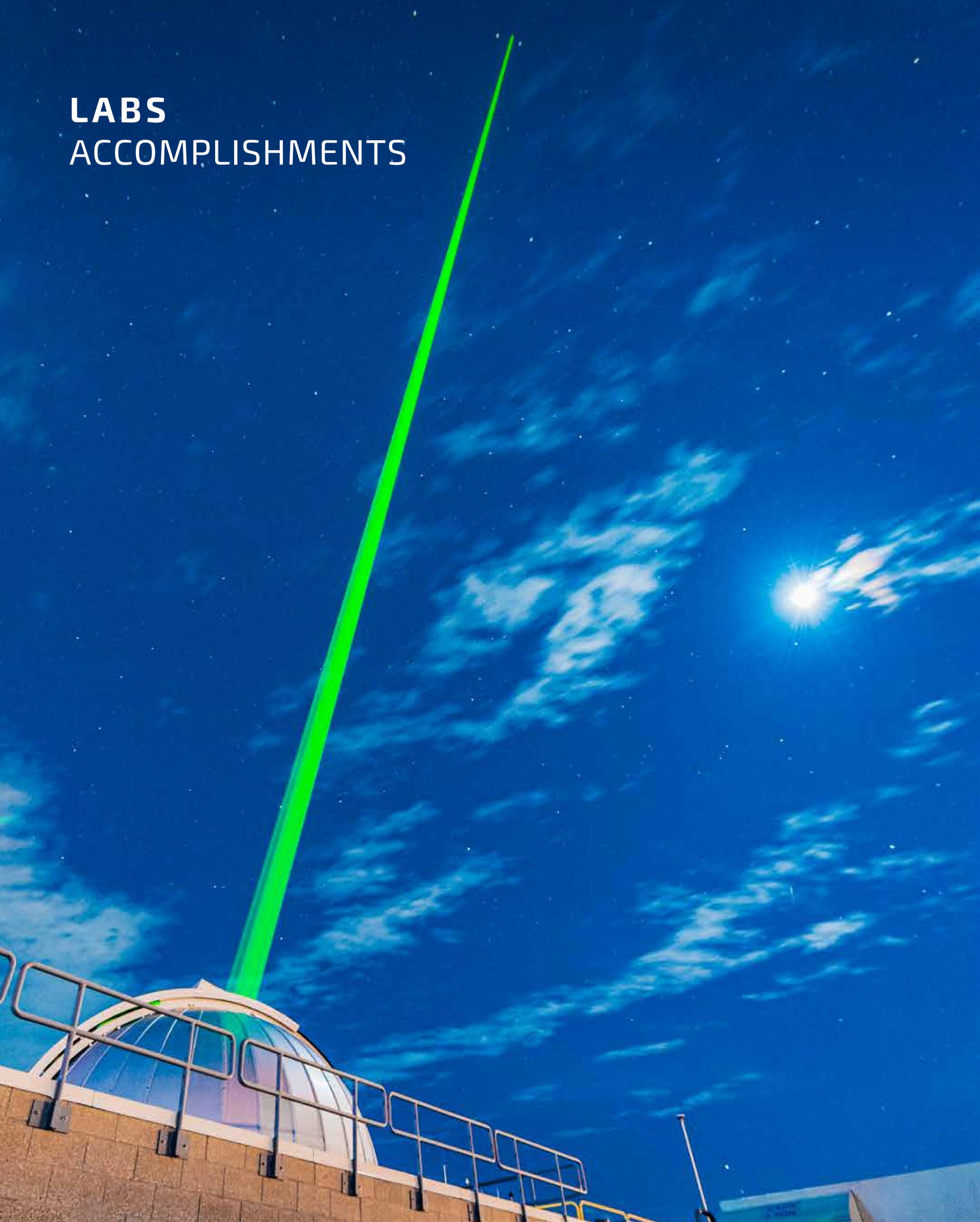


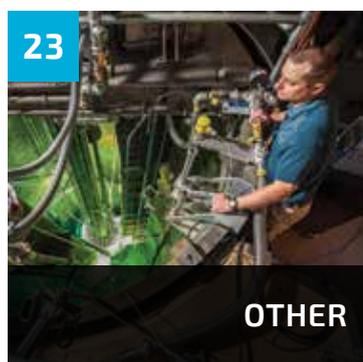
# LABS ACCOMPLISHMENTS



**SANDIA LABNEWS**  
March 2020

*Exceptional service in the  
national interest*

# CONTENTS



## A letter from the Labs Director



One of the many reasons I am excited to be back at Sandia Labs is right in your hands. Labs Accomplishments is a highlight of the past year. From my first days as a Sandian 30 years ago, I have eagerly looked forward to seeing the breadth of the Laboratories' activities and marveling at the achievements.

This issue is no exception. The 2020 edition of Labs Accomplishments is overflowing with remarkable successes by the staff at Sandia Labs. From critical milestones in our key mission areas to scientific breakthroughs, from Laboratory Directed Research and Development to valuable advances in support of the mission, the work profiled on these pages demonstrates that we continue to provide "exceptional service in the national interest."

Sandia is fulfilling its national security missions against a wider set of threats than ever before. Our deep science and engineering foundations give us a cross-disciplinary advantage that helps solve some of the nation's toughest problems and sustain America's security.

In this publication, you'll read about Sandia's contributions to supporting the warfighter, protecting the homeland, ensuring the nation's energy security, working with national and international partners and developing innovative approaches to cybersecurity. Our staff continues to advance best-in-enterprise leadership in safety and security, sustainability, quality and employee benefits. You can read about their latest achievements here as well.

Every Sandian plays a role in the Labs' service to the nation. Each accomplishment is the product of a team of talented and hard-working people at the very top of their game.

So, settle in and enjoy this look at significant work performed at Sandia over the past year.

**James S. Peery**, Labs Director

## COVER FEATURES

Photos by **Randy Montoya**



### FRONT COVER

A green laser shoots skyward as part of a Sandia Laser Applications, or LAZAP, project. The LAZAP program, launched in the mid-1970s, uses high-powered laser beams to calibrate optical sensors on Global Positioning System and Defense Support Program satellites from low-earth to geosynchronous orbits. The facility recently received a major upgrade, including two new laser labs and a 0.5-meter telescope/beam director.



### BACK COVER

Sandia ecologist Jennifer Payne examines native vegetation planted to stabilize soil in an area following a construction project. Having an ecologist who specializes in restoration ensures Sandia upholds commitments to protect leased land. Jennifer is one of two Certified Ecological Restoration Practitioners in New Mexico, a title held by only 150 people in the country.

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#### Sandia National Laboratories

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## NUCLEAR DETERRENCE



## B-2 Aircraft test success

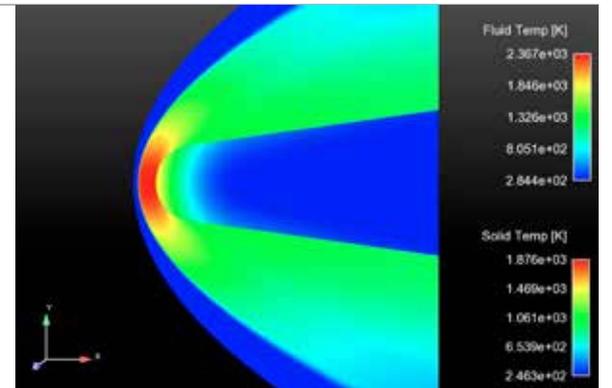
*Fleet of B61-7, B61-11 and B83 test units loaded for shipment*

B-2 Aircraft Monitor and Control testing was completed using a full load B61-12 weapon simulator. This was the first time a full load of digital interface weapons has been demonstrated on the B-2 bomber. The test was completed in conjunction with final AMAC testing needed to certify the weapon system. (2000, 5000, 8000)

## Hypersonic fluid, material response, trajectory coupling

Sandia researchers completed an effort to tightly couple the trajectory analysis code, TAOS, to their computational fluid dynamics and ablation code, SPARC. The two-way coupled capability enables the prediction of hypersonic reentry flight physics from reentry to impact and reduces the reliance on empirical models that are currently built into Sandia's trajectory solvers. The work is part of an effort to develop a virtual flight test capability. (1000)

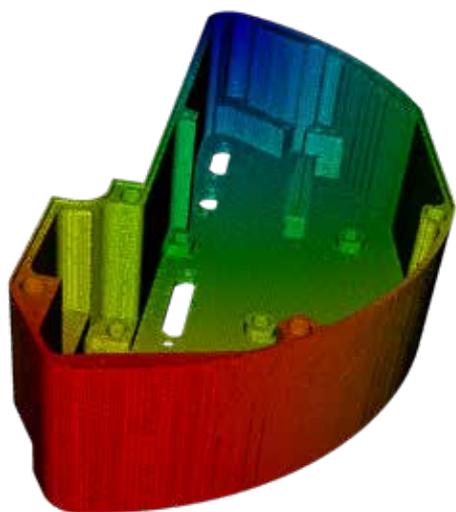
*Temperature field in the hypersonic flowfield and solid nosetip of a generic reentry vehicle (image generated during coupled fluid flow and ablation simulation of vehicle during ballistic reentry)*



## Delivering Next Generation ModSim capability

Enabling rapid computer-aided design-to-analysis workflow and generating qualification evidence via simulation are the tenets of Sandia's Next Generation Simulation capability development project. Developed as part of NNSA's Advanced Simulation and Computing Program, the cross-Labs team is delivering automated simulation capabilities to greatly reduce the time to produce an analysis. Two important elements are virtual design, including performance and safety assessments, and obtaining qualification evidence via simulation. Real-time user-experience testing and user-interface development are providing integrated solutions to all levels of analysts. Initial efforts have already shown months-to-minutes improvements. (1000, 2000, 6000, 8000, 10000)

*Automatic mesh generated in minutes with newly developed Next Generation Simulation tool*



## Headers produced at high-yield

Sandia's advanced science and technology and nuclear deterrence divisions collaborated to produce a critical build run of electrical headers with an incredibly high yield of 98%. Sandia was the only institution in the initial run that produced these parts to specification in a short time frame. This high yield was achieved by maintaining precise process and environmental controls established through applied materials science



research and multi-disciplinary collaboration. These headers provide electrical isolation and hermeticity to internal components, ensuring that assemblies meet performance and lifetime expectations. (1000, 2000)

*Headers, such as the ones shown here, provide both hermeticity and electrical isolation for transmission of electrical signals and power.*

## ■ NUCLEAR DETERRENCE



### P19 project execution

*Sandia's P19 project team*

The P19 project represents Sandia's commitment to respond to critical national security challenges. A diverse team from across almost every division responded rapidly, contributing expertise in design, qualification, production, acceptance and fielding to meet a tight deadline. Executing the project capitalized on Sandia's advanced capabilities and commitment to quality to deliver a solution to our DoD and NNSA stakeholders within a highly compressed schedule. The success of the P19 project clearly demonstrates Sandia's "exceptional service in the national interest." (2000, 6000, 5000, 8000, 9000, 10000)

### Strategic Intent of Collaboration signed

The U.S. and U.K. have a rich history of cooperation dating back to the Manhattan Project. Since 1958, the countries have shared ideas, information, materials and equipment within the provisions of the Mutual Defense Agreement. In a June visit to the U.K.'s Atomic Weapons Establishment, Steve Girrens, Sandia's associate Labs director for nuclear deterrence, and Dave Chambers, AWE's director for science engineering and technology, on behalf of Graeme Nicholson, AWE's head of programme, signed a Strategic Intent of Collaboration, describing and endorsing mutually beneficial opportunities for strategically aligned collaborations between Sandia and AWE. While each nation prepares for its respective future deterrence needs and maintains focus on its existing stockpiles, both Sandia and AWE recognize that through collaboration, the risk carried by each organization in delivering its mission will be reduced. (2000)



