Welcome to the 2018 edition of the annual Lab News Labs Accomplishments. In these pages, you will read about a remarkable array of achievements by the staff at Sandia National Laboratories.

Sandia is fulfilling its national security missions, including maintaining the safety, reliability, and effectiveness of the US nuclear deterrent forces against a wider set of threats than ever before. The scope of our capabilities sets us apart. Sandia's deep science and engineering foundations give us a cross-disciplinary advantage that helps us solve some of the nation's toughest problems and make the world a safer place.

From critical milestones in our key mission areas to scientific breakthroughs reached via Laboratory Directed Research and Development to valuable tools in our Stockpile Stewardship program and could open the door to high-yield inertial confinement fusion. You’ll find examples of the strides we are making in our nuclear deterrence mission, meeting key deliverables in all our weapons programs.

You’ll discover how our high-performance computer modeling and simulation capabilities are playing an ever-more-important role in supporting our mission. You’ll learn here about important experiments sensitive for general publication. But you’ll learn here about important experiments of our greatest accomplishments have come in areas of national security that are too sensitive for general publication. And we’re doing our work more safely and with a more diverse workforce. Every Sandian plays a role. Behind every accomplishment is a team of talented and hard-working people at the very top of their game.

It’s impossible to collect all the great work done at Sandia in a single volume. Many of our greatest accomplishments have come in areas of national security that are too sensitive for general publication. But you’ll learn here about important experiments with tritium on the Z machine, ground-breaking work that represents a powerful new tool in our Stockpile Stewardship program and could open the door to high-yield inertial confinement fusion. You’ll find examples of the strides we are making in our nuclear deterrence mission, meeting key deliverables in all our weapons programs.

You’ll discover how our high-performance computer modeling and simulation capabilities are playing an even-more-important role in supporting our mission work across the enterprise.

The 2018 Labs Accomplishments provides a snapshot of the contributions we are making in supporting the warfighter, protecting the homeland, ensuring the nation’s energy security, working with international partners to ensure global peace, developing innovative approaches to cybersecurity, and supporting research to advance our fundamental understanding of the universe.

Our mission support and mission assurance organizations continue to provide best-in-enterprise leadership in the areas of safety and security, sustainability, quality, and employee benefits. You can read about their latest achievements here as well.

So sit down and enjoy this look at significant work performed at the Labs over the past year. I promise it will be time well spent and make you, like me, proud to be a Sandian.

Steve Younger
Laboratories Director
Nuclear Deterrence

In FY17, Group 1530 test completed a rocket-assisted cable pull-down (CPD) test for the B61-11 program. This test was the end-point of over a year of hazardous test activities including static fire tests to characterize rocket motor thrust profiles, and a calibration CPD test. The surveillance test involved accelerating a high fidelity B61-11 test unit into a concrete target at a controlled impact velocity and angle. Data from internal instrumentation, photometrics, and post-test assessment of the test article provided key data to the surveillance program and to the annual assessment report.

In FY17 the B61-12 and W88 ALT 370 programs successfully conducted key component reviews. The B61-12 program conducted 21 of 44 component Final Design Reviews (FDRs) in FY17 and has conducted 39 of 44 since 2016. The W88 ALT 370 program conducted 13 component FDRs in FY17 and has conducted 16 of 19 component FDRs since FY15. Also in 2017, the Mk21 program conducted five of eight component Baseline Design Reviews (BDRs) and the AFA RDR. Mk21 jointly participated in three of eight component FDRs with the W88 ALT 370 Program.

The B61-12 Nose Bomb Sub-Assembly (NBSA) team relies on computational simulation to successfully meet design requirements for ground impact (e.g. fuzing time, crush, and damage). Only five relevant tests were conducted, but the NBSA team simulated more than 2,000 impact scenarios spanning a range of impact speeds, angles, and orientations, using an estimated 13.2 million cpu hours. The NBSA model enabled evaluation of requirements over the full impact space.

MESA (Microsystems Engineering, Science, and Applications) delivered a record 26,000 microfabricated parts to DOE for the B61-12, W88-ALT-370, and Mk21 Fuze programs. Parts include Application Specific Integrated Circuits (ASICs) and Heterojunction Bipolar Transistors (HBTs). This is the largest ASIC production run in Sandia history and the first-ever HBT delivery from the MESA microfab. The high volume deliveries were enabled by a new Electronic Production Control System (EPCS) that reduced acceptance time by 80 percent, saved more than $18 million, and received a Defense Programs Award of Excellence.

The Mk21 Fuze program made significant system testing progress in FY17. Data from the successful Light-Initiated High Explosive (LIHE) test series (May 2017) was used to validate system models and determine mechanical-shock environments. In preparation for the first flight test, a ground test vehicle was assembled and environmentally tested at Sandia/California. The vehicle was then sent to Boeing and successfully tested in the integration tested with Minuteman III missile system hardware in collaboration with Boeing, Lockheed Martin, BAE Systems, and the US Air Force.

The W80-1 Alt 369 first production unit (FPU) was completed on Sept. 30, 2017, concluding a six-year development effort that met such challenges as redesigning components and gaining Fcant's authorization. According to the National Nuclear Security Administration, this accomplishment is an important step toward maintaining nuclear capabilities that will help deter attacks on the United States and its allies. The W80-1, a warhead carried by the air-launched cruise missile, was first introduced to the stockpile in 1982. Alt 369 replaces limited-life components in the warhead.

The W80-1 WARRIORD is carried by an AGM-86 air-launched cruise missile, a stand-off weapon deployed from the B-52H Stratofortress bomber.
Nuclear Deterrence

In September 2017, the W80-4 Life Extension Program team delivered Foundation Bus Development Kits to support integration with the Long-Range Stand-Off (LRSO) cruise missile. This is the first hard delivery to the US Air Force, which selected Raytheon and Lockheed Martin to competitively develop missile designs over the next four years. The development kits provide the LRCS program office and prime contractors with the necessary resources to develop, test, and verify the missile and warhead interface.

