Battelle Energy Alliance, LLC (BEA) 2017

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Self-Assessment Report

For Idaho National Laboratory

Idaho National Laboratory

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EXECUTIVE SUMMARY

This report provides Battelle Energy Alliance's (BEA) self-assessment of performance for the period of October 1, 2016, through September 30, 2017, as evaluated against the goals, performance objectives, and notable outcomes defined in the *FY 2017 Performance Evaluation and Measurement Plan (PEMP)*. BEA took into consideration and consolidated all input provided from internal and external sources (e.g., Contractor Assurance System, program and customer feedback, external and independent reviews, and Department of Energy Idaho Operations Office quarterly PEMP reports and Quarterly Evaluation Reports).

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ACRONYMS

AGR	Advanced Gas Cooled Reactor
ATR	Advanced Test Reactor
ATRC	Advanced Test Reactor Critical Facility
BEA	Battelle Energy Alliance, LLC
CCE	Consequence-driven, Cyber-informed Engineering
CEO	chief executive officer
CIC	Core Internal Change-out
CRADA	cooperative research and development
CYOTE-A	Cybersecurity for the Operational Technology Environment Pilot Project A
DHS	Department of Homeland Security
DNN	Defense Nuclear Nonproliferation
DOE	Department of Energy
DOE-NE	Department of Energy Office of Nuclear Energy
DOE-OE	Department of Energy Office of Electricity Delivery and Energy Reliability
EPMA	Electron Probe Micro Analyzer
ERISA	Employee Retirement Income Security Act of 1974
ESSAI	Energy Systems Strategies, Assessment, and Integration
FBI	Federal Bureau of Investigation
FY	fiscal year
GAfG	Google Apps for Government
GAIN	Gateway for Accelerated Innovation in Nuclear
GLASS	General Line Ampacity State Solver
IAEA	International Atomic Energy Agency
ICS	Industrial Control System
ICS-CERT	Industrial Control System Cyber Emergency Response Team
IMCL	Irradiated Materials Characterization Laboratory
INL	Idaho National Laboratory
ISER	Infrastructure Security and Energy Restoration Division
IWTU	Integrated Waste Treatment Unit
LDRD	Laboratory Directed Research and Development

LINE	Leadership in Nuclear Energy
MOOSE	Multi-Object Oriented Separate Effects
NNSA	National Nuclear Security Agency
PALM	Powered Axial Location Mechanism
PEMP	Performance Evaluation and Measurement Plan
R&D	research and development
RDD&D	research, development, demonstration and deployment
RAN1	Radio Access Network 1
SEM	Scanning Electron Microscope
SMC	Specific Manufacturing Capability
SMR	small modular reactor
SQT	Sensor Qualification Test
STEM	Science, Technology, Engineering, and Mathematics
TEM	Transmission Electron Microscope
TMIST	Tritium Producing Burnable Absorber Rods (TPBAR) Materials Irradiation Separate-Effects Test
TREAT	Transient Reactor Test Facility

INTRODUCTION

Battelle Energy Alliance (BEA), inspired by America's call for energy and national security, created a bold vision for the future of Idaho National Laboratory (INL)—*changing the world's energy future and securing our nation's critical infrastructure*. With an invigorated sense of what can be accomplished, a collective and abiding passion for innovation, integrity, and excellence—along with financial strength—INL produced exciting new breakthroughs and sought expanded capabilities and program opportunities in fiscal year (FY) 2017.

ACCOMPLISHMENTS

INL took significant steps in support of the U.S. Department of Energy (DOE) Office of Nuclear Energy (DOE-NE) priorities to reestablish United States (U.S.) leadership in nuclear energy. INL led a multi-laboratory effort to outline a national nuclear energy strategy, which resulted in policy papers on nuclear energy, civilian spent nuclear fuel, and cyber control systems. Concepts outlined in the papers were mentioned in speeches and administration proposals and policies, including a speech from U.S. President Donald Trump during "Energy Week" that contained positive messages about nuclear energy. INL leadership worked directly with nuclear energy advocacy groups and "think" tanks to better articulate the value proposition for nuclear energy and advance a greater understanding of nuclear energy's contribution to the power grid and clean air and water. Among the groups that worked with INL were the Nuclear Energy Institute, Third Way, Clear Path, Nuclear Innovation Alliance, and the Nuclear Infrastructure Council.

Dr. Mark Peters was elected to the Nuclear Energy Institute Board of Directors. He also remained an active and engaged member of Idaho Governor C. L. "Butch" Otter's Leadership in Nuclear Energy (LINE) Commission, which includes state and local policymakers, academics, and leading members of industry. LINE has taken an active role in deploying small modular reactor (SMR), solving issues involving Idaho's Settlement Agreement, and the demonstrating the value of a regional nuclear energy supply chain. Membership in these groups gives Dr. Peters a forum from which to educate policymakers, industry, and the public about key INL initiatives, and provides him direct access to important decision-makers in state government, industry, and universities. INL leaders have also educated civic, education, and industry groups at the local, statewide, regional, national, and international levels on the merits of nuclear energy, have written articles for newspapers across Idaho, and been quoted in newspaper and magazine articles. Some examples include *CleanTech Innovation Showcase*, *Select USA Conference*, *Idaho Legislature's Economic Outlook and Revenue Assessment Committee*, *Third Way Advanced Nuclear Summit*, opening remarks at the *Aspen Institute*, and panel discussions during the *2017 Intermountain Energy Summit*.

INL worked directly with industry to sustain America's existing fleet of nuclear reactors and enable the next generation, including small modular and light water reactors. The INL-led Gateway for Accelerated Innovation (GAIN) initiative has become a critical enabler of the emerging advanced nuclear entrepreneurial network. INL worked on early-stage research for multiple advanced reactor developers addressing materials, fuels, fundamental property measurements, instrumentation and control systems, and multi-scale, multi-physics modeling and simulation. For instance, INL conducted research and development (R&D) on fuels that can sustain much higher burnup and radiation damage compared to previous technologies for the TerraPower traveling wave reactor. GAIN convened important discussions on the structure of federal regulations, research, and financial assistance programs showing strong and growing interest in GAIN. The second round of GAIN voucher awardees were announced in June 2017

with 14 applicants receiving a total of $4.2M, more than double from FY 2016. INL also worked on two comprehensive, multi-disciplinary research studies, on the social, economic, legal, policy, and systems-level strategic issues facing nuclear energy: market challenges facing nuclear energy deployment and the national security implications of U.S. market positions.

INL made a number of advances in nuclear fuels and materials. Significant activities were executed in FY 2017 in preparation for the fueled accident tolerant fuels test to reduce schedule and execution risk associated with the complexity of this instrumented, fueled, pressurized water reactor (PWR) condition loop test in the Advanced Test Reactor (ATR). INL established PWR coolant conditions and chemistry in 2A Loop. INL completed a Sensor Qualification Test (SQT) Autoclave Test in the Westinghouse Advanced Loop Tester Loop. Data from the autoclave mock-up SQT was beneficial in final assembly and chemical analysis of the SQT in ATR Cycle 162A. The SQT test was inserted in the ATR Cycle 162A-1. INL continued fabrication of industry silicide fuel (U_3Si_2) for use in ATR irradiations. INL developed an update to the *Advanced Reactor (Transmutation) Fuels Handbook*, now titled, *Metallic Fuels Handbook, Part 1 and Part 2*. The update to the Handbook summarizes and assesses experimental data on elements, binary alloys, and ternary alloys in the U-Np-Pu-Am-La-Ce-Pr-Nd-Zr system, which encompasses most of the metallic transmutation fuels of current interest to the Fuel Cycle R&D program. The handbook has also been re-organized to make it easier to find information from similar alloys, and identifies new references to be considered in the next revision. INL established the capability for remote casting of metal fuels. *The Fast/Thermal Comparison Report* was completed. The report includes post-irradiation examination data on neutron radiography, dimensional characterization, gamma-ray spectroscopy, fission gas and helium release, metallography, electron microscopy, and burnup determination for the four FUTURIX-FTA pins, corresponding rodlets from AFC-1, as well as data from AFC-2C,2D. Analysis of restructuring from the mixed oxide fuels from AFC-2C,2D have been compared to models from the literature, and this analysis was also included in the report. BWX Technologies completed final heat treatment of Advanced Gas Cooled Reactor (AGR)-5/6/7 fuel compacts and shipped them to INL, completing a DOE-NE Level 2 milestone 3 weeks ahead of schedule. This completed the fabrication of fuel compacts for the AGR-5/6/7 test train. Finally, in collaboration with TerraPower, INL achieved the first successful extrusion of a TerraPower fuel design.