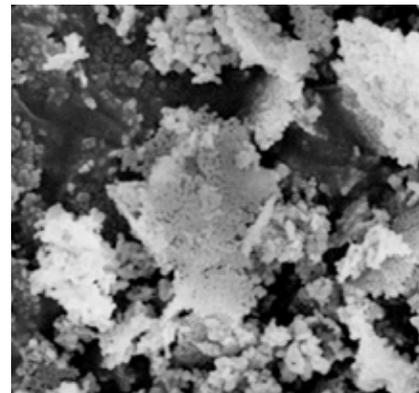
*U.K. Atomic Weapons Establishment Director for Science Engineering and Technology Dave Chambers, left, and Sandia Associate Labs Director for Nuclear Deterrence Steve Girrens signed a strategic intent document to verify and describe collaboration between the two organizations.*

### Components in full-scale development

Multiple weapons design and assurance organizations, spanning several teams and disciplines, provide critical engineering, science and business operations support for Sandia's W80-4 program. The following components have all passed conceptual design reviews and are in full-scale development: Firing Set Assembly, Firing Set Stronglink, Detonator Stronglink, magnetics, cables, connectors and commercial-off-the-shelf. (2000, 8000, 10000, 1000, 9000)

### Magnesium oxide development

Sustained research and development efforts at Sandia have led to a mechanistic understanding of legacy MgO, a critical material for thermal batteries. Legacy MgO has a highly specialized nanoscale structure, critical to its function, and the supply is very limited. Failure to develop a new source of this material would adversely impact the ability to deliver thermal batteries to support current modernization or future nuclear deterrence systems. In FY19, the team demonstrated the ability to design and synthesize candidate MgOs and, for the first time, demonstrated function in prototype batteries. (2000, 1000, 6000, 9000, 10000)



*Scanning electron micrograph of microstructure in porous magnesium oxide*

### Sandia Production milestones

Sandia Production delivered 100% of FY19 First Production Unit hardware requirements for the B61-12 LEP and W88 ALT 370 programs, including microelectronic, neutron generator, power source and explosive components. Power sources reached FPU for seven components, and explosives reached FPU for three components. These accomplishments were achieved through a combination of Sandia in-house production capabilities and outside suppliers. In addition to achieving FPU for two components, the neutron generator enterprise exceeded planned builds and met all customer shipments while staying on budget. (2000, 1000, 5000, 9000, 10000)



*W88 Neutron Generator Assembly*

# NUCLEAR DETERRENCE



The HOT SHOT 5 flight launched from the Kauai Test Facility on Aug. 28, 2019.

## HOT SHOT flights

The HOT SHOT team designed, integrated and successfully launched four payloads on Terrier-Malamute rockets in FY19. HOT SHOT flights launched out of Kauai Test Facility and carried more than 35 experiments from organizations across the Nuclear Weapons Complex, impacting the current and future U.S. stockpile. The HOT SHOT program marks NNSA's return to rockets, providing a flexible flight-test platform to accelerate technology maturation and reduce development-cycle time, increasing the responsiveness of future modernization programs and the agility of nuclear deterrence efforts to address emerging threats. (2000, 5000)



B61-12 weapons system affixed on an F-15 aircraft

## Tonopah Test Range flight test cycle

The Sandia team at TTR compressed three normal years' worth of technical weapons testing into 12 weeks, June to September 2019. The test team completed 17 B61-12 and stockpile surveillance flight tests, including six events in only two days, and incorporated two partner nation tests. The TTR team adjusted technical upgrades, shifted schedules, mitigated impacts and ensured 100% data capture without a single safety or security incident. During FY19, the team successfully recovered multiple test units and completed several enhancement projects. (2000)

## Firing systems and controllers

Sandia's weapons design and assurance organizations are responsible for the design, development, qualification and First Production Unit for firing systems and controllers. In FY19, the teams completed FPUs successfully and on time across the W88 ALT 370 Impact Fuze, Terminal Protection Device and Firing SubSystem, and the B61-12 Impact Sensor and PreFlight Controller. (2000)

## Functional AMAC System Tester 2

The Functional AMAC System Tester 2, or FASTER2, is a custom data recorder designed and built by Sandia's handling gear and telemetry engineering team. FASTER2 is the electrical centerpiece of the B61-12 Compatibility Test Units and enables Sandia's aircraft compatibility group to validate and certify compatibility of the interfaces between the B61-12, the Boeing Tail Kit Assembly and the delivery platforms. The FASTER2 team completed its design qualification and delivered 46 units with exceptional quality to fully support future B61-12 CTUs and ACC flight tests. (8000, 9000, 2000, 5000)



FASTER 2.0 Assembly

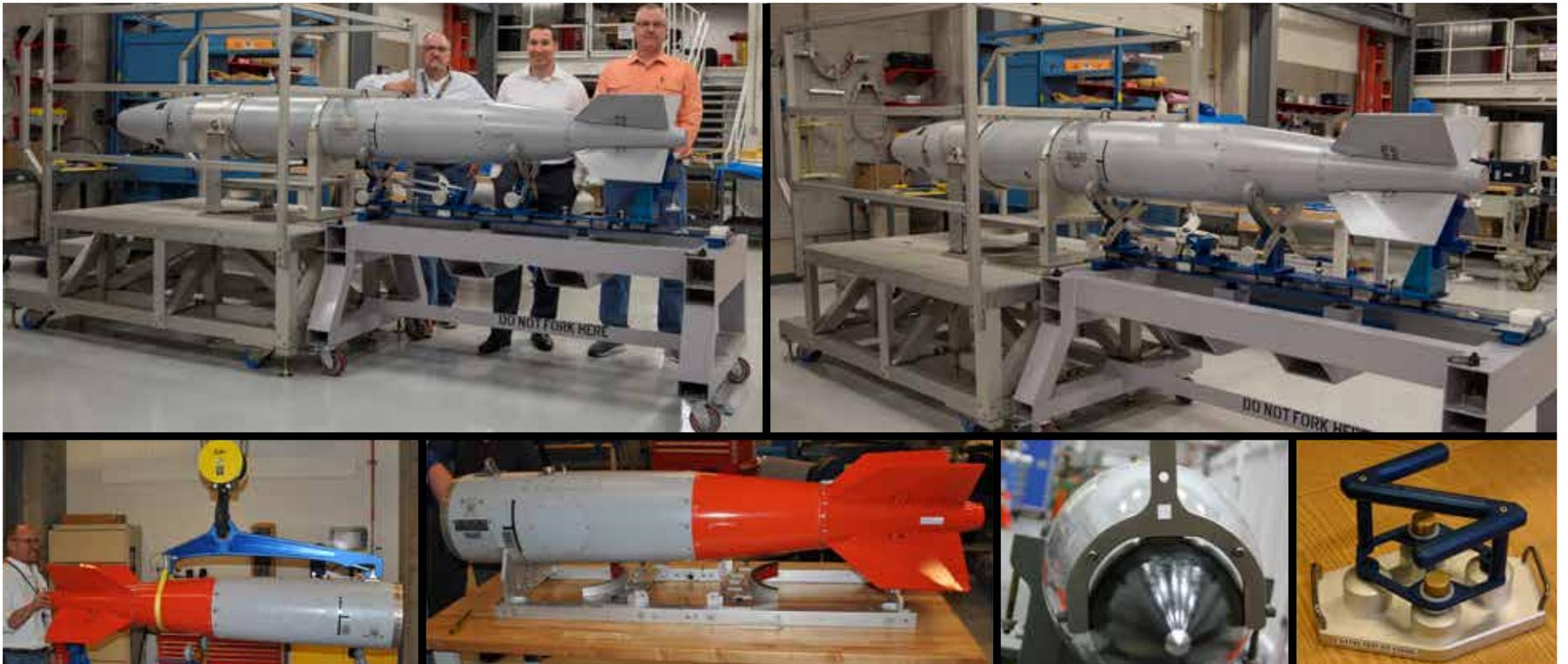


## Mk21 Superfuge tests

In August 2019, the Mk21/W87 Arming and Fuzing Assembly qualification team successfully completed the first centrifuge test for record on a powered D30-pedigree AFA at Sandia's superfuge facility. As part of the comprehensive Accumulated Damage Test, the ADT-2B test unit was mounted to the facility's 29-foot-radius indoor centrifuge, and a combined reentry acceleration, reentry vibration and axial spin test was run on the powered and operational AFA during a simulated atmospheric reentry mission. (2000)

Superfuge indoor centrifuge

## ■ NUCLEAR DETERRENCE



### B61-12 handling gear designed, developed

Sandia's handling gear and telemetry engineering team designed and developed 17 pieces of equipment (16 handling gear and 1 test gear), enabling the DoD customers to complete limited-life component exchanges, general maintenance and special repair operations for the B61-12. In FY19, all 17 tools achieved Qualification Engineering Release status, and the First Production Units were successfully manufactured. (8000)

*Top row, from left: Maintenance stand and advanced positioning alignment tool holding B61-12*

*Bottom row, from left: Tail Kit Assembly hoist adapter, stand, aerodrome spanner and handling tool interacting with B61-12 components*

### Nuclear deterrence program equipment needs

In response to multiple data calls from the NNSA Programmatic Recapitalization Working Group, Sandia's nuclear deterrence program management office led a multi-division effort creating an integrated list of programmatic capital equipment inventory and investment needs. To maintain and sustain weapon activity capabilities, the list spans the fiscal year nuclear security program period. The integrated information will provide NNSA greater transparency on actual costs, improve Sandia's ability to prioritize investments and enable better annual budget planning, allowing superior capability maintenance. (2000, 1000, 5000, 6000, 8000, 9000)



B61-12 Type 3C Trainer First Production Unit

### B61-12 Type 3C Trainer

The U.S. Air Force uses the Type 3C Trainer is a military training unit for B61-12 field maintenance, as well as limited life component exchanges. A Qualified Engineering Release for the Type 3C was released on Jan. 31, 2019, enabling Kansas City National Security Campus to complete the First Production Unit build. (2000)

### W88 ALT 370 hostile-shock testing

HS-2, the final hostile-shock test for qualification of the W88-0/Mk5 ALT 370 Arming, Fuzing and Firing Assembly, was completed Feb. 7, 2019. HS-2 successfully exposed an AF&F assembly to a triaxial-shock loading representative of several hostile environments. The assembly was electrically functional during the hostile encounter, which verified its capability to properly fuze after exposure. Data from HS-2 will serve as the primary AF&F assembly-level qualification evidence for hostile-shock environments. (2000)

### Orthogonal component testing for counterfeit detection



A cross-division team demonstrated unique component data signatures generated via fast, non-destructive and simple tests, providing a reliable method to qualify material feedstocks, identify deviations in materials manufacturing, and potentially detect changes in assembled components. Termed orthogonal testing, the method generates a robust component signature by integrating independent material properties from methodologies that operate on fundamentally different principles. While materials changes might fool a single test method, integrating independent testing nodes ensures a high reliability signature and can instill trust in U.S. national security systems. (1000)



*Illustration of B61-12 with stand and H-Gear as viewed through a Microsoft HoloLens*

### Augmented Reality nuclear deterrence training

Augmented Reality is an emerging technology that offers an opportunity to blend the physical and digital worlds, allowing participants to rapidly and accurately absorb information, make decisions and execute required tasks quickly and efficiently. Sandia's advanced science and technology organizations are exploring how AR technology can benefit U.S. nuclear deterrent activities ranging from design collaboration to nuclear weapons training. With use of a Microsoft HoloLens, Sandia created an AR training scenario to augment current hands-on B61-12 bomb disassembly training. (2000)

## NUCLEAR DETERRENCE

## New Product Introduction initiative

Sandia co-led the New Product Introduction initiative with Kansas City National Security Campus to increase design and production integration, apply lessons learned from past nuclear deterrence programs and augment nuclear deterrence development with industry best practices. This effort is accelerating progress and reducing risks in modernization programs, including the W80-4. Examples of accomplishments include creating a list of pre-approved commercial off-the-shelf electrical component parts, piloting an enhanced process for conducting technical and programmatic reviews, introducing new product development methods used in industry and facilitating design failure mode effects analysis for weapon components. (8000, 0002, 2000, 5000, 6000, 9000, 10000)



Rendering of W80-4 warhead



The W76-2/Mk4A Reentry Body Low-Yield Working Group includes members from NNSA, Sandia and multiple organizations across the U.S. Nuclear Weapons Complex.