A team from Sandia’s DICE and STAR facilities and the nuclear weapons engineering, modeling, and simulation groups made key contributions to the scientific basis for certifying major weapon components and systems. The team instrumented sled track tests, supported the iterative design and validation of a key component, and characterized the crash response of an aluminum honeycomb material. The gun experiments provided cost-effective data to complement large-scale testing. The new data acquisition techniques afforded a 10-fold improvement in timing resolution compared to previous diagnostics. (2000, 2000)

Partnering with Lawrence Livermore and Los Alamos national lab colleagues, about a dozen Sandians completed an 18-month project to inform the nation’s Nuclear Posture Review. This Tri-Labs effort resulted in 14 background papers succinctly describing pros and cons for various nuclear weapons policy options. These well-received, high-impact, national-level decision-making products, delivered last year, are now being used by the White House and Defense Secretary James Mattis, demonstrated Sandia’s ability to anticipate national needs and work at the intersection of technology and policy. (8000, 1000, 100, 2000, 5000, 6000)

The Program Office led a multidisciplinary team that exceeds requirements for the program. 1800, 2300, 4100, 2000, 2100, 4000

Sandia and the Kansas City National Security Campus (KCNSC) have identified, researched, and selected a new conformal coating for the W80 ALT 370 program. A conformal coating is a required application in the production of a coating that provides environmental protection to the sensitive electronics. The new conformal coating replaces a previously selected coating that had demonstrated significant off-gassing of volatile species and poor accelerated aging performance. The new coating does not suffer from poor aging behavior and exceeds requirements for the program. 1800, 2300, 4100, and KCNSC were the lead organizations.

The Program Office led a multidisciplinary team that evaluated nine different stockpile scenarios for the Nuclear Posture Review development. The analysis showed the ability of each site to deliver, what risks would be introduced, what assumptions would need to be made, how each site would be impacted, and how surveillance and dismantlement would be affected. The analysis and the results were completed in time to inform the discussions at HQ. The work used tools developed by the Enterprise Modeling and Analysis Consortium to quickly perform this task. (2000)

The Program Realization Information Management & Exchange (PRIME) project created an application that can be used to verify the capability of certain facilities to produce nuclear warheads. The PRIME team developed a database of warhead specifications and electronic signatures that allow the verification of warhead designs. This project was successful and deployed in December 2016 across the NSE. PRIME

This year marked the beginning of the 24-flight, three-year-duration, qualification flight test program for the B61-12. Since March 2017, the B61-12 flight test team, in partnership with Sandia’s Tonopah Test Range and the Air Force 422nd Test and Evaluation Squadron, have successfully planned and executed five development flight tests. The tests were flown on F-16C and F-15E aircraft originating from Nellis Air Force Base, and exercised both ballistic and guided trajectories with a variety of aiming, fuzzing, and fusing settings. (2000, 600, 1000)

FIRST B61-12 DEVELOPMENT FLIGHT TEST just after release from an F-16C. Clearly visible are the spin rocket motor flames, which are part of the arming subsystem.

The W88 ALT 370 program completed its first fully functional flight test in FY17. This was the fifth flight test performed as part of the W88/03 & ALT 370 qualification program. The two flight bodies demonstrated end-to-end functional performance of the development joint test assembly, and collected critical functional data to verify requirements. The successful flight was accomplished by a multi-disciplinary team from Sandia’s California and New Mexico sites as well as external partners. (2000, 1000, 5000, 8000, 9000)

A B61-11 Cable Pulldown Surveillance Test was conducted at the Sandia Aerial Cable Facility on Sept. 7, 2017. This test imparted worst-case temperature and impact environments not achievable through flight testing. This significant accomplishment demonstrated a cross-cutting team’s readiness to execute a complex surveillance test that occurs infrequently, as well as an integrated process and ability to successfully manage significant hazards for safe acquisition of high-value data. (2000, 8000, 4000, 6000, 6000, LANL, KAF Firefighters)

Magnetox oxide (MgO) is a critical material for pow- ering the Nuclear Deterrent (ND) Mission. For the first time, the MgO team has developed the fundamental sci- ence-based understanding of the material structure-func tion relationships for ion transport and has captured the critical parameters needed to replicate its performance. While this work is of primary interest to our ND capabilities, it also impacts our defense community. Significant contributions to this work were made by 1000 and 2000.

The Design of the Common Authentication Module (CAM), Applica- tion Specific Integrated Circuit (ASIC) has been completed and produc- tion has commenced with the delivery in Octo- ber 2017 of 96 diamond stamped parts. The CAM ASIC is a secure process- ing platform meeting strict National Security Agency security require- ments for the U.S. Com- mand and Control and similar high consequence applications and is fabri- cated using Sandia’s jokes CMOS 110 nm hard-process. (2000, 5000, 8000)

Sandia provided all its deliverables in support of the Department of Energy’s National Nuclear Security Admin- istration (DOE/NNSA) officially authorizing the Production Engineering Phase (Phase 6.4) for the W88 Alteration (ALT) 370 program on Feb 22, 2017. This milestone represents the culmination of four years of work in the Development Engineering Phase (Phase 6.3) of the program, and marks the beginning of the Production Engineering Phase prior to production. The first production unit (FPU) of this weapon is planned for December 2019. (2000, 1800, 2000, 2000, 6000, 10000)

Sandia successfully executed end-to-end performance functional demonstration of the ISA-SCR (Integrated Safety Architecture - NGA Compatibility Retofit) compo- nents and ALT 940 electronics in the Sandia Test Vehicle. This represents an important integration milestone between the ISA hardware and the transportation venue critical to successful project execution.
Nuclear Deterrence

The Nuclear Weapon Legacy Hard-ware Laboratory Team received an NNSE DP Award of Excellence for successfully creating and implementing robust processes for the characterization and disposition of legacy nuclear weapon hardware, while enhancing the preservation of historically significant nuclear weapon systems and hardware knowledge. This work provides the foundation for nuclear weapon engineering education and studies in safety, surety, emergency response, and intelligence analysis and nonproliferation research. (2000, 10000)

The Neutron Generator Enterprise (NGE) met or exceeded all deliverable commitments in the FY17 NGE Integrated Program Plan. This included a significant number of NG builds representing nine NG products in development and production. There were more than 45 unique continuous improvement activities worked within the NGE focusing on production operations in FY17, including fixture and inspection enhancements, increased data analytics capabilities, equipment modernization, and optimization and standardization of processes. (2500, 9400, 1500, 2100, 2300, 8200)

What happens when a detonation hits a corner? Modelers/designers need to understand to optimize explosive performance. Techniques to see “inside” explosives during detonation, like flash X-ray, have limited resolution. Images of high explosive detonation using the micro-mushroom test. Pentathlon/Pentetritate (PETN, left) shows no dead zone during corner turning, while hexanitroazobenzene (HNAZ, right) does.

