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National Nuclear Security  
Administration

Lawrence Livermore  
National Security, LLC

Fiscal Year 2015  
Performance Evaluation  
Report (PER)

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NNSA Livermore Field Office

Performance Period:  
October 1, 2014 – September 30,  
2015

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November 3, 2015

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## Executive Summary

This Performance Evaluation Report (PER) provides the assessment of Lawrence Livermore National Security, LLC's (LLNS') performance in managing and operating the Lawrence Livermore National Laboratory (LLNL) under contract DE-AC52-07NA27344 for the period of October 1, 2014 through September 30, 2015, as evaluated against the objectives defined in the Fiscal Year (FY) 2015 Strategic Performance Evaluation Plan (PEP). The National Nuclear Security Administration (NNSA) took into consideration and consolidated all input provided (e.g. Contractor Assurance System (CAS), Program Reviews, etc.) from NNSA Program and Functional Offices both at Headquarters and in the field. NNSA also considered LLNL's self-assessment, which was provided per the terms and conditions of this contract, and is generally in agreement with the information provided in that assessment. The PER includes adjectival ratings per the Federal Acquisition Regulation (FAR) Subpart 16.4, Table 16-1, for each PO based on LLNL's performance against the Contributing Factors, Site Specific Outcomes, and other criteria as set forth in the Strategic PEP. The evaluation of performance considers unanticipated barriers (e.g., budget restrictions, rule changes, circumstances outside Contractor's control), accomplishments, and other events. The degree of difficulty is considered when determining whether these outcomes meet or exceed expectations. Performance against each of the POs is summarized below:

PO-1: Manage the Nuclear Weapons Mission was rated as Excellent as LLNL exceeded nearly all expectations. LLNL made substantial progress in improving efficiencies at the National Ignition Facility (NIF), significantly improving the shot rate, and made major contributions to High-Energy Density (HED) science support of the stockpile. LLNL made significant advancements in Advanced Manufacturing (AM) and effectively executed NNSA Life Extension Programs (LEPs). LLNL also successfully executed all but one Level 2 milestone funded by Defense Programs, exceeding many technically challenging performance expectations, in a safe and secure manner. It is noted that the missed milestone was due to non-availability of a facility at another Management and Operations (M&O) site.

PO-2: Reduce Global Nuclear Security Threats Mission was rated as Very Good as LLNL successfully executed the Broader National Security Mission work, exceeding many expectations in non-proliferation, emergency management, incident response, forensics, and nuclear counterterrorism. LLNL consistently provided high-quality project support on four key Russian nuclear security engagements as well as nuclear security best practices engagement with China and North Africa. LLNL was able to overcome significant barriers on performing work in the Russian Federation in a very short timeframe by recovering and repatriating four radioisotope thermoelectric generators (RTGs) from Antarctica to the Russian Federation for disassembly and final disposition. LLNL also made advancements in analyzing and modeling threat materials and completed nuclear threat device "task list" items ahead of schedule.

PO-3: DOE and Strategic Partnership Project Mission Objectives was rated as Excellent as LLNL exceeded nearly all NNSA expectations, pursuing and executing high-impact work for DOE and Strategic Partnership Project (SPP) mission objectives. LLNL earned numerous prestigious awards from US Government sponsors, including the Department, demonstrating the quality of this work and its strategic value. LLNL pursued and successfully executed numerous high impact projects for both the Department and other sponsors that strategically align with NNSA mission objectives. An

example of such work performed under the SPP program is research sponsored by the Department of Homeland Security (DHS) for the evaluation and testing of first responder preventative/nuclear detection (PRND) equipment to provide state and local agencies with guidance on how to best use radiological search and interdiction systems and equipment for consequence management and response after a radiological/nuclear release or detonation.