### W76-2 PRT milestones

The W76-2/Mk4A Reentry Body System Product Realization Team delivered on their commitments to the U.S. Navy and NNSA, on budget and ahead of schedule. The team is on track to complete a closeout review, which will mark the end of the development and production period and will support the upcoming W76-1 closeout process. The team has successfully collaborated internally and externally to deliver with excellence and bring an orderly conclusion to the project. (2000, 9000)



The Sandia/NM B61-3/4 ALT 372 team shows off the first accepted lot of Sandia-built hardware.

### B61-3/4 ALT 372 delivery

Sandia successfully delivered the first seven lots of B61-3/4 ALT 372 kits to the U.S. Air Force, including achieving First Production Unit one day ahead of schedule. This was an unprecedented response to a DoD request, which required a high level of quality (Mark Quality rigor) and no impact to safety or reliability for the B61. (2000)



B61-12 Spin Rocket Motor functional ground test

### Component science, engineering and production successes

Eight neutron generator, explosive and power source components completed Qualification Evaluation Release for modernization programs in FY19. The B61-12 Spin Rocket Motor, a propellant-based energetic component, and the SRM ignitor were successfully qualified to new requirements and completed QER. The W88 ALT 370 Neutron Generator Assembly QER was released five weeks early and under budget. Three power source components were successfully qualified at an entirely new supplier in less than 18 months, and 86% of needed components have been qualified for the Mk21 program. (2000, 1000, 9000, 10000)

### W88 ALT 370 Abnormal Thermal Test

The W88-0/Mk5 ALT 370 Abnormal Thermal Test, AET-3C, was successfully completed between Nov. 8-Dec. 13, 2018, at Sandia. Two Arming, Fuzing and Firing Assemblies were subjected to high-heat input comparable to an engulfing propellant fire. The primary objective was to record thermal responses internal and external to the AF&F assemblies during the test. In addition, electrical response was monitored. Both units performed as expected to ensure reliability of nuclear safety components. (2000)



B61-12 Hazards of Electromagnetic Radiation to Ordnance testing sensor

### B61-12 HERO testing

The B61-12 systems team successfully completed Hazards of Electromagnetic Radiation to Ordnance, or HERO, testing in FY19. The test ran from June 21-Aug. 8, 2019, completing about two weeks ahead of schedule. The two test objectives were: 1) quantifying the transfer function of Electrically Initiated Device current as a function of electric field, and 2) extrapolating the achieved margin with respect to EID minimum no-fire stimulus. (2000)



Centrifuge arm, including the ALT test bed used to simulate launch and reentry accelerations

### W88 ALT 370 PPI testing

In May and June 2019, testing of three W88-0/Mk5 ALT 370 Product Prove-in units was completed successfully at the Weapons Evaluation Test Laboratory. The testing simulated launch and reentry acceleration profiles while gathering key system performance data, which included 650 waveforms and 330 single-value outputs for each test. The testing provided critical evidence for the W88 ALT 370 Systems qualification program and directly supported laboratory test program qualification activities. (2000, 9000)

## ■ NUCLEAR DETERRENCE

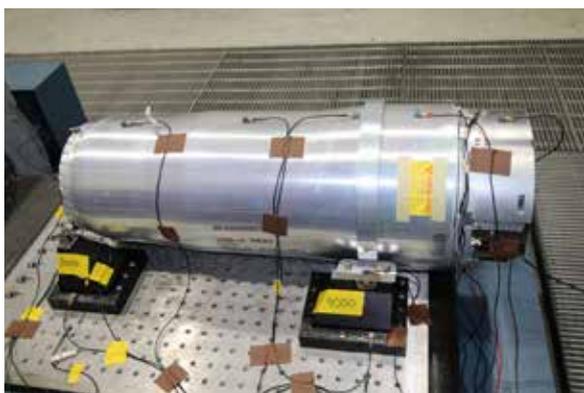


Workshop attendees participate in a PoNG session at U.C. Berkeley.

### Project on Nuclear Gaming

The Project on Nuclear Gaming, or PoNG, held a workshop at the University of California, Berkeley, on Dec. 3, 2018. PoNG is a U.C. Berkeley-led project, funded by the Carnegie Corporation of New York and executed in partnership with Sandia and Lawrence Livermore national laboratories to study nuclear deterrence through analytic games. PoNG explores the use of experimental games to better understand problems of

strategy, conflict and escalation. Its current focus is examining implications for strategic stability in different nuclear weapon capabilities through game environments in which players use escalation dilemmas. The 57 PoNG workshop attendees included representatives from universities, national labs, think tanks and DoD agencies. (8000)



A W80-4 Ground Test Unit goes through qualification testing.

### W80-4 program conceptual design

The W80-4 Life Extension Program accomplished a major milestone during FY19, completing the system conceptual design review and several component conceptual design reviews. Following system conceptual design, the W80-4 undertook an effort to simplify the system design to meet schedule constraints, resulting in a revised design that balances programmatic and performance risk. The program now proceeds into the baseline design phase with a design that meets the established military performance requirements while eliminating significant schedule risk for the system and components. (8000, 2000)

### W87-1 relaunches program, partners early

The W87-1 modernization program, paused in 2014, was back on track in FY19 with systems engineering and project management structures in place and 12 component teams and 16 mission realization partners on board. The technical team engaged in rigorous assessment of multiple design architecture options. Establishing strong partnerships early in the program is a priority for the W87-1. Sandia and Lawrence Livermore national laboratories began collaboration in January 2019. Sandia and Kansas City National Security Campus held a joint kick-off in March 2019. (8000, 2000, 1000)

### B61-12 Radar Antenna First Production Unit

In support of the B61-12 Life Extension Program, the development and qualification cycle for bringing the B61-12 Radar Antenna through the FPU process is complete. The collaborative effort resulted in the achievement of significant milestones for this component. The Product Realization Team successfully achieved FPU status for the B61-12 Radar Antenna on April 2, 2019. The FPU milestone indicates receipt of certification from NNSA of successful completion by the production agency and subsequent yielding of the first unit to the stockpile. (5000, 2000, 6000)

### Code Management System upgrade

Sandia's CMS supports the Labs' nuclear weapons program to keep the nation's stockpile secure. The CMS manages Permissive Action Link codes stored in each weapon for the life of the weapon, and it must be reviewed and analyzed for correct operations by several organizations. The software also is required to obtain certification as a National Security Agency Type 1 cryptographic system. In FY19, the CMS successfully completed all required reviews and analyses to obtain NSA Type 1 certification and the Quality Assurance Inspection Procedure. Successful completion of the QAIP resulted in the DOE Diamond Stamp, required by the DoD customer prior to delivery of the software to DoD and DOE customers. Diamond Stamp was the culmination of the team's efforts over six years and fully supports the PAL-equipped weapons in the current stockpile, as well as the B61-12. (2000)

### Sensors detect nuclear proliferation

A Sandia team led the seismic and infrasound sensor networks that collected the primary scientific diagnostic data for the source physics experiment dry alluvium geology test series, which consisted of three underground chemical explosions conducted in FY19. (8000)

### W80-4 Weapon Design and Cost Report

Sandia's W80-4 team used programmatic processes and tools more advanced than any prior Life Extension Program to complete the WDCR. The WDCR package is a major deliverable for the Phase 6.2/6.2A period of the LEP lifecycle. Throughout this period, Sandia's WDCR team pursued rigorous schedule and cost analysis activities using defensible, resource-loaded schedules and conducting formal Schedule and Cost, Risk and Uncertainty Analysis to estimate program cost. Their pioneering efforts resulted in an on-time delivery to NNSA of a comprehensive WDCR package, a critical step in the W80-4 LEP's progression to the next phase of development. (8000)

### W87 ALT 360 First Production Unit

The W87 ALT 360 Product Realization Team completed the Gas Transfer System FPU in January 2019, completing a six-year effort. A broad group of engineers, scientists and business professionals worked in partnership with counterparts at the production agencies (Kansas City National Security Campus and Savannah River Tritium Enterprise) to realize the design, deliver and test hardware and complete qualification activities on schedule and under budget. The new GTS meets DoD requirements while improving performance margins and extending the GTS lifetime. (8000)



Completed Mk21 Fuze Flight Test Unit 1 in handling gear

### Mk21 Fuze flight test success

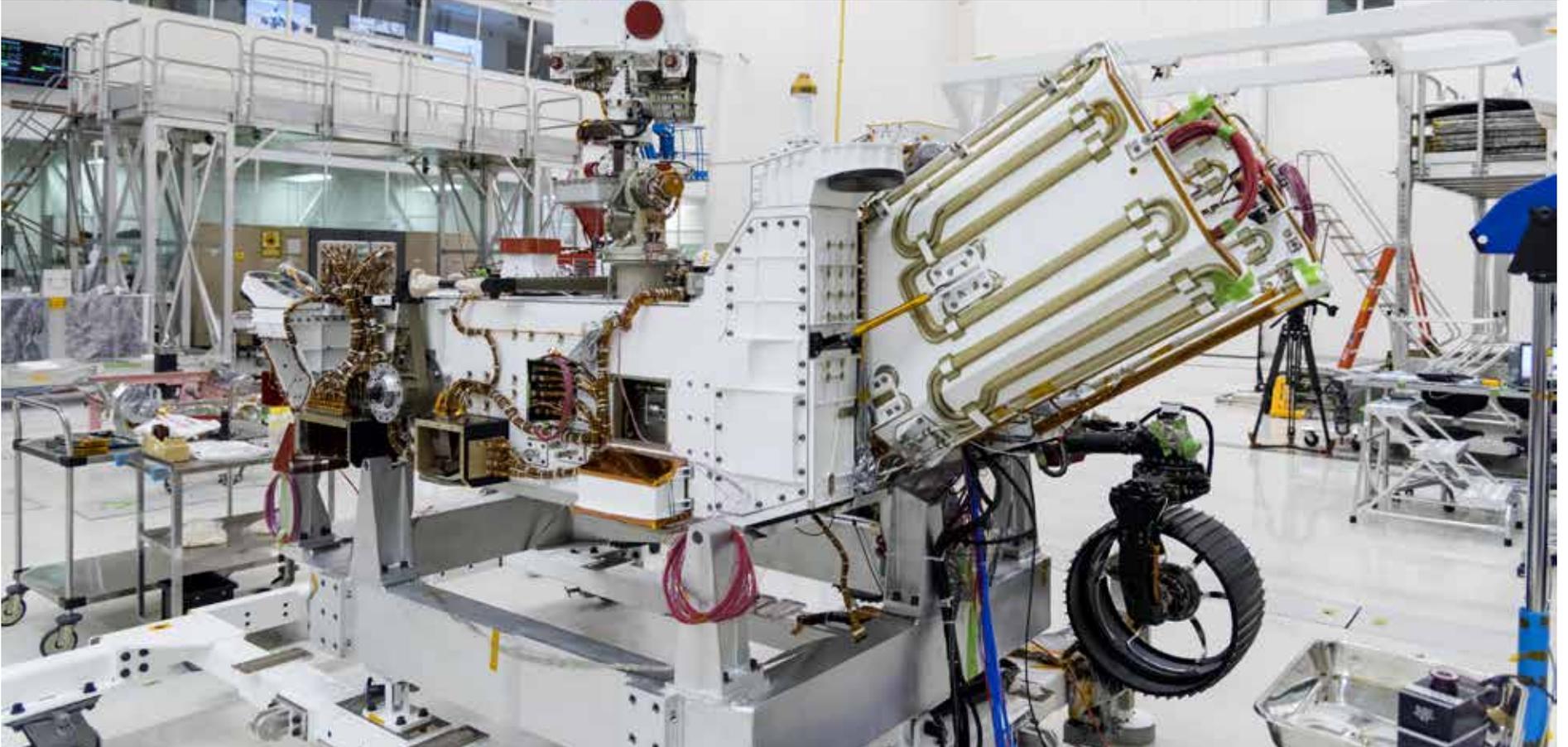
The Mk21 Fuze program's first flight test vehicle, Flight Test Unit 1, was launched from Vandenberg Air Force Base on a Minuteman III missile on Feb. 5, 2019. Telemetry data confirmed successful performance of the fuze and telemetry system. Completion of FTU1 was a coordinated effort across Sandia. The Mk21 Fuze program, a Strategic Partnership Program funded by the U.S. Air Force, entered phase 6.4 production engineering in January 2019. (8000, 2000, 5000)