Researchers in O2554 developed techniques to deposit and detonate thin-films of explosives to study performance at small scales. Using conventional ultra-high-speed imaging, the first optical images of corner turning behavior were presented at the 2017 American Physical Society Shock Compression Conference in October 2017. These images were collected using flash X-ray to detect the corner turning behavior of explosive thin films. The first optical images of corner turning behavior were presented at the 2017 American Physical Society Shock Compression Conference in October 2017. These images were collected using flash X-ray to detect the corner turning behavior of explosive thin films. The images show that the shock wave propagates through the explosive film as a single, coherent wave, without any evidence of discontinuities or instabilities. This suggests that the thin-film explosives used in these experiments are highly homogeneous, and that they exhibit good performance characteristics at small scales.

For eight surety mechanism major components, comprising several hundred custom mechanical parts, the following milestones have been completed: five Final Design Reviews, one Baseline Design Review, two Production Readiness Reviews, four top level Complete Engineering Reviews, and numerous sub-assembly and production tester Qualification Evaluation Reviews. First Production Unit is less than one year away for most of these components supporting B61-12, W80 ALT 370, and MK21 Fuze, and development hardware has been flown successfully in all flight tests. (2600, 2300, 2200, 1800, 1500, 9400)

Organization 2630 has successfully completed all component Final Design Reviews for custom connectors, capacitors, cables, and magnetic components for the B61-12 and W80 ALT 370 programs, with many having completed Process Prove-In and several having been qualified. This represents almost 200 component designs. In addition, the COTS department has released life of program buy engineering releases for more than 1,000 parts, with roughly 500 having received their final qualification. This effort represents a tremendous accomplishment in partnership with our production agency, the Kansas City National Security Campus.

A large remote sensing ground system called FROGS was successfully transitioned into an operational capacity in October 2017. This marks the near completion of a 45 year enterprise project to upgrade hardware and software, add new mission capabilities, and improve operator workflow. The new ground station is exemplary in design and function for the nation. As significant contributors to the Advanced Systems Program Office, Data Systems Engineering (2660) staff and management are proud of our contributions to the design, integration, deployment, and operations of this milestone.

Sandia External Production (SEP) delivered thousands of parts for multiple weapon systems, in support of the stockpile, with a budget of more than $325 million. SEP production efforts focus on a challenging mix of hardware products not produced elsewhere within the Nuclear Security Enterprise. External supplier partnerships exist for products with highly integrated technical production challenges. Hardware is produced internally when vendor base cannot support production. SEP provides program and supply chain management to ensure requirements and expectations for nuclear weapon production deliverables are met. (2000, 5000, 10000)

The B61-12 program has successfully executed a series of monthly system-level assembly builds of trainer hardware to support process development, tooling trials, and definition maturation for production transition. Using an early Type-5B trainer, Sandia, in coordination with Los Alamos National Laboratory and CNS Pantex, has successfully demonstrated the ability to safely and securely produce the B61-12 ultimate user configuration. Requirements, tooling, and processes were developed to ensure principles such as nuclear safety, assurance, and use control are at the forefront of the production strategy. (2000)

In 2015, a SERT-led effort began to develop tooling to support the installation of the new B61-12 Mark 21 Fuze (M21F). These tooling components ensure the fuze components are free of contaminants and damage during installation. The M21F was delivered to Pantex in 2017 for testing and integration into the 5B trainer. The delivery of the Mark 21 Fuze into the trainer marks a significant milestone for the B61-12 program.

SEP of Parts

SEP delivers parts to homesteading work centers in support of weapon system development and production. SEP parts support the B61-12, W80 ALT 370 and MK21 Fuze programs, and are flown successfully in all flight tests. (2600, 2300, 2200, 1800, 1500, 9400)

SEP delivers many parts to Pantex after completing the assembly of the B61-12 5B trainer. Sandia External Production (SEP) delivered thousands of parts for multiple weapon systems, in support of the stockpile, with a budget of more than $325 million. SEP production efforts focus on a challenging mix of hardware products not produced elsewhere within the Nuclear Security Enterprise. External supplier partnerships exist for products with highly integrated technical production challenges. Hardware is produced internally when vendor base cannot support production. SEP provides program and supply chain management to ensure requirements and expectations for nuclear weapon production deliverables are met. (2000, 5000, 10000)

SEP is supporting the customer by delivering more than 6000 parts to Pantex after completing the assembly of the B61-12 5B trainer. Sandia External Production (SEP) delivered thousands of parts for multiple weapon systems, in support of the stockpile, with a budget of more than $325 million. SEP production efforts focus on a challenging mix of hardware products not produced elsewhere within the Nuclear Security Enterprise. External supplier partnerships exist for products with highly integrated technical production challenges. Hardware is produced internally when vendor base cannot support production. SEP provides program and supply chain management to ensure requirements and expectations for nuclear weapon production deliverables are met. (2000, 5000, 10000)

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Sandia engine researchers are exploring ducted fuel injection (DFI), a new concept where fuel is injected through a small, cylindrical duct aligned with the fuel axis. Orders-of-magnitude soot reduction was demonstrated, which shows great promise for typical diesel engines. DFI may also increase combustion efficiency by decreasing unburned hydrocarbons and carbon dioxide emissions. DFI research is funded by DOE’s Office of Vehicle Technologies and is supported by work-in-kind from Caterpillar and Ford via a cooperative research and development agreement. (8300)

Sandia-designed microneedle sensors can extract interstitial fluid, the clear fluid between cells in the middle layer of skin, for further study. Fussile and minimally invasive, the needles can be left in for hours, enabling constant sampling of biomarkers to monitor and diagnose health conditions ranging from dehydration to life-threat- ening sepsis. A study conducted by Sandia and the University of New Mexico investigated needle length and compared interstitial fluid to blood. Interstitial fluid may someday join blood and urine as a fluid routinely tested for clinical diagnoses. (8600, LDRD)

Can one of California’s largest and most polluted lakes become its most productive and profitable? To find out, Sandia is testing an algae-harvesting system that uses water from a tributary to the Salton Sea. The project could yield renewable energy while providing a safe process for removing harmful chemicals. Sandia’s electric-grid researchers received two R&D 100 awards in 2017. One is for the Microgrid Design Toolkit, a publicly available software product that uses powerful search algorithms to help microgrid designers explore technology and performance trades in the preliminary design phase. The second is for a control system that damps oscillations in transmission lines using new smart-grid technology, enabling greater grid stability, higher power flows, and lower costs. The control system was proven effective during demonstrations on the Western US power grid. (8800, 1000, 3000, 6000)