PO-4: Science, Technology, and Engineering (ST&E) was rated as Excellent as LLNL exceeded nearly all expectations in effectively advancing the frontiers of Science, Technology, and Engineering (ST&E), including successfully executing the Laboratory Directed Research and Development (LDRD) and Technology Transfer programs. LLNL research consistently remained transformative, innovative, and of high quality as recognized by the ST&E community and validated through various internal and external reviews. LLNL researchers broke records for the number of awards received and their publication rate continued to climb along with their patents and records of invention. The DOE Secretarial Honor Award was presented to an LLNL team for participation in an Office of Intelligence and Counterintelligence Analytic Team that significantly contributed to understanding of a growing foreign nuclear threat. An example of such research includes innovative experiments on NIF that obtained crystal structures for high-atomic-number elements under conditions never before experimentally accessed for these highly program-relevant materials. LLNL also continued to provide leadership in advanced manufacturing, developing processes that were implemented by the Kansas City Plant and Y12 that support the cost-effective modernization of a safe, secure, and effective stockpile. LDRD results included creating novel energy absorbing materials for sensitive components to combat the effects of temperature fluctuations and vibration, which can be used in helmets.

PO-5: Operations and Infrastructure was rated as Very Good as LLNL exceeded many expectations in managing the safe and secure operations of the Laboratory and its infrastructure. LLNL maintained effective and efficient quality, security, and environment, safety, and health programs and achieved an excellent record of safety for the year. LLNL continued to implement long-term work planning and control improvements to ensure safe work execution. While LLNL provided new strategies and investments to achieve superior facility management results and has become NNSA's "go to" Site for many critical infrastructure initiatives, significant long-term challenges remain in deferred maintenance and work order backlogs, especially at Site 300. LLNL continued to deliver efficient and effective business systems, exceeding the overall goal for small business and producing outstanding personal property inventory results. LLNL also provided outstanding legal management as it successfully settled very high profile and complex litigation.

PO-6: Leadership was rated as Excellent as LLNL exceeded nearly all expectations, continuing to build upon the significant leadership improvements in support of the DOE/NNSA mission recently achieved. LLNL leadership effectively supported DOE/NNSA missions, improved safety culture, its responsiveness to issues and opportunities for continuous improvement internally and across the Enterprise, and parent company involvement/commitment to the overall success of the Laboratory and the Enterprise. LLNL demonstrated strategic leadership through its participation and key role in numerous enterprise initiatives, councils, working groups, and collaborations that addressed issues and led to performance improvements. Changes in key personnel were well coordinated with DOE/NNSA leadership and LLNL continued to provide improved transparency, communication, and customer focus, especially with respect to work performed by the NIF organization.

Performance against each of the Performance Objectives is detailed as follows:

## Performance Objective 1: Manage the Nuclear Weapons Mission

### Summary

Manage the Nuclear Weapons Mission was rated as Excellent as LLNL exceeded nearly all expectations, successfully delivering on our nation's challenging stockpile requirements as it executed 109 of 110 Level 2 milestones funded by Defense Programs. It is noted one milestone was not met due to facility non-availability at another site. LLNL continued to lead the Weapons Laboratories in strengthening the underpinning and future of stockpile stewardship. LLNL made substantial progress in improving efficiencies at NIF, which were highlighted in NNSA's report to Congress on cost efficiencies, significantly improving the shot rate, and made major contributions to High-Energy Density (HED) science support of the stockpile. LLNL substantially exceeded the stretch goal of 300 shots for NIF, achieving a total of 356 shots for the year, a new record for the facility. This included 266 shots specifically for the Stockpile Stewardship Program (SSP) as well as the first-ever Pu shots on NIF, which were well coordinated with all stakeholders and executed flawlessly. LLNL demonstrated a new NIF capability for quick-turnaround shots that led to a five-shot campaign being executed in just over 24 hours, another record, and also fulfilled a very challenging and key NA-10 Get-the-Job-Done-List (GTJDL) priority by successfully executing four special nuclear material (SNM) shots and rapidly returning to normal shot operations. LLNL demonstrated outstanding leadership in the national-level Exascale Program and in the execution of the procurement of the next generation of Commodity Technology Systems for the Tri-Labs (Livermore, Sandia, and Los Alamos), continuing to drive the state-of-the-art in high performance computing (HPC) and leverage the NNSA spend to maximize program dollars. This required a high degree of collaboration and coordination with NNSA, Los Alamos, and Sandia to ensure that all of their requirements for HPC equipment known as Scalable Units (SUs) were met in order to perform critical scientific and engineering research for the SSP. Despite limited resources, LLNL overcame substantial challenges and successfully completed the W-80-4 (Long Range Stand-Off) Phase 6.1 study, providing important design options and paving the way to the transition to Phase 6.2 work during the Quarter 4. LLNL also made significant advancements in Advanced Manufacturing (AM) that will continue to pay dividends through increased manufacturing capabilities for the Department. Performance highlights are set forth below:

- Successfully completed one Defense Programs (DP) level-1 milestone, 109 of 110 active DP level-2 milestones, and the 4 Getting-the-Job-Done List (GTJDL) items.
- Executed W78 GT-214 mission despite adverse weather conditions (tropical storm and typhoon).
- Completed a preliminary vulnerability and hardness (V&H) assessment of a candidate Life Extension Program warhead option in 6 weeks, which typically takes up to 6 months to complete.
- Built the first full scale, all optical probe dome.
- Developed and applied physics-based shape metric to a range of underground tests and design assessments, which is the first tie of shape metrics to performance.
- Made significant achievements in Advanced Manufacturing including:
  - Fabricating the first classified 3D multilayer demonstration object.
  - Completing the first-ever Additive Manufacturing of 21-6-9 stainless steel.
  - Installing and commissioning new AM equipment, a NanoScribe Photonic Professional photon lithography system.
  - Synthesizing a new explosive molecule (LLM-227) for the first time.

- Producing additively manufactured War Reserve (WR) shaped parts with new target features required for upcoming integrated assembly experiments.
- Successfully executing a series of Focused Experiments at the Contained Firing Facility (CFF) using two different types of Additively Manufactured components.
- Completed the W80-4 (LRSO) "Phase 6.1 Concept Assessment" for Nuclear Weapons Council decision and initiated W80-4 Phase 6.2 with the formation of some Product Realization Teams.
- Executed 266 Stockpile Stewardship Program experiments in high-energy density (HED) and inertial confinement fusion (ICF) at the National Ignition Facility (NIF), which included 4 special nuclear material (SNM) shots, significantly exceeding the total shot goal of 300 by executing 356 shots in FY 2015.
- Obtained the first-ever Equation of State (EOS) and kinetics measurements on overdriven, doubly shocked LX-17 high explosive.