## ENERGY &amp; HOMELAND SECURITY

## Mars 2020 Final Safety Analysis Report

Dan Clayton and Sandia's Mars 2020 team submitted the Mars 2020 FSAR to DOE in support of NASA's Mars 2020 mission. This report fulfills the analysis requirement of the presidentially mandated launch approval process. Without a completed and approved report, launch approval cannot be given. (8000)

*The electricity needed to operate NASA's Mars 2020 rover is provided by a power system inserted into the aft end of the rover between the heat exchange panels with gold tubing, visible at the rear. (Image courtesy of NASA)*



400-gallon  
Bakken crude-  
oil fireball

## Safe crude oil transportation

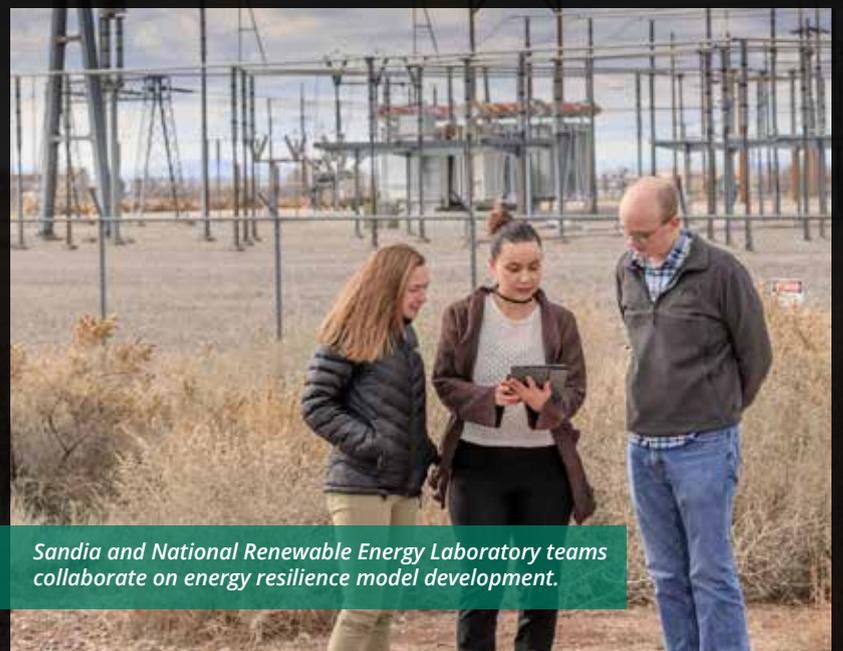
Sandia completed a multi-year project, sponsored by the DOE Office of Fossil Energy, U.S. Department of Transportation and Transport Canada, to assess combustion hazards associated with transportation of nonconventional crude oils in North America. One-of-a-kind critical fireball tests at the scale of 400 gallons required overcoming multiple technical challenges, including transporting full-component fuels from their sampling locations in North Dakota and Texas to Albuquerque and designing and implementing test apparatus that raised the oil to its boiling point and then released it instantaneously, triggering ignition. Three fireball tests were completed successfully. This work will inform state and federal lawmakers regarding U.S. regulation of crude-oil rail transport. (8000)

## Co-Optima biofuel molecules discovered

As a part of DOE's Co-Optima initiative working to improve biofuels and engines in tandem for increased efficiency and lower carbon emissions, Sandia researchers discovered three new biofuel molecules that show octane hyperboosting (a phenomenon where the octane of a blend exceeds the octane rating of the base fuel or the pure biofuel). This discovery suggests there may be many biofuel molecules that exhibit this behavior, potentially paving the way for new discoveries in combustion and faster market adoption of new sustainable biofuels. (8000)

## North American Energy Resilience Model

Sandia has developed advanced open-source production cost modeling codes to assess the coupling between the electric power grid and other critical infrastructure (e.g., natural gas), and to quantify system resilience to natural and man-made disasters for the DOE Office of Electricity's NAERM. Given recent widespread power outages caused by extreme events such as Hurricane Katrina and Superstorm Sandy, the ability to accurately model the electricity grid and associated interdependencies is a high priority. The development of the NAERM is the highest priority goal for the DOE Office of Electricity. (8000)



*Sandia and National Renewable Energy Laboratory teams collaborate on energy resilience model development.*

## GLOBAL SECURITY

The first Global Burst Detector III payload launched from Cape Canaveral aboard a GPS satellite on Dec. 23, 2018.



### Nuclear detonation detection payload launches

The first two launches of Global Burst Detector III, the latest nuclear detonation detection system, occurred on Dec. 23, 2018, and Aug. 22, 2019. Launched aboard a GPS satellite, the GBD payloads, built by Sandia and Los Alamos national laboratories, look for nuclear detonations around the world, offering real-time information about potential activity to U.S. decision makers. Six additional GBD III payloads are scheduled to be launched over the next several years in support of the U.S. Nuclear Detonation Detection System. (6000)

### Detecting underground explosions for global monitoring

A Sandia team, working with researchers from across the Nuclear Security Enterprise, concluded nine years of field experiments to improve the nation's ability to differentiate earthquakes from underground explosions and advance U.S. global monitoring capabilities. Sponsored by NNSA, the source physics experiments were a series of underground chemical high-explosive detonations at various yields and depths to improve understanding of seismic activity around the globe. Three underground chemical explosions were conducted in FY19, with the final test occurring in June. (6000, 8000)

### Predicting performance of energetic tools

Sandia's nuclear threat sciences organization, partnering with the advanced simulation and computing program, has developed a capability to predict the performance of as-built energetic tools. The capability leverages high-fidelity computerized tomography scans as input for hydrodynamic models, allowing irregularities like voids created by the manufacturing process to be quantified and simulated. Previously, individual tool performance envelopes have been based on historical knowledge and lot sampling; this new capability assesses each tool at each life-cycle stage. This advancement enables high-confidence performance predictions for high-consequence applications. (6000)

### Materials visually reveal tampering

Sandia researchers have designed and developed tamper-indicating materials that could be used in treaty verification. Called "bleeding materials," the materials change color upon mechanical damage, alerting users that an area may have been breached. These materials would allow inspectors to realize penetration of a material simply by looking at a tamper-indicating enclosure. Most traditional methods rely on time-consuming examinations by inspectors or use of cameras or other equipment. (6000)

### Mobile Guardian Transporter Prototype 1

Members of the transportation safety and security program successfully completed assembly of the first Mobile Guardian Transporter prototype, achieving a major milestone for Sandia and NNSA's Office of Secure Transportation in support of the mission to ensure safe and secure over-the-road transportation of nuclear deterrence assets for the coming decades. This major development unit is undergoing a variety of operational and environments testing that will conclude with a crash test planned for the summer of 2020. (6000)

### Biometric security device collaboration

Sandia signed a Cooperative Research and Development Agreement in July with Albuquerque-based Aquila Inc. to develop and test a biometric security system based on the human heartbeat. The technology uses unique electrocardiogram signals streamed in real time from a wearable device to identify a person for security purposes. Sandia will apply expertise in security systems and testing facilities to emulate real-world characteristics in testing access-control prototypes. (6000, 1000)

### Global Burst Detector advances

Sandia executed an aggressive schedule to develop the next-generation GBD payloads for the U.S. Nuclear Detonation Detection System GBD IIIF program. This included completing Engineering Unit 1 testing, supporting all system tests and completing critical design review. GBD IIIF is the follow-on to the GBD III program; the first IIIF satellite payloads are scheduled to launch in 2025. (6000)

### Counter-Unmanned Aerial System installed

Sandia completed several significant physical security enhancement efforts in FY19, including installation of the first counter-UAS at an NNSA site. This has led to additional tasking from NNSA to install counter-UAS systems at three additional sites. Sandia's counter-UAS work is part of its Physical Security Center of Excellence, which supports DOE and DoD in ensuring the security of the nation's nuclear arsenal and special nuclear materials. (6000)



Democratic Republic of Congo lab personnel, Sandia biosecurity experts and Department of State representatives at biosecurity training

### Enhanced Ebola diagnostic lab security

Sandia personnel provided biosecurity subject matter expertise and training for laboratory personnel at the Democratic Republic of Congo's Institut National de Recherche Biomédicale to help secure Ebola patient samples at the research facility and at regional Ebola diagnostic labs. The purpose of this work, conducted during separate engagements in March and June 2019, is to increase the INRB's biosecurity capabilities to secure its Ebola outbreak-related samples. (6000)

### DoD accreditation for security simulation software

DoD accredited Sandia's Dante software for use in DoD physical security studies. Dante is combat simulation software used to inform decision makers and response forces on the effectiveness of existing and future security systems and policy. The software has been used to quantify the impact of new protection concepts employed at multiple high-value facilities. (6000)

### Nuclear physical security training course

The 28th International Training Course on the Physical Protection of Nuclear Materials and Nuclear Facilities was held Oct. 28-Nov. 15, 2019, at Sandia's Integrated Security Facility. About 60 students from 40 countries participated in the course, which is the International Atomic Energy Agency's flagship nuclear physical protection advanced training course. Sandia developed and implemented ITC28 in coordination with IAEA and NNSA. Subject matter experts from Sandia and other U.S. labs provided technical guidance on physical protection of nuclear material and facilities, technology demonstrations and hands-on exercises. (6000)



ITC attendees from Denmark and Malaysia participate in a hands-on exercise demonstrating how different mechanical delays can be effective in physical protection.

### WōWōHa-2019 workshop and hackathon

WōWōHa-2019, the first annual DOE workflow workshop and hackathon, was hosted at Sandia's Livermore Valley Open Campus on March 19-22, 2019. Fifty researchers and practitioners from eight DOE labs and the French Alternative Energies and Atomic Energy Commission (CEA) attended talks on a range of simulation process and data management topics. A series of hackathons was held over two additional days, during which practitioners worked with the developers of a variety of workflow tools, getting hands-on experience with the SPDM capabilities represented. A second annual workshop is scheduled for March 2020. The 2019 event led to increased collaboration across the DOE labs and with CEA. Representatives of the U.K. Atomic Weapons Establishment and vendors have asked to participate in the 2020 event, leading to the establishment of a community of practice. (8000)



Universal Ground Nuclear Detonation Detection System Terminal loaded onto a C-17

### Mobile detonation detection system

Sandia delivered the final Universal Ground Nuclear Detonation Detection System Terminal to the U.S. Air Force, completing a 13-year effort. Sandia designed, developed and performed acceptance testing for UGNT, a mobile ground system for monitoring above-ground nuclear detonations. This system provides data processing for NNSA's space-based nuclear detonation detection payloads. (6000)



### Improving seismic detection accuracy

A Sandia researcher inspects a sensor that looks for vibrations in the ground.

