

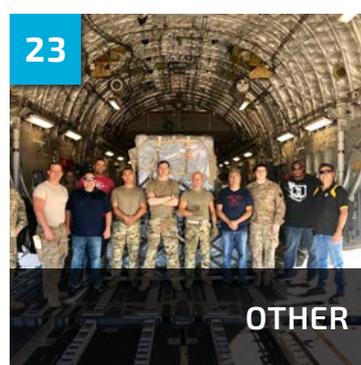
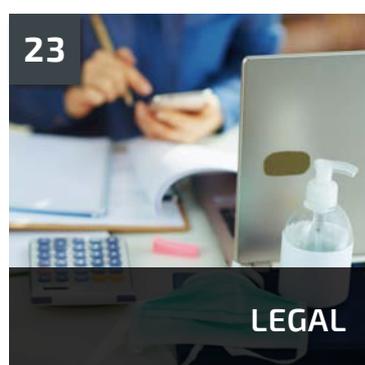
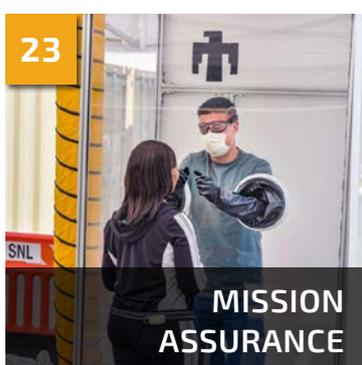
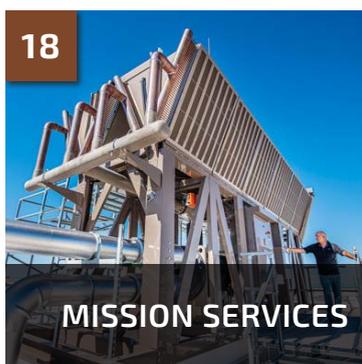
LABS ACCOMPLISHMENTS



SANDIA LABNEWS
March 2021

*Exceptional service in the
national interest*

CONTENTS



A letter from the Labs Director



This issue of *Labs Accomplishments* has special meaning considering the year it reflects. To say 2020 was challenging is an understatement. The global COVID-19 pandemic left no corner of our lives, work and institution untouched. But Sandians delivered, and this publication is a record of those remarkable accomplishments.

It is impressive. This edition of *Labs Accomplishments* is overflowing with successes by the Sandia staff. They range from critical milestones in our key mission areas to scientific breakthroughs from Laboratory Directed Research and Development to valuable advances in support operations. They show Sandians using multidisciplinary skills to fulfill our national security missions against a wider range of threats than ever before.

You'll read about Sandia's comprehensive COVID-19 response that allowed us to keep our sites safe while continuing our critical work. You'll read about Sandians' generosity in a time of extreme crisis. You'll read about leadership in safety and security, quality and employee benefits. And you'll read about contributions to stockpile stewardship, homeland protection, energy security, national and international partnerships, and emerging cybersecurity threats.

There is much, much more, touching everyone who works at our laboratory. Each Sandian plays a role. Each accomplishment is the product of a team of talented and dedicated staff performing at the top of their game.

These achievements would be impressive in any year but against the backdrop of a global pandemic they are even more extraordinary. So please take time to look through *Labs Accomplishments* and be proud of your work, of your colleagues and of being a Sandian in service to the nation. I know I am.

James S. Peery, Labs Director

COVER FEATURES

Photos by
Randy Montoya



FRONT COVER

Warren Davis has been recognized for his consistent leadership in discovering, developing and implementing new machine learning technologies. He's shown at Sandia's supercomputing center.



BACK COVER

Sandia designed and built this dry cask simulator for reactor assemblies to study how hot spent nuclear fuel will get during storage and how peak fuel temperatures affect the integrity of storage casks over time. It uses electrical heaters shaped like fuel rods instead of spent nuclear fuels in the otherwise prototypical fuel assembly.



Throughout this year's edition, work that was performed in response to the global pandemic is indicated with a COVID-19 icon. Many of the photos in this edition, which covers Sandia activities between September 2019 and September 2020, were shot prior to the implementation of COVID-19 mask-wearing and other restrictions halfway through the fiscal year.

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Sandia National Laboratories

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NUCLEAR DETERRENCE



B61-12 ACCD release

The Aircraft Compatibility team, with the assistance of the B61-12 Systems teams, successfully released the first B61-12 Aircraft Compatibility Control Drawing (ACCD) for the F-15E aircraft. The ACCD is critical to the B61-12 Major Assembly Release, which certifies the extent to which this weapon design meets its Military Characteristics, Stockpile-to-Target Sequence and applicable interface requirements. The ACCD release, which culminated over six years of testing and analysis, granted F-15E and B61-12 compatibility and codified that the electrical and mechanical interfaces meet requirements. (2000)

B61-12 compatibility testing with the F-15E at Nellis Air Force Base in March 2020.

B61-12 Life Extension Program achieves stockpile acceptance

A Final Design Review and Acceptance Group panel met in September to determine compliance of the B61-12 final design with requirements. The panel concluded that NNSA, Sandia and Los Alamos National Laboratory have successfully demonstrated that the B61-12 meets all safety and surety requirements and is fully qualified for all evaluated environments. The panel recommended acceptance of the B61-12 as a Limited Stockpile Item, with acceptance as a Standard Stockpile Item upon successful completion of the Qualification Design Review of the Base Metal Electrode capacitor respin qualification testing. (2000)

The B61-12 meets all safety and surety requirements and is fully qualified for all evaluated environments.



ND programmatic equipment investment tool

The Nuclear Deterrence (ND) Program Management Office led a multidivisional (divisions 1000, 2000, 5000, 6000, 8000 and 9000) effort to create a tool to manage programmatic capital equipment inventory and investment needs to sustain ND capabilities. This tool improves the efficiency, consistency and traceability of equipment needs to capabilities, and provides a single integrated list to rapidly prioritize investments across the ND portfolio to enable rapid decision making in response to funding opportunities and operational needs, and to improve annual NNSA Future Years Nuclear Security Program budget planning. (2000)

W76-2 final production unit

The W76-2 program was executed on a highly accelerated timeline to implement the Nuclear Posture Review's direction to develop a low-yield submarine-launched ballistic missile. The work of the Stockpile Systems Product Realization team jointly with teams across the Nuclear



W76-2 first production unit at Pantex.

Security Enterprise laid the foundation for successful execution. The program started with a 6.2/6.2A study in January 2018 and completed first production unit on February 2019. The W76-2 was accepted into the U.S. nuclear stockpile by the DoD and the W76-2 final production unit was completed in June 2020. (2000)

NUCLEAR DETERRENCE

Successful W88 ALT 370 respin qualification testing

Over the past 18 months, the W88 ALT 370 program rapidly responded to capacitor respin, and successfully planned and executed a series of qualification tests and analyses necessary to prove in new respin designs and in support of a System Qualification Evaluation Release. This included testing under an array of environments, such as electrical, radiation and missile integration, at the major component, subsystem and system levels. This monumental effort was accomplished with collaboration and support across the Labs. (1000, 2000, 5000, 9000, 10000)

Snapshots of radiation testing and D5 missiles from qualification flight tests.



B61-12 conducts F-35A testing

The B61-12 Life Extension Program (LEP) completed umbilical certification pull testing and aircraft integration testing for the F-35A fighter jet. These tests ensure that the umbilical cable will accurately separate from the weapon, and that the weapon integrates with platform software and hardware. In addition, an F-35A aircraft successfully delivered one B61-12 Guided Test Vehicle flight test unit at the Tonopah Test Range on Aug. 25, 2020. This flight test was the first of four Enhanced Fidelity Instrumentation flight test units planned for F-35A compatibility testing. (2000)



B61-12 LEP F-35A flight test.

Creative telemetry training for staff

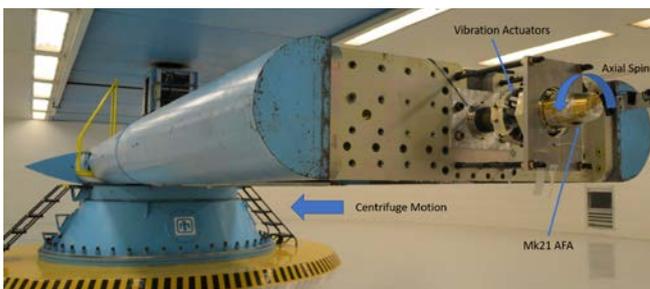
ND Weapon Engineering Professional Development transformed mandatory training during the pandemic by creatively using online training methods, allowing members of the workforce to comply with COVID-19 guidance and remain current with all ND training requirements. The new approach offers classes via live e-learning platforms and through previously recorded sessions. Examples include several comprehensive, multiday telemetry and telemetry software analysis tool training classes. Over 95% of existing training was made available, enabling over 3,300 students to remain up to date while effectively eliminating possible COVID-19 exposure. (2000, 5000, 8000)



Four decades of telemetry transmitters support various Sandia systems.

Mk21/AFA superfuge combined mechanical environments

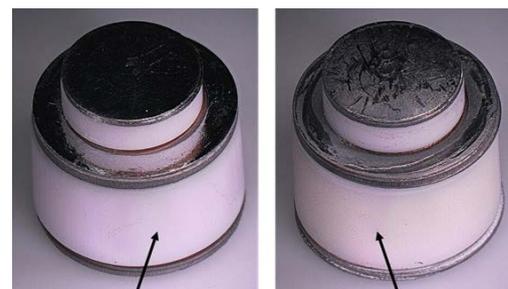
The Mk21 Arming Fuzing Assembly Qualification team, along with the Mechanical Environments team, successfully conducted the first combined mechanical reentry environments test with fully powered, operational test hardware. The Tech Area III superfuge test consisted of three simultaneously applied normal mechanical reentry environments, including acceleration, axial spin and random vibration. This new capability further closes the gap between flight and ground testing in the Nuclear Deterrence community at Sandia and the DOE complex. (1000, 2000)



Mk21 AFA mounted on the end of the Tech Area III superfuge arm.

Demonstration of additively manufactured (AM) sprytrons

A fully functional sprytron was demonstrated using an AM alumina ceramic body printed on a ceramic AM capability newly commissioned in house at Sandia. The supplier of the AM tool is certified to formulate Sandia's proprietary base material. The AM ceramic brazed hermetically, and life testing indicated equivalent performance to conventional sprytrons. This demonstrates the potential to shorten the sprytron ceramic body procurement cycle by up to 75% and enables incorporation of new insulator design features and creation of parallel design variants during development cycles. (2000)



Additive manufactured alumina ceramic body

Conventional alumina ceramic body

Cycle 25 annual assessment

Sandia delivered the Laboratories Director's annual nuclear weapons stockpile assessment letter, which summarizes the safety and reliability of the nation's nuclear weapons stockpile. Sandia conducted a two-week Laboratories Director nuclear weapons program review and organized the Labs' participation in the U.S. Strategic Command's Strategic Advisory Group Stockpile Assessment team review. Each review adhered to COVID-19 safety protocols. The unprecedented amount of logistical planning and coordination for these reviews was extremely successful. (1000, 2000, 3000, 4000, 8000, 9000)



Labs Director James S. Peery signing the annual stockpile assessment letter.

NUCLEAR DETERRENCE



The 16-inch Mobile Davis Gun during test firing. The reaction mass exiting the top of the gun is visible at the top of the image.

Stockpile responsiveness Davis Gun testing

Sandia's Stockpile Responsive Program team successfully completed a series of tests in July and August 2020 using Sandia's unique 16-inch Mobile Davis Gun. With an internal barrel diameter equal to the largest of the famed U.S. WWII battleships, the 16-inch Davis Gun can shoot payloads up to 2,000 pounds at high speeds. The team used the Davis Gun tests to provide valuable experimental data for comparison to computer simulations that model impact at high speeds. (1000, 2000, 5000, 8000)



GTU1A test unit impacting rigid target.