A joint Department of Energy/Spanish/Korean project was conceived, designed, and managed by Sandia to quantify the shocks and vibrations spent nuclear fuel experiences during trans- port. A storage/transportation cask containing surrogate nuclear fuel was transported by truck in Spain, by ship to Baltimore, and by rail to Colorado for specialized tests. Data—6 terabytes—were continuously collected over 9,600 miles. Strains measured on the surrogate fuel tubes will be compared to the stress of simulated accidents to estimate the fuel’s ability to withstand extended storage and transportation. (8800, 1000)

A new class of scintillation material for radiation detection. It has the uncommon ability to detect a variety of infectious diseases in less than an hour. This year, the team added even more capability to their mobile diagnostic device. Now, users can watch the test develop in real time, so they can see the results as they turn positive. In theory, this allows a scientist to estimate the amount of pathogen present in a sample — and help the medical community quickly prepare an appropriate course of treatment. (8600)

Sandia’s chemical engineer has designed, modeled, and tested a control system that doubles the amount of power a wave energy converter (WEC) can absorb from ocean waves, making it more cost-effective. Sandia glass is a new class of scintillation material for radiation detection. It has the uncommon ability to detect a variety of infectious diseases in less than an hour. This year, the team added even more capability to their mobile diagnostic device. Now, users can watch the test develop in real time, so they can see the results as they turn positive. In theory, this allows a scientist to estimate the amount of pathogen present in a sample — and help the medical community quickly prepare an appropriate course of treatment. (8600)

Intermittent fluid may someday join blood and urine as a fluid routinely tested for clinical diagnoses. (8600, LDRD)

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The SolidSene Gas Analyzer on a Chip robust sensor platform combines electrochemical sensing techniques with neural network machine learning to detect the first small, low-cost, high-temperature stable, on-vehicle sensor that detects and characterizes all EPA-regulated automotive gases emissions with unprecedented parts-per- million-level sensitivity. The device enables continuous optimization of combustion chemistry, control of catalytic converter chemistry, and monitoring of exhaust chemistry at the tailpipe. The platform can also be modified to monitor ambient air quality, characterize the chemistry of power plant stack emissions, detect explosives compounds, and address numerous other sensing challenges.

Sandia organic glass is a new class of scintillation material for radiation detection. It has the uncommon ability to detect a variety of infectious diseases in less than an hour. This year, the team added even more capability to their mobile diagnostic device. Now, users can watch the test develop in real time, so they can see the results as they turn positive. In theory, this allows a scientist to estimate the amount of pathogen present in a sample — and help the medical community quickly prepare an appropriate course of treatment. (8600)
Technological innovations in Safeguards and Security are setting standards for other DOE programs. Among the innovations is a new email masking tool that was beta tested on Sandia’s classified network by NNSA’s Office of the Chief Information Officer (OCIO) before full deployment across the enterprise — the tool will better detect unauthorized network-based transmissions. Another engineered control reduces complexity for mission partners when working in secure areas, reducing what was a cumbersome eight-step lock process to a simplified, yet more secure, three-step process.

Sandia’s custodial services deployed the Sandia Total Access Request Tool (START), which consolidates eight applications to streamline the clearance/badging process and interfaces with DOE, General Services Administration, and multiple Sandia applications. START simplifies both the experience for members of the workforce and the processing steps for Personnel Security. Improvements include improved uncleared badging, real-time status of requests, and a single location for all badge/clearance related requests.

HR and Communications

Sandia’s health plan ended FY17 $4 million (2.3 percent) under budget partially due to negotiated cost savings through effective contract management as well as progressive wellness efforts to maintain a healthy workforce. The low cost means lower premium increases for employees. Sandia’s low healthcare costs are supported by the October 2017 DOE Contractor Benefits Benchmarking and Metrics Study, which shows total cost for active employee health at $13,383 per employee per year, well below the DOE weighted average of $15,861. (3500)

On Oct. 9, 2017, a new agreement was ratified between Sandia and the Metal Trades Council (MTC) that is effective through Sept. 30, 2020. There are approximately 440 employees in the MTC labor union at Sandia. The new contact continues supportive partnerships and provides wage increase in all three years of the agreement, and simplifies a number of aspects of the prior contract to better support Sandia’s critical national defense mission.

The National Museum of Nuclear Science & History, managed by DOE by Sandia and operated by a not-for-profit organization, successfully designed, created, and erected a nearly full-scale replica of the Trinity Tower on which the Trinity Test of the world’s first atomic detonation occurred in July of 1945. The exhibit erected outside the museum in Heritage Park includes a replica of the plutonium device “gadget” hanging below the cabin that was atop the tower. The privately funded project enhances community appreciation for the Sandia/DOE role in this technology development and history. (3800)

An active shooter at the Labs is considered a top safety and security concern. In July, Sandia’s Protective Force and Emergency Management led efforts to develop a joint training exercise with numerous other aid agencies. While exercises and staff trainings at Sandia locations take place regularly, this exercise was the first of its kind that allowed internal and external agencies to practice responding to a simulated incident and assess how response capabilities are integrated on Sandia property.

In addition to SANDIA FIRST RESPONDERS, this exercise included the FBI, NMAA, Kirtland AFB, Albuquerque Police, and UNM Hospital, as would be the case in a real-world event. (Photo by Randy Montoya)

The California site’s materials science and microscopy capability greatly advanced with the acquisition and installation of an aberration-corrected scanning transmission electron microscope (AC-STEM). To house the AC-STEM, the California site operations team had to create a tightly controlled laboratory environment and install dedicated power and cooling systems. A normal timeline for a project of such complexity is about one-and-a-half to two years. However, the AC-STEM project was largely completed in eight months, thanks to the team’s agility, creativity, advanced planning, and dedication to cross-functional partnerships. (8300)

The California Security Operations team facilitated a smooth transition to a competitively bid Protective Force security contract, significantly reducing Sandia’s costs. The team also successfully completed an audit of the Sandia/California Security Program. Requested by the Department of Energy’s Office of Enterprise Assessments to provide DOE and Sandia leadership with an evaluation of program effectiveness, the audit concluded that sensitive information and material at the California Laboratory are being adequately protected and that the California site’s core safeguards and Security programs are effective and compliant. (8000)

Buildings 756 in New Mexico and 936 in California both achieved the Leadership in Energy and Environmental Design (LEED) gold rating by the US Green Building Council, bringing Sandia’s total to 13 certified buildings. LEED is a third-party program and the nationally accepted benchmark for the design, construction, and operation of high-performance green buildings.