LLNL exceeded expectations in accomplishing work as negotiated with program sponsors and partners to ensure safe, secure, reliable weapon performance, transportation, and cost effective operations. LLNL provided effective program management as evidenced through its performance against NNSA milestones. LLNL met extremely challenging cost, schedule, and technical performance requirements in the areas of Nuclear Explosive Safety Studies; Quality Assurance Surveys; management of materials and storage programs; implementation of released Nuclear Security Enterprise-wide business requirements, processes, policies, earned value management, risk management, resource loaded schedules, program plans, cost controls, configuration management; and successful completion of Office of Secure Transportation task agreements and change control. LLNL continued to provide outstanding stockpile services, air delivered and ballistic missile systems maintenance, and limited life components exchange requirements, which helped ensure the uninterrupted work on NNSA weapons. LLNL reported one red activity for work related to Getting-the-Job-Done (GTJD) List (manufacture 4 developmental pits using the W87-like pit design) due to the production pause in TA-55 at Los Alamos National Laboratory (LANL), although LLNL did complete W87 pit design, development and certification activities to increase safety, surety, and manufacturing features. LLNL successfully staffed workloads across the four LLNL systems (W80, B83, W84, and W87) per their individual requirements, and supported external groups and functions as needed. LLNL provided reports, updates, and other documentation per the requested frequency. While LLNL generally delivered monthly reports as required and on time, there were opportunities to improve their timeliness, accuracy and supporting detail. Specifically, additional detail is needed on significant cost variances in a more timely manner in support of the NNSA Program Managers. LLNL provided many deliverables ahead of schedule and completed a Management Self-Assessment of DOE-STD-3016 implementation (hazard analysis of nuclear explosive operations). In addition, LLNL supported the Core Infrastructure, Risk-Informed Strategic Planning (CRISP) Team and NNSA Maintenance Best Practices workshop. LLNL participated in multiple working sessions at MBIT for Technical Data Package (TDP). TDP has the goal of introducing part-centric 3D PDF to authorize models as primary definition to manufacture, inspect, and accept weapons products. Participants defined a TDP framework to test as a proof of principle. In addition, LLNL led the Enterprise Modeling and Analysis Consortium (EMAC) Benefits Model as scheduled and updated models supporting Scope Comparison of Options, Risks and Excursions (SCORE). LLNL identified potential authorization bases impacts associated with Weapon Response-related changes or potential changes, including revamped Weapons Response processes to enable effective NNSA support action. Timely

notifications allowed for coordination of issues with weapon response between the Laboratories and CNS-Pantex in an efficient manner. Several examples include the W76 Isolator, B61 Weapon Response Issue B document, and the W80/B61 Army/Navy Can issue, which enabled work to re-start on these programs. However, there is some concern regarding availability of qualified weapon responders to perform this work in the future. LLNL ensured packaging program and activities were within budget, scope, and schedule. LLNL provided system requirements information by releasing a Systems Requirements Document (SRD) on the W80, W84 and W87 contents, and additional information requested by Design Agency (DA) in support of the DPP-3 development; LLNL met the milestone to prepare an approved disposition plan on packaging for the UC-609. The UC-609 disposition will not commence until after the UC-609 certification expires in August 2016. In addition, LLNL worked effectively with NA-10 and NA-70 to advance the proposal to bring surrogate material into Building 332 on the basis that from a safety and security perspective it is equivalent to a form of uranium that can be stored and processed within the parameters of a Radiological or Category III facility. LLNL provided technical analyses, inputs, and presentations numerous times during the performance period in support of a significant NA-10 mission need area. While this matter is still under discussion with DOE/AU, LLNL's efforts in this area have been strong, significant, sustained, and clearly aligned with NA-10 program priorities.

LLNL exceeded expectations in executing the stockpile surveillance program, developing a robust scientific and engineering understanding for the delivery of the annual stockpile assessment. It successfully completed the Cycle 20 Annual Assessment Review process, and improved the science and understanding behind the process including the data and methods used such as surveillance, flight, laboratory, hydro and environmental testing data, and Quantification of Margin and Uncertainty (QMU). LLNL provided terminal diagnostics for both the W78 GT-214 and the W87 GT-215 extended range missions despite severe weather conditions. LLNL completed all requirements in support of Annual Assessment activities for the W80, W87, and B83 weapon systems and completed and distributed the final Cycle 20 Annual Assessment reports and released the Cycle 20 Annual Assessment Laboratory Director letter, which certifies the safety, security, and reliability of the W80, W87, and B83 weapon systems. LLNL also completed scheduled surveillance, flight and subsystem test activities and deliverables on schedule and within budget; the one exception being pit surveillance for two LLNL weapon systems which could not be completed because of the pause in TA-55 operations at LANL. In addition, LLNL completed a preliminary vulnerability and hardness (V&H) assessment of a candidate LEP warhead option in an accelerated turnaround time. LLNL met all Independent Nuclear Weapons Assessment Process requirements, continued abnormal environment safety testing for the B83 and safety support for LANL for the B61, supported Plant weapon activities as required, addressed