W80-4 abnormal drop testing

Six drop tests executed from January through March 2020 comprised the successful completion of the Abnormal Shock Breach Phase 1 test series, culminating in the GTU1A drop from 285 feet. The tests were conducted at Sandia's Tech Area III Drop Tower Complex in Albuquerque, in partnership with Lawrence Livermore National Laboratory. This test series will provide critical data for qualification teams to further understand W80-4 system response in abnormal mechanical environments. (600, 1000, 2000, 4000, 8000, 9000)

ALT 370/940 production readiness

Production readiness for the W88 ALT 370 and W88 ALT 940 programs achieved a substantial milestone with the completion of Production Capability Units (PCU). The W88 ALT 370 program completed the second of two production capability units exercising the entire suite of assembly, disassembly and satellite facility operations. The W88 ALT 940 program demonstrated readiness by performing its first PCU. (2000, 9000, LANL, Pantex, Lockheed Martin)

War Reserve parts delivered

Despite the COVID-19 pandemic, Sandia's Production Agency delivered more than 38,300 war reserve parts in eight technology areas — power sources; explosives; neutron generators; Application Specific Integrated Circuits; Heterojunction Bipolar Transistors; Switch Tubes; ISA; and timers/detonators — affecting 71 major components. Sandia manufactured all NG, ASIC, HBT, and ISA parts on-site, more than 24,800 parts for 38 major components. (2000, 5000, 9000)

Aircraft Compatibility personnel install flight instrumentation in an air-launched cruise missile system.



B-52H/W80-1 comprehensive test completed after years of delays

The Aircraft Compatibility team, with the assistance of the W80-1 Systems team, successfully completed comprehensive ground and flight testing on the B-52H aircraft. This test had been delayed for several years and required coordination with NNSA leadership, the commander of U.S. Air Force Global Strike Command, and the Air Force Nuclear Weapons Center. Joint USAF and Sandia testing was successfully completed across multiple aircraft at Minot and Barksdale Air Force Bases to assess continued aircraft and weapon interface compatibility despite the constraints associated with COVID-19. (2000, 8000)

NUCLEAR DETERRENCE



Sandia ISA production

P19 delivery to the field.

Center 2500 has delivered significant ISA Production milestones, utilizing rapid development and production cycles. These include achieving Multi-application Transportation Attachment Device development build and process prove-in for the ALT 940 amid pandemic challenges, completing production, acceptance and deliveries for the ALT 372, and completing production and acceptance for the P19 program. Executing this work involved close coordination and partnership with teams across Sandia, Los Alamos National Laboratory and the Kansas City National Security Campus. Achieving these milestones demonstrates Sandia's ability to deliver rapid production to meet urgent program and national security needs. (2000)

Neutron generator foundation bus interface

Ferroelectric and electronic neutron generators were the first components to successfully integrate a timed input/output module to help realize distributed-bus-based architecture for future systems. This endeavor encompassed functional demonstration and environmental testing of packaged form factors in mechanical shock and thermal extremes. This standardized interface is the first step in enabling backward and forward compatibility to realize the vision of system agility through block upgradability. Next steps include the challenge of operating in other environments. (2000, 5000, 8000)

Advances in modeling dense plasmas

Scientists in the Neutron Generator Enterprise have developed a powerful new capability to model the dense, low-temperature plasmas used in these devices. By enabling 1,000-10,000 times faster simulation of the plasmas, this capability provides new insights into the normal and abnormal behavior of ion sources and allows for rapid exploration of design ideas and trade-offs with increased confidence. This capability is a critical element of a complete numerical model for these components, thus enabling a "digital twin" development. (2000)



Nuclear Deterrence Strategy v3.0

The ND and Weapons Science & Technology programs initiated a years-long integrated effort to drive technology, capabilities and processes to a more responsive/agile state for an uncertain future. The ND Strategy v3.0 provides a strategic framework to position Sandia to assure U.S. nuclear deterrence in a rapidly changing global environment. It provides a strategic vector and shapes priorities regarding sustainment of our capability-based science and engineering foundation. Strategic execution, via exemplars spanning the product lifecycle and Sandia's programs, will drive to near-term impact and long-term transformation. (1000, 2000, 5000, 6000, 8000, 9000)

Completion of ALT 372



ALT 372 maintenance crew.

Division 2000 provided technical oversight for the U.S. Air Force to successfully deliver ALT 372. The on-site technical observers resolved Unsatisfactory Reports in real time, enabling mission success. Division 2000 provided Disablement Management System (DMS) 1st Generation Training to 63 personnel to three OCONUS Munitions Support Squadrons and published key UD1702-2 DMS Technical

Procedure updates. Sandia's unwavering support allowed the Air Force to execute this DMS Surety Program during the unprecedented COVID-19 pandemic. (2000)

NUCLEAR DETERRENCE



An unarmed Minuteman III intercontinental ballistic missile launches during a developmental test on Feb. 4, 2020, from Vandenberg Air Force Base.

Mk21 Fuze major milestones achieved

The Mk21 Replacement Fuze program achieved several major milestones in FY20, including a successful developmental flight test, a programmatic re-baselining up to First Production Unit and completion of numerous developmental test series. The program received a favorable pass with no conditions at the Final Design Review. The program is now pivoting to Process Prove-In and is on track to provide the U.S. Air Force with a modern arming and fuzing capability for the strategic land-based deterrent. (1000, 2000, 8000)

W80-4 WHC DB1 design and build

After a major system design change on the W80-4, the Warhead Case team, including the Lightweight Structures Lab, worked closely with systems, the Mechanical Computer Aided Design team and the Kansas City National Security Campus to successfully redesign and build new hardware in less than a year. This major achievement for the team is even more impressive with the ongoing constraints of the pandemic. (8000)

Sharing supplier evaluations saves \$1 million

Saving a projected total \$1 million in FY20 and FY21, Sandia and Kansas City National Security Campus co-led an effort that allows secure sharing of supplier assessments across the Nuclear Security Enterprise. Los Alamos National Laboratory subsequently used Sandia's audit of an electronics parts supplier in its quality management system review of the same supplier, saving employee time and associated costs. This marked the first time LANL used a Sandia audit report to complete such a review. (9000)

W88 ALT370 Telemetry First Production Unit

The W88 ALT370 Telemetry Assembly supporting the Joint Test Assembly 8 achieved the First Production Unit milestone in June 2020. The Kansas City National Security Campus produced the unit, which was successfully incorporated into the next level assembly and delivered to Pantex. (2000, 8000)



The Weapons Quality Assurance team joined Deputy Labs Director Dori Ellis and Director James S. Peery at a recognition event.

Sandia processes record number of weapons components

Sandia processed a record number of components for weapons, neutron generators, power sources, energetics and microelectronics during FY20. The Labs' quality processing of 458 product submittals exceeded its most recent eight-year average by 195%. Sandia's weapons quality assurance team accepted 113,919 units into the stockpile, up by more than 140% over FY19. Innovating to fulfill its critical mission during the pandemic, Sandia also completed its first-ever virtual visual quality inspections. (9000)

NUCLEAR DETERRENCE



Sandia HPC among world's fastest

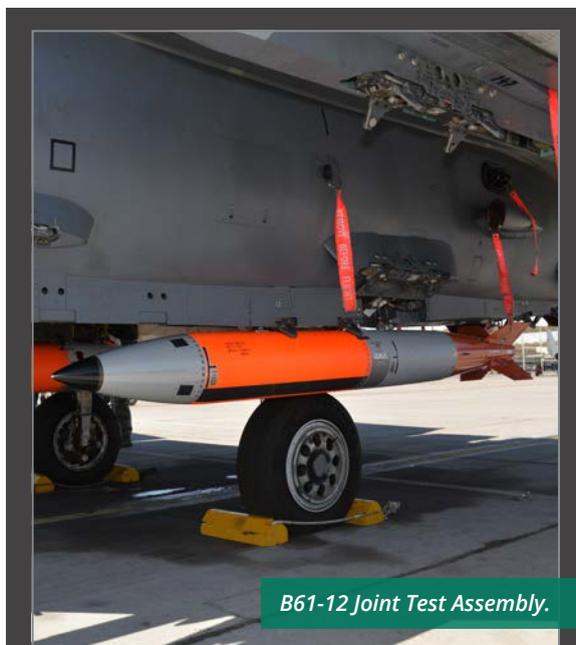
Sandia's Attaway High Performance Computer placed 94th on the November TOP500 list of the world's fastest supercomputers, with a Linpack benchmark of 2.7 PetaFLOPS. A more advanced sister system, Manzano, acquired at the end of FY20, will be placed into operation in early FY21, with expected Linpack of 4.3 PetaFLOPS. Between the two systems, Sandia has added more than a billion processor-hours per year to serve the computational needs of its national security missions. The system was named to honor the late Sandia engineer Steve Attaway. (9000)



The W80-4 team completed extensive testing of the Environmental Test Unit 1, collecting data needed to qualify the W80-4 warhead. Testing included multiple temperatures and a telemetry system to capture internal and external environments.

Qualification testing proves flight worthiness of W80-4 test unit

The W80-4 team completed extensive testing to demonstrate flight worthiness of the Environmental Test Unit 1, an instrumented test asset that provides captive carriage environmental data for warhead qualification. A pre-ETU1 test unit withstood vibration and shock testing at multiple temperatures to prove survivability and proper function for a full ETU1 lifetime. The testing also demonstrated the robustness of the warhead design — including new bolted joints — in transportation and captive carry flight environments, and supported on-time delivery of ETU1s to the Air Force. (8000)



B61-12 Joint Test Assembly.

B61-12 Telemetry First Production Unit

Telemetry supporting the B61-12 Joint Test Assembly achieved the First Production Unit milestone in January 2020. The unit, produced by the Kansas City National Security Campus, was successfully incorporated into the next level assembly and delivered to the Pantex Plant in Texas. (2000, 8000)



Equipment is staged for the opening of the Sandia Programs Engineering and Assembly Research (SPEAR) facility in summer 2020. The SPEAR team supports test and assembly activities needed to ensure the W80-4 design meets requirements.

SPEAR expands California test, assembly capacity

The Sandia Programs Engineering and Assembly Research facility opened in summer 2020, providing state-of-the-art assembly and electrical testing capabilities for current and future modernization programs. The SPEAR team promptly completed several milestones, including CASE 1, one of the most comprehensive builds of the W80-4 to date. The team also delivered two W80-4 Warhead Electrical System decks for environmental testing and qualification, updated numerous W80-4 Fit Check Unit-3s with design modifications and developed complete 3D-printed parts for W80-4 cutaway construction. (8000)

ENERGY & HOMELAND SECURITY



Francisco Alvarez works on the supercritical CO₂ loop attached to the particle-to-sCO₂ heat exchanger on top of the solar tower at Sandia's National Solar Thermal Test Facility.

First sCO₂ loop integrated with concentrated solar power generation

Sandia achieved the first on-sun heat transfer from falling particles to a supercritical carbon dioxide heat-exchanger system at design pressures and temperatures. Particles were heated to 800 C using concentrated sunlight at the National Solar Thermal Test Facility. The heat was then transferred through a primary heat exchanger to the working liquid supercritical CO₂. The heat exchanger is the world's first to transfer heat from particles in a moving packed bed to supercritical CO₂ at design temperatures and pressures greater than 700 C and 20 megapascals pressure. (8000)

Strategic Petroleum Reserve filled successfully

In response to a presidential directive to fill the U.S. Strategic Petroleum Reserve, Sandia led rapid development, integration and documentation of an oil quality characterization program. The assessment provided specific, actionable recommendations to DOE on maximizing inbound crude oil compatibility with current SPR inventory and maintaining operating requirements for both near-term oil volatility upon return to customers and long-term integrity of the reserve. The effort was key to the success of DOE's crude oil exchange-for-fill program that supported the U.S. energy sector during the pandemic-related economic downturn. (1000, 8000)



Crude oil samples from the U.S. Strategic Petroleum Reserve were planned, captured and analyzed based on recent Sandia research to inform operational decisions during quick-turnaround redelivery to industry customers in 2020.