INL continued to support the deployment of the first domestic commercial SMR. Successful SMR deployment in Idaho is envisioned to lead to successful deployment and implementation of SMRs throughout the U.S. and abroad, as well as deployment of advanced reactor technologies at INL and elsewhere. INL developed a special version of safety analysis software to support a NuScale SMR design certification and U.S. Nuclear Regulatory Commission license application by the Utah Associated Municipal Power System. In addition, INL, NuScale, and Utah Associated Municipal Power System collaborated on a joint concept (Joint Use Module Project) to use one or two of the modules from the first plant constructed to conduct experiments on nuclear hybrid energy systems. Dr. Peters (U.S. House of Representatives) and Dr. Beierschmitt (U.S. Senate) participated in Congressional forums working to remove barriers impeding the deployment of SMRs.

INL achieved a significant milestone by completing all readiness activities to restart the Transient Test Reactor (TREAT). The Resumption of Transient Testing Program completed its work on August 31, 2017, 13 months ahead of its baseline schedule and under budget by more than $17M from the baseline budget of $75M. INL's accelerated restart activities will allow resumption of transient testing earlier than anticipated, placing the U.S. at the forefront of nuclear fuel safety research by restoring a national capability for understanding the response of nuclear fuel materials and designs to the non-equilibrium conditions experienced during transient events.

INL led a multi-laboratory, industry, and academic-community initiative to perform R&D leading to a versatile reactor-based fast-neutron source concept. This capability will assure U.S. maintains technology leadership in the area of advanced nuclear energy systems for many decades to come, and provides a vital instrument to support experimentation from basic principles to proof of concepts. INL also collaborated with DOE's Office of Science to co-host a basic research need workshops to inform future early-stage research programs that are necessary for understanding and improving the performance of materials and chemistry in the extreme environments anticipated for future nuclear reactors.

International Atomic Energy Agency (IAEA) recognizes INL and ORNL as International Centre based on Research Reactors (ICERR). The IAEA designation makes the U.S. one of only three countries identified for unique capabilities and excellence in nuclear research, joining France and Russia. The world-class facilities at INL were recognized for their support of scientific discovery, medical and industrial isotope applications, and the advancement of nuclear fission, fusion energy, and global security technologies. The ICERR recognition encourages designees to collaborate in ways that maximize the use of research reactors in all IAEA member states. In Secretary Perry's own words: "I am incredibly proud to accept this prestigious designation on behalf of the United States, the Department of Energy, and our national lab system. This is a tremendous honor recognizing the critical work being conducted at DOE's Oak Ridge and Idaho National Laboratories, and it highlights the importance of our nuclear research facilities and the scientific and nuclear security contributions they bring to the world."

INL made significant improvements in the Laboratory Directed Research and Development (LDRD) program to align investments and to accelerate delivery of INL's science and technology strategy. LDRD program was enhanced by improving long-range planning to increase investment, implementing joint calls and review process to deliver critical outcomes and advance INL's core capabilities, and expanding university and industry collaborations to develop and strengthen science and technology pipeline and staff. INL made outstanding progress in R&D metrics to support the "how we know" we are making progress on science and technology strategies, validating science and engineering excellence, and attracting talent.

INL staff continued to publish nuclear-energy-related R&D in refereed journals and other high-impact publications. Examples include: K. Shrestha et al. titled, "Tricritical point from high-field magnetoelastic and metamagnetic effects in UN," accepted for publication in *Nature Scientific Reports*; editors of *Nuclear Engineering and Design* are publishing "Impact of Gap Size Uncertainty on Calculated Temperature Uncertainty for the Advanced Gas Reactor Experiments," by Binh Pham, Jeff Einerson, Grant Hawkes, Nancy Lybeck, and David Petti in a special issue of *Nuclear Engineering and Design* containing the best papers of the International Topical Meeting on High Temperature Reactor Technology; and at the *2017 International Conference on Mathematics and Computations*, 27 papers were presented based on INL's Multi-Object Oriented Separate Effects (MOOSE) applications.

INL continued to make investments and show progress advancing nuclear energy research capabilities. For example, Irradiated Materials Characterization Laboratory's (IMCL's) new Titan Transmission Electron Microscope (TEM) was used to perform nanoscale characterization of the fuel/cladding interface of irradiated U-Zr fuel. Characterization revealed features in the fuel and fuel/cladding interface that had not been previously identified. This information feeds back to behavior models that improve fuel performance codes. The Titan's four-quadrant Energy Dispersive Spectroscopy detector was used to characterize xenon gas bubbles in irradiated fuel. Along with Atom Probe Tomography, this work will provide an indirect measurement of fission gas bubble pressure—a

significant unknown in fuel behavior models. The IMCL Electron Probe Micro Analyzer (EPMA) provided first-of-a-kind detailed micro-chemical analysis of an irradiated minor actinide-bearing fast reactor fuel experiment (FUTRIX/DOE-1), which represents some of the first detailed information on the behavior of this complex fuel type. This information will also be used, in part, to validate the use of cadmium-shrouded experiments in the ATR for testing of fast reactor fuel. Researchers have demonstrated the feasibility of performing neutron-computed tomography using the NRAD reactor. This technology will accelerate the collection of neutron tomography data by an order of magnitude.

A concerted effort was made to validate INL's modeling and simulation tools using microstructural and thermal property data before and after irradiation. Detailed microstructural characterization and thermal property measurements were made on a set of U-Pu-Zr alloys to establish the starting thermal properties and microstructure. This characterization revealed several microstructural features not previously known to exist. These alloys are planned for irradiation in TREAT, followed by post-irradiation characterization to allow the first known direct correlation of pre-irradiation and post-irradiation properties and microstructural features. The data will be used to validate Marmot microstructural evolution models.

INL received DOE approval to start work with highly irradiated materials in the IMCL. In FY 2017, buildout activities focused on final preparation and acceptance testing of the EPMA, Shielded Sample Preparation Area, and Shielded Container. The Thermal Property Cell (TPC) was delivered to the Materials and Fuels Complex (MFC) on budget and 2 months ahead of schedule. Installation of the Focused Ion Beam (FIB) and Scanning Electron Microscope (SEM) is nearing completion. More than halfway through the fiscal year, INL management made the decision to suspend work on the FIB and SEM to focus on the EPMA, Shielded Sample Preparation Area, and shielded container. This action was taken to avoid exceeding available funds. INL applied additional project management resources and established a recovery baseline, including a comprehensive analysis of risks to complete buildout. The project ended in FY 2017 with improved overall project performance and communication, and received most of the funding needed in FY 2018 to complete installation of the FIB and SEM.

ATR continued to support irradiation needs of the nuclear energy community. In FY 2017, ATR completed a significant series of Powered Axial Location Mechanism (PALM) tests in support of U.S. Naval Reactors and commenced irradiation of the Tritium Producing Burnable Absorber Rods (TPBAR) Materials Irradiation Separate-Effects Test (TMIST). INL also provided the U.S. Naval Reactors with an assessment of key needs to extend ATR operations beyond 2050, which also informed an update to the ATR 5-year age-management and plant health strategy.