LEED Gold-certified Bldg. 936 (California)

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Sandia advanced its academic partnerships by building new faculty relationships, research collaborations, and strengthening its talent pipeline. Under its Academic Alliance program, the Chief Research Office hosted about 40 early-career professors from leading universities for a two-day orientation in August 2017. They toured Sandia’s research facilities and networked with leadership and principal investigators. Sandia also established more than 30 new research collaborations by leveraging faculty expertise in cyber and infrastructure security, shock dynamics, additive manufacturing, data sciences, and other important capability areas. (1000, 2000, 5000, 6000, 8000, 9000, LDRD)

Manufacturing, data sciences, and other important capabilities in cyber and infrastructure security, shock dynamics, additive manufacturing, data sciences, and other important capability areas. (1000, 2000, 5000, 6000, 8000, 9000, LDRD)

In 2017, Sandia won five Federal Laboratory Consortium awards for remarkable technology transfer achievements. Awards included Outstanding Regional Partnership for the National Rotor Testbed with Oak Ridge National Laboratory and TPF Composites Inc., which works to reduce costs and production time for wind turbine blades; and Outstanding Commercialization Success for SpinOn™ and the Truth® Male Fertility Testing System. These prestigious awards recognize the range of technologies developed at Sandia that are successfully transferred to the private sector, resulting in valuable social and economic impacts.

A new technique for reducing noise in coincidence measurements of ion mass and electron energy from photoionization events provides unprecedented accuracy for identifying and quantifying products in gas-phase chemical reactions. The approach, invented by physical chemists at Sandia’s Combustion Research Facility collaborating with University of the Pacific and Swiss Light Source colleagues, removes “false coincidences” from chemical-physics experiments. Dynamic range is improved by a factor of 100, enabling the quantification of minute amounts of one chemical in the presence of enormous amounts of another. (8300)

Computational analysts deployed and used electrical modeling tools developed by the Qualification Alternative to the Sandia Pulsed Ractor (QASPR) project for the first time to predict the margin of circuit performance in the W80ALT.404/F under neutron radiation from hostile nuclear bursts. Advanced Uncertainty Quantification (UQ) techniques were used to raise confidence in the calculations to levels acceptable for qualification evidence. These activities were identified on the FY17 NNSA NA-10 “Getting The Job Done List.”

The Focused Ion Beam (FIB) Interferometer team was responsible for inventing and proving the effectiveness of an in-situ interferometer tool within an FIB vacuum chamber. In-situ interferometry is a groundbreaking capability in the world of FIB processing, where ultra-precise measurements of very thin films are crucial for success. The consequences of misjudging thickness measurements by even hundreds of nanometers are typically catastrophic and unrecoverable. In-situ measurement techniques allow an FIB operator to be incredibly accurate in these routine processing steps. (5000)

ARTIST RENDERING of light passing down a silicon photonic waveguide, and the subsequent encoding of information onto the light using a resonant silicon microdisk cavity.

We have developed three prototype accelerators that have established a technical foundation for revolutionary next-generation pulsed-power machines. Centipede (history’s first gigawatt-class four-pulse accelerator) is used to evaluate multi-pulse technology for radiographic measurements of sub-critical experiments at Nevada. Thor (history’s first megampere-Class arbitrary waveform generator) is optimized for plasma-source ion-beam acceleration, while the cavity driver accelerated the tests. Z-Nex Cavities are some of the most advanced high-yield neutron burst切尔的磁性结构，其磁性可以抵抗外部磁场的影响，使得这种结构在材料科学中有着广泛的应用。HAANA has introduced three new brain-inspired architectures, including the first 2-meter-diameter 100-gigawatt pulse generator; the cavity could serve as a phase-power source for a future 1,000-terawatt accelerator that is optimized for thermoelectric fusion research. (1000, LDRD)

Sandia is fabricating hardware using new programmable resistors that mimic neural synapses. The Sandia hardware fundamentally changes how computations are done by using device physics to train neural networks. A key challenge remains for designers as materials, devices, circuits, architectures, and algorithms must be co-designed. A crossbar simulator, Croesus, that leverages Sandia’s Xylo circuit-simulator was created to study these co-designs. Croesus has guided the development of better artificial synapses and allowed for algorithmic innovations to use noisy, nonideal devices. (8700, 5000, 1000, LDRD)

CROSSSIM USES MEASURED DEVICE properties to model a neural network performs on a new architecture, allowing for the co-design of materials to algorithms.
Advanced Science and Technology

Sandia scientists showed that the world’s largest laser, the National Ignition Facility at Lawrence Livermore National Laboratory, could be used to study thermomechanical shock from intense X-ray bursts, important for qualifying additively manufactured and other advanced materials to radiation environments.

In each experiment, 160 laser beams energized a krypton plasma, launching ~13 keV X-rays into specimens monitored with high-speed, ultralow noise interferometry developed by Sandia. Collaborations from Los Alamos National Laboratory provided high-resolution X-ray tomography using the Advanced Photon Source at Argonne National Laboratory to study microstructural damage caused by the extreme radiation.

Mission applications such as impact sensor analysis for the B61 require efficient solution of multiphysics problems with multiple material interfaces. Sandia’s coupling tool, Forte, enabled partitioned solution of such problems for the B61-12 Nose Bomb Subassembly field tests. By allowing non-matching interfaces, enabling key timely analysis of the project developed and implemented an algorithm for accurate but fast processing of the simulation data.

A cross-organizational team executed the first tritium experiment on the Z machine, using engineered systems and thoughtful work planning to mitigate this new hazard at the facility. Thermonuclear fusion of deuterium and tritium can increase the neutron yield ultimately by factors of 50-100, enhancing the impact of Z for Nuclear Survivability and High-Energy-Density science supporting Stockpile Stewardship. This initial experiment opens the door to higher quantities of tritium on the path toward high-yield Inertial Confinement Fusion in the future of the pulsed power program.