Deployable wind turbine analysis

In 2009, Air Force Gen. Charles Wald called for reducing fuel reliance by U.S. armed forces, saying, "The biggest game changer for reducing casualties is reduction in convoys." In 2020 the Sandia-led Defense Deployable Disaster Wind Turbine Team completed a detailed analysis for DOE that found that wind turbines could reduce the operating time of diesel generators at bases by more than 80%. (8000)

Nuclear fuel cycle knowledge management pilot

Sandia's Nuclear Energy Fuel Cycle program, in collaboration with the DOE Office of Nuclear Energy, piloted a groundbreaking knowledge capture project, collecting and cataloging tacit knowledge from experts across the field of nuclear waste management. Experts shared their experience with Sandia staff in a series of workshops addressing a variety of critical topics. This extremely valuable information, in the form of searchable videos, presentations and reference resources, is now available to inform future generations as they support the nation in resolving its nuclear waste challenges. (8000)



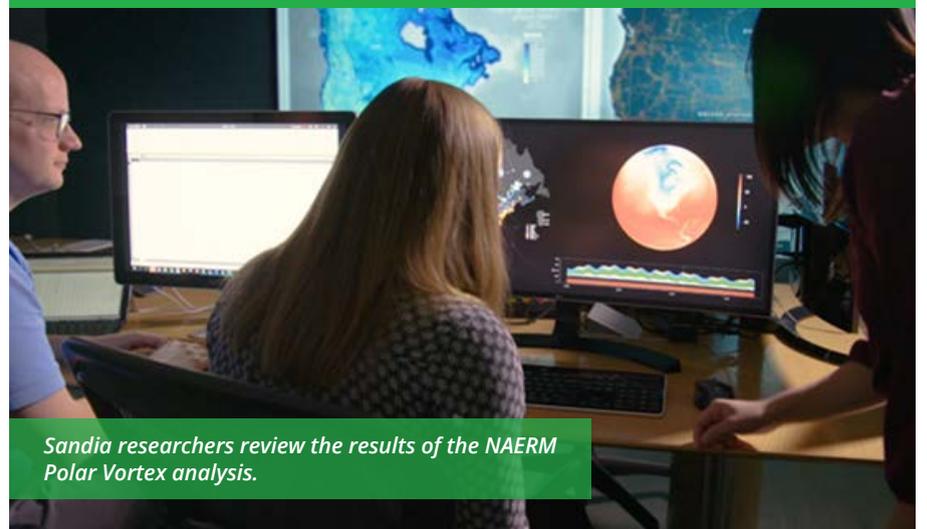
Jackie Chen

Jacqueline Chen

Jacqueline Chen, Sandia senior scientist, was selected as a Distinguished Scientist Fellow by DOE's Office of Science, one of only eight people to hold that honor. The award recognizes her pioneering studies of turbulence-chemistry interactions in combustion, using direct numerical simulation of the turbulent motion, which has helped advance the design of automotive, gas turbine and jet engines. As a fellow, she will expand connections to university partners as she develops new exascale computational methods that incorporate physics-informed machine learning for even larger-scale high-fidelity combustion investigations. (8000)

North American Energy Resilience Model

Sandia developed resilience metrics for the North American Energy Resilience Model and completed "Resilience Metrics for Informing Decisions Associated with the Planning and Operation of the North American Energy System: Technical Report." Recent widespread power outages caused by extreme events such as hurricane Katrina and superstorm Sandy have made the ability to accurately model the electricity grid and associated interdependencies a high priority. The development of NAERM is the highest-priority goal for the DOE's Office of Electricity. (1000, 5000, 8000)



Sandia researchers review the results of the NAERM Polar Vortex analysis.

GLOBAL SECURITY



Prototype weapons transporter crash test

Data from the MGT crash test will be used for qualification of the transporter and to better understand cargo response in accident scenarios for years to come.

Sandia's Mobile Guardian Transporter team met a major milestone with the first full-scale semi-tractor/trailer crash test conducted at Sandia in nearly two decades. A tractor trailer propelled to highway speeds by two rockets impacted MGT's Prototype 1 during the test at Sandia's 2K sled track facility — even more remarkable because the test met a tight schedule despite challenges posed by the COVID-19 pandemic. The team collected over 400 channels of sensor and video data to assess nuclear explosive safety in over-the-road transportation. (1000, 6000)

Pulsed irradiation of photovoltaic cells

Photovoltaic cells subjected to high-radiation doses at Sandia's SPHINX accelerator facility exhibited fast, sensitive responses at distances 20 times greater than the original project goal. PV cells harvest and convert solar energy. These test results demonstrated an improved capability to remotely sense short-pulse gamma radiation, which has national security implications. (6000)



Pandemic doesn't stop global engagements

In the face of COVID-19-related travel restrictions, the Center for Global Security and Cooperation pivoted rapidly to virtual platforms for international global threat reduction engagements. From April through September, the center hosted 93 virtual events with 3,220 attendees from 79 countries. International engagements included remote inspections of physical security upgrades to nuclear reactors in Nigeria, counter-unmanned aircraft system interactions with Korea and Belgium, and training courses on the safe and secure handling of SARS-CoV-2 specimens for diagnostic laboratories across the globe. (6000)



Countries shown in orange participated in virtual engagements held by the CGSC in FY20.



Autonomous detection and assessment research

A three-year research effort, the Autonomous Detection and Assessment with Mobile Sensing project, concluded in FY20, is laying the foundation for the role of mobile, unmanned systems in security systems of the future. ADAMS produced a new methodology for rapidly fusing sensor information from heterogeneous unmanned air and ground assets to autonomously discern approaching threats from non-threats. The methodology is being applied to other operational domains to allow rapid assessment of cluttered environments and provide decision makers with enhanced, more relevant information to improve situational awareness. (LDRD, 6000)

The ADAMS Laboratory Directed Research and Development project completed a successful flight test with ground robots streaming sensor data to the unmanned aerial system.

Enhanced Surety Program project

The Enhanced Surety Program project represents the commitment by Sandia to respond to critical national security challenges. A diverse team from across almost every division at the Laboratories rapidly responded to contribute expertise in design, qualification, production, acceptance and fielding to meet a priority requirement and deploy to DoD sites. (2000, 5000, 6000, 8000, 10000)

Radiation detection analysis software overhaul

Sandia completed a major overhaul of its Gamma Detector Radiation and Analysis Software, the cornerstone of many major radiation detection programs. Building on previous incremental updates, a team converted the Fortran programming language to modern coding techniques and designed an architecture and code structure to enhance readability, allowing developers to more quickly add new features and increasing the stability and maintainability of the code. The modernization also gives GADRAS programming and high-performance computing capabilities previously not possible. (6000)



A radiological emergency responder using GADRAS for analysis.

GLOBAL SECURITY



At the 2018 International Training Course on the Physical Protection of Nuclear Material and Nuclear Facilities, attendees practice nuclear materials accounting. The graduate-level UNM program will extend similar resources to students.

UNM nuclear security program launched

Sandia partnered with the University of New Mexico and Los Alamos National Laboratory to create a new, one-of-a-kind graduate school program in nuclear security engineering. Coursework will prepare students to incorporate nuclear security considerations into designs for new energy,

defense and medical technologies. The new UNM program will give students a significant advantage in the field and broaden employment opportunities. The resulting pipeline of working professionals, with knowledge and skills cutting years of on-the-job training, will bolster nuclear security worldwide. (6000)

Virtual testbeds accelerate software development

Sandia developed a capability to virtually simulate physical information systems using a cluster of servers, virtual machine technology and automated provisioning technology. Virtual testbeds can now be created within minutes, allowing each software developer and tester on a large project to rapidly develop and test capabilities. More than 100 virtual testbeds are now in use across the U.S. Nuclear Detonation Detection System ground program, allowing work to proceed in parallel and avoiding the bottlenecks experienced with physical testbeds. (6000)

Global Burst Detector deliverables

Global Burst Detector payloads aboard U.S. Air Force Global Positioning System satellites monitor and analyze remote signals from space in support of the nation's nuclear detonation detection mission. The Sandia team supporting development of the next-generation payload, GBD IIIF, produced interface simulators and payload emulators in support of the Air Force's risk-mitigation approach on an accelerated schedule, exceeding original NNSA expectations. This work is vital to ensure that the U.S. nuclear detonation detection capability remains safe and effective. (5000, 6000)

Array ensures chain of custody

Sandia and Savannah River Site nuclear safeguards engineers completed the design, fabrication and field testing of the prototype Transport-Remotely Monitored Sealing Array. The T-RMSA system enables monitoring of TRUPACT-II nuclear materials containers during transportation. The array's fiber optic loop seal technology facilitates third-party verification that the chain of custody is not broken during transport of the containers. Field testing confirmed successful performance of the T-RMSA and delivery of the prototype to the Kansas City National Security Complex for manufacturing and production. (6000)

Y-12 security enhancement design completed

Sandia completed final design for the West End Protected Area Reduction (WEPAR) project at the Y-12 National Security Complex in Tennessee. WEPAR is a system design and installation initiative to improve physical security at Y-12 while reducing the security and operational area footprints, thereby reducing long-term costs. The project, when completed, will include a number of security upgrades, including a new Perimeter Intrusion Detection and Assessment System and a new, modernized Entry Control Facility that will be the first of its kind in the NNSA complex. (6000)



Interacting in CAD2VR with a CAD model of Sandia's Gemini Scout Robot.

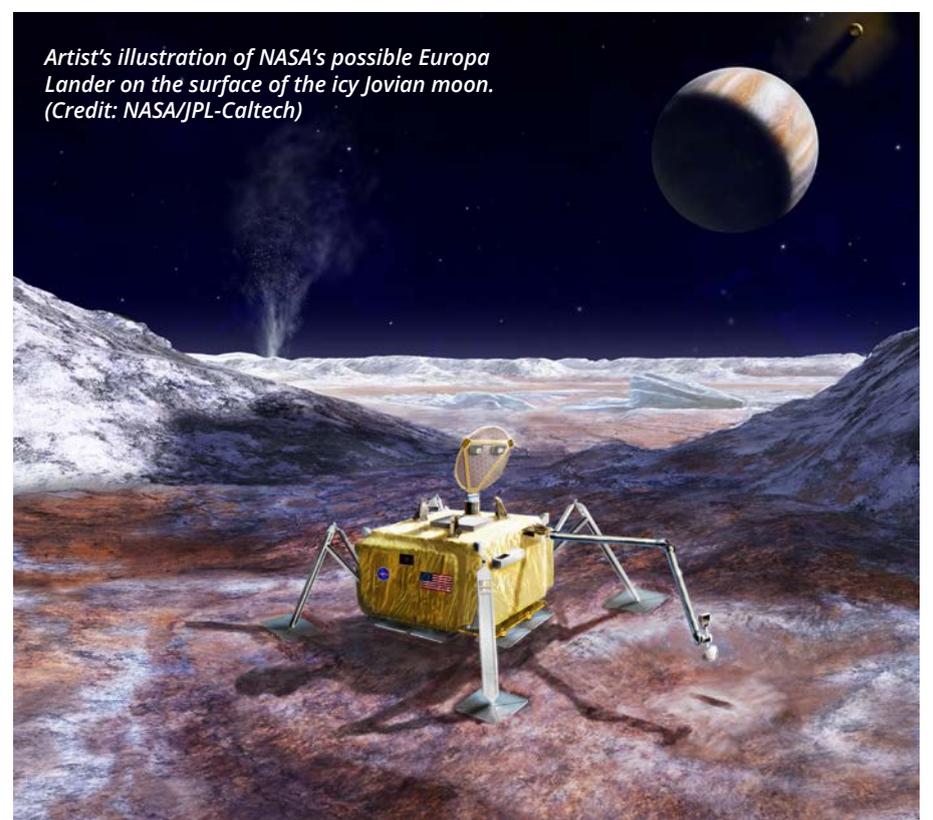
Virtual reality software developed and fielded

A Sandia team developed and launched software for importing computer-aided design models into virtual reality environments and interacting with them. Called CAD2VR, the copyrighted software is being shared with government agencies, several of which have used it to replace live training

where the training was extremely hazardous or training venues were not available. The team worked with other Sandia organizations to develop plugins that extend CAD2VR's functionality. One plugin, for example, enables importing computed tomography scans into virtual reality and examining them for defects. (6000)

Radiological incident response management software developed

A Sandia team developed the Consequence Management Operational System, working with end users to replace an inadequate paper and email tracking system. COSMOS is Sandia-developed software that prioritizes and tracks requests for information received by the Federal Radiological Monitoring and Assessment Center, enabling more timely response to radiological or nuclear incidents. COSMOS improves the efficiency of the management of requests for information for FRMAC, the interagency entity that coordinates U.S. monitoring and assessment activities for radiological or nuclear incidents. (6000)



Artist's illustration of NASA's possible Europa Lander on the surface of the icy Jovian moon. (Credit: NASA/JPL-Caltech)

Europa Lander energetic material test

Sandia completed a milestone test in the development of a new energetic material for the Europa Lander Terminal Sterilization System. Sandia is collaborating with NASA and Jet Propulsion Laboratory to help solve the challenging problem of preventing biological contamination on the mission to search for life on Jupiter's moon Europa. The TSS applies rapid heating using energetic materials to sterilize components and reduce the threat of contamination. Sandia is developing the technique for JPL because commercially available energetic materials do not meet mission requirements. (6000)

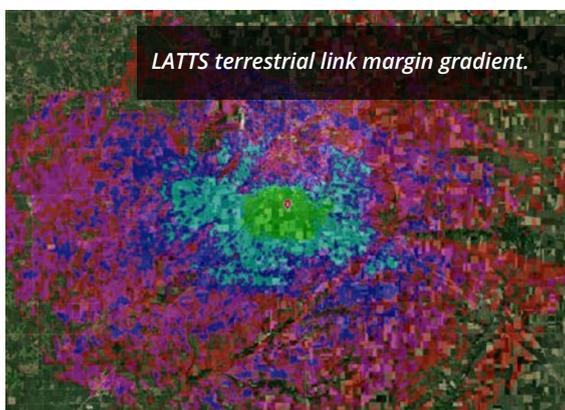
NATIONAL SECURITY



Copperhead program wraps up

The Sandia-developed Copperhead miniature Synthetic Aperture Radar system, which can detect IEDs day or night and in any weather, has concluded its operational deployment.