ATR's availability is expected to fall short of target due to equipment reliability issues and integration and coordination of experimental activities. Most disappointing was ATR's performance during the 162-1A outage, which was impacted by equipment failures and lack of functional spare parts (e.g., pressurizer pump). Also impacting performance was the execution and decision-making/communications regarding the Accident Tolerant Fuel Sensor Qualification Test.

INL continued to address the ATR's plant health improvements with significant upgrades and maintenance activities (e.g., crane repair/replacements, computer system replacements, radiation monitoring system replacements, ATR Critical Facility [ATRC] control system component replacements, ATRC magnet cans replacement, loop control valve procurements, major electrical upgrades, pond liner replacement, and replacement of nuclear instrument components). Some of these activities did not go without issues; in particular, replacing the pond liner and nuclear instruments presented significant

execution challenges, prompting management to adjust scope, schedule, or cost estimates. INL continued its preparations for Core Internal Change-out (CIC), currently scheduled for FY 2020, with the hiring of a dedicated CIC manager and assignment of a core CIC team.

INL completed substantial construction of the Remote-Handled Low-Level Waste Disposal Project. Throughout construction, INL proactively managed subcontract execution, responded effectively to challenges, and maintained project cost and schedule performance well within DOE metrics. As of fiscal year end, the project is approximately 90% complete, with project activities shifting from facility construction to operational readiness. The new disposal facility will provide replacement disposal capability that is critical for continuing INL research and Naval Reactors missions at the Idaho Site. INL effectively adjusted plans for the Sample Preparation Laboratory awarding a subcontract to design of the facility.

INL took notable action to address ATR spent nuclear fuel disposition and long-term environmental liabilities. INL completed and issued the *ATR Spent Nuclear Fuel Management Options Study* and recommended management options supportive of operations to 2050. INL completed detailed planning to implement a canal to dry storage option by FY 2019. INL also developed a strategy and plan for disposition of legacy and future reactive wastes that provides a basis for FY 2017/2018 Site Treatment Plan compliance and planning for FY 2019 and beyond.

INL researchers supported the restart of the Integrated Waste Treatment Unit by conducting testing and engineering evaluations to define control strategies and operating boundaries to operate predictably and reliably. INL completed two major deliverable pilot tests that provided valuable data to improve understanding of wall scale formation and fluid bed stability. In addition, the technical review group, led by an INL researcher, provided recommendations that were integrated into Fluor Idaho's plans for developing the modifications and operating parameters necessary for the operation of the plant.

INL remained committed to building the science and engineering talent and facilities necessary to address national control systems cyber risks. INL made significant progress in advancing Cybercore's strategic objectives for the development of partnerships, researcher skills, and collaborative programs to transform the cyber-informed science and engineering utilized to assure the security of control systems in critical infrastructure and national security systems. INL received approval from DOE and the State of Idaho for the new CIC. INL aligned the Cybercore strategy and progress with DOE S-1's advocacy for a cyber-focused effort to protect the U.S. power grid, receiving new FY 2017 funding to lead Westworld—a program that supports DOE in executing its sector agency leadership role in protecting the nation's electricity infrastructure. INL supported DOE Office of Electricity Delivery and Energy Reliability's (DOE-OE) in the development and implementation of a cooperative programmatic cybersecurity strategy through DOE-OE's Cybersecurity for the Operational Technology Environment Pilot Project A (CYOTE-A) and the DOE-OE's Infrastructure Security and Energy Restoration Division (ISER).

The initial pilot study of INL's proprietary Consequence-driven, Cyber-informed Engineering (CCE) methodology was successfully completed with the delivery of cybersecurity mitigations and recommendations to the chief executive officer (CEO) and executive directors of a major U.S. electric utility. As a result of this cooperative research and development (CRADA) project, the utility is implementing changes to internal processes, engineering practices, system architecture designs, and cybersecurity culture. The utility's chief information security officer briefed the Section 9 electric utility partners in July, and the CEO is scheduled to brief the U.S. Senate Select Committee on Intelligence with

INL in September. Findings from this successful pilot were briefed to key intelligence community representatives from DOE, Central Intelligence Agency, National Security Agency, and Department of Homeland Security (DHS) during a full-day workshop, providing lessons learned and influencing future discussions on how to better develop and approach grid threat analyses. INL published CCE LDRD results in two INL external reports, described CCE in an INL Invention Disclosure Record, discussed CCE during INL's testimony to the Senate Committee for Energy and Natural Resources, and presented the methodology in multiple conference and workshop forums. Based on the success of the LDRD and the CRADA, DOE-OE funded further research on the CCE methodology as part of its baseline efforts in CYOTE-A. INL is continuing to improve its transformational approach to cybersecurity protection for U.S. Government applications by partnering with naval reactors on a pilot study.

In expanding INL's leadership in control systems cybersecurity across all sectors of critical infrastructure, INL significantly influenced the advancement of the DHS Aviation Cyber Initiative. INL developed a re-write of "National Strategy for Aviation Security"; completed analyses of threats posed by unmanned aerial systems and hacking of wireless vehicle communications; and conducted an ICS-CERT Red/Blue (301) cybersecurity training course for students from the domestic aviation industry representing the major airlines in the United States, major airports, aviation aircraft, and material vendors.

INL provided experts in cybersecurity and power grid security to help government and industry leaders formulate policies, research, and operations to protect electricity supply and infrastructure. Most notable is that INL provided testimony on the protection of U.S. energy systems from cybersecurity threats for the U.S. Senate Committee on Energy and Natural Resources; co-authored a publication "IoT, Automation, Autonomy, and Megacities in 2025" with the Center for Strategic & International Studies; and conducted a demonstration "The Ukraine Event In a Box" during the *SANS Industrial Control Systems Security Summit 2017*. INL supported *2017 GridEx IV* by producing the realistic scenario information that will be used during a national exercise designed to harden the North American grid to a cyber or physical attack. INL presented "Ukrainian Hack: What it Means to the U.S. Grid" at the *Industrial Control System (ICS) Security Conference*, and ICS resilience presentations to the White House Office of Science and Technology Policy's Networking and Information Technology Research and Development High Confidence Software and Systems working group.

INL's Andy Bochman was awarded by the Energy Sector Security Consortium—a nonprofit formed to support energy sector organizations with the security of their critical infrastructure—the *EnergySec's Cybersecurity Leader of the Year 2017* for displaying core values of service, innovation and excellence. In presenting the award, EnergySec acknowledged that "…Andy has provided analysis on energy sector security actions, standards, and gaps to DOE, DOD, FERC, NERC, NIST, NARUC, the Electricity Subsector Coordinating Council, and state utility commissions, most recently testifying before the Senate Energy and Natural Resources Committee on energy infrastructure cybersecurity issues…"

INL worked with educational institutions across Idaho to build the talent pipeline that will support future cybersecurity research. INL gained commitments from three Idaho university presidents to deliver Cybercore to more interns, graduate fellows, postdocs, joint appointments, employee education students, and new faculty by 2025. INL partnered with the city of Idaho Falls, Idaho State University, University of Idaho, and Boise State University to host the Cybercore summer camp—a 3-day camp that provided 18 high school students with hands-on experience using various ethical hacking techniques and methods to better understand and improve security applications.

INL and DHS achieved a significant milestone with completion of the 100th Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) Red/Blue (301) cybersecurity training course. This course provides participants with hands-on training to discover who and what is on the network, identify vulnerabilities, understand how those vulnerabilities may be exploited, and learn defensive and mitigation strategies for control system networks. To date, over 4000 attendees from national and international government, industry, and academia have completed the course.