Sandia developed an algorithm that automatically adjusts detection settings from sensors in a network to better detect earthquakes and explosions and tune out common sounds such as traffic and footsteps. In a Laboratory Directed Research and Development-funded project, researchers used seismic data from dormant Antarctica volcano Mt. Erebus to test the software, achieving 18% fewer false detections and 11% fewer missed detections than the sensors' original performance. The software ensures that sensors detect unusual seismic activity as distinct from regular activity for accurate detection rates. Accurate detection rates are important because sensor networks generate a lot of data, but only a small percentage of the data, used to verify compliance with treaties, can be analyzed due to the volume. (6000)

## NATIONAL SECURITY PROGRAMS



*A microelectronics technician at MESA studies a wafer — a thin slice of semiconductor material used in integrated circuits.*

### MESA 8-inch silicon wafer conversion

Sandia's Microsystems Engineering, Science and Applications facility has completed phase one of an anticipated three-year upgrade. The facility is now fully compatible with industry-standard, 8-inch silicon wafers. The conversion from 6-inch wafers will help sustain production of microsystems for national security applications through 2040, with a more sustainable supply of starting materials, tools and service. The tooling upgrade is the first of four steps toward the facility's conversion. The remaining three steps requalify the production line. Prototyping and product development activities have already resumed. (5000)

### Conventional Prompt Strike product transition

In partnership with DoD, U.S. Navy Strategic Systems Programs and the U.S. Army Rapid Capabilities and Critical Technologies Office, Sandia is transitioning government-developed hypersonic technology and capabilities to industry partners, including Lockheed Martin, Raytheon, Dynetics and General Atomics, to enable an initial operational capability that enhances U.S. national security. Sandia has initiated product transition activities, including sharing knowledge via data packages and hosting technical workshops and hands-on trainings with Sandia subject matter experts. Industry partners relocated to Albuquerque to begin working jointly with Sandia to build hardware onsite. (5000, 1000, 10000, 11000)

### West Coast Winter Cohort

The June 2019 West Coast Winter Cohort Cyber Engineering Development Workshop was funded by the Department of Homeland Security and led by Sandia. WCWC attendees performed hands-on engineering development in the cyber-threat landscape, including developing a collection of analytics. Tools developed in the workshop support the DHS National Cybersecurity Communications Integration Center by detecting and mitigating malicious PDF files. Attendees included representatives from DHS, other federal agencies and Sandia. (8000)

### Mobile Guardian Transport environmental testing

In partnership with the MGT program, the engineering sciences validation and qualification team designed, executed and analyzed multiple mechanical and thermal environmental tests that had significant impact to national security. These test series included small to large fire tests, full-scale indoor actuator facility cargo tests and the first full-scale sled track calibration test. Additional collaboration critical to the success of the tests included thermal sciences and engineering; environment, safety and health; advanced science and technology business operations; asset security and WMD business operation; emergency management and nuclear deterrence system organizations. (1, 1000, 2000, 4000, 10000)

### High Accuracy Separation Package

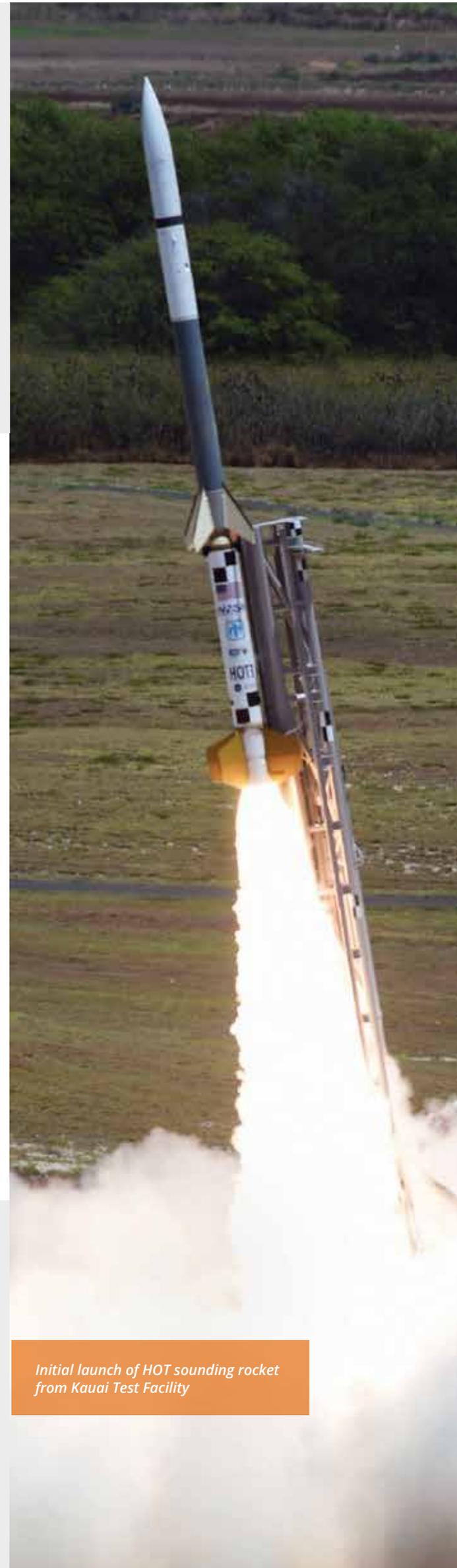
The HASP Product Realization Team successfully delivered a prototype unit in support of the U.S. Air Force NNSA Demonstrator Initiative led by Sandia/CA systems. The Sensor, HASP and Controller prototype unit was delivered three months early, enabling validation of a new telemetry design and supporting the start of system integration testing. The SHaC delivery included all mechanical and electrical infrastructure required to prove the readiness of controller electronics, power systems and a telemetry interface. (5000)

### Formidable Shield 2019 defense exercise support

Sandia participated in Formidable Shield 2019, a multinational, live-fire, integrated air- and missile-defense exercise conducted at the U.K. Ministry of Defence Hebrides Range in Scotland. The exercise included more than a dozen successful live-fire and simulated engagements against subsonic, supersonic and ballistic targets. Sandia provided the navigation systems, flight software and flight termination systems for two successful launches of first-of-kind, thrust-vector-controlled, guided ballistic target missiles. Sandia personnel supported these missiles from design, development, integration and fielding through launch. (5000, 10000)



*The first of two guided ballistic missile targets supported by Sandia during Formidable Shield 2019*



*Initial launch of HOT sounding rocket from Kauai Test Facility*

# NATIONAL SECURITY PROGRAMS

## High Operational Tempo Sounding Rocket Program

Sandia successfully completed two flight campaigns, launching two rockets each in April and August 2019 from its Kauai Test Facility in Hawaii. The tests were a continuation from the successful launch in FY18. The payloads carried experiments designed to deepen scientific understanding and support the stewardship of the U.S. nuclear weapons stockpile. Sandia and Oak Ridge national laboratories partnered to develop the first known additively manufactured rocket nose shroud. The High Operational Tempo sounding rocket program seeks to provide an agile testing platform to validate modeling and simulation assumptions and perform other non-nuclear research. (2000, 5000, 8000, 1000, 10000)

### Additively manufactured rocket nose shroud

In support of Sandia's Strategic Initiative to advance additive manufacturing technology, Sandia and Oak Ridge national laboratories partnered to develop an additively manufactured rocket nose shroud for one of Sandia's High Operational Tempo Sounding Rocket missions. This shroud was built layer-by-layer using a robotic, metal, inert-gas welding process that was developed at ORNL. The finished part was successfully launched in August 2019, reaching a speed of Mach 7.5 and an altitude of about 184 miles, demonstrating the use of additive manufacturing in critical applications. (2000, 5000, 8000, 1000, 10000)



Robotic lay-up of rocket nose shroud pre-machining (about 60-hour build time)

### Artificial Diversity & Defense Security

ADDSec, a 2019 R&D 100 World Magazine Award winner, is technology that automatically detects and responds to cyber threats within critical infrastructure environments in real time. The detection approach uses a set of machine learning algorithms that recognizes anomalous behavior and then classifies those anomalies into categories of attacks. It provides a defensive response that uses software-defined networking to randomize Internet Protocol addresses and application port numbers, invalidating the attacker's knowledge of the network and preventing successful deployment of attacks. (5000)

### Hardware assessments support weapons acquisitions

DoD is relying on a Sandia hardware assessment team to address critical issues affecting major weapons acquisition programs. DoD has engaged Sandia embedded software, device fabrication and system analysis expertise to evaluate the extent of two identified issues and provide prompt, data-driven analysis for the types of problems being addressed. The team's contributions will affect major acquisition programs over the next several years and are a recognition of Sandia as a center of excellence for hardware assessment in support of critical U.S. government missions. (5000)

### Dangerous chemical agent vials destroyed

A quick-response request from the U.S. Army to Sandia's explosive destruction system team to develop a method and equipment culminated in the destruction of 7,200 Chemical Agent Identification Set vials containing mustard agent long-buried and recently discovered at Pine Bluff Arsenal, Arkansas. Sandia's solution enabled the Army to safely dispose of dangerous chemicals that they otherwise had no good, alternative means of destroying. (8000)

### Radio frequency and acoustic wakeup systems

Sandia and partners demonstrated both RF and acoustic wakeup systems that detect vibration, sound or electromagnetic signals for situational awareness and require little power to operate. Both the Microelectromechanical Systems accelerometers and transformers, as well as the complementary metal-oxide semiconductor application-specific integrated circuits were fabricated leveraging Sandia's Microsystems Engineering, Science and Applications Silicon Fabrication facilities. Relevant stimuli are acoustic signatures of particular vehicle types or radio signatures of specific communications protocols important to national security. (5000)

### Life-saving personnel recovery beacons delivered

The advanced radio frequency systems group successfully delivered updated ECHO personnel recovery beacons, achieving a key deliverable. ECHO, a specialized personnel tracking and distress alert system, has been directly responsible for saving the lives of personnel. These high-performance RF tagging, tracking and locating systems stem from Sandia's long history in exquisite RF design for the radars required for NNSA missions. (5000)



Chemical Agent Identification Set vial operation in a P2 Explosive Destruction System unit (Photo courtesy of the U.S. Army Combat Capabilities Development Command Chemical Biological Center)

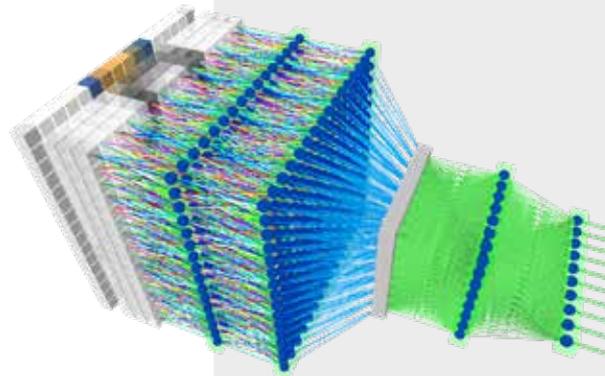
## ADVANCED SCIENCE & TECHNOLOGY



Sandia-designed fuze mounted on High-G test apparatus for a combined environments experiment

### Combined hostile shock, radiation testing

Sandia engineers completed two major experiment milestones focused on reconstitution of combined hostile environments at the Annular Core Research Reactor. The High-G project focused on producing a combined hostile radiation exposure and specifically timed hostile shock application to a test object. These advanced, qualification-like experiments were performed on both a fuze system and material test samples, in preparation for potential future qualification activities for Sandia and Lawrence Livermore national laboratories. These experiments were the culmination of an accelerated 18-month concept-to-completion cycle for the apparatus. (1000, 2000, 8000)



Whetstone can accurately train deep neural networks for deployment on neuromorphic processing hardware.