The Copperhead program was initiated in 2008 to support the Joint Improvised Explosive Device Defeat Organization in Iraq and Afghanistan as an improvised explosive device detection sensor. The IED detections were used by the military to avoid critical injuries and deaths. Sandia has received more than \$400 million in funding for the Copperhead program since its inception. With troop reductions in Afghanistan and funding shifts, the Copperhead program ceased operations on March 15, 2020. (2000, 5000)

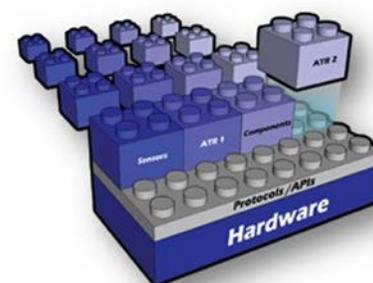


Low Altitude and Terrestrial Transmitter System

The Sandia Advanced Radio Frequency Systems group has worked with six cross-community partners to advance the Low Altitude and Terrestrial Transmitter System, a highly reliable global communication system that ensures operational capability in hostile and contested environments. The team's efforts have resulted in direct requirement generation and cross-agency coordination for warfighter support and eventual significant distribution of hardware worldwide. LATTS is highly expandable and provides the ability to transmit a variety of secure signals with near on-demand command and control capability. This system leverages expertise in both hardware and secure waveforms and in turn advances state-of-the-art RF electronics and sensing. Sandia's depth and breadth of RF expertise enables the development of cutting-edge solutions for critical national security needs. (5000, 8000)

Open Threat Assessment Platform work for TSA

The Sandia Open Threat Assessment Platform team developed and demonstrated a next generation software integration platform for the DHS Transportation Security Administration that allows third-party applications to be deployed onto proprietary screening equipment such as baggage X-rays. Among other capabilities, the OTAP project enables nonproprietary threat-detection algorithm solutions, which result in greater detection efficacy. In August 2020, TSA, other regulators and airport operators across the globe issued a policy statement supporting open architecture and OTAP's products specifically. (1000, 2000, 5000, 6000, 8000, 9000)



Charles Reinke and Ihab El-Kady design materials with exotic electromagnetic properties.

Award-winning DARPA extreme MIRaGE software

To realize the potential of metamaterials, the Multiscale Inverse Rapid Group-theory for Engineered-metamaterials project team developed easy-to-use design tools for the architecture of metamaterials exhibiting exotic electromagnetic behaviors beyond what nature can provide. The project, previously highlighted in DARPA's 60th anniversary showcase, was recognized as an FY20 Laser Focus World Innovators Platinum Award winner and nominated for an FY21 Federal Laboratory Consortium Tech Development Award. Metamaterials designed with MIRaGE will serve in specialized optics, advanced lasers, cloaking materials, thin/flat lenses and national security and space program applications. (1000, 5000)

Breakthrough in quantum photonic platform

Sandia's National Security Photonics Center at MESA achieved multiple world's first results in developing integrated photonic chips that manipulate single atoms for quantum computing and sensor applications. Generating precise optical signals to address atomic transitions, quantum photonics can shrink a quantum system from a car-sized table to a computer chip using heterogeneous integration. Record results included a silicon photonic (side-band modulator) chip performing atom cooling, trapping, state preparation and detection; lowest optical loss ultraviolet waveguides; ultra-narrow linewidth vertical cavity surface-emitting vertical cavity surface-emitting lasers (VCSEL) at 780 nanometers; and high-power-handling suspended waveguides. (5000)

NATIONAL SECURITY

Multimission RF Architecture implemented across Radar ISR Portfolio

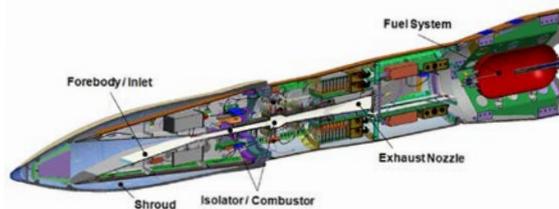
Sandia is implementing the LDRD-funded Multi-Mission Radio Frequency Architecture and associated Radio Frequency Module on next-generation systems for deployed programs. The MMRF architecture enables arbitrary waveform generation/detection needed in current mission spaces. The technology permits future integration of multi-mission technologies with minimal nonrecurring engineering and lower costs. (5000)

Industrial Control System Cybersecurity Symposium

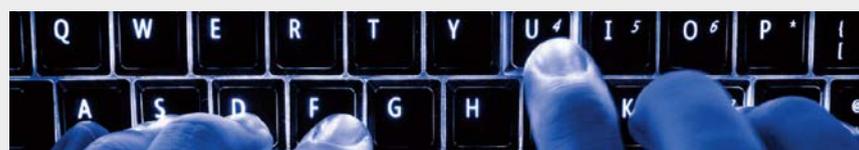
Sandia hosted a two-day ICS Cybersecurity Symposium in February with more than 80 external attendees from across the federal government, including seven other government laboratories, DOE, the four military service branches, the combatant commands, the intelligence community, academia and industry. The goal was to share information on national security mission needs related to ICS cybersecurity, highlight existing capabilities and research roadmaps to address those needs. The symposium was well received by those in attendance and spurred new collaboration opportunities within the community. (5000, 9000)

Uncertainty quantification in Scramjet combustion computations

Modeling Scramjet combustion with inclusion of uncertainty quantification involves exceptional complexity and high computational cost. Through DARPA sponsorship, Sandia demonstrated a practical approach to analyze and optimize a laboratory-scale Scramjet combustor, allowing for uncertainty in operational and model parameters. The achievement is crucial for hypersonic systems R&D, providing insights into potential paths toward applying these capabilities in supersonic and hypersonic engine designs. The work employed computational capabilities using high-fidelity Large Eddy Simulation for modeling unsteady turbulent flow, shock physics and chemical kinetic modeling of reaction processes. (1000, 8000)



Air Force Research Laboratory image.



The Sandia-led NNSA Cyber Security COE allows faster coordination across the Nuclear Security Enterprise.

Sandia-led center mitigates complex-wide cyber threat

The Sandia-led NNSA Cyber Intelligence Center of Excellence quickly analyzed and wrote detailed reports to share across the Nuclear Security Enterprise about the risks of the Ripple20 vulnerabilities. These vulnerabilities impact a small library widely used by companies to allow their devices and software to connect to the internet. The COE's analysis and dissemination of information was shared using tools that allow analysts to quickly understand the threat and collaborate with team members across the NNSA complex. (9000)

Radar to Optical Feature Extraction and Correlation flight test succeeds

The first Synthetic Aperture Radar flight to generate navigation data with ROFEC on the Sandia Facility for Advance Radar and Algorithmic Development radar system, for a live GPS-Denied operation, was successful. The ROFEC algorithm, developed under the DoD/DOE Joint Munitions Program at Sandia, is an innovative methodology that correlates images from two heterogeneous imaging modalities, SAR and optical. The flight test demonstrated that ROFEC and aircraft velocity algorithms are contenders as navigational aids in GPS-compromised environments, a huge step toward GPS-denied operational capability using Sandia systems. (5000)

Xyce release supports enhanced electrical simulation

Sandia's Xyce circuit simulator team released Xyce version 7.2 to support DARPA's Push Open Source Hardware and Intelligent Design of Electronic Assets programs. The project is creating tools to usher in an era of 24-hour design cycles for defense-related hardware systems, shorten hardware upgrade times and enable proliferation of custom systems-on-chip. Xyce can simulate modern process nodes, including 12 nanometer FinFET-based technologies. The Xyce circuit simulator develops simulation-based evidence for nuclear weapon system qualification through large-scale, predictive simulations with quantified uncertainty for NW electrical systems. (1000)

Annual All-Army Cyber Stakes

The Army held the 4th Annual All-Army Cyber Stakes, a U.S. government cyber practitioner exercise. The event drew thousands of competitors, both federal employees and civilians, from across the departments of Defense and Homeland Security as well as the Office of Global Affairs. Darek Jensen placed third overall and second among civilians in the competition, demonstrating his skills and helping to solidify Sandia's technical credibility in this domain. (8000)

Pandemic modeling analysis for COVID-19

Sandia's cross-division COVID-19 Pandemic Modeling and Analysis team supported the DOE Office of Science in technical efforts of recovery modeling, economic modeling and analysis, data analysis and epidemiological forecasting. The work was done in coordination with Los Alamos, Oak Ridge and Argonne national labs and the National Virtual Biotechnology Laboratory, a consortium of all DOE labs. Results have been disseminated to DOE, the departments of Commerce and State, the Defense Threat Reduction Agency and the New Mexico Department of Health. (8000)

National Risk Management Center

In response to an Executive Order, the Risk Analytic Methods and Support team responded to a rapid analytic request from the National Risk Management Center at the Department of Homeland Security's Cybersecurity and Infrastructure Security Agency. Sandia used the Cyber Risk Framework it has been developing for NRM to produce risk analytic results in eight working days, validating the Cyber Risk Framework. The results of the analysis became a large part of the DHS response to the White House request. (8000)

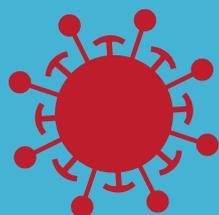


Hypersonic mission launch, March 19, 2020.

Successful hypersonic flight at Kauai Test Facility

Sandia employees and contractors saw their work culminate in a successful hypersonic flight test March 19, 2020, at the Kauai Test Facility in Hawaii. Sandia provided design and fabrication of the flight vehicle; preflight modeling, simulation and analysis; ground testing of common hypersonic glide body components; and launch support at the test range. The successful test and future experiments will further inform DoD's hypersonic technology development and provide a technology maturation pathway that directly benefits future Nuclear Deterrence programs. (600, 1000, 2000, 5000, 10000)

EXECUTIVE SUPPORT GROUP



A layered defense to COVID-19

As the COVID-19 pandemic escalated in early 2020, Sandia's leadership responded quickly and proactively, not only to protect the workforce but also to maintain continuity of operations and mission delivery. A pandemic planning team was assembled to oversee the Labs' response, field questions and coordinate interfaces with external stakeholders. ES&H enhanced on-site safety and protocols and issued new policies and guidance for pandemic-related best practices and telecommuting. Sandia also implemented a layered, defense-in-depth approach to health surveillance, including screenings, testing, contact tracing, disinfection and supplying PPE. (ESG)

Sandia's Defense In-Depth Approach graphic.