TRINITY ADVANCED TECHNOLOGY SYSTEM — The capabilities of Trinity are required for the NNSA Stockpile Stewardship mission to support annual assessments and qualification.

The Trinity supercomputer, a joint project of Sandia and Los Alamos, successfully passed in Production Readiness Milestone, the final step to transitioning into full production for support of NNSA’s stockpile stewardship mission. Trinity features a innovative architecture, including Intel Phi 68-core processors (code named Knights Landing) with integrated high bandwidth memory. The system was integrated by Cray and features its high performance Aries interconnect network. The system architecture effort was led by Sandia, while Los Alamos leads operations and the project office.

Reported in November’s Nature Scientific Reports, researchers from 5200, 1800, and 6700 developed a photodetection paradigm based on graphene, a single layer of carbon atoms, enabling smart charge integrating pixels that offer high-sensitivity while simplifying complex read-out architectures currently employed. Developed under the Smart Sensors Technology Grand Challenge LDRD, this advance provides a path to next-generation multi-modal (visible/infrared/radiation) sensors, allowing the use of new absorbers and architectures currently unavailable. Functionally, graphene acts as a local amplifier with large photogain, creating pixels that are individually controllable.

The Ultra-Wide-Bandgap Grand Challenge Laboratory Directed Research and Development team recently won an R&D 100 award for developing the next generation of semiconductors to enable dramatic improvements in electrical power conversion. The technology will benefit numerous critical applications, ranging from ultra-compact and robust power converters for nuclear and defense systems, to ultra-efficient power converters for a resilient electric grid. The award recognizes two ultra-wide-bandgap semiconductor devices, a diode and a transistor, each of which is the first of its kind and has exhibited record performance.

Over the past three years, the PELE ALMOND* team has successfully designed and manufactured an “embedded” fuse for the Air Force Research Laboratory (AFRL) capable of surviving extreme pressure and high-G environments. As part of the design task, the Dept. 2627 team collaborated with both internal organizations (2533) and external vendors to qualify a Direct Header Deposition (DHD) Exploding Wire Initiator detonator. The success of this project has led to significant follow-on work with AFRL and a high likelihood of transitioning the DHD technology to industry partners.

The TWO neutron radiation effects cassettes aim toward the center of the containment structure housing a tritium gas transfer system in the Z vacuum chamber.

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The final payload of the next generation of Global Burst Detector, GBD III, was delivered Nov. 7, 2017. The first launch of GBD III is expected in mid-2018. This generation, hosted on GPSIII, will join GBD systems on prior generations of GPS satellites. The Global Burst Detection system looks for nuclear detonations around the world, offering real-time information to US policymakers about potential activity. Sandia has developed and delivered satellite-based nuclear detonation detection systems since 1963. (6700)

A multi-level security special communications system that supports multiple transport segments has formally been declared an Initial Operational Capability by DoD. A $50 million, five-year effort, the Special Communications Portal for Enterprise (SCOPE), will be operated out of Sandia's California site. The highly complex SCOPE application is built on a modern software architecture and includes ~500,000 lines of source code supporting national security needs. In April and July 2017, the project completed three weeks of customer-witnessed acceptance testing of functional requirements. (6300, 2600, 5100, 8700, 9300, 10600, 10700)

A workshop spearheaded by Sandia researcher David Reyna eventually led to solving a 43-year-old physics mystery. Using the world’s smallest neutrino detector, a collaboration of 80 researchers from 19 institutions and four nations detected and characterized coherent elastic scattering of neutrinos off nuclei. Sandian Belkis Cabrera-Palmer oversaw the analysis of data collected with the Sandia-developed neutron scatter camera. Published as a Science cover article, the COHERENT project’s breakthrough research paves the way for additional discoveries in neutrino behavior and the miniaturization of future neutrino detectors. (8600, LDRD)

Sandia’s Physical Security Center of Excellence was tasked to conduct engineering site surveys at nine NNSA sites to gather current physical security system status. Sandia developed optimized technical approaches, rough estimates, and a master schedule to revitalize the security systems at all nine sites in accordance with DOE directives and funded and directed under a Congressional mandate “Center for Security Technology, Analysis, Response and Testing (CSTART).” The 10-Year plan was formally approved by General Klotz, NA-1, in August 2017.

Sandia and Worcester Polytechnic Institute completed a study demonstrating particulate resuspension of americium-241 is much lower than previously estimated. Resuspension is a critical parameter in modeling the prospective radiation dose in the event of an incident. Since there are more than 7,000 well-logging sources worldwide that use Am-241, this new information can be used by policy makers to re-evaluate radiation protection measures to decrease risk to emergency responders, radiological security specialists, and the public. (6000)
Due to the significant proliferation in small Unmanned Aerial Systems (UAS) usage and sales, the commercial sector has begun to market detection, assessment, and neutralization systems to counter potential UAS concerns to national security. Sandia (Group 6520) was tasked by NNSA to develop a methodology to test and evaluate cUAS commercial-off-the-shelf products and provide decision makers with information on performance, maturity, and technology gaps. The cUAS T&E methodology (see illustration at bottom of page) developed provided a comparable, scalable, and repeatable standard whereby all systems could be evaluated equally. (6500)

The next generation Global Burst Detector payload, III Prime, is in the critical design phase. This year, a system-level test campaign commenced to perform system-level Assembly, Integration, and Test activities with high-fidelity subsystem engineering units, cables, and system test equipment. Two campaigns successfully tested the integrated payload verifying functionality and interfaces. At the end of the multi-year test series, system test equipment and test processes will be ready for flight use, reducing execution risk in a challenging schedule to deliver the first GBD flight systems to GPS host space vehicles.