### Whetstone brain-inspired computing

Signal processing and sensor analysis applications increasingly rely on machine learning via artificial neural networks to make inferences and rapidly identify information. For power-constrained applications, neuromorphic processors that mimic the behavior of the human brain offer a low-power solution, but at the cost of significantly greater programming complexity. Whetstone software trains conventional learning networks to behave like the spiking neural networks required by neuromorphic processors, thereby simplifying development and accelerating time to deployment. Whetstone is an open-source software tool. It has been published in Nature: Machine Intelligence and has been adopted at Oak Ridge National Laboratory, the University of Tennessee and Virginia Tech. (1000)



Hardware installed in containment system on the Z machine

### Temperature of dynamically compressed plutonium

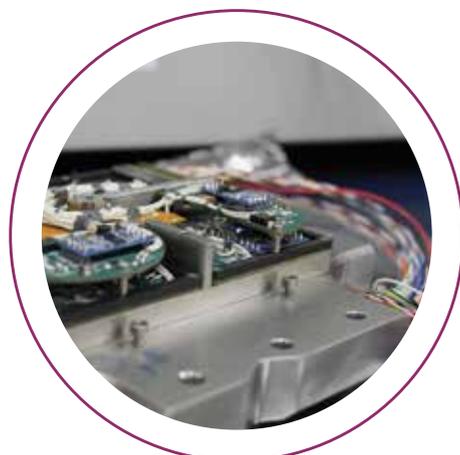
Sandia, in collaboration with Los Alamos National Laboratory and the Nevada National Security Site, measured the temperature of plutonium undergoing rapid compression at Sandia's Z machine. Driving materials with more than 100 thousand times atmospheric pressure, applied over billionths of a second, causes significant heating. This was quantified for the first time in plutonium experiments. The new measurements provide key thermophysical data and greatly enhance researchers' knowledge and confidence in the dynamic properties of plutonium. The measurements were made possible by a multiyear, collaborative development effort for infrared pyrometry in a challenging environment. (1000)



System-generated electromagnetic code-validation experiments were performed on four small-volume cavities and one large-volume complex cavity at various gas pressures. The instrumented cavities were exposed to high-intensity X-rays.

### Nuclear survivability experiments

High fluence X-ray experiments were performed at NNSA High Energy Density facilities: Lawrence Livermore National Laboratory's National Ignition Facility and Sandia's Z Pulsed Power Facility. Sandia, LLNL and others collaborated on system-generated electromagnetic code-validation experiments at NIF. A record seven shots were executed in 48 hours. Similar Cavity SGEMP experiments were performed at the Z facility. Additionally, Sandia conducted experiments at Z that developed the capability to recover material samples exposed to thermo-mechanical shock from simulated warm X-ray insults. Recovery allowed the determination of material failure mechanisms and thresholds essential for establishing material survivability. (1000)



### Power conversion in outer space

Power distribution and conversion are a standard fixture of most complex electrical systems. For outer space applications, power distribution subsystems rely on power electronics with superior reliability in harsh environments. The August Campaign 3 HOT SHOT flight included a payload with power conversion circuits built using Sandia-developed gallium nitride and aluminum gallium nitride materials. These wide and ultra-wide bandgap semiconductor materials exhibit superior performance in these environments. The HOT SHOT flight also helped to establish these components as robust to the mechanical stresses of flight. (1000, 2000, 5000, 6000, LDRD)

Several power-conversion circuits (left image) containing Sandia-developed devices made from advanced semiconductor materials were included on the top deck of the Campaign 2 HOT SHOT flight.

## ADVANCED SCIENCE &amp; TECHNOLOGY

### Energy I-Corps participation doubled

In 2019, DOE's Energy I-Corps funded four Sandia teams — more than any other lab in cohort 10 — and doubled Sandia's participation in the program. Energy I-Corps equips national lab researchers with tools to understand the real-world relevance of their technologies, inform future research and identify viable pathways to market for lab-developed technologies. Sandia's 2019 cohort-funded projects include wear-resistant alloys, ultra-fast X-ray imagers, carbon dioxide memzyme and algae cultivation. (1000, 5000, 8000)



*Energy I-Corps funded a Sandia team that created a membrane loaded with enzymes for cost-effective carbon dioxide capture from gas mixtures.*

### Ion tunable transistor for neuromorphic computing

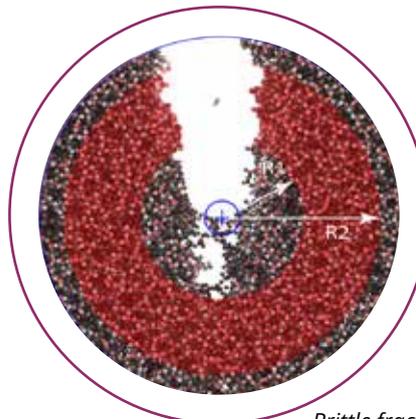
Sandia researchers led a team with collaborators from Stanford and the University of Massachusetts, Amherst, to invent the Ion Tunable Redox Transistor, which has great potential for implementing low-energy artificial intelligence and machine learning based on neuromorphic computing. The work was published in Science Magazine on April 25, 2019, and was awarded a patent (10429343) by the U.S. Patent and Trademark Office. The achievement will strengthen Sandia's leadership in brain-inspired computing and impact Sandia's mission areas, as well as the U.S. microelectronics industry. (8000)



*Sandia researchers test an artificial neural network chip based on the Ion Tunable Redox Transistor.*

### Predictive model of brittle fracture

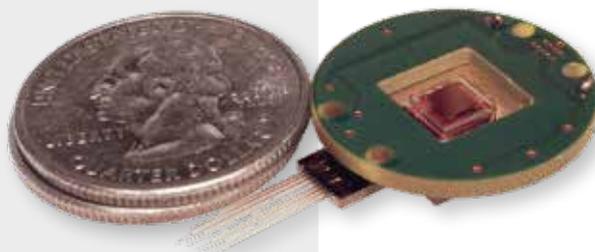
Brittle fracture of glass and ceramic materials is often unpredictable; understanding the crack nucleation and the details of failure is critical for determining component lifetimes. Sandia has developed methods to determine brittle failure from atomistic simulations, linking nanoscale mechanisms to macroscale fracture. This allows for a detailed understanding of the effects of chemical additives (e.g., intentional additives, environmental water) on fracture. A science-based understanding of brittle fracture will enable design of materials that avoid issues with slow crack growth over decades of storage. (1000)



*Brittle fracture in a glass sample*

### Ultra-compact optical power link

Transmitting power by optical fiber rather than metal wire protects electronics from voltage surges (e.g., static electricity, lightning). Optical power links convert electricity to light (laser), transmit that light and convert light back to electricity (photovoltaic). To meet Sandia's needs for harsh environment operation and extremely low size and weight, Sandia developed a unique microsystem platform of heterogeneously integrated chip-scale gallium arsenide photovoltaics that generate from 3.3 to 1,000 volts. Sandia then demonstrated an optical power link operating flawlessly throughout a sounding rocket flight. (5000, 1000, LDRD)



*Photovoltaic array with optical fiber*

### Quantum Scientific Computing Open User Testbed

Quantum computing promises disruptive speed-ups to many algorithms critical to U.S. national and economic security. QSCOUT is a new quantum computing facility at Sandia whose purpose is to assess the potential of near-term quantum computers to address scientific computing applications of interest to DOE and its Advanced Scientific Computing Research program. QSCOUT uses trapped ion qubits that enable high-fidelity gate operations and all-to-all connectivity. The team has designed and realized the initial facility and demonstrated that they can trap ions, perform basic quantum operations and achieve extremely long (8-second) coherence times with the facility. (1000, 5000)

### Autonomy for Hypersonics mission campaign

Sandia's Laboratory Directed Research and Development-funded A4H mission campaign, focused on pioneering autonomous system technologies, has established AutonomyNM, a novel research coalition engaging dozens of faculty and students from across the country. Faculty collaborators contributed to developing an autonomous mission planning solution that rapidly generates flight plans. This solution will enhance U.S. leadership in this critical national security area. A4H currently has 24 collaborations with Sandia's Academic Alliance and other university partners, and it contributed to a University of New Mexico-led, \$5.5 million grant to design autonomous systems responsive to humans. (1000, 5000, LDRD)

### Line VISAR implementation

Measuring the electrical current delivered to nuclear fusion targets on Sandia's Z machine is essential to understanding the target implosions. Over the past three years, Sandia and Lawrence Livermore national laboratories have collaborated to develop the most advanced current diagnostic ever deployed on a pulsed power facility: Z Line VISAR. This instrument provides unprecedented spatial and temporal resolution, delivering critical insight into current losses that may occur close to the target, as well as their potential impact on the fusion yield. (1000)

### Institutional BioSafety Committee consolidation

Sandia conducts biological sciences research in New Mexico and California labs that are regulated by federal, state and local guidelines. For many years, Sandia had two IBCs that governed work in these labs. Management determined that one IBC could govern biosafety activities to meet all applicable requirements. A single IBC was formed to streamline practices, reduce risk and create a unified user researcher experience across the two sites. (8000)

## MISSION SERVICES



### Reducing information technology heterogeneity

Sandia's IT organizations are in the process of implementing a long-term governance strategy, and efforts are already under way to reduce heterogeneity. In FY19, IT published an approved list of hardware, restricting employees to 21 options, down from 36. Linux versions were reduced from 48 to 12; mobile device restrictions were implemented, and more than 400 unused devices were disconnected; 72 environment, safety and health websites were consolidated down to 40; and a process and standards were established to decommission outdated content on the Sandia Restricted Network. The IT organization's efforts should result in an annual savings of \$2.5 million for the Labs. (10000)

### Laboratory Operating System successes

In FY19, Sandia's LOS team supported 115 projects, achieving \$13 million in cost avoidance, 55% reduction in steps, 326 user pain points reduced, 78 standard works created and 469 weeks of cycle time reduced, with an average of 37 days to complete a project. Launched in FY18, LOS is Sandia's approach to Lean in a research and development environment. Its purpose is to increase the Labs' capacity to learn, innovate and respond in rapidly changing environments. (10000)



*Replacement capacitors used in some of the re-spin components are smaller than a Tic Tac.*

### Base Metal Electrode Capacitor re-spin

In FY19, the BME Capacitors failed qualification testing, impacting the B61-12 Life Extension Program and the W88 ALT 370, which led to the need for a component re-spin and re-baseline on both programs. Beginning in July, a team of project managers and project controllers collaborated with Kansas City National Security Campus to develop an integrated schedule for the affected components, complete a \$276 million definitive cost estimate and submit a baseline change proposal to NNSA by September. This was completed in an accelerated timeframe to deliver on the NNSA expectation of implementation by October. (10000)

### Financial partnership with other labs

In FY19, several laboratories, including Pacific Northwest, Argonne, Lawrence Livermore and Lawrence Berkeley national laboratories, SLAC and Fermi national accelerator laboratories, NASA's Jet Propulsion Laboratory and the NNSA Office of Management and Budget actively engaged Sandia for financial best practices and expertise. Topics included implementation of a new financial model, indirect sizing and rates, production accounting handbook and inventory streamlining. (10000)

### New Product Introduction success

Sandia co-lead the NPI initiative with Kansas City National Security Campus to increase design and production integration, apply lessons learned from past nuclear deterrence programs and augment ND development with industry best practices. The cross-Nuclear Security Enterprise effort is accelerating progress and reducing risk on the W80-4 Life Extension Program. NPI created a list of pre-approved, commercial-off-the-shelf parts; piloted an enhanced process for preparing for technical and programmatic reviews; introduced new product development methods used in industry; facilitated the implementation of Programmatic Tier for W80-4, setting the standard for all modernization programs; and facilitated design failure mode and effect analyses for more than a dozen W80-4 components. (10000)

### Enhanced fraud risk management environment

Sandia established a charter and working group consisting of six management and operating contractors, the NNSA Office of Management and Budget and DOE to enhance internal controls. The charter and working group positioned Sandia to lead the NNSA complex in demonstrating a cohesive approach for managing fraud risk in federal programs using the Government Accountability Office framework. Sandia's internal charter and working group are an entity-wide collaboration and include the data analytics working group, internal audit, Office of Management and Budget A-123 program and contractor assurance organizations. (10000)