Virtual programs succeed during pandemic

Faced with the challenge of continuing leadership development while unable to gather in groups larger than ten, Sandia developed and provided original virtual leadership programs for Fall Leadership Forum and the National Security Leadership Development Program. Using Microsoft Teams, programming included speakers from around the country, virtual break-out rooms for discussion, and virtual "paired walks." Participants reported they valued the connection with their colleagues in the remote COVID-19 environment and learned to be more creative within pandemic constraints. (1, 3000, 10000)



ES&H 5-Year Strategy implemented

Environment, Safety and Health implemented its ES&H 5-Year Strategy to renew focus in leadership engagement, injury reduction, environmental stewardship and hazard identification and control. The strategy also led to the formation of an ES&H Governance Board to drive cohesive Labwide goals and initiatives, the reimagining of manager training, and the launch of an IT consolidation project that streamlines more than 50 tools and processes. With the integration of ES&H and Emergency Management, Sandia is strengthening its culture of safety, sustainability and preparedness. (ESG)

Internal Audit and Ethics/EEO Investigations

Internal Audit and Ethics/EEO Investigations completed 26 audits and 76 investigations to mitigate risks. The audits evaluated internal controls, compliance and best practices in Environment, Safety and Health, information technology, and financial processes. Contract Audit completed \$325,800,000 in 148 subcontract audits. All audits identified best practices and deficiencies to quantify process weaknesses, thus supporting continuous improvement. The Ethics and EEO programs teamed to introduce a new Personal Conflict of Interest disclosure tool and database, and rewrote procedures to assure consistency in all investigations. (800)

Executive Protocol hosts 112 events

Members of Executive Protocol are trusted advisers and subject matter experts on the accepted practice of diplomatic and business etiquette. Executive Protocol supported 112 events with successful outcomes, including but not limited to hosting Ambassadors Wilcott and Billingslea, assistant secretaries, U.S. general officers, British Gen. Hyde, and numerous congressional visits, six of which were virtual. During the time of COVID-19, Executive Protocol has added risk mitigation and developed job aid tools for novice event coordinators, and created a robust event registration site accessible by external non-Sandia attendees. (ESG)

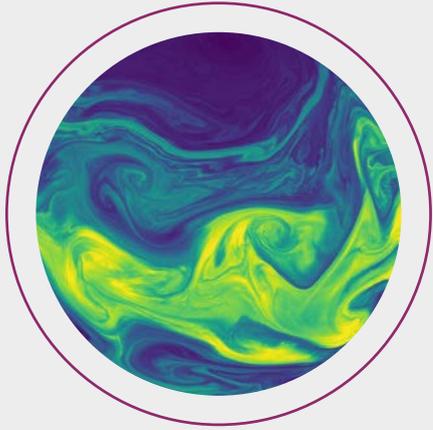


Transuranic waste shipment to WIPP

Sandia worked with the Waste Isolation Pilot Project to complete transuranic material-at-risk waste shipments in July 2020 — the first shipments since 2012. The waste was remote-handled transuranic waste generated by reactor fuel testing in the 1980s and early 1990s. The waste was packaged in shielded container assemblies. Sandia shipped 11 of 25 RH-TRU waste containers in July; the remaining 14 require an additional special container because the radiation dose is higher. (1000)

Packaging the RH-TRU waste took extreme coordination and teamwork within Sandia and support from WIPP and LANL.

ADVANCED SCIENCE & TECHNOLOGY



Exascale computing resources will allow for unprecedented fidelity in Earth system models. A visualization of specific humidity in the Earth's atmosphere, computed with a 3km grid spacing, shows the fine details that can now be captured.

Climate model prepares for exascale

Sandia computational science researchers notched several successes in preparing DOE's Energy Exascale Earth system model "E3SM" for the exascale era. In the spring, the team performed calculations with Sandia's new atmosphere dynamics code on Summit, the world's fastest computer at the time, using 27,600 GPU processors simultaneously, achieving record-setting performance on a benchmark problem. Separately, Sandians integrated several novel algorithmic developments into E3SM to double the model throughput for the upcoming science campaigns. This has tremendous impact because the campaigns consume a year of supercomputer allocation. (1000)



Improved warm X-ray sources for survivability

Ensuring that the U.S. stockpile is effective requires an ability to test electronics and materials under intense X-ray environments. Sandia demonstrated record yields and reproducibility of warm X-ray sources on the Z machine, improving the quality of experimental data related to hostile survivability studies. The warm X-ray yield was increased by 40% and these sources are being applied to assessment of new engineering materials and to validation of numerical models for system-generated electromagnetic pulse resulting from extreme radiation exposure. (1000)

The target and diagnostics setup on Sandia's Z machine for a hostile survivability experiment is shown here. The X-ray radiation source is in the center, surrounded by several test cassettes; the setup makes for efficient use of the facility.

Ducted fuel injection

Sandia received a 2020 Outstanding Technology Development Award from the Far West Region of the Federal Laboratory Consortium for Technology Transfer for "Ducted Fuel Injection for Clean, Sustainable Diesel Engines and Fuels." Sandia has worked with partners Ford and Caterpillar through Cooperative Research and Development Agreements to develop the technology, which is capable of simultaneously suppressing soot and nitrogen oxide emissions from diesel engines. (8000)



New fuel injection method results in reduced emissions.

The PMK design consists of a polished aluminum tube that amplifies energy from embedded UV light to decontaminate the exhaled breath by disabling pathogens that pass through. The PMK was developed, built and tested to ensure sufficient exposure of the entrained pathogens to UV energy.



COVID-19 research

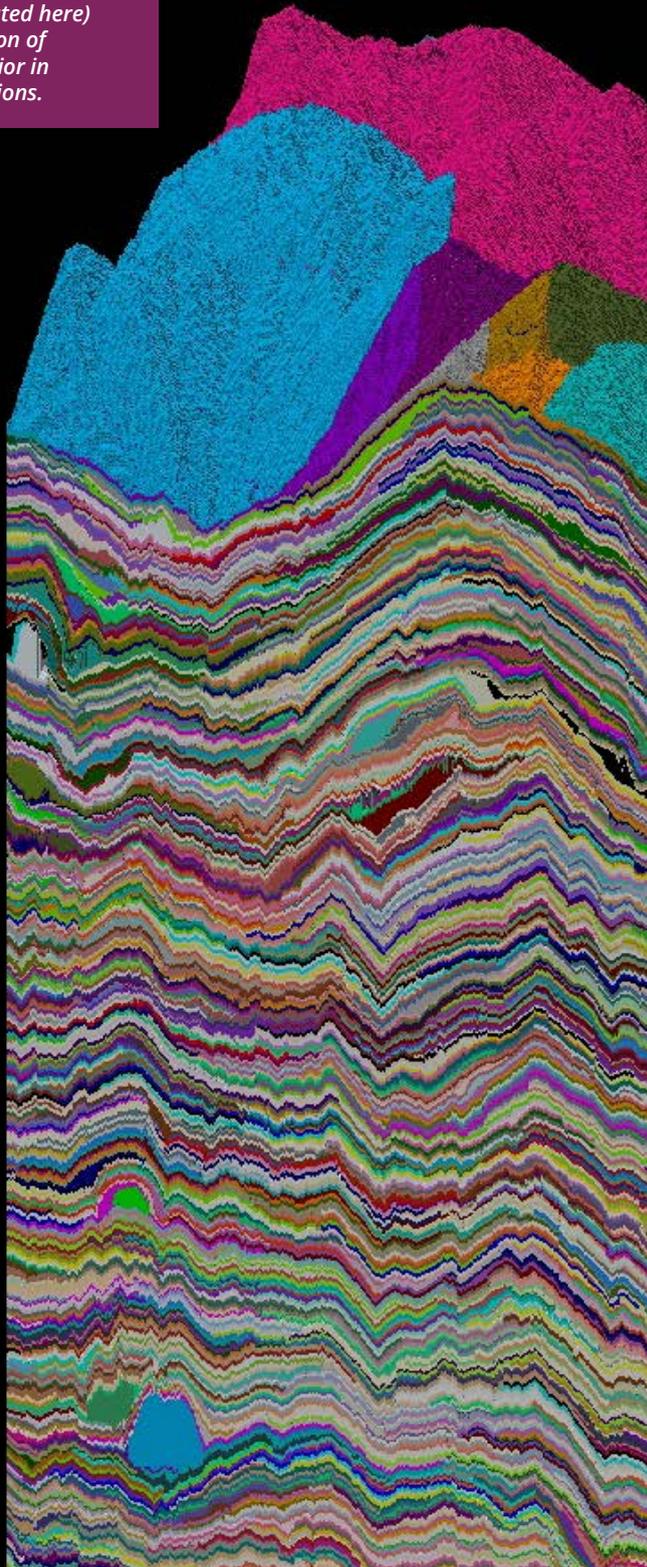
Within days of the work-from-home order, Sandia established a COVID-19 Rapid Response Research and Technology Transfer Program spanning fundamental research through technology transfer. Assistance was provided to local medical providers and Sandia executed 80 R&D and technology transfer activities. (1000)

Researchers developed a conversion kit to upgrade Bi-level Positive Airway Pressure (BiPAP) machines into fully functional ventilators using an expiratory decontamination component and ultraviolet light, ensuring elimination of coronavirus and other pathogens. Sandia produced 100 respiratory machines that were delivered to New Mexico hospitals. (1000, 2000, 5000, 6000, 8000)

Using Sandia's high-performance computing clusters, researchers developed a model to predict the need for medical resources and a framework for predicting uncertainty. The resource model turns disease-spread predictions into actionable information about healthcare system resources needed at the state and county level. (1000, 8000)

ADVANCED SCIENCE & TECHNOLOGY

Newly developed numerical methods for analyzing, synthesizing and simulating materials with complex microstructures in computer models (illustrated here) allow exploration of material behavior in extreme conditions.



Materials in extreme environments

Sandia scientists are teaming to unravel the mechanisms of material degradation under extreme conditions. Accomplishments include new techniques for recovering samples after exposure to the world's brightest X-ray pulses at the Z machine and shock at the Dynamic Integrated Compression Experimental Facility; first-of-a-kind numerical methods for imaging, parsing and analyzing composite material microstructures; and new radiation, shock, electromagnetic and thermal multiphysics coupling modalities with the SCEPTRE and ALEGRA codes incorporating novel material properties determined with atomistic simulation, to support wide-ranging science and defense programs. (1000, LLNL, LANL, ANL, NNS, LDRD)

Predicting the strength of metals

Sandia researchers have developed a simple theoretical model that can accurately predict the maximum strength of pure metals and alloys, without the use of adjustable parameters. The strength of metals is a crucial factor in the design of reliable, cost-effective materials for use in energy-efficient vehicles, aircraft and renewable energy systems, such as wind turbine gearboxes. This direct link between theoretical calculations and practical measurements provides fundamental insight with strong implications for the design of new materials. (1000, LDRD)

Fusion on Z and beyond

A laboratory capability to produce multi-megajoule (MJ) thermonuclear fusion yields would revolutionize studies of nuclear explosive package physics and weapon survivability. Sandia has moved closer to this challenging long-term goal by developing and validating a new theory for scaling magnetically driven fusion targets from the Z machine today to multi-MJ performance on a larger, next-generation pulsed-power machine; predicting and demonstrating tenfold improvement in fusion output on Z; and doubling the amount of tritium used on Z for improved plasma diagnosis and operational understanding. (1000)

JaqalPaq quantum software stack is released

Sandia's QSCOUT (Quantum Scientific Computing Open User Testbed) Software Stack team created a new quantum assembly language called Jaqal (Just another quantum assembly language) and released an open-source Python programming package for it called JaqalPaq on GitLab. JaqalPaq offers an unmatched level of control, including explicit parallelization, access to underlying laser pulse sequences, comprehensive metaprogramming and a full emulation suite. JaqalPaq is a key enabler for Sandia's first externally accessible quantum computing testbed. (1000, 5000)

Quantum Systems Accelerator stands up

Sandia and Lawrence Berkeley National Laboratory stood up the Quantum Systems Accelerator, one of five DOE-funded National Quantum Information Science Research Centers. The QSA, funded at \$115 million over five years, will engage a multidisciplinary team comprising researchers from 15 labs and universities to advance quantum computing technologies across a broad set of quantum platforms to help build the quantum ecosystem and educate the future quantum workforce. (1000, 5000)

Advanced modeling and simulation

Working with Sandia's SIERRA code developers, the Mobile Guardian Transporter modeling and simulation team developed a complex finite element model capable of accurately simulating a trailer crash to assess safety and security of the system and its contents. This close working relationship between code developers and analysts reduced runtime by half for pretest predictions of the Prototype 1 test, enabling a powerful simulation strategy that includes assessing uncertainty for the MGT system level qualification. (1000, 6000)

Concentrating Solar Power Library Archive

The Technical Library and Concentrating Solar Technologies partnered to establish the world's only publicly available, digital collection of concentrating solar power historical documents, dating back to the program's inception in the 1970s at Sandia. This unique, full-text collection of Sandia documents and external reports is accessible globally via Sandia's website for use by the larger scientific community. The archive sets a precedent for the continued exchange of historical information in the renewable energy field among domestic and international partners. (1000, 8000)

ADVANCED SCIENCE & TECHNOLOGY



Dave Clovis suspends from a crane to perform in-reactor-tank repairs on inaccessible areas.

Annular Core Research Reactor recovery

The Annular Core Research Reactor was successfully returned to operation supporting nuclear weapons programs after a breached reactor safety rod was discovered. New and noteworthy activities planned and safely executed included: removing a damaged rod from the reactor pool; inspecting and qualifying replacement rods after decades of storage; precision installation and testing with new hardware; and ultimately suspending a diver from a crane to reach inaccessible areas in the pool tank. Much of the work was executed before and during the COVID-19 pandemic. (1000)



Sandia Security analysts review data associated with the award-winning HECATE software security tool.