Sandia designed, built, and delivered to the Defense Threat Reduction Agency a replacement for radiation detection equipment (RDE) employed by US arms control treaty inspectors. The new RDE was approved for use in May 2017 and deployed in Russia for a New START (Strategic Arms Reduction Treaty) inspection. The RDE is used to verify that items declared to be nonnuclear are indeed nonnuclear. The original RDE was more than 25 years old, and maintenance was difficult. The replacement RDE offers improved sensitivity, durability, safety, and ease of use. (6000, 5000)

A SANDIA ENGINEER DEMONSTRATES radiation detection equipment used in the New Strategic Arms Reduction Treaty (New START).
National Security Programs

Sandia’s Kusal Test Facility (KTF) successfully supported the Standard Missile-3 Cooperative Development Flight Test 02, Feb 2017. The US Missile Defense Agency, Japan Ministry of Defense, and US Navy successfully intercepted a ballistic missile target using the Standard Missile 3 Block IIA. This joint US-Japan mission provided key test data to improve Medium and Intermediate Range Ballistic Missile intercept capabilities to meet future mission objectives. Sandia collaborates with numerous interagency customers to utilize KTF’s unique resources which include all aspects of rocket launch and mission support. (5000)

WeaselBoard

The modern world is run by embedded computers that manage physical processes, including electricity generation, manufacturing, and ship operations. The embedded computers that do this work have received a lot less cyber-security monitoring and protection than the ones on our desktops. The WeaselBoard adds cyber-security inspection to these embedded computers. The Department of Defense has begun deploying WeaselBoards to high-value locations where they can be alerted (out-of-band) to adversaries’ attacks. The development of this custom hardware/firmware/software/network solution has engaged experts from Divisions 5000 and 2000.

Sandia’s Advanced RF Systems Group successfully demonstrated its multi-mission, Intelligent Transceiver for Universal Signaling (ITUS) payload during a multi-agency military exercise in Florida. The ITUS payload, integrated into an unmanned aircraft, exceeded expectations as it dynamically detected, tracked, and engaged all targets in its area of responsibility via proven-unique methods. Sandia’s successes garnered accolades from the host organizations. (5000)

The simulated “footprint” of materials needed for trans- port to the scene of an explosive threat. Further, a com- mercial oxidizer, commonly used in pool cleaners, has been tested and proven as an effective additive for chemical and biological agent decontamination. (6000)

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Mission Assurance

In 2017, weapon response analysts in Surety Engineering & Weapons Quality worked with NNSA, Lawrence Livermore and Los Alamos national laboratories, and Pantex to develop, test, and implement new processes in nuclear explosive operations. Analysts worked on multiple projects — the W88 and B61 stockpile systems, the vacuum chamber, and the warhead measurement campaign — to reduce risk, increase efficiencies in production, and support joint NNSA defense and nonproliferation efforts. Team members, who averaged only two years of experience, potentially identify their attacker, and increase the time and resources the adversary must expend to successfully breach a cyber system. In an era of increasing sophistication among cyber criminals and state-sponsored threat actors, HADES could lead to a dramatically improved cybersecurity posture for American enterprises. (9300, LDRD)

In 2017, weapons and means analysts at Sandia developed HADES, the High-fidelity Adaptive Deception & Emulation System, which won an R&D 100 Award in 2017. HADES, provides a comprehensive solution for detecting, deceiving, engaging, and analyzing the cyber adversary. The High-fidelity Adaptive Deception & Emulation System, or HADES, provides analysts the ability to isolate an attack while collecting raw intelligence about threat actors and their tools, tactics, and procedures. This increased awareness, and the ability to adjust the deception environment to provide the attacker with a realistic environment that is both challenging and evolving, enables cybersecurity professionals to better defend their networks from current attacks, learn their attacker’s methods and motives, potentially identify their attacker, and increase the time and resources the adversary must expend to successfully breach a cyber system. In an era of increasing sophistication among cyber criminals and state-sponsored threat actors, HADES could lead to a dramatically improved cybersecurity posture for American enterprises. (9300, LDRD)

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On Sept. 14, 2017, Sandia broke ground on a new, ultra-modern computer annex designed by Sandia data center engineers to meet the needs of future high-performance computing systems. New building technology will help minimize water and energy use, and green-building construction and an external solar panel field are expected to help achieve LEEDS certification. The multi-petaflop computer the facility is intended to contain is expected to be as much as a hundred times faster than the storied Red Storm supercomputer, housed in an adjoining center in the early 2000s, in performing large-scale weapons simulations.

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In 2017, the newly formed Quality Assurance (9100) team applied its specialized technical, systems, and quality assurance expertise to organizations across the Labs to help ensure the continued delivery of exceptional products and services. Highlights include the update of Sandia’s Quality Assurance Program regulatory document and corporate roles definitions, managing issue closure efforts during the review of Sandia’s highest-risk processes for the incoming NTESS management team, implementation of a Labs-wide quality assurance process through blanket ISO certification, and creation of a more user-friendly corporate acronym and dictionary manager and policy informational programs. During the past fiscal year, Product Acceptance and Supplier Quality has pursued Diamond/STAR Stamp authority, which would allow Sandia to accept Mark Quality products as a delegate of NNSA and help speed component delivery to meet increased production demand from the Nuclear Weapons programs. To consider awarding this authority, NNSA-SFO performed 14 Quality Assurance Surveys (QAS) to assess inspector competence, procedure and process compliance, and the ability for inspectors to make the right technical judgments, which Sandia passed with a 100 percent performance inspection grade. This outstanding record gave NNSA-SFO the confidence to grant Sandia interim authority, with full Diamond/STAR Stamp authority to follow.

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This blend of innovation and familiarity gives customers a hazardous and nonhazardous materials across both sites. Both New Mexico and California used to use Sandia’s newest laboratory-wide service-request systems. Advanced Enterprise Software Engineering, is one of ment requests. (10200) to assist members of the workforce in tracking procureinformation. This is the first of several tools being released needed), as well as a link to a site that includes additional provided information on who the buyer is, recent update pools by 50 percent, reduced the number of service centers, pools, and reduced the number of rates by more than 75 percent, and provides a significant reduction in indirect cost recycling. It will foster understanding of what Sandia spends taxpayertools on and allow efficiencies to be gained in future years. (10500)

Laboratory Operating System

SANDIA defined a high-level Laboratory Operating System (LOS) framework to increase Sandia’s capacity to learn, innovate, and respond to the rapidly changing environment. LOS is our purposeful multi-year journey to evolve the Laboratory culture to a learning organization, aided by six enablers (Tiered Accountability, Data-dri-ven & Visual Management, Rapid Problem Solving and Continuous Improvement, User-Centered Design, Velocity Technology, Development, and Strategy Deployment). One of the six enablers, Tiered Accountability, is currently deployed at the Director-level and above supporting timely information sharing, issue resolution, and transparency. (10500) To increase transparency into Sandia’s overhead cost pools, the Labs deployed a new financial model at the beginning of FY18. The new Cost Accounting Standards-compliant model reduced the number of overhead cost pools by 50 percent, reduced the number of service centers by 75 percent, reduced the number of rates by more than 75 percent, and provides a significant reduction in indirect cost recycling. It will foster understanding of what Sandia spends taxpayertools on and allow efficiencies to be gained in future years. (10500)