INL completed the Power Grid Test Bed Enhancement Project, establishing a national capability to test a broad range of the Smart Grid's distribution voltages, equipment, and systems. These new capabilities at INL were significant contributors in DOE's selection of INL as the lead laboratory for the Westworld program. The project did experienced schedule and costs impacts caused by weather- and vendor-related delays, requiring close management and oversight by INL and NE-ID to assure project was delivered within original budget estimates and program reserves.

INL led strategic planning efforts for DOE-OE to develop a report on natural and human-caused electric grid disturbances. The report entitled, *A Strategic Framework for Electromagnetic Pulse/Geomagnetic Disturbance Electric Grid Impacts and Mitigation Strategies,* included collection and analysis of technical information and exchange of research strategies with multiple federal agencies and laboratories, including DOE-OE ISER, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Sandia National Laboratories, and Savannah River Laboratory. The report outlined national knowledge gaps in the area of electromagnetic pulse/geomagnetic disturbance phenomena and strategies for R&D programs. The report was delivered to the Mission Executive Council, an executive-level forum of DOE, Department of Defense (DOD), DHS, and the Office of Director of National Intelligence leaders. INL also developed and delivered reports for DOE-OE titled, *Vulnerability of the Electric Grid to an Electromagnetic Pulse and the Potential Impact on Electric Power Delivery and Reliability*, and *U.S. Department of Energy Geomagnetic Disturbance Monitoring Approaches & Implementation Strategies*.

INL completed many Wireless Test Bed experiments, exercises, and tests critical to demonstrating enhanced communication technologies, techniques, tactics and procedures for military operations, emergency response, and resilient recovery. In FY 2017, INL served in a critical role in advancing the scientific data gathering for the *DHS Security Exercise Jam X 17* to observe and measure the impacts of intentional radio frequency interference on first responder equipment used for communications, navigation, and timing. Hundreds of participants from first response organizations from across the country gathered on INL's unique test ranges to collect critical data for DHS, DOD, Department of Justice, Federal Communications Commission, Federal Aviation Administration, and state and local first responder agencies.

INL made significant progress in the strategy for research, development, and deployment of INL's proprietary WSComm radiofrequency spectrum sharing technology. INL continued to receive favorable peer-review through multiple publications and patents, increased programmatic funding, and inclusion within industry standards. The innovative components of INL's WSComm technology were further validated when INL was awarded a fourth U.S. patent and an international patent. University of Utah graduate students conducting dissertation research with INL researchers co-authored a publication of WSComm experimental results in multiple Institute of Electrical and Electronics Engineers forums. INL continued to gain acceptance of WSComm into the Third Generation Partnership Project–Fifth Generation (5G) Radio Access Network 1 (RAN1) Committee's industry standards. INL received approval from ~80% of the members within the RAN1 Committee for a novel feature of WSComm and

approval from >25% of the members for adoption of a second feature. As a result of participation in this standards committee, INL has developed and applied for two additional patents to enhance INL's intellectual property protection of WSComm's capabilities. The U.S. Drug Enforcement Administration significantly increased funding by $6M to continue WSComm's R&D for future applications, including federal video surveillance activities.

INL demonstrated strong national and international leadership in nuclear forensics, treaty verification, and emergency response. INL published, participated in, and deployed significant innovations in support of strategic technology requirements for isotopic reference material production, operational response readiness, and proliferation threat reduction and detection. INL researchers presented research results on innovations in methodologies for ^{134}Ba and $^{236/237}$Np production and purification to advance the U.S. requirements for reference materials for isotope measurements. INL's innovations resulted in increased funding for R&D from the Defense Threat Reduction Agency and the DHS Domestic Nuclear Detection Office.

INL had a number of other notable non-proliferation activities. In support of the National Nuclear Security Agency (NNSA) Office of Counterterrorism and Counter-proliferation INL served as the lead exercise planner for a joint U.S.-Canada post-detonation nuclear event emergency response exercise in Nova Scotia. The exercise, simulating a nuclear detonation, enabled nuclear forensics experts from the U.S. and Canada to respond during a nuclear/radiological event. INL completed the development and delivery of a plutonium diversion training course for IAEA, enabling the IAEA to re-establish capabilities to accurately assess member states' declared inventories. INL nuclear fuel conversion research received positive reviews from NNSA's Office of Materials Management and Minimization as a result of INL's progress in re-baselining and exploration of options needed for TREAT low-enriched uranium fuel development, and issuing, for review and comment, the *Preliminary Report on U-Mo Monolithic Fuel for Research Reactors*. This report, when NNSA provides it to the U.S. Nuclear Regulatory Commission, achieves a major milestone towards the development of a new, high-uranium density plate-type fuel for eventual conversion of high performance research reactors.

INL's Specific Manufacturing Capability (SMC) met all armor production and delivery expectations of the U.S. Army. SMC effectively advanced opportunities to expand the scope of the program by coordinating with DOE and the U.S. Army on corrective actions and plans for customer-driven Foreign Military Sales issues, and delivering affordable, high-quality process development and production plans for critical military systems (U.S. Marine Corps, etc.). SMC was recognized by the U.S. Army for research performance in demonstrating an engineering and production pathway for future armor systems.

INL researchers were part of a Critical Materials Institute team that successfully fabricated magnets made entirely of domestically sourced and refined rare-earth metals. This was an important accomplishment because rare-earth magnets are used in a wide number of modern technologies and the critical materials needed to produce them must be imported because of the limited domestic supply.

The Society for Automotive Engineers approved an international standard for wireless chargers for electric vehicles based on interoperability testing conducted by INL researchers. INL researchers also developed a new metric—self-discharged current—that can be measured quickly and used to detect internal shorts in lithium-ion batteries before they reach a stage called thermal runaway. Thermal runaway can lead to catastrophic failures such as explosions, fires, and release of electrolyte

vapors. This patent-pending method is noninvasive and can be applied to any battery chemistry or design. INL's findings were published in the *Journal of the Electrochemical Society*.

INL added a new laboratory that greatly expands battery performance and testing capability. The Nondestructive Battery Evaluation Laboratory enables researchers to study in detail how batteries perform in aggressive environments. This state-of-the-art laboratory and technology allow researchers to push energy storage devices to levels of stress short of catastrophic failure and gather information on long-term performance.

INL's General Line Ampacity State Solver (GLASS) technology was named a finalist for a R&D 100 Award. This technology is able to more accurately realize additional electric power capacity through existing power lines in and around wind farms. The software manages and provides historical, real-time, and forecast data to take advantage of a range of environmental conditions such as the concurrent cooling of overhead transmission lines by the same wind that is generating wind power.

INL led a team of researchers from around the world who demonstrated an eight-simulator system known as a "Super Lab" that can be used to study how electricity can be rerouted across vast distances to address disruptions. The ability to move electricity around the globe, similar to how U.S. utilities do regionally, rather than only within isolated networks could lead to vast savings on infrastructure and energy consumption. The effort builds on work done between INL and the National Renewable Energy Laboratory (NREL) and included researchers from Sandia National Laboratories and five universities (two of which are from Europe).

INL researchers developed a process for pelleting raw biomass in a way that could make biofuels more sustainable and profitable for U.S. bioenergy companies. Densifying biomass into pellets or briquettes can reduce transportation costs and improve performance at bio-refineries. INL's High-Moisture Pelleting Process eliminates the energy intensive rotary drying stage of traditional pelleting processes. Also, researchers from INL and Virginia Commonwealth University developed and began testing an adaptive control system in the Process Demonstration Unit that can automatically adjust equipment to compensate for moisture and other types of biomass variability, which would solve a major issue for biorefineries. Initial FY 2017 results indicated the automated control system, which relies on sensors and intelligent algorithms, maintained a higher reliability than the fully human-controlled systems used currently.