HECATE wins R&D 100 Award

Sandia's High-density Evaluator of Commercial off-the-shelf Applications for Trust and Efficacy (HECATE) won a 2020 R&D 100 Award in the Software/Services category from R&D World. The awards are given annually in recognition of exceptional innovations. An analysis platform that automates the identification of software supply chain risks and provides heuristics on suspect behaviors, HECATE uses virtual and physical assets to create a wholly immersive environment to install, execute and observe software. (9000)



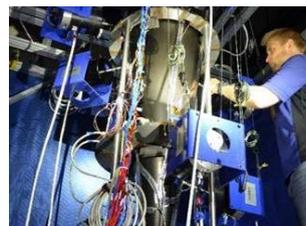
Plutonium experiments on Sandia's Z machine are executed with a containment system that encloses the sample using an ultra-fast explosively driven closure valve. The picture shows the team installing the record-setting FY20 plutonium experiment.

Record plutonium pressure achieved on the Z machine

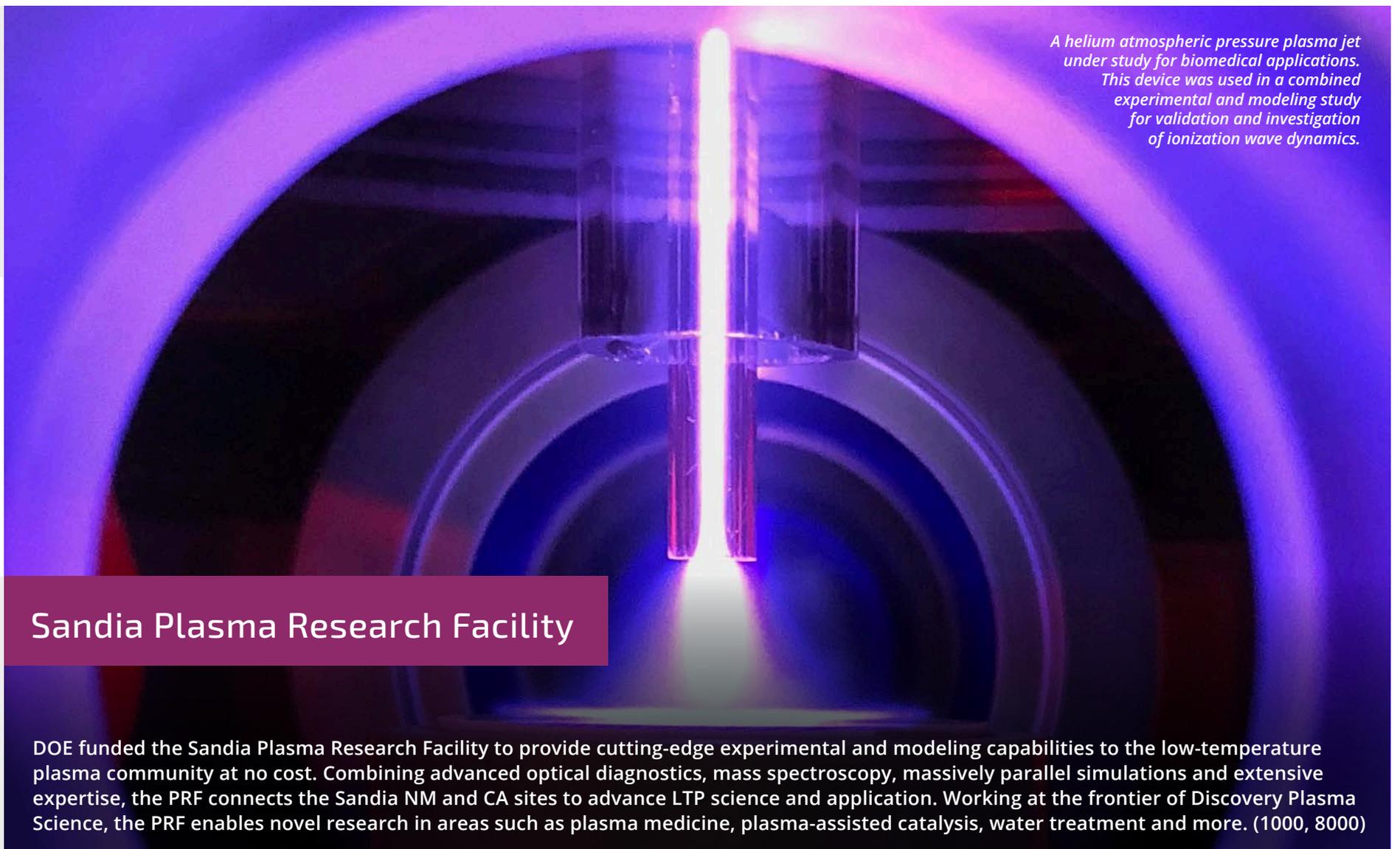
An accurate understanding of the behavior of materials at extreme pressures is central for successful stockpile stewardship, including annual assessments, safety analysis, design within the modernization programs and more. In 2020, Sandia successfully developed new ways to perform material experiments on the Z machine, reaching and accurately diagnosing record high pressures in platinum and plutonium. In partnership with Los Alamos National Laboratory, Sandia accomplished close to 22 Mbar, or 22 million atmospheres, pressure in a shock experiment in platinum and a record high ramp compression pressure in weapons-grade plutonium. (1000)

Advances in reentry qualification

Sandia, with the United Kingdom's Atomic Weapons Establishment, has demonstrated new methods for qualifying weapons to reentry environments. In a partnership between the Joint Technology Demonstrator, Delivery Environments and Verification & Validation programs, Sandia performed detailed simulations using the Sierra Mechanics code suite to design multi-axis vibration and combined acceleration, vibration and spin tests. Testing was performed on a demonstrator system at Sandia's large-scale test facilities. These new analysis and testing capabilities pave the way for agile qualification of future reentry systems. (1000, 2000)



Test engineer Ryan Schultz adjusts a novel multi-axis vibration test conducted at Sandia's large-scale vibration test facility.



A helium atmospheric pressure plasma jet under study for biomedical applications. This device was used in a combined experimental and modeling study for validation and investigation of ionization wave dynamics.

Sandia Plasma Research Facility

DOE funded the Sandia Plasma Research Facility to provide cutting-edge experimental and modeling capabilities to the low-temperature plasma community at no cost. Combining advanced optical diagnostics, mass spectroscopy, massively parallel simulations and extensive expertise, the PRF connects the Sandia NM and CA sites to advance LTP science and application. Working at the frontier of Discovery Plasma Science, the PRF enables novel research in areas such as plasma medicine, plasma-assisted catalysis, water treatment and more. (1000, 8000)

MISSION SERVICES



Data center earns LEED Gold

David Martinez watches as water rushes through the tubes and computer racks, providing a warm-water cooling system and keeping the high-performance computers from overheating.

Sandia's Albuquerque campus 725E data center for high-performance computing earned the LEED v4 Gold BD+C: Data Center Certification. To perform large-scale computations, HPC systems consume substantial amounts of energy. Because heat is a sizable byproduct, stringent cooling regimens are required to keep these computers running, including the use of warm water to conserve energy. An additional method is cooling with outdoor air using thermosyphon technology. This cooling unit saves a half million gallons of water, with expected savings of 16 million gallons annually. (10700)

Indirect budget reductions

Sandia achieved a congressional mandate to reduce indirect costs by 5% in FY20. As part of an effort to continually enhance stewardship of its indirect budgets, Sandia redefined and implemented a Labs-level indirect budget allocation process for FY21 that is future-focused, strategic, agile, transparent and owned and supported by leadership. The new Indirect Planning, Programming, Budgeting and Execution Process was developed by leveraging benchmarks of various leading models. Enhancements include deploying Indirect Planning Guidance to codify leadership intent, completing bottoms-up budgets and defining principles for Service Level Agreements. (10000)

Architecture for partnering with excellence

The Architecture for Partnering with Excellence Office and the Standard Financial Reporting team partnered with IT in FY20 to develop a standardized financial reporting tool using Power BI. The team worked closely with Sandia's business community to gather requirements, test drive the tool and create standard reporting templates. This effort promotes greater efficiencies and enhanced customer satisfaction by reducing risk and time spent on manual updates and streamlines financial services. (10000)

Cloud platform for multilab project

Sandia delivered its contribution ahead of schedule for a multilab, NNSA-sponsored project — a cloud-based secure computing environment using a shared services model. Participants across the NNSA complex include Kansas City National Security Complex, Lawrence Livermore and Los Alamos national laboratories and Sandia. Sandia was responsible for deploying the first phase of a hybrid cloud platform for use as a new enterprise secure computing testing environment. This included deployment of Azure Stack, the supporting hardware and the manual utilization of the security testing process and other supply chain capabilities. (10700)

Continuous improvement for mission delivery

Sandia's Business Excellence team continued to stand up intentional management operating systems and solve enterprise-level problems with lean thinking through the Laboratory Operating System. FY20 results from structured problem solving included applying new methods to shorten the design cycle of power sources while ensuring effective knowledge capture and transfer for future programs; streamlining and integrating the capital acquisition (CapAx) process and investment strategy for future capabilities; and delivering multiple improvements to reduce burdens for managers. (10000)

Expanded International Organization for Standardization certifications

Sandia completed a three-year plan to assess Quality Management System implementation across all centers, a requirement for maintaining its ISO 9001:2015 certification in New Mexico and expanding certification to the California site. This activity established the foundation for an enduring, risk-based assessment program that provides information to management about the effectiveness of the Labs' QMS. (10000)



Business operations adapt to ensure continuity

Sandia adapted key finance and supply chain operations to ensure continuity during the COVID-19 pandemic. These included creating unique accounting and reporting processes to monitor COVID-19 costs, employee leave, and other effects of reduced operations; developing and communicating charging, funding and other guidance; analyzing COVID-19 cost and funding impacts; and launching a temporary vacation donation program. Supply Chain successfully procured scarce personal protective equipment and set up PPE storage and inventory systems; established processes to reduce COVID-19 transmission via received packages; and implemented tracking for needs and coordinated distribution. Enterprise Excellence led the PPE acquisition and allocation task force. (10000)

MISSION SERVICES

New Enterprise Excellence Center

To streamline and reduce redundancies between assurance management systems and the work of the lean operation system, Contractor and Quality Assurance was combined with Business Excellence into a single center. This center has Labswide accountability for issue and risk management, maintaining ISO certification, ownership of the Labs Policy System, development of the Labs management systems and championing continuous improvement. (10000)

Fraud risk management

Sandia's Chief Financial Officer office led an NNSA working group to define an enterprise-wide approach to managing fraud risks. With stakeholders from DOE, NNSA headquarters and five laboratories and sites, Sandia drafted a documented approach for NNSA and DOE to implement the GAO Fraud Risk Management Framework, Best Practices and Lessons Learned. Sandia's CFO office continues in FY21 to partner with NNSA and DOE on enhanced fraud risk management practices through a DOE Internal Controls Evaluation Site Program Pilot. (10000)

Strategic cost savings result from subcontracting solutions

Sandia's FY20 contribution to DOE's Strategic Cost Savings goal — measuring an organization's use of strategic subcontracting solutions — was \$91.1 million, representing 7.1% of Sandia's total spending (the highest percentage in the Nuclear Security Enterprise) and accounted for 41.4% of the NSE's total Strategic Cost Savings. This helped NNSA exceed its goal. (10000)

Project management master's degree program

Sandia partnered with the University of New Mexico to establish an agreement to advance project management as a profession. A critical component is development of a master of science degree program in Project management, which unanimously passed the New Mexico Higher Education Department's final approval process in mid-December. The program will begin formally accepting applicants this fall for the state's first master's degree program in project management. (10000)

Issue and risk management improvements

In FY20, Sandia's Senior Leadership Team reviewed SLT-level risks and refreshed the top 10 risks that SLT will monitor through its operating rhythm. The Operational Management Review was revamped to focus on risks and issues that warrant leadership attention. The revamped OMR is structured to conduct a monthly dashboard review, monitor the state of current business and focus deep dives on operational risks and issues, including SLT-level risks. (10000)

Portfolio management maturation

Sandia is establishing a user-friendly, integrated, Labswide project and product delivery system consisting of competencies, processes and tools and solutions. The effort includes revamping the Program Management Review, establishing a new center and launching a new portfolio management tool. (10000)

Sandia small-business program manager Paul Sedillo presents to representatives and owners during a forum in 2019 at the University of New Mexico Lobo Rainforest.