SANDIA made significant changes to the travel process and launched enhancements to the expense report system (ERPlus). These changes included: • Paperless receipt documentation for travel/non-travel reports determined to be low risk • Lodging costs verified using the Federal Travel Regulations that specify allowable costs based on destination • Transition to per diem reimbursement for meals and incidental expenses

These changes simplified the travel process for employees and aligned Sandia practices to those of other major national labs. (10500) On Oct. 30, the Program Management Office launched the Corporate Earned Value Management System (EVM). It provides enterprise-wide transparency in project manage-ment and EVM processes, and also delivers effective and efficient project planning and controls and auditability, traceable, and reliable performance reporting. It improves customer confidence in Sandia, assurance for Sandia’s project sponsors and professional that the processes are in aid of delivering projects within scope, schedule and budget, and accountability for project managers, team members and onboarding. Five online EVM courses were delivered, eight more courses are being created. (10600)

Two corporate-supported reporting/analysis applica-tions were released in October. Financial Analytics is a project reporting/visualization application providing financial project reporting from programmatic levels down to the lowest task level. It shows breakthroughs of expenditure types and detail, trending projections, and links to other financial systems. Org on a Page shows charged/managed projects at the organization level for divisions, centers, groups, and departments. It lets users drill down into project totals, the top five projects for changing and managed projects, high-level non-base info, and HR counts info. (10600)

New CET functionality enabling users to quickly esti-mate labor related to chargebacks won a Division 10000 Innovation Award. The project was completed ahead of schedule. The wide-ranging impacts include: • Reduced the time needed to calculate project impacts from several weeks per project to several days. • Generates analysis wide consideration when making changes to their financial models. • Enables the controller to analyze multiple options and communicate the impacts of Burden Rate and Stan-dard Labor Rate changes; which helps support data-driven decisions across the Labs. (10700,10600)

The EBI team launched the Enterprise Business Intelli-gence Portal (EBI) to replace older, less user-friendly report-ing systems with a modern tool for managing BI and financial reporting. EBI provides a single, trusted source of data for enhanced security and consistency. It will significantly reduce staff time and effort in gathering, interpret-ing, and sharing data for decision making and regulatory compliance. (10700)

An outreach effort by Enterprise Collaboration Services (ECS) and partners led to a 30-percent increase in Skype-based collaboration on the classified network. ECS worked with the Nuclear Weapons Planning, Operations office, and Assurance Deputy and Classified Computing Contin-uance, and sharing data for management decision making and auditable, efficient project planning and controls and auditable, traceable, and reliable performance reporting. It improves customer confidence in Sandia, assurance for Sandia’s project sponsors and professional that the processes are in aid of delivering projects within scope, schedule and budget, and accountability for project managers, team members and onboarding. Five online EVM courses were delivered, eight more courses are being created. (10600)

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Executive Support Group

"Get Your Head in the Game," "Out of Bounds," and "The Missing" provided the basis for this year’s annual awareness training videos. For the first time, these training scenarios were created from concept to production at Sandia from dramatizations of real Sandia events. This year’s awareness videos received unprecedented feedback for their relatability and usefulness in the Sandia environment. In support of the NTESS contract transition, 100 percent training compliance was also achieved for both the annual awareness training and the newly updated Code of Conduct. (800, 3600)

To further effective and resourceful mission support, the Air Quality Program developed and implemented a site-wide fugitive dust control programmatic permit strategy. By reducing administrative burden and expanding environmental best management practices, this year-long project resulted in a single permit (down from 12) that increased efficiency and decreased regulatory risk to Sandia. This also further enhances the Labs’ reputation as a leader in environmental protection. The collaboration involved both internal and external partnerships, and strengthened relationships with the Sandia Field Office, the city of Albuquerque, and Kirtland AFB. (600, 4000)

The executive strategy development team led the design and execution of five day-long workshops to explore the future of advanced technologies and global peace and security through the lenses of deterrence, information, innovation, nonproliferation, and population and earth systems. The workshops brought together more than 130 experts and leaders from diverse fields within and beyond Sandia. Workshop participants imagined the global security environment in 20 years and the national security challenges associated with these potential future environments. The output provides the foundation for leaders in shaping the long-term Labs-level strategy. (100)

MESA uses a preventive safety program based on Mistake-Proofing that is derived from quality assurance practices. Inexpensive engineered controls and warnings, created by our technical staff, are used to reduce the likelihood of human error leading to an accident. MESA averages one improvement per month and the controls pay for themselves within 18 months so there is no limitation on the number of improvements, only on the rate of implementation. (5000, 600)

In 2017, the National Security Leadership Development Program (NSLDP) completed the second of two recent 10-month programs focused on developing core groups of Sandia’s next generation of senior leaders. The programs encompassed building leadership skills, site tours that provided exposure to the national security enterprise, and additional project team meetings. Participants explored how their values impact their leadership, behavior, and decision-making, they built relationships with peers, the institution, and other external entities, and applied tools for thinking, leading, and communicating with confidence and courage through changing circumstances. (5000, 600)

International Isotope Inc. technicians operate manipulator arms of the Mobile Hot Cell during the retrieval of legacy radioactive sources.

Radiation Protection retrieved, encapsulated, and packaged two highly radioactive cesium-137 sources for disposal using a mobile hot cell as part of DOE’s Orphan Source Recovery Program. The legacy sources were for a project in the 1980s and have not been used since the 1990s because of the potential significant radiological consequence. Collaborative efforts among many support organizations across the Labs contributed to the safe execution of this operation. The project significantly reduced Sandia’s risk, liability, and environmental impact. (600, 4800, 4200)

Legal and Prime Contract/Export Div. 11000 was integral to the successful Sandia management & operating (M&O) contract transition, the first for the Labs in more than 24 years. As the M&O contract is the governing vehicle that drives all Sandia requirements and policies, the group led the following key efforts: Ensured new contractual requirements, risks, and government expectations were analyzed and addressed by key stakeholders; adapted two critical compliance programs, OCI and Export Control, to the new contractual environment; and closed out the Lockheed Martin Corporation contract.