The Collaborative Computing Center and CIC were approved by the State of Idaho Building Authority and Department of Education. Ground breaking for the two facilities is expected by FY end. The acquisition of these facilities was made possible by a strong public/private partnership between BEA and DOE, Idaho Governor's Office, Idaho's public universities and colleges, Idaho State Legislature, State Building Authority, and the State Board of Education and is an example of BEA's innovative approach to acquire new facilities to meet mission needs.

INL continued to improve innovation by developing the first open source software guidance in the DOE Complex, achieving a year-over-year increase in software disclosures, innovation disclosures, patent licenses and total number of license agreements. In addition, INL assumed National Technology Transfer Working Group leadership positions, received recognition from Federal Laboratory Consortium, Idaho Innovation, Idaho Genius, and R&D 100 and led among DOE laboratories in Technology Commercialization Fund awards and Energy I-Corps participation.

INL continues to be recognized nationally for its Environment, Safety, Health, and Quality (ESH&Q) programs. It was recognized as the recipient of the 2017 Voluntary Protection Program Participants' Association National Board of Directors' Safety & Health Outreach Award. This is the second award INL obtained in FY 2017 from Voluntary Protection Program Participants' Association. INL received the regional Safety and Health Outreach Award in May. The Safety and Health Outreach Award provides recognition for private industry and federal agencies that have outstanding outreach capabilities in safety, health, and technical management. The INL Occupational Medicine Program received the 2017 American College of Occupational and Environmental Medicine's Corporate Health Achievement Award. Finally, the Environmental program received recognition at a national level by being awarded the "Electronic Product Environmental Assessment Tool 2017 Purchasers Award."

During FY 2017, injury prevention showed improvement with Days Away, Restricted, or Transferred case rate at 33% lower than 2015 (0.54 versus 0.81)—maintaining the improvement initially achieved in 2016 of 0.53. The Total Recordable case rate has also improved at 1.01, as compared to a 3-year average of 1.25, resulting in a 19% improvement. Since FY 2015 when INL implemented an initiative to reduce back- and shoulder-related injuries, back and shoulder sprain/strain related injury rates have decreased by 47% (back and shoulder Total Recordable case rate) and 34% (back and shoulder Days Away, Restricted, or Transferred case rate).

In FY 2017, a negative trend in work planning and control and conduct of operations prompted NE-ID to issue a letter of concern to INL. INL responded by implementing near- and long-term actions to improve culture, contractor assurance system, and work planning and execution. By all indications, these actions are having a positive effect on operational performance.

INL continued to deliver high-impact programs to strengthen and build a future workforce. In FY 2017, educational programs experienced incremental growth and participant expansion from more diverse and highly recognized institutions. The Deslonde de Boisblanc and INL Graduate Fellowships were successfully implemented and will contribute to the scientific eminence of INL. INL intern and post-doctoral hires accounted for approximately 48% of INL's FY 2017 hires. INL Director Mark Peters was an active member of Idaho Business for Education, a non-profit consisting of more than 180 business leaders committed to transforming Idaho's education system and helping fill the talent pipeline for technology-based companies. He was also appointed by Idaho Governor C. L. "Butch" Otter to serve on the board of Idaho's Science, Technology, Engineering, and Mathematics (STEM) Action Center. The STEM Action Center creates, identifies and funds STEM opportunities for Idaho students, offers opportunities for STEM educator professional development, engages industry to support STEM education outcomes, and educates Idaho communities on STEM career opportunities. Dr. Peters' involvement on the STEM Action Center Board of Directors allows INL a seat at the table as the state works to improve its workforce development efforts in the technology sector. INL supported 152 mission-aligned outreach activities to engage the next generation talent pipeline: Multicultural Leaders, Sho-Ban, and Hispanic workshops, scholarships, camps, science fairs, Nuclear Science and Engineering Nights, job shadows, and business/educator exchanges. INL worked with the University of Idaho to create a Graduate Certificate in Critical Infrastructure Protection, which will familiarize current and future technology management, engineering, and computer science students with the needs and issues surrounding the protection of U.S. critical infrastructure. INL also partnered with Idaho State University's Energy Systems Technology Education Center and industry to expand the school's Cyber Physical Security program.

INL demonstrated effective business management in FY 2017. At $1,001M, business volume (BV) finished $33M below FY 2016, driven by a decrease in non-labor spending. Funding (new budget authority) was $1,106M, $61M more than FY 2016. Direct full-time equivalents (FTE) were 2,851, 51 above FY 2016. Indirect FTEs grew at a faster pace than direct FTEs, causing INL's direct FTE ratio to decline from 65.5% to 64.7%. Investment FTEs and other indirect investments in the mission organizations were the primary driver for indirect FTE growth. INL's indirect recovery position remained very strong and was used to help position INL for FY 2018 by executing "buy-downs" of out-year commitments (pension reserve, investments, etc.). In FY 2017, performance against the small business plan was strong with all six socio-economic goals achieved for the fourth time.

The results of the INL Procurement Evaluation and Re-engineering Team (PERT) review were very favorable with INL receiving a "best practice" for our exemplary approach to on-boarding new contract professionals, which resulted in a "center of acquisition excellence." In addition, INL received an "acceptable" rating for all 12 audit tenets, and five subcategory criteria were identified as "strengths." No areas of weakness were identified. INL's performance was noteworthy as we were the first contractor site to be reviewed under the new PERT Contractor Purchasing System Assurance Criteria. PERT reviews are conducted every 6 years and represent a key input to DOE contractors in retaining their procurement authority.

The FY 2017 DOE Office of the Inspector General Consolidated Financial Statements Audit recommended no findings and validated closure of all previous audit findings. The audit validated INL's improvements in cyber security controls.

INL collaborated with Fluor-Idaho, Naval Reactors Facility, local and regional communities, and DOE to plan for the potential impacts of the Great American Solar Eclipse. This included planning for increased wildland fire threat, traffic hazards and congestion, increased emergency calls, emergency resource shortages, communication system and infrastructure failures, anti-nuclear demonstrations and terrorism. INL's level of preparation assured no impact to INL and site operations and was recognized by multiple stakeholders.

INL took steps in FY 2017 to improve operating efficiency. The Travel upgrade to Concur cloud solution was rolled out in May. The new, improved system provides a modern look and feel, self-booking tool, mobile capability, automated receipt capture, auto-loaded General Services Administration per diem rates, and a simplified approval process. A new time policy and system will go live early in FY 2018. This new policy is more aligned with an innovative R&D environment (new +80 to -20 "flex range" for exempt staff replaces comp time), user-friendly system, and built with mobile standards to support mobile release in Phase 2. INL also revamped five all-employee refresher training courses (Security Refresher, Cyber Security Refresher, Standards of Conduct, BEA-Specific iGET, and Substance Abuse for Employees), resulting in an estimated training reduction of five productive hours per employee, a cost avoidance of approximately $1.8M. Other efforts continue to evaluate reduction, elimination, or transformation of required training without sacrificing effectiveness, thus far yielding an additional cost avoidance of approximately $800K. Moving forward INL, is implementing a Management Systems Transformation initiative designed to optimize the operating environment (work processes, service delivery) for staff and users.

In summary, performance in FY 2017 was strong. INL conducted relevant and impactful research activities, continued to build on INL's mission as DOE-NE's lead nuclear energy laboratory, and continued to develop INL's reputation as a world-class laboratory. As noted in the body of the report, INL exceeded almost all of the significant award fee goals and objectives and met overall cost, schedule, and technical performance requirements of the contract in the aggregate as defined and measured in the Performance Evaluation and Measurement Plan (PEMP) for the award fee evaluation period. INL's performance exceeded expectations made toward realizing strategic objectives with positive impact on DOE's mission.