**Small business engagement and development**

Sandia exceeded the FY20 small business goal of 56% and all five socioeconomic subcategory goals. The Labs established a Mentor-Protégé program to pair qualified small businesses with Sandia subject matter experts and help them be more competitive for federal and industry opportunities. The first three protégé agreements became final in October 2020. (10000)

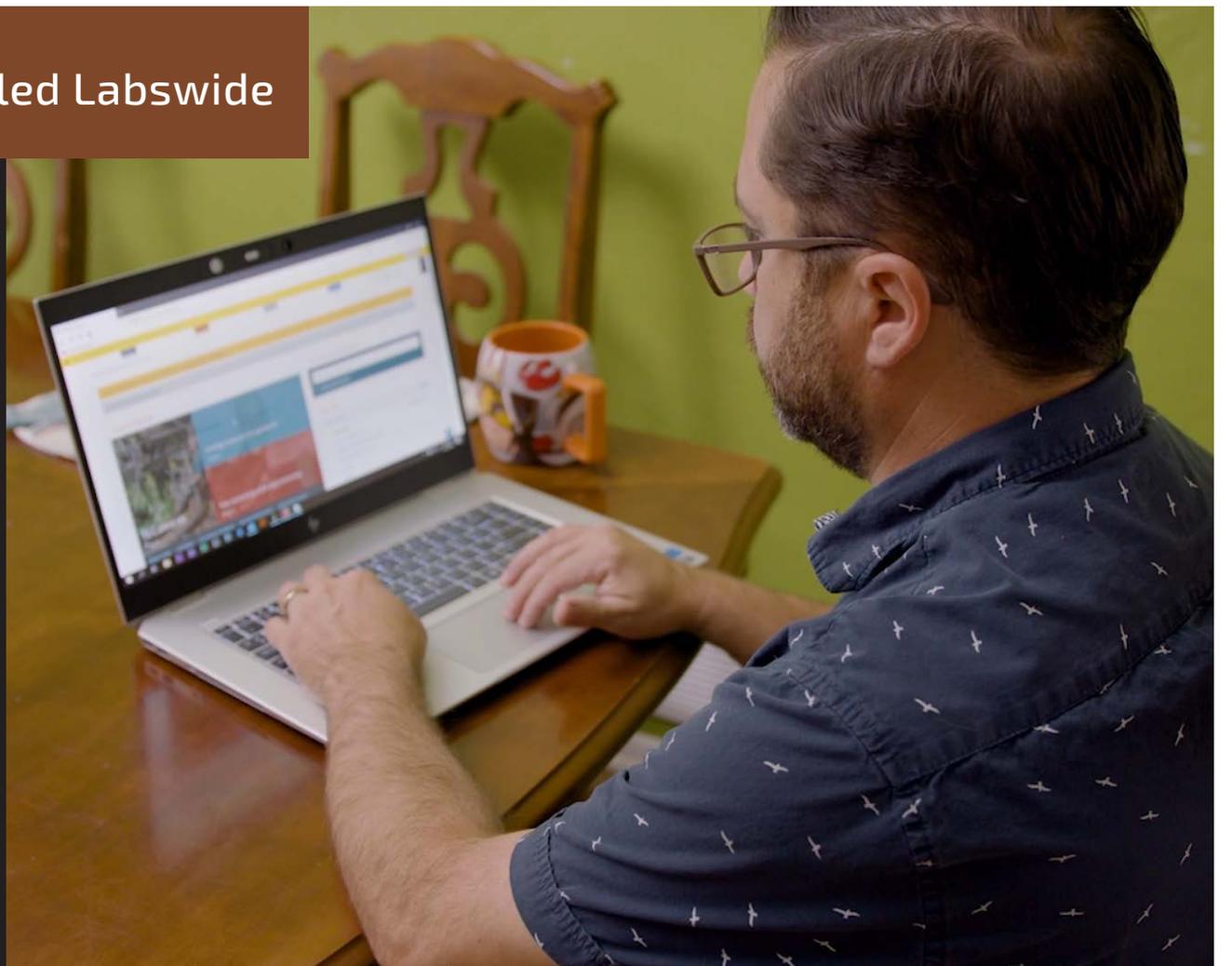
Laboratory Partnerships Small Business Tax Credit

Sandia coordinated and worked with 192 New Mexico small businesses to receive a \$2.4 million Laboratory Partnerships Small Business Tax Credit. The tax credit was used to offset the current year New Mexico Gross Receipts Tax liability. (1000, 10000)

**Remote work enabled Labswide**

In just days, Sandia's information technology and cybersecurity organizations equipped nearly 14,000 people to work remotely. IT rapidly purchased and distributed thousands of laptops and authentication devices and ensured users had remote accounts. The help desk trained remote workers in twice-daily virtual Cyber Cafes. As infrastructure reached limits, IT rapidly increased the capacity and stability of such systems as Skype, Pulse Secure VPN and phone lines. In record time, IT stood up entirely new systems such as Microsoft Teams and GlobalProtect VPN. (9000, formerly 10700)

Responding to the pandemic, Sandia moved fast to enable employees to work from home.



INFRASTRUCTURE OPERATIONS

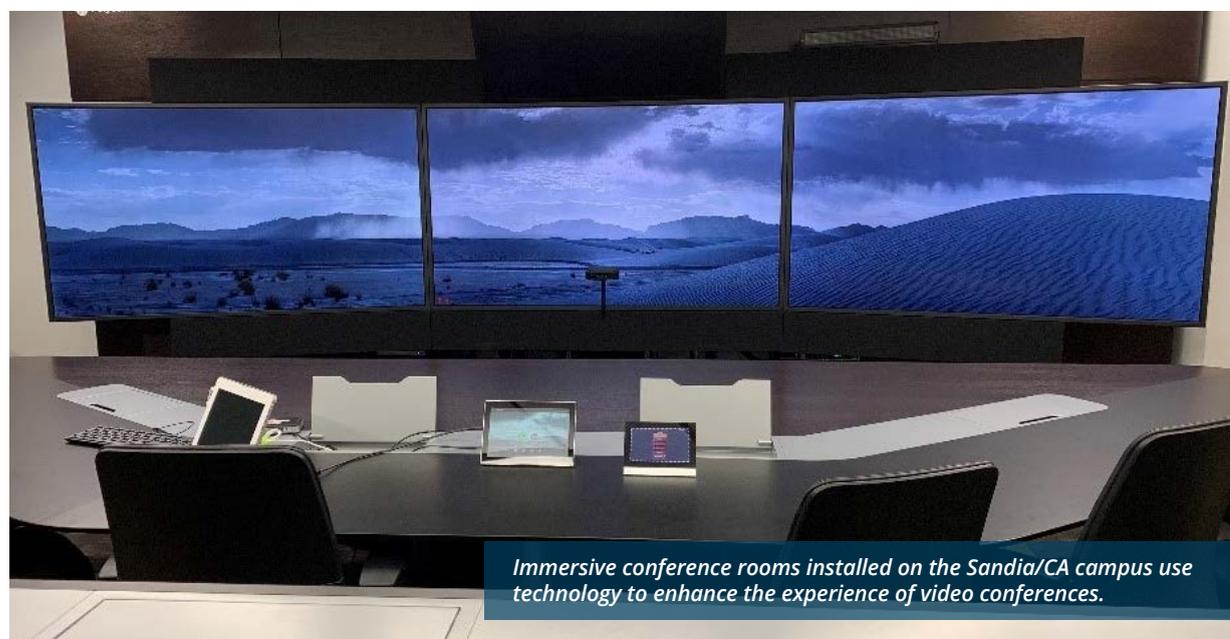


Custodians like Veronica Duran worked tirelessly to keep the Labs clean and safe throughout the pandemic.



Sanitation remains priority during COVID-19

Sandia's Custodial Services team worked diligently to keep the entire Albuquerque site sanitized and safe for those required to work on-site. The team increased cleaning frequencies to three to six times per day, disinfecting high-traffic areas, points of contact and fomite areas. The swing shift Hot Shot team extended services to include disinfecting keypads, phone boxes and outside handrails. Sandia's maintenance teams also remained working on-site, keeping buildings functional and ready for mission essential work. (4000)



Immersive conference rooms installed on the Sandia/CA campus use technology to enhance the experience of video conferences.

Digital infrastructure enhancements

Early in 2020, Sandia's Facilities organization at the California site had to quickly determine how to enable work to continue remotely. Within days, the team increased telephone and virtual private network capabilities to enable remote work and mission program delivery and improve the user experience. They consolidated video collaboration and event technology for optimized service delivery. For Sandians working on-site, the team enabled classified desktop and conference room collaboration and upgraded conference room user interfaces. (8000)

Security meets performance improvement goal

Sandia reported improvement in Category A Incidents of Security Concern over 2019, meeting a key strategic milestone for FY20. Among key actions contributing to the success were the application of additional measures to protect information transmitted within the DOE enterprise; movement of legacy information from a restricted network to a classified network; and deployment of engineered controls for email, reduced a classified network timeout and collaborative drives. (4000)

What's old is new again



A collaborative team led by Physical Security embarked on a two-year effort to remove all mobile devices from newly defined Secure Spaces. With this

initiative, more than 900 new building signs and 180 new device storage units were installed across the Labs. For longtime employees, the change is a return to previous requirements, but for the new generation of Sandians, it was a monumental shift in security culture. NNSA is implementing the new requirement complex-wide to reduce the risks posed by the devices. (4000)



New mobile device storage units were installed across Sandia/NM and Sandia/CA.

INFRASTRUCTURE OPERATIONS



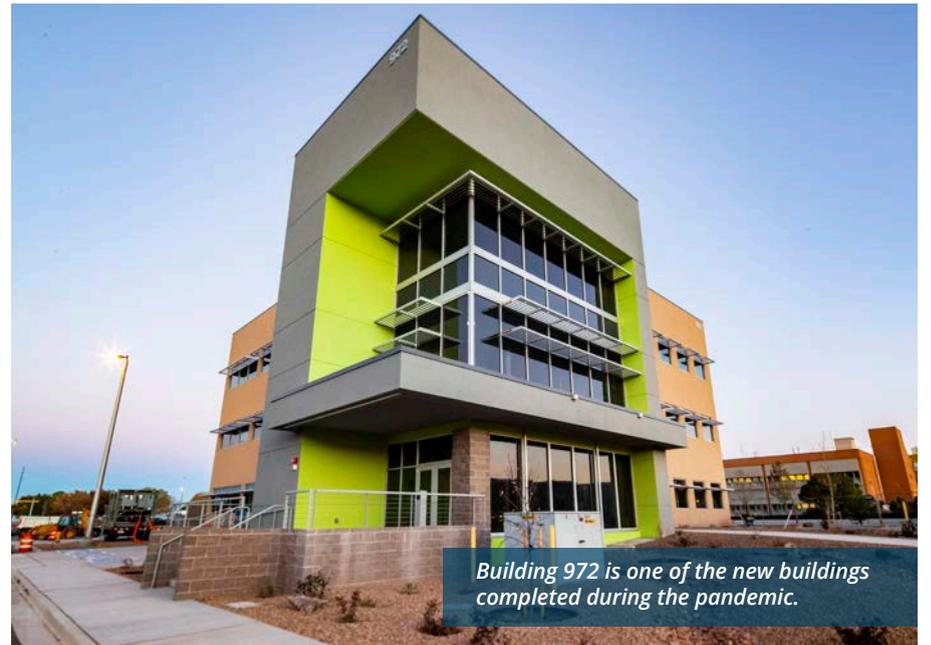
The Innovation Parkway Office Center was used as a COVID-19 testing site for Sandians.

Security meets pandemic challenges

Adapting quickly to a new normal of maximum telework, International Security worked around the clock in March to bring international travelers home safely. The Personnel Security team developed processes to minimize contact while providing essential services. Security leadership worked with Kirtland Air Force Base to establish a waiver process for the 14-day quarantine requirement so mission essential work could continue, while Physical and Technical Security facilitated accurate contact tracing at Sandia sites. Security also played a key role in the early deployment of COVID-19-safe workplace practices. (4000)

New Mexico site capacity planning

To fully understand the Labs' growth constraints and create a model for the future, a study examined utilities, parking, information technology infrastructure and office space, to holistically evaluate overall capacity. Following the onset of COVID-19, the team pivoted to study options for a continued telecommuting posture for some employee populations. This included examining several potential strategies, incorporating touchdown space for telecommuters, reducing the overall leased space footprint, and/or decommissioning and demolishing modular or other substandard facilities. (4000)



Building 972 is one of the new buildings completed during the pandemic.