### Workplace Enhancement Council

Mission Services launched a new Workplace Enhancement Council focused on fostering diversity and inclusion, health and wellness, safety and security, community involvement and mentoring. To date, the WEC team has met with the corporate D&I team and the Mission Services Talent Management Steering Committee to ensure alignment. The WEC team publishes a monthly manager email with recommended activities, videos and other resources to facilitate staff discussion and engagement. They also cosponsored a Sandia presentation, are partnering with Employee Health Services on Labs events and are promoting D&I in the Mission Services quarterly newsletter. (10000)

## MISSION SERVICES

### Telecommunications fail-safe measures

In FY19, strong partnership and proactive planning between Sandia/CA and Sandia/NM ensured continued connectivity following a CenturyLink equipment failure in Santa Clara, California. This equipment failure took down two fiber connections carrying Sandia's primary and secondary paths for inter-site connections. The traffic failed over to a third link provided by a second carrier, as planned. The Labs' intersite configuration, which supports all traffic, but primarily enterprise telephone and the Sandia Restricted Network, Sandia Partnering Network and encrypted Sandia Classified Network, remained resilient and experienced no data loss. Critical work was uninterrupted. (10000)

### Sandia Classified Network enhancements

The Labs' information technology organizations made several improvements to the Sandia Classified Network to improve speed, increase capacity and enhance security. As part of these improvements, two project management tools were deployed on the SCN in FY19, creating greater efficiency by eliminating project management coordination in two environments and reducing risks associated with tracking classified project timelines and budgets in an unclassified environment. (10000)

### Project management maturation

Sandia has categorized 99% of its projects after integrating the existing Project Mission Assurance Category Evaluation and Project Rigor Evaluation tools into a single tool, PrE V3.0, setting Labs-wide standards for project execution. Sandia placed a subcontract for a Labs-wide portfolio management tool and awarded two contract purchase agreements for Agile project management support. Sandia is on the path to implementing a portfolio data management tool that will enable mission-specific portfolios of work that are currently siloed to be viewed and managed from a Labs-wide perspective, to ensure consistent and predictable success of all missions. The project rigor evaluation, portfolio data management tool and contract purchase agreements are steps to ensure processes and tools enable the Labs to meet deliverables and fulfill commitments transparently. (10000)

### Key Labs-level financial planning

Sandia implemented enhancements to key financial planning processes, including projections and indirect budgeting, to enhance effectiveness and strengthen controls. Additionally, Sandia proactively enhanced its annual indirect planning process to lay a foundation to ensure the Labs achieves the 5% congressional indirect reduction in FY20. (10000)



### Computer donations

Sandia's property organization coordinated the donation of more than 1,200 computing assets and hundreds of

monitors and peripherals to 41 schools in New Mexico in FY19. The Labs also donated 61 laptops, 45 monitors, 35 docking stations, 21 printers and multiple boxes of power cords and cables to the Adelante Development Center, a nonprofit organization that supports people with disabilities, seniors and disadvantaged populations across New Mexico. Adelante received these items in time to support their new facility's grand opening. (10000)

### Tiered Accountability

Sandia continues to find value in the Tiered Accountability process and boards, Sandia's approach for communicating regularly to assess performance, identify problems and respond rapidly using a tier structure. The Laboratory Operating System team completed maturity activities for Tiers 3, 4 and 5, summarized results and created improvement action plans in FY19. Tier 5 transitioned to an electronic board, improving content, experiences and metrics and altering content and flow to better align with the spirit and intent of Tiered Accountability. (10000)



### Small business outreach

*Sandia's small business team, from left, Paul Sedillo, Eric Lochausen, Patricia Brown, Marie Myszkier, Del Salazar, Shannon Mulligan, Gabe Hollimon and Leo Valencia*

In FY19, Sandia exceeded all socioeconomic procurement goals, awarding 61.15% of subcontract dollars, valued at more than \$847 million, to small businesses. Sandia received an Office of Small Disadvantaged Business Utilization Director's Excellence Award at the 18th annual DOE Small Business Forum & Expo in recognition of its efforts to educate suppliers on doing business with the Labs. More than 431 small businesses engaged with Sandia in FY19 through small business forums, events and presentations at supplier community events. (10000)

## MISSION ASSURANCE



*Sandia's new high-performance computing facility*

### High-performance computing facility opens

Sandia dedicated its new high-performance computing facility on Nov. 28, 2018. Home to the NNSA-funded Vanguard/Astra Supercomputer, the world's largest Arm-based supercomputer, this fully-automated facility features a 14,000-square-foot machine floor and innovative energy- and water-saving infrastructure technologies projected to save 10-15 million gallons of water per year when the building is fully occupied. This new HPC facility will help to ensure that Sandia remains at the forefront of computational science and engineering and continues to be a leader in HPC research. (1000, 4000, 9000, 10000)

### Sandia-led collaboration finds savings

Sandia worked with contractors throughout the Nuclear Security Enterprise to identify opportunities for cross-complex collaborations that could yield more than \$1.7 million in cost avoidances over three years. Led by Sandia's trusted assurance systems engineering team, the NSE Supplier Quality Working Group included Los Alamos and Livermore national laboratories, Y12 National Security Complex, Pantex Plant, Savannah River Site, Kansas City National Security Campus and Nevada National Security Site. The group achieved its initial goal of sharing supplier assessments across the NSE, avoiding costs of more than \$400,000 in FY19. (9000)

### Quality management system certified

For the first time, the scope of the Sandia Quality Management System ISO 9001:2015 certification was expanded to include both the Albuquerque and Livermore sites. While identifying 15 noteworthy practices, an external audit of both sites found the QMS meets the ISO standard's requirements and is effectively implemented. The QMS enables employees to get things done right the first time. (9000)

### 3D visualization software aids classification

In FY19, Sandia delivered the Weapon Component Visual Information System, a software package offering 3D visualization of nuclear weapon components to improve the accuracy, speed and ease of classification determinations. While ensuring need-to-know access, WCVIS uses a gaming engine and 3D technologies to display models of nuclear weapon components for derivative classifiers across the Nuclear Security Enterprise. Facilitating deeper understanding of components and associated classification information by derivative classifiers, the system mitigates risk of security incidents. (4000, 9000)

### Cyber hunt parties mitigate threats

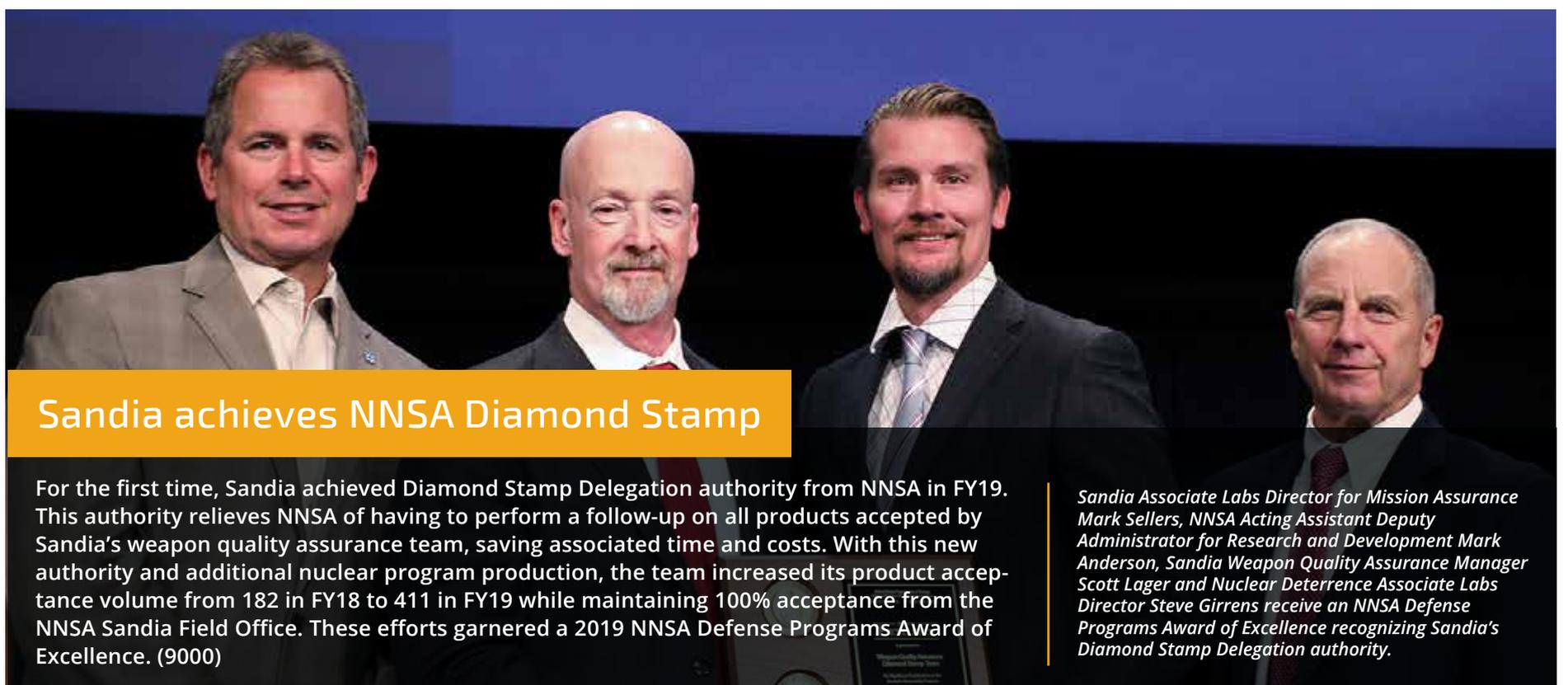
As lead of the NNSA Center of Excellence in Cyber Threat Intelligence, which is comprised of eight NNSA sites, Sandia established twice-a-week cyber hunt parties in FY19. Analysts from across the NNSA sites worked together to actively hunt for adversarial activity in the networks and cyber environments of the participating organizations. This activity led to finding and mitigating 172 new cyber intelligence events. The Center of Excellence is an NNSA-wide capability that better protects each site and strengthens the Nuclear Security Enterprise as a whole. (9000)

### Contractor Assurance System matured

Sandia matured its Contractor Assurance System in FY19 by deploying executive-level issue- and risk-review boards Labs-wide; revising the Labs' operational management review with deliberate links to strategic objectives, Labs-level risks and Performance Evaluation and Measurement Plan objectives; deploying the Labs' Assurance Portal; and expanding Sage, a CAS tool that supports customer feedback, lessons learned and requirements management. Sandia and the NNSA Sandia Field Office hosted senior leaders from DOE, the National Technology and Engineering Solutions of Sandia LLC Board of Managers and the Nuclear Security Enterprise for an NNSA Site Governance Peer Review, which noted several best practices. (9000)

### Qualification Evaluation Releases surge

In partnership with their Product Realization Teams, Sandia's surety engineering team issued 1,975 QERs for products, testers and processes in FY19, in support of modernization programs. This represents a historic high since the current tracking method began in FY04 and a 500% increase over FY17. (9000, 2000, 5000, 8000)



### Sandia achieves NNSA Diamond Stamp

For the first time, Sandia achieved Diamond Stamp Delegation authority from NNSA in FY19. This authority relieves NNSA of having to perform a follow-up on all products accepted by Sandia's weapon quality assurance team, saving associated time and costs. With this new authority and additional nuclear program production, the team increased its product acceptance volume from 182 in FY18 to 411 in FY19 while maintaining 100% acceptance from the NNSA Sandia Field Office. These efforts garnered a 2019 NNSA Defense Programs Award of Excellence. (9000)

*Sandia Associate Labs Director for Mission Assurance Mark Sellers, NNSA Acting Assistant Deputy Administrator for Research and Development Mark Anderson, Sandia Weapon Quality Assurance Manager Scott Lager and Nuclear Deterrence Associate Labs Director Steve Girrens receive an NNSA Defense Programs Award of Excellence recognizing Sandia's Diamond Stamp Delegation authority.*

## EXECUTIVE SUPPORT GROUP



## Executive Protocol supports 204 events

*Sandia's Protocol team organized and facilitated a visit to the Labs from then Energy Secretary Rick Perry at the beginning of FY2019.*