SELF-ASSESSMENT

After considering the information related to performance during the rating period, including feedback from the Office of Nuclear Energy (NE), Idaho Operations Office (ID), and other programmatic sponsors, BEA has self-assessed the Laboratory's performance at a grade of A, an adjectival rating of "Excellent." Table 1 documents BEA's assessment of performance to the goals and individual performance objectives. Table 2 documents completion of the notable outcomes. A more-detailed assessment of performance for each individual performance objective is documented in the closeout reports (see the PEMP reporting system). Table 3 includes an update to "Performance Challenges" as reported in the *FY 2016 Self-Assessment Report*.

Table 1. BEA Assessment of Performance Evaluation and Measurement Plan (PEMP) Performance.

Objective	Description	Final*
1.1	Nuclear Energy	**A**
1.2	National and Homeland Security	**A**
1.3	Science and Technology Addressing Broad DOE Missions	**A**
1.4	Collaborations	**A**
2.1	Provide Effective Facility Design(s) as Required to Support Laboratory Programs	**B+**
2.2	Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components	**A**
2.3	Operation and Maintenance of Facilities	**A-**
2.4	Utilization of Facility(ies) to Provide Impactful S&T Results and Benefits to Internal and External User Communities	**A-**
3.1	Leadership and Stewardship of the Laboratory	**A+**
3.2	Management and Operation of the Laboratory	**B+**
3.3	Contractor Value-Added	**A**
4.1	Provide an Efficient and Effective Worker Health and Safety Program	**B+**
4.2	Provide Efficient and Effective Environmental Management System	**A-**

Objective	Description	Final*
5.1	Provide an Efficient, Effective, and Responsive Financial Management System	**A**
5.2	Provide an Efficient, Effective, and Responsive Acquisition Management System and Property Management System	**A**
5.3	Provide an Efficient, Effective, and Responsive Human Resources Management System and Diversity Program	**A+**
5.4	Provide Efficient, Effective, and Responsive Contractor Assurance Systems, including Internal Audit and Quality	**B+**
5.5	Provide Efficient, Effective, and Responsive Information Management System	**A-**
6.1	Manage Facilities and Infrastructure in an Efficient and Effective Manner that Optimizes Usage, Addresses Sustainability Goals, Minimizes Life Cycle Costs, and Ensures Site Capability to Meet Mission Needs	**A**
6.2	Provide Planning for and Acquire the Facilities and Infrastructure Required to Support the Continuation and Growth of Laboratory Missions and Programs	**A**
7.1	Provide an Efficient and Effective Emergency Management System	**A**
7.2	Provide an Efficient and Effective Cyber Security System for the Protection of Classified and Unclassified Information	**A-**
7.3	Provide an Efficient and Effective Physical Security Program for the Protection of Special Nuclear Materials, Classified Matter, Classified Information, Sensitive Information, and Property	**A**

*Grades as submitted in PEMP close-out reporting system reports and Annual Self-Assessment Report.

Table 2. FY 2017 Performance Evaluation and Measurement Plan (PEMP) Stoplight Report by Notable Outcome.

Notable Outcome	***Description***	***Status/Risk***
1.1.A	Based on input received from GAIN stakeholders during FY 2016 workshops and meetings, the following are the important activities identified for FY 2017: • Lead development of a new flexible fast spectrum test reactor research and development program; and • Develop an electronic catalogue for MOOSE and MOOSE-based applications with a description and a set of demonstration problems for each applications and make it available to industry.	✓
1.1.B	Perform Electron Probe MicroAnalysis (EPMA) on a full cross section of an Advanced Fuel Cycle (AFC) relevant irradiated fuel sample. This Notable Outcome will demonstrate the successful demonstration of the IMCL's capabilities to analyze irradiated metallic fuel. This Notable Outcome would correspond to successfully providing the analysis of a full cross-section of irradiated metallic fuel specimen from the AFC program as a demonstration of the first high burnup – high dose full cross-section fuel sample analysis using the EPMA.	✓
1.1.C	Demonstrate use of BISON fuel performance code to simulate a real Loss-of-Coolant-Accident experiment performed on a PWR fuel rod (Halden IFA 650.10). BISON results will be compared with experimental data collected on rod pressure, ballooning, time to rupture, and end-of-life cladding profilometry, as well as results from other advanced fuel performance codes from nations participating in IAEA's ongoing Fuel Modeling Under Accident Conditions (FUMAC) benchmarking exercise (to the extent such benchmarks are available from other nations). Success will be measured against the degree to which BISON predictions agree with experimental results (including a detailed assessment of the discrepancies when there are differences between the data and the predictions), and how BISON agreement compares with that of the best codes from other nations.	✓
1.1.D	Complete the preliminary design and business case for a modernized control room at the Palo Verde Nuclear Generating Station. Legacy analog instrumentation and control technologies represent a key challenge to the long term sustainability of the existing fleet of light water reactors due to aging, obsolescence, reliability, and familiarity to a future work force. Working with the Palo Verde Nuclear Generating Station, INL will complete a preliminary design and accompanying business case for a control room end state concept for a modernized commercial nuclear power plant control room implemented and tested in the Human System Simulation Laboratory, with accompanying human factors engineering review. This includes industry communication and outreach to promote use of results by industry and application to other commercial nuclear power reactor plant settings.	✓

Notable Outcome	*Description*	*Status/Risk*
1.2.A	Lead development and implementation of several initiatives intended to strengthen the National Nuclear Security Administration's Office (NNSA) of Defense Nuclear Nonproliferation (DNN) leaders and personnel on nuclear related cybersecurity issues to include training, threat information sharing, and program planning. DOE and INL are committed to the global implementation of INL's transformative concepts for cybersecurity as it applies to the nuclear security and industrial controls system (ICS). INL serves as the lead laboratory in the development and implementation of the nuclear-cybersecurity program plan for NNSA's, DNN. This plan has objectives to strengthen DNN's approach on integrating cybersecurity with nuclear security among the international nuclear energy community. This Notable Outcome captures INL and NNSA's priority to strengthen DNN's leaders and personnel on nuclear related cybersecurity issues. Successful achievement will be recognized by a signed letter describing completion of the Objective from the DNN nuclear-cybersecurity leadership team to INL leadership.	✓
1.3.A	Simulate and/or demonstrate grid-scale hybrid energy systems. With the hybridization of the electric grid – connecting nuclear and thermal generation with renewable resources – the need for energy storage technologies to capture intermittent, abundant and cheap electrons has become increasingly evident. This has led industry and researchers to investigate a variety of energy storage technologies such as lithium ion batteries, super capacitors, etc. INL researchers are investigating the viability of two promising technologies: using electrolyzers as a resistive load on the grid for stabilization and energy storage (hydrogen production) and using a zinc-iron flow battery for energy storage for distributed power systems. Priority programs tied to mission innovation strategy include grid-scale energy storage. Success will be indicated by completion of the following activities: • Complete a demonstration that leverages industrial data (Pacific Gas and Electric), experimentally generated data from INL and other national laboratories and the Real Time Digital Simulator (RTDS) to assess viability of using electrolyzers for grid-scale storage and load leveling/stabilization; • Bring zinc-iron flow cell battery at ESL to operational status and begin generating data for the RTDS grid-scale storage models and demonstration; and • Prepare and submit at least two publications related to flow battery and electrolyzer demonstrations/models and submit them to peer-reviewed journals.	✓