Project execution continues during pandemic

Despite the numerous challenges and daily changes due to COVID-19, Sandia's Projects team continued construction with limited impacts to baseline costs and schedules and executed \$208 million in projects in FY20. Construction managers, project managers, inspectors and safety engineers remained on-site to ensure mission essential projects continued and daily changes were managed, coordinated and well understood. Even with the reduction of other project support personnel that would normally be on-site, exceptional teaming resulted in the continuation of significant construction activities. (4000, 8000)

Centralized Space Management backfill strategy

The Sandia/NM Centralized Space Management team led the development of a Labs-level strategy to accommodate growth for both on- and off-site locations. Following significant workforce growth in late FY18 and throughout FY19 due to the increased portfolio of mission work, the team worked attentively to optimize a space footprint that led to an integrated plan to migrate staff to locations that aligned with their security needs and co-located them to critical assets and synergistic partners. (4000)

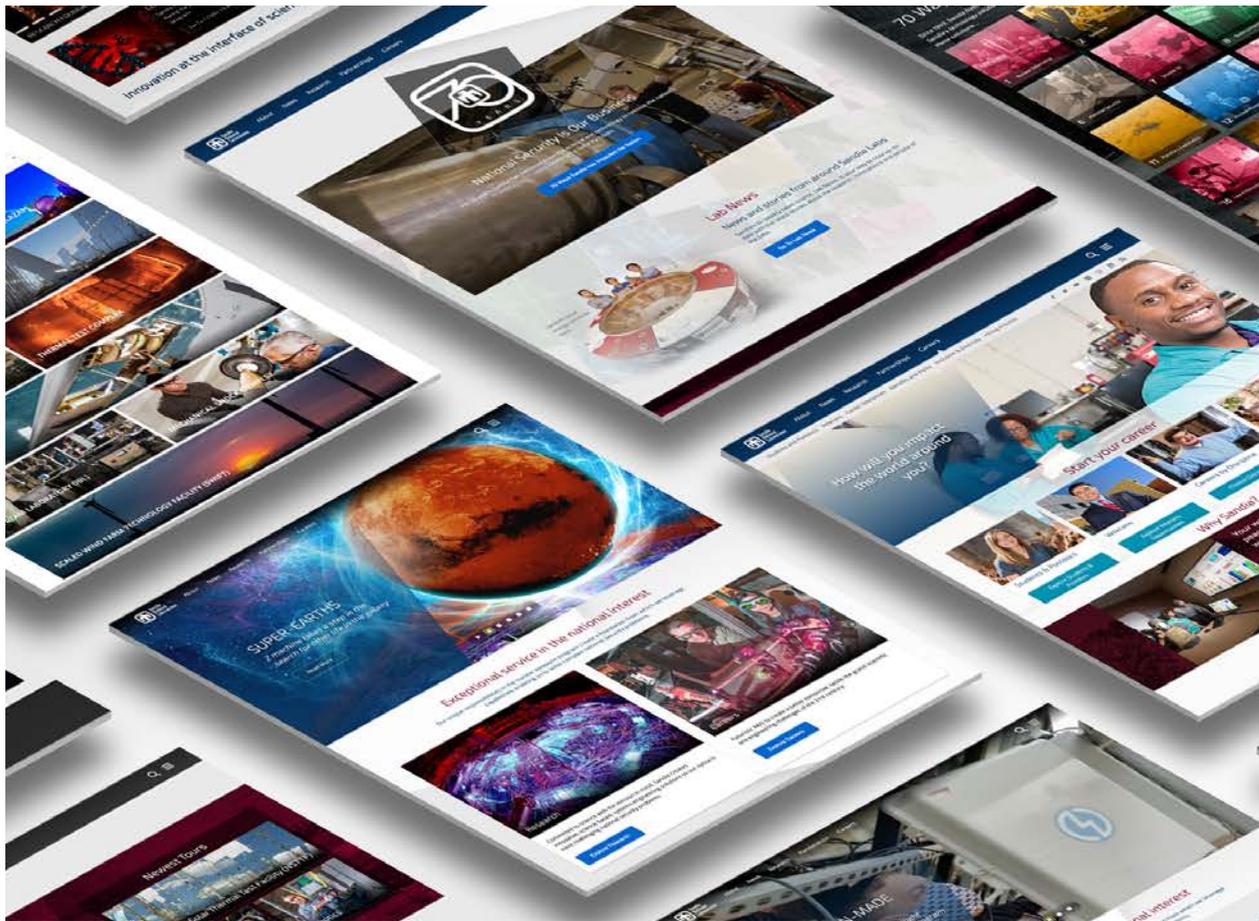


Eubank Gate project completion

The 12-month construction project on Kirtland Air Force Base was completed ahead of schedule and under budget with significant collaboration among the NNSA Sandia Field Office, Kirtland and Sandia/NM. The completed project will improve security on the military base and provide access to the new NNSA Albuquerque Complex. (4000)

The Eubank Gate project kicked off in October 2019.

HR & COMMUNICATIONS



Sandia launches refreshed website

Sandia's external web refresh launched in the first quarter of FY20, the first major design update in more than seven years. The design was driven by cross-departmental usability evaluations, analysis of the prior site's metrics, studies of target audiences and feedback solicited from stakeholders. The resulting refresh was benchmarked against web presences of other national labs, industry leaders in aerospace and defense and sites recognized for best practices with similar target audiences. The updated design supports improved accessibility compliance, which had evolved since the relaunch of the Sandia.gov website in 2012. (3000, 9000)

Screenshots of the refreshed Sandia.gov website, launched in Q1 of FY20.

Diversity and Inclusion leadership

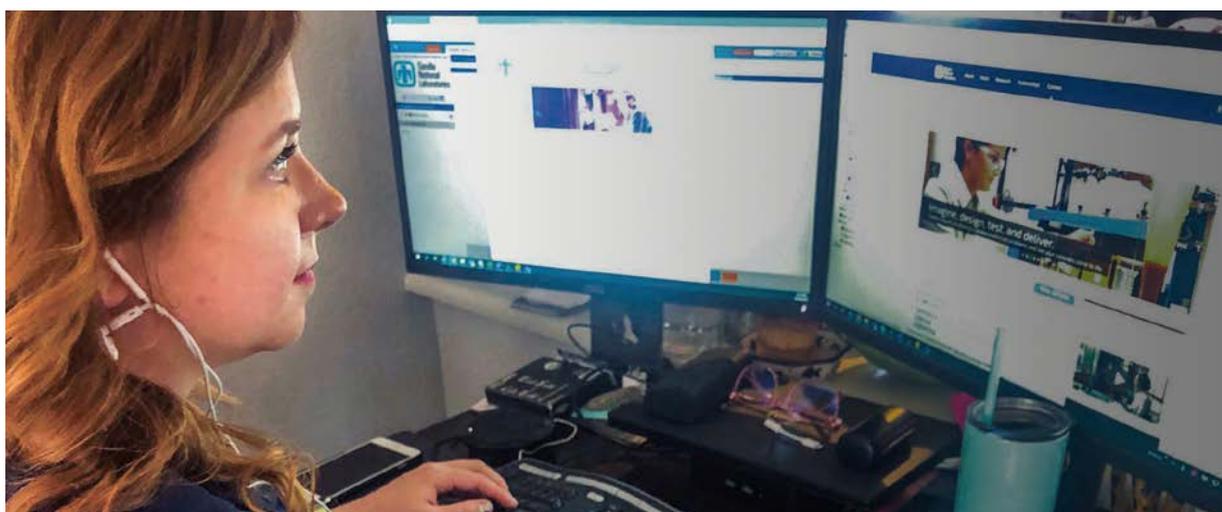
Sandia hosted the 5th Annual National Laboratory Directors Council Diversity Forum at the Albuquerque site. The NLDC encompasses 17 national laboratories committed to advancing diversity and inclusion. Sandia received two prestigious diversity awards, the "Organization of the Year" award from the Society of Asian Scientists and Engineers and the "Inclusive Leadership and Transformative Change" award from Profiles in Diversity Journal as one of 14 leading companies whose programs and initiatives take diversity and inclusion to a new level. (3000)

Building Sandia's talent pipeline

Innovative university collaborations and Labwide efforts have enhanced access to top talent despite highly competitive recruiting environments. The average number of technical student interns doubled from 44 to 88 per year from FY13-FY15 to FY18-FY20 at out-of-state Sandia Academic Alliance universities. Of significance was a 200% increase in new year-round representation over the past five years, peaking at 91 in FY20. This is leading to a steady increase of student conversions to regular hires, from 33% in FY13 to 47% in FY20. (1000, 2000, 3000, 5000, 6000, 8000)

Modernized Human Resources service delivery

Sandia launched a new shared service delivery model, HR Solutions, that aligns with the best HR operations across the globe to provide exceptional customer service. The new model modernized more than 133 processes and procedures and leveraged a new technology platform to decrease processing time and improve transparency. Sandia stood up part of the HR Solutions operations early to help support employee questions and needs during the onset of COVID-19. (3000)



Labwide telecommuting study completed

A Labwide team formed to learn from Sandia's telecommuting experiences during the pandemic and made recommendations to inform leaders and future policy changes. Representatives from every division worked on various aspects of the initiative such as an initial survey, focus groups, benchmarking and discussions with key stakeholders. The findings and recommendations were presented to the Senior Leadership Team and, as a result, the Labs' telecommuting policy is being updated and a new execution team will implement the recommendations. (8000)

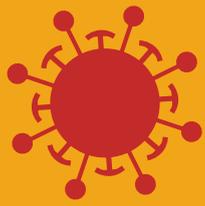
Thunderbird Kudos

Sandia launched a Labwide employee recognition program, "Thunderbird Kudos," which encourages employees to show their appreciation for the efforts of their co-workers and teams. Sandia employees showed their gratitude in the more than 3,150 Kudos handed out since the program's January launch. (3000)

Support for employees during COVID-19 impacts

In response to COVID-19, Sandia rapidly deployed numerous measures to support employees. Teams that included the California site, Information Technology and Medical reprioritized work and implemented testing facilities for employees and dependents, pretravel consultations, contact tracing and positive case response. They also made benefit changes to support medical and childcare needs, and created a dedicated website and regular communications to keep employees informed, along with a mobile app to monitor symptoms and site access. They made changes to programs such as internships, training, onboarding and interviewing to keep employees safe. (3000, 8000, 9000, 4000)

MISSION ASSURANCE



COVID-19 diagnostic lab operations



Led by bioscientists collaborating with Employee Health Services, Sandia set up and operated a COVID-19 diagnostic lab for Sandia and local DOE personnel to monitor workforce health and assure continued operations. Sandia was the first national lab to establish an on-site diagnostic lab, initiating testing 21 days from the start of the effort, and was the first national lab to receive Emergency Use Authorization from the U.S. Food and Drug Administration for its diagnostic protocol. (1000, 3000, 6000, 8000, 9000)

A Sandia-constructed sampling booth is used to collect COVID-19 samples, protecting the healthcare worker and minimizing PPE use.



LEGAL



Division 11000 support for COVID-19 impacts

Legal and Prime Contract Division supported both mission and mission enabling divisions on a wide variety of evolving complex legal issues arising from the COVID-19 pandemic. NTESS attorneys and Prime Contract professionals advised the Labs' leadership, all levels of management and subject matter experts on the transition to a largely remote workforce, and a host of laws implemented and affected due to COVID-19, such as the FFRCA and CARES Acts, privacy laws, ADA, FMLA, pension and benefits and tax laws. Legal identified and proposed risk mitigation on potential liabilities for employers; implemented Prime Contract clause changes; obtained indemnification under Public Law 85-804; assisted with rapid LDRD funding and technology deployment; and assisted with licensing and approval of COVID-19 testing and processing, medical requirements and numerous other initiatives to ensure employee health, safety and well-being, all of which enabled mission deliverables to be met. (11000)

OTHER



P19 project execution

The P19 project represents Sandia's commitment to respond to critical national security challenges. A diverse team from several divisions worked diligently to complete production and meet customer delivery needs throughout FY20. The team partnered with our DoD and NNSA stakeholders to successfully navigate the complexities of COVID-19 and produce, accept and install high-quality systems. The continued success of the P19 project clearly demonstrates Sandia's "exceptional service in the national interest." (2000, 6000, 5000, 8000, 9000, 10000)