Sandia's Executive Protocol team members are trusted advisors and subject matter experts on the accepted practice of diplomatic and business etiquette. Executive Protocol supported 204 events with successful outcomes in FY19, representing the best of Sandia, including but not limited to the National Laboratories Director Council, Life Saver Recognition Ceremony, Defense Science Study Group, Assistant Secretary visits, numerous congressional visits, external advisory boards, general officers and the National Security Leadership Development Program. (ESG)



## Overexertion corporate initiative

Sandia's environment, safety and health organization had a tremendous FY19 with its corporate initiative on preventing overexertion. The initiative resulted in a 70.92% reduction in overexertion recordable injuries Labs-wide. The impact was far-reaching, well exceeding the 50% reduction target by integrating the initiative into the Work Planning and Control process and critical-thinking mindset of Sandia's workforce. (ESG)

## Pressure Systems Registry

Sandia's environment, safety and health organization identified a gap in knowledge related to pressure systems (positive and negative) across the Laboratories and launched a pressure-system registry to capture basic information and identify the total number of systems. Capturing and maintaining the information will help Sandia meet regulatory requirements, reduce risk, enhance workforce safety and support the Labs' mission. (ESG)

## Internal audits mitigate risks

Sandia's Independent Audit and Ethics/Equal Employment Opportunity organization continued internal audits and investigations to identify potential risks to Sandia. Thirty audits were completed in FY19 to evaluate internal controls, compliance and best practices in environment, safety and health; computer information technology and cyber; and financial processes. The audits identified best practices and vulnerabilities that could be corrected to avoid process failures and preempted external government bodies' potential audit findings. The investigations program assured compliance with EEO law and ethical corporate practices through awareness training and implementation of critical inquiries and investigations. (ESG)

## Strategy and Executive Operations

Sandia researched and evaluated seven visionary themes that cross-cut multiple missions with the potential to dramatically enhance the Labs' national security impact over the next 20-30 years. The evaluations will influence investment and partnership decision-making to deploy outstanding engineering, science and technology to the Labs' missions. Sandia accomplishments have directly supported NNSA Strategic Vision desired outcomes and mission priorities. Four strategic pillars were identified to make Sandia more agile and remove barriers to speed, flow and impact. Sandia developed near-, mid-, and far-term roadmaps outlining completion activities. (ESG)



## INFRASTRUCTURE OPERATIONS



*Sandia's emergency responders were recognized in a special ceremony for their life-saving actions.*

### Sandians save lives

Sandia's emergency responders addressed 91 medical issues in FY19, including 911-based medical responses in the field and transports out of the Sandia Medical Clinic. When clinic paramedics respond to a medical call in the field, they team with Sandia Emergency Medical Technicians and Protective Force officers. Sandia emergency response team members have encountered patients experiencing life-threatening medical issues, including cardiac arrest, and have saved eight lives in the past several years. (4000, 3000)



*A new 20,000-square-foot building on Sandia's Albuquerque campus will house support personnel for the Labs' Z Pulsed Power Facility.*

### Building facilities to meet growth

Sandia manages a complex framework to acquire, maintain, modify and dispose of real property assets. In addition to a strategy that outlines highest-priority investments through 2040, Sandia is executing on its five-year build plan. New facilities that will change the footprint of Sandia include: five office-support buildings in California and New Mexico that will accommodate more than 600 people, a new California data center, a power sources capability site, a sprung structure, a radiation protection instrumentation calibration facility, an explosives manufacturing facility and an agile high-bay laboratory. (4000)

### New approach to managing space

Expanded workforce hiring in 2019 significantly increased the demands for office and lab space. Paired with space optimization strategies that seated 978 individuals in new spaces, Sandia also acquired two offsite leases that will temporarily house approximately 600 employees through FY25. Moving those employees until new facilities are completed will free up needed space onsite for those performing classified work. Additional parking is also planned. The Labs' short-term tactical lease approach garnered an NNSA Award of Excellence for balancing onsite and offsite needs. (4000)

### Critical infrastructure investments

Sandia completed a record 3,392 projects in FY19, totaling \$177 million, including critical utility and recapitalization projects. Key projects included renovations to the Annular Core Research Reactor; a five-year project to eliminate failure risk on an acid exhaust main duct; installation of a new backup natural-gas-fired power generator; replacement of several water and natural-gas lines; completion of an electrical distribution reliability project; design of a chilled water loop and central utility building in Tech Area IV; and replacement of more than 30 roofs. (4000)



*Crews test equipment as they work on the electrical distribution system reliability project in Tech Area V.*

# INFRASTRUCTURE OPERATIONS

*New employees stream into the auditorium for their comprehensive security briefing, led by Rob Kim and Sylvia Chavez. Sylvia (pictured) earned a 2019 NNSA Excellence in Security Awareness Award.*



## Safeguards & Security training program expands

When onboarding new employees, providing proper training and introduction to Sandia's security culture is essential. To meet the demands of 1,917 new employees last year, the capacity of the Labs' DOE-required live comprehensive security briefing increased by about 60%. In addition, a new clearance holder orientation was developed and deployed for the 3,010 individuals who received a clearance or transferred to a new program in FY19. (4000)

## Protecting people and property

To ensure Sandia's aging fire protection and emergency notification systems continue to keep the workforce and facilities safe during emergencies, a three-year effort to replace and test these vital systems neared completion in FY19. In addition to upgrading about 25% of sprinkler heads and replacing obsolete fire alarm panels, Sandia deployed a new mass notification network using text and email messaging. Additionally, Sandia's Protective Force welcomed 13 new officers, and in conjunction with other emergency responders, completed 23 interagency active-assailant response exercises to refine their skills. (4000)



*Aerial photo of Sandia/NM Tech Area I*



*Sandia's legacy classified weapon characterization and disposition team*

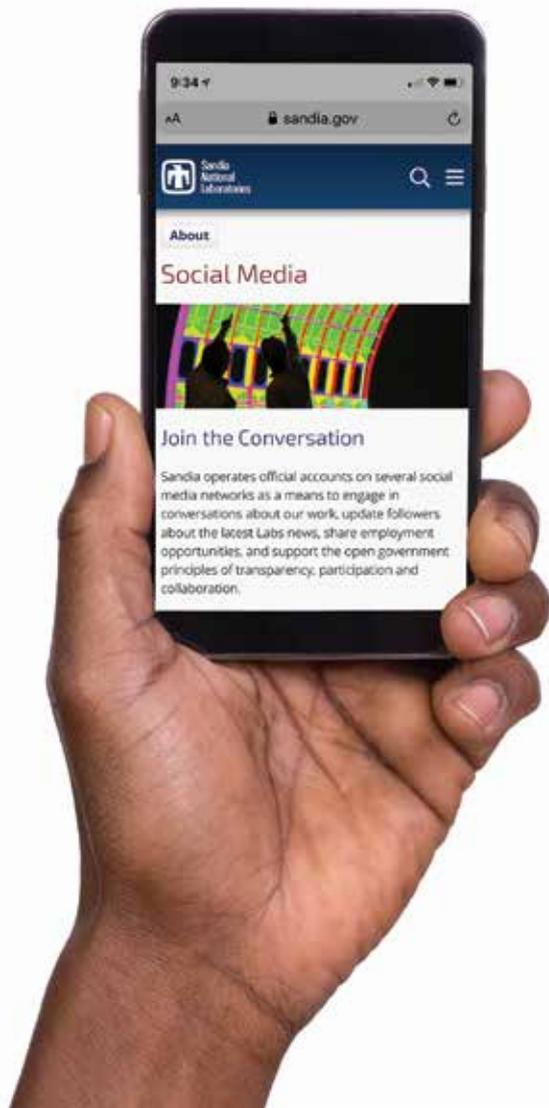


*Roger Showalter*

## Sandians win prestigious NNSA Awards

Roger Showalter was named the 2019 NNSA Bradley A. Peterson Contractor Security Professional of the Year, recognizing outstanding security professionals. Roger helped achieve a 95% reduction in incidents associated with high-security work areas. Sandia's legacy classified weapon characterization and disposition team earned a 2019 NNSA Defense Programs Award of Excellence for coordinating the characterization and disposition of more than 200 legacy weapon items, including more than 2,500 kg of accountable nuclear material. (4000)

## ■ HR & COMMUNICATIONS



### Social media connections and awards

Sandia's communications team received its fourth consecutive 2019 APEX Grand Award for social media campaigns and strategy. The campaign resulted in Sandia surpassing 70,000 Twitter followers and 50,000 LinkedIn connections, both of which lead all DOE labs. This is significant considering that some DOE labs, including Argonne, Stanford Linear Accelerator Center and Lawrence Berkeley, are in major metropolitan areas. (3000)



### Efficient and effective hiring

Sandia met a record-high goal of hiring more than 1,900 employees during FY19, which is an increase of 50% over FY18 and the highest number of annual hires in Sandia's history. This was achieved while maintaining a focus on finding diverse, high-caliber talent, deploying key initiatives to simplify the hiring process and reducing the hiring-cycle time by 30%. (3000)



### Effective and efficient health services

The Sandia Medical Clinic successfully renewed its American Association of Ambulatory Healthcare 3-year accreditation, a status that has been active continuously since 1999. In collaboration with external healthcare industry leaders, Sandia has used clinical risk utilization management tools to eliminate unnecessary services and improve onsite care. Initial savings have been shown in several areas, including pharmacy, onsite blood-draw lab and X-ray test services. (3000)



### Diversity excellence and national recognition

Sandia was recognized as one of America's Best Employers for Diversity by Forbes Magazine. In FY19, the Labs' efforts to create a culture shift in inclusion and diversity reached 39% of the workforce, with focused concepts delivered through online and classroom resources. Sandia was also recognized by Forbes Magazine as one of America's

Top 500 Best Large Employers. Coming in at 277, Sandia was the only DOE lab and the only New Mexico-based entity on the list. (3000)



### Interview Resource Center goes live

Sandia's interview framework team was created in response to hiring managers and employees asking for interviewing resources to help ensure we hire the best talent for Sandia's mission. With that in mind, the team created a comprehensive Interview Resource Center that includes 18 interview resources and guides, an interview question repository with more than 500 questions and an interview

wizard. The team also created eLearnings on how to conduct effective and appropriate interviews. (8000)

## LEGAL ■



## Freedom of Information Act activity management

Sandia's FOIA team, in collaboration with NNSA and the Sandia Field Office, developed a new process to strengthen final responses in protecting national security information. In FY19, the team created information technology tools to expedite the new process and reduce processing times, resulting in better efficiency, quality and delivery. The FOIA team was recognized for its achievements by the NNSA FOIA Director in the Intermediate Feedback Report. (11000, 4000)



*Cindy Lovato-Farmer,  
Senior Managing  
General Law &  
Litigation Counsel*

## Effective Legal partnership with management

The Sandia General Law Center's strategic approach to legal partnership with management and proactive risk mitigation resulted in zero litigation at the end of FY19 and a significant state tax refund award to the Labs. Combining hands-on training for managers that uses actual Sandia case studies of past personnel matters with in-house legal expertise and active involvement in handling litigation and claims proved to be an effective strategy. The team's proactive efforts have had a positive impact across the Labs, as reduced litigation and effective handling of claims enables Sandians to focus on mission. (11000)

## OTHER ■



## Innovative license for startup success

*A researcher stands near Sandia's Annular Core Research Reactor, where scientists discovered a way to make medical isotopes.*

Sandia's molybdenum-99 nuclear reactor concept provides an efficient, cost-effective way to produce enough Mo-99 to meet current world demand. Sandia's licensing and legal teams worked with startup Eden Radioisotopes on a unique license structure customized for a company entering a highly regulated industry and requiring substantial investment. Its flexible structure enabled Eden to seek funding and permits to build a medical isotope production facility in New Mexico and will make the state a key player in meeting the world's need for Mo-99. The licensing effort won a Federal Laboratory Consortium award. (1000, 11000)

