORRTX on Livermore-designed tests and even on tests in the Soviet Union. In 1988, Sandoval

spent seven weeks at the Semipalatinsk Test Site in Kazakhstan, fielding CORRTX on a Soviet test as part of the Joint Verification Experiment (JVE), during which U.S. and Soviet scientists worked together at one another’s nuclear testing sites to evaluate methods of measuring the yields of nuclear tests. CORRTX was a crucial part of this process and helped enable the 1990 ratification of the Threshold Test Ban Treaty, which limited nuclear tests to 150 kilotons.

INFRASOUND

Sandoval supported the September 1992 Divider test, after which a moratorium on all nuclear testing was put into effect. That moratorium, which is still in place today, meant that Sandoval had to find other work. Sandoval started working with Los Alamos scientist Rod Whitacre and quickly became familiar with yet another type of diagnostic: infrasound. He learned to field infrasound arrays—systems of sensors (usually infrasonic microphones) that can detect sound waves with frequencies below the range of human hearing.

Sandoval traveled all around the country setting up these arrays. “You can get a sense for where things are in the atmosphere and how fast they’re traveling by the way they sound,” he explains. “Among other things, we were looking at how meteors were traveling through and breaking up in the atmosphere.” He pauses and continues. “When the Challenger exploded, we picked it up on three arrays.”

In September 1996, the Comprehensive Test Ban Treaty came into effect, and the Comprehensive Test Ban Treaty Organization (part of the United Nations) needed ways to verify that countries weren’t clandestinely testing nuclear weapons. “That’s when I was going to places like France, Austria, and Germany to talk about infrasound,” Sandoval says.

As the CTBTO dialed in locations for infrasound arrays, Sandoval would go install them. “I was in Ascension Island—in the middle of the Atlantic—for three weeks,” he remembers. “I spent 18 months going back and forth to Fairbanks, Alaska.” He also traveled often to Alabama, Wyoming, and Virginia.

EXPLOSIVES

Of course, Sandoval, now a Los Alamos employee, was still spending plenty of time at Los Alamos and the Nevada Test Site—both of which had infrasound arrays. “I knew infrasound and CORRTX,” he says. “So I fit right in at the firing sites—the places where the Lab conducted high-explosives experiments that also incorporated a lot of diagnostics.” Before he knew it, Sandoval was hired into the Dynamic Experiments group and began leading explosively driven experiments. He used tools such as photonic doppler velocimetry, x-rays, and pins to study fragment impact—how pieces of an explosive are propelled outward upon detonation. Some of his work happened at Los Alamos’ Lower Slobbovia firing site, but bigger experiments were conducted at Nevada.

Some work led Sandoval farther afield. In 2008, Sandoval supported Chevron Corporation, which had a cooperative research and development agreement with Los Alamos. That work took Sandoval up to Rifle, Colorado, to study oil shale fracking. “We tried different explosives on different boulders to see how they split apart,” he remembers.



■ In 1998, the Defense Threat Reduction Agency sent Sandoval to Kazakhstan to help close a nuclear testing tunnel in Degelen mountain.

In 2015, Sandoval became the acting group leader for Focused Experiments at Los Alamos and subsequently the permanent group leader. During his tenure as group leader, 300 experiments were successfully executed in one year at the Laboratory. Despite this cadence, Sandoval recognized that the group should be fielding more and bigger experiments. The hang up was at Los Alamos, where increasing numbers of red flag days meant it wasn’t safe to detonate explosives. And because of the Laboratory’s proximity to residential areas, the detonations were limited in size. The solution quickly became apparent: Nevada.

In December 2016, Sandoval stood up the Kappa West firing site at Nevada’s already established Big Explosives Experimental Facility (BEEF, p. 30). As demand surged for large, fragment-producing experiments, Sandoval built a dedicated team. “We’ve gone from 2 employees there to a team of 24,” he says. “If we have a capability, we will have customers.”

In 2017, Sandoval became the group leader for Los Alamos employees based in Nevada. During this period, he also played a key role in upgrading the NNSS U1a facility—now known as the Principal Underground Laboratory for Subcritical Experimentation (PULSE, p. 36)—from a Hazard Category 3 to a Hazard Category 2 facility. This reclassification means that greater quantities of special nuclear material can be used for experiments.

NEVADA PROGRAMS OFFICE

In 2020, Sandoval was on the verge of retirement but reconsidered when Los Alamos stood up its Nevada Programs Office (p. 7) to coordinate Lab work at NNSS. Today, Sandoval leads the Nevada Experimental Operations branch of the office. In this role, he oversees experiments at Kappa West, PULSE, and other areas, such as P Tunnel, where various global security experiments are underway.

Sandoval continues to travel regularly to Nevada, and even after four decades at NNSS, he finds his work as engaging and meaningful as ever. His pride in the Laboratory’s national security mission remains strong, and he’s deeply appreciative of the extraordinary journey it’s taken him on—across the country and around the world.

“It’s been a hell of a ride,” Sandoval says. “Where else is a kid from northern New Mexico going to do stuff like this?” ★

ACHIEVEMENTS OF LOS ALAMOS EMPLOYEES

An international team of 13,508 contributors, which included Los Alamos scientists, received the 2025 Breakthrough Prize in Fundamental Physics for its decade-long work at the European Organization for Nuclear Research's Large Hadron Collider. Prizewinners from the Lab's Physics division include **Cesar da Silva**, **Matt Durham**, and **Hubert van Hecke** (retired), working with postdoctoral researchers and affiliates **Thomas Boetcher**, **Jana Crkovska**, **Cameron Dean**, **Eliane Eppe**, **Jakub Kvapil**, **Cheuk-Ping Wong**, **Nicolas Schmidt**, and **Krista Smith**.