Notable Outcome	*Description*	*Status/Risk*
1.4.A	Development and implementation of a strategic systems analysis capability in support of the Office of Nuclear Energy via Energy Systems Strategies, Assessment, and Integration (ESSAI). ESSAI seeks to provide timely, quantified, and unbiased data to inform global clean energy investment and policy decisions through comprehensive, multi-disciplinary research that integrates social, economic, legal, policy, and systems-level strategic insights with a focus on the role of nuclear energy. ESSAI studies will host projects through the Center for Advanced Energy Studies (CAES) and coordinate the outcomes through the GAIN initiative. ESSAI will combine the skills of national and international partners with a unique set of analytical capabilities required to achieve the volume and complexity of the required studies in an increasingly fast-paced and uncertain international energy market. In FY 2017, INL will achieve the following: • Implement the ESSAI functional structure; • INL will support the following studies, with government and industry input: - Economic and Market Challenges Facing U.S. Commercial Nuclear Fleet. This is a 12 month study that will be completed in FY 2018. The first phase of the study, defined with input from DOE, will be completed in FY 2017 with an interim report as the deliverable. - Quantifying the National Security Implications of U.S. Market Position in the Global Nuclear Supply Chain. This study will be conducted by JASON under a contract. INL will define the scope and deliverables of the study and provide the technical input needed during the conduct of the study. • Based on the first year's experience, evaluate and provide a report on the functioning of the initial ESSAI model; suggest modifications as necessary.	✓
2.2.A	Complete line-item project deliverables and critical decision milestones consistent with approved schedules and plans. This Notable Outcome provides for the effective and efficient capital acquisition of line items in support of INL's mission (e.g., RH-LLW and SPL).	✓
2.3.A	Activities to resume TREAT operations in accordance with approved plan. This Notable Outcome will assure continued progress to resume transient testing. Key activities will include readiness reviews, support for authorization to restart critical operations, and preparations for transition to operations and the first transient test.	✓

Notable Outcome	*Description*	*Status/Risk*
2.3.B	Safe and reliable operations of the ATR/ATRC and facilities at MFC are essential for providing mission support to numerous DOE (including NNSA) program offices, as well as NSUF users and the GAIN initiative. As such, it is critical for INL to successfully implement the agreed upon ATR/ATRC and MFC investment strategies to improve facility reliability and maintain safe operations. Prioritized plant health investments, well planned and high quality maintenance activities, and good conduct of operations help sustain safe operations and improved reliability.	✓

✓ Notable Outcome met.

BEA has identified challenges to the INL's wide-ranging operations as well as problems with specific management performance. The overall goal is to focus attention on key issues, with the objective of aiding in efforts to enhance the effectiveness and efficiency of INL's programs and operations. Table 3 represents the best opportunities to improve INL's performance. Though there has been marked progress, many of these are enduring challenges from the prior year.

Table 3. Performance Challenges.

External Factors	
Integrated Waste Treatment Unit (IWTU) impact – INL's ability to acquire research quantities of commercial nuclear fuel for new work is impacted by the ability of an external contractor (i.e., Fluor) to meet regulatory-driven commitments to process waste.	*Idaho Settlement Agreement* – The reputation of INL has the potential to be negatively impacted by external contractor's ability to meet waste treatment milestones. INL must continue to actively engage with leadership at the community, state, and federal level to proactively educate and mitigate concerns.
Scientific and Technical Reputation	
Scientific and technical leadership reflected in publications – Increasing the leadership, impact, and reputation of INL will require continued visibility and communication through scientific literature. Tools and processes must support and encourage impactful publication, tracking, and assessing of the quality of publications to better understand our leadership position.	*Scientific and technical leadership through internal and external collaboration* – The ability to support continued innovation requires further access to and collaboration with broad scientific communities, industry, government, and thought leadership. Processes and resources must be designed to support this objective both internally and externally.
NEW *Effectiveness of nuclear experimental processes* – Delays and missteps associated with the ATF Sensor Qualification Test reinforces that although improvements have been made to better coordinate/integrate nuclear experiment design and insertion in ATR, these actions remain short of providing systemic and sustained improvements. The nuclear experimental process will be targeted as an FY 2018 priority for improvement under the Management System Transformation initiative.	
People – "Attract, Retain, Develop"	
Meeting the workforce needs of tomorrow – The ability to attract and retain talent through competitive salaries and other cash compensation, effective succession planning and professional development, and job classification system and benefits redesigned to market will be essential to mission execution. Single point vulnerabilities remain a challenge. These were the result of past workforce reductions or are likely to be caused by the wave of retirements forecasted for the next 3–5 years. University collaboration, internships, postdoc program, joint appointments, etc., will need to be prioritized to address talent pipeline concerns.	*Improving scientific productivity and "thought" leadership"* – Increasing scientific leadership and impact will require effective development of early-mid career researchers through sustainable programs (e.g., formal mentoring, knowledge transfer, and peer reviews). In addition, processes and policies must support, rather than impede, scientific excellence and productivity. Processes must promote safety, address regulatory and contractual requirements, be easy to understand and implement, and encompass all interfaces and hand-offs. This must be done in a manner that limits administrative burden and the potential for error or non-compliance.

Strengthening first-line supervisors and managers – The ability of supervisors and managers to establish a strong organizational culture that values the safe conduct of research, delivers frequent and meaningful *performance* feedback, and encourages and supports collaboration across INL will increase engagement, higher performance, and delivery of mission outcomes. This is a constant and ongoing challenge. Continued investment in leadership development forums (e.g., LOSA, LOLA) are essential to ensure work is performed safely every time.	*Diverse and inclusive work environment* – The ability to attract and retain a diverse workforce and create an inclusive work environment will establish a culture that values all employees' *contributions* and greater collaboration, and enables broader research outcomes.
Operations – Management Systems, Safety Performance, Governance	
Sustained high performance – INL must sustain a high level of operations performance. Although events cannot be completely eliminated, INL's ability to respond to events and identify and correct causal factors must be effective. In addition, INL's Contractor *Assurance* System must be transparent, self-critical, and effective at identifying and correcting performance deviations.	*Hazard identification* – Hazard identification is frequently the most challenging of the Integrated Safety Management System core functions. Assessments continue to identify hazards that are typically mitigated effectively; the greater challenge seems to rest on identifying hazards related to emerging conditions. Continued focus on understanding the hazards at all phases of research and operations is an important and constant challenge.
NEW *Safety Culture Improvements* – A serious injury to a delivery driver, recurring low-level instances of non-compliance with administrative controls, recurring lockout and tagout issues, weaknesses in the Contractor Assurance System to identify and act on low-level trends, and breakdowns in management and oversight of subcontractors (in particular during construction) challenged management during FY 2017. These conditions continue to highlight the importance of ongoing efforts to improve safety culture and assurance activities. Management has taken action and will continue to monitor progress in FY 2018.	
Governance - implementation of contract and oversight reforms – DOE and INL continue to implement a framework to improve Laboratory stewardship. This *framework* has the following objectives: (1) align governance to promote a mission-oriented and performance-based culture; (2) strengthen INL stewardship through effective communications, transparency, trust, and clearly defined responsibilities; (3) collaboratively manage contract requirements to eliminate or reduce unnecessary burdens; and (4) enable system-level performance-based oversight and challenge that duplicate low-value oversight. These objectives are reflected in the Laboratory Agenda and Annual Laboratory Plan, and are embedded in the Contractor Assurance System Management System approach to monitor and assess implementation and impacts. Continued attention to these objectives will assure long-term success of INL.	*Cyber security* – Protecting INL's networks, information, and services from unintended or unauthorized access, change, or destruction is an enduring and increasing risk. Direct and indirect requirements are growing to implement mandated cybersecurity improvements, defend against a rapidly evolving and increasing threat, maintain secure IT assets, and to provide leadership in developing secure IT and managed service solutions.