Brian Weaver, of the Computer, Computational and Statistical Sciences division, was elected a fellow of the American Statistical Association (ASA) for his distinguished service and commitment to advancing the field. Weaver was selected "for exemplary leadership in the development of statistical methods in national security science, for major collaborations that have advanced the physical sciences, and for sustained impact on the ASA through a dedicated history of strategic service."

The Minerals, Metals, and Materials Society named Los Alamos engineer **Kester Clarke** a member of its Brimacombe Medalist class of 2025. The mid-career award recognizes sustained excellence and achievement in business, technology, education, public policy, or science related to materials science and engineering and with a record of continuing service to the profession. Clarke was recognized for "sustained contributions to the science and application of metals processing, outstanding service to our technical community and excellence in mentoring."

Chris Stanek, the director of the Lab's Nuclear Energy Programs, was named a fellow of the American Nuclear Society. Nominated by his peers in the nuclear science and engineering community, Stanek earned the distinction of fellow for his "pioneering contributions to fuel and materials research and his exceptional leadership in advancing modeling and simulation for nuclear energy."

The National Academy of Sciences elected two Laboratory scientists—**Brenda Dingus** and **Thomas Terwilliger**—as members. Dingus, an astrophysicist, has carried out several seminal analyses and led several pioneering gamma-ray experiments. Terwilliger, a senior scientist at the New Mexico Consortium, has long been at the forefront of computational structural biology.

Two Los Alamos publications—*National Security Science* (NSS) and *1663*—were recognized in the 2025 National Federation of Press Women Communications contest. The New Mexico issue of NSS, edited by **Whitney Spivey**, placed second in the magazine editing category. The NSS article "Beyond the blast," written by **Jill Gibson**, won third place in the science and technology category. The *1663* article "Fighting fentanyl overdose and the opioid crisis," written by **Eleanor Hutterer**, received an honorable mention in the "specialty articles, social issues" category.

The Society for Industrial and Applied Mathematics selected nuclear engineer **Luis Chacón** of the Lab's Theoretical division to join its 2025 class of fellows. Chacón was recognized "for seminal contributions to scalable, multiscale fluid, kinetic and hybrid algorithms, enabling breakthrough simulations of magnetic and inertial fusion plasmas."

Los Alamos theoretical physicist **Francesco Caravelli** collaborated with United Kingdom researchers to address the challenge of identifying important nodes in complex networked systems. Calculating a node's centrality traditionally involves evaluating the entire network, which becomes computationally intense as the size of the network grows. Their paper, which was published in *Proceedings of the National Academy of Sciences*, received a Cozzarelli Prize from the National Academy of Sciences for outstanding scientific quality and originality.

Diego Dalvit, a scientist in the Theoretical division at Los Alamos, was elected a fellow of Optica, formerly known as the Optical

Society of America, a leading professional society for the science of light. Dalvit's election recognizes his expertise in a range of physics and quantum physics topics, including "outstanding theoretical contributions in electromagnetic quantum fluctuations and quantum optics in metamaterials, plasmonic surfaces and other nanostructured materials."

Atmospheric scientist **Manvendra Dubey** is one of 21 international experts selected by the United Nations (UN) Secretary-General as a member of a new independent scientific panel entitled "Nuclear War Effects and Scientific Research." The panel will examine the consequences of a nuclear war from the perspective of everything from local communities to the planet as a whole. This work will culminate in a comprehensive report delivered to the UN General Assembly in 2027, which has not received such a report in almost 40 years. Dubey is one of the world's foremost scientists studying the interactions between wildfire smoke, solar radiation, and clouds and their impact on society. His expertise will help the UN make science-based recommendations to ensure that nuclear war effects are well understood in the context of public health, socioeconomics, ecology, and agriculture.

Since 1982, the National Nuclear Security Administration's Office of Defense Programs has recognized individuals and teams across the nuclear security enterprise with the Defense Programs Awards of Excellence, which acknowledge significant achievements in quality, productivity, cost savings, safety, or creativity in support of the nuclear weapons program. In 2024, five teams from Los Alamos were recognized: the W87-1 Plutonium Pit FPU Team (exceptional achievement), the Moonshine Experiment Team (exceptional achievement), the Los Alamos ENDF/B-VIII.1 Development Team, the Detonator Pellet Can Assembly Team, and the Tri-Lab High Fidelity Weapons Effects Modeling Team. ★

BETTER SCIENCE = BETTER SECURITY

Hardworking people—the Laboratory's most important asset—enable Los Alamos to perform its national security mission.

68 YEARS AGO

On August 7, 1957, the United States conducted its 99th nuclear test, **Stokes**, which was designed by scientists at Los Alamos Scientific Laboratory and yielded 19 kilotons. Featuring a U.S. Navy-provided blimp, **Stokes** was used to evaluate blast and heat effects on aerial vehicles. Although the thermal effects from the explosion were minimal, the shock wave caused the unmanned blimp to rupture. The blimp slowly descended, nose-first, to the ground, where a Navy ground crew inspected the damage. ★





Scan code to subscribe to
our newsletter and read the
magazine online.



THEN & NOW

Between 1965 and 1972, every Apollo astronaut who walked on the Moon first trained in the craters of the Nevada Test Site (now the Nevada National Security Sites, NNSS). The site's cratered landscape—formed by hundreds of underground nuclear detonations—closely resembles the Moon's pockmarked surface, making NNSS an ideal training ground. At left, Apollo 16 astronauts maneuver a moon rover near the Schooner crater in November 1970.

In 2023, astronauts returned to NNSS in preparation for Artemis, NASA's program to establish a sustainable human presence on the Moon and enable future crewed missions to Mars. They are pictured here in front of the Icecap tower, a structure built in 1992 for a nuclear test that was never conducted. ★