NEW

Google Violates Terms of Contract – BEA maintains a contract with Unisys for mail and collaboration services through the Google Apps for Government (GAfG) cloud environment. Without authorization, Google migrated INL information from the contractual environment to one which violated Google Terms of Services. It took approximately 3 months for Google to migrate 100% of the data back to the GAfG environment and provide assurance that all data was transferred back, with all INL data on Google Apps Unlimited destroyed per the contract. BEA is seeking a change of its contract with Unisys to offer a month-to-month arrangement at completion of the current option year on September 30, 2017. This is to allow BEA the opportunity to cancel the contract as soon as an alternate solution (Office 365) is ready. INL also seeks remuneration of the costs to transfer its data from Google to Office 365 to compensate INL for the time expended addressing this incident.

Infrastructure – Critical R&D Capability, IT, Roads/Grounds/Utilities, Legacies

Sustained infrastructure investment – Significant multi-year fiscal challenges have resulted in an increase in deferred maintenance and/or needed upgrades: fire protection systems; Environment, Safety, and Health backlog (non-compliant ladders, underground storage tanks, etc.); roofs; roads and parking; *fleet*; rail; and other critical infrastructure (electric power grid, supervisory control and data acquisition, and information management capability). Funds are also limited to address decontamination and decommissioning of non enduring assets, and space optimization.

Funding for ATR and MFC – MFC's transition to a new cost model continues to present affordability and timing challenges with sponsors/funding sources. ATR is proceeding with a multi-year effort to improve plant and loop health with expected improvements in availability and irradiation days in support of research. Both face aging facility/equipment challenges requiring continued focus to ensure research commitments are met.

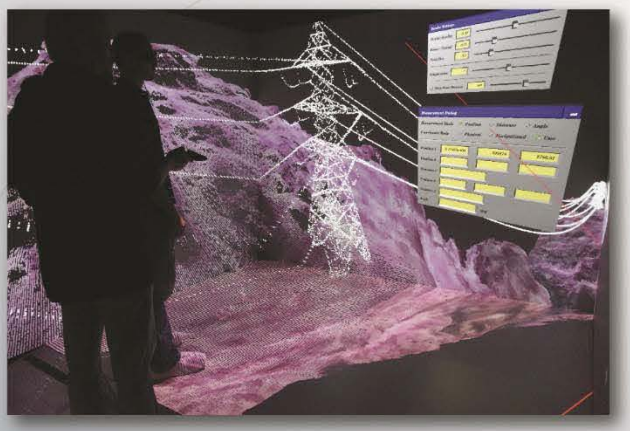
NEW

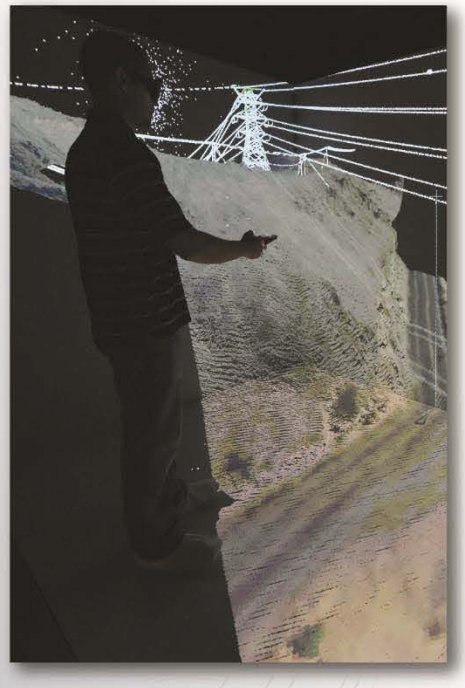
NHS Test Range Activities – INL increased the complexity of test range activities, which led to new challenges in obtaining authorities and approvals for safe, secure, and environmentally sound operations. These increased test range activities required active engagement between INL and DOE for resolution relevant to release of isotopic materials to test air dispersal models and detection systems; expansion in the scope and locations of tests, training and exercises on the Radiological Response Test Range and the National Security Test Range; and radiofrequency jamming tests on the Wireless Test Bed in support of DHS. To gain these authorities and approvals, INL and DOE are mutually developing cooperative approaches to communicate, prepare, and conduct appropriate reviews.

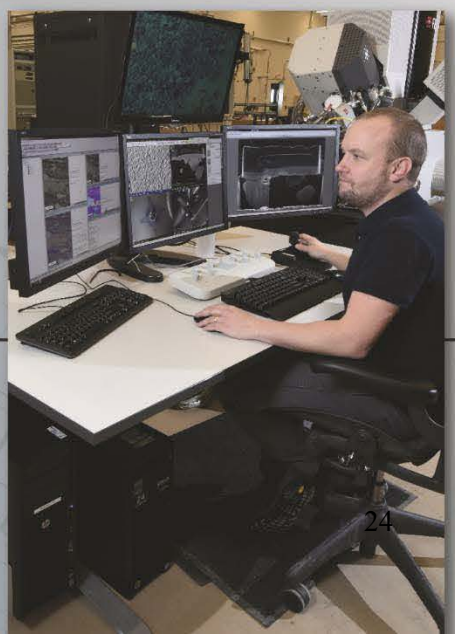
NEW

Project Performance and Cost of Construction – Although generally improved, issues remain for achieving consistent project execution. The INL director issued a letter of expectations to strengthen project management. This letter communicates expectations to manage risks inherent to capital asset projects through reviews and assigned project management competencies. Additionally, the cost of subcontracting work has steadily increased over the past few years. INL has begun an initiative to identify and mitigate the impact of project cost-driving issues (terms and conditions, diversity of suppliers, labor agreement, subcontract management, and oversight).

Business systems and decision support – A lack of a mature business systems environment, including a robust business intelligence capability, limits the ability for INL to conduct performance monitoring, decision support, and predictive analytics. Business software applications are not well integrated, are approaching end of life, and are not user friendly. Many of the tools are in place, yet investment is still needed to coordinate disparate data sources.	*Information systems and technology applications* – INL has not effectively invested in technology, such as mobile applications and hardware, to increase connectivity and productivity. Information systems are aging and not broadly supported, which increases the risk of cyber incidents, unplanned outages, new Congressional and Administration requirements to address cyber threats, and impacts to mission production/efficiency from outdated, unreliable systems. High Performance Computing is an essential capability. Although INL acquired a new High Performance Computing computer (Falcon) and is making core upgrades, it is expected that a replacement capability will be needed in 3–5 years.
Environmental legacy – Managing the disposition of environmental legacy waste and materials and establishing an enduring waste management capability create challenges to effectively address the long-term stewardship of INL. This includes managing impacts of changes to site services (mandatory and optional), disposition of spent nuclear fuel, and management of other nuclear and legacy materials.	
NEW *Pension and Investment Retirement Plan* – BEA, as the plan administrator of the pension and investment retirement plans, self-identified an overpayment of administrative expenses. Both plans had been paying for the services of staff administration back to 2008. It was discovered that in these services there were embedded overhead costs being charged to both plans similar to the allocation of overhead costs for other Strategic Partnership Projects work. However, ERISA does not allow the charging of overhead costs to the plans to self-managed, employer-sponsored plans. BEA filed a voluntary application under the Department of Labor's Voluntary Fiduciary Correction Program. Corrective actions and controls have been implemented to ensure full Employee Retirement Income Security Act of 1974 (ERISA) compliance. It should be noted that this issue was not identified by the plans' external auditor nor by a Department of Labor audit that was conducted in 2012.	
Budget and Funding	
Indirect affordability insufficient to address infrastructures – Current management models require continued evaluation to ensure critical research, development, demonstration and deployment (RDD&D) capability investments are supported. The RDD&D Capability Management Model is a key example of a solution to address RDD&D capability investment and sustainment for long-term success.	*Work acceptance* – INL continued to make progress to define processes for proposing and accepting work; however, gaps remain in INL's ability to manage proposal submittals effectively, identify available resource capacity/capability and risks properly, and accept and plan work effectively to ensure full-cost recovery.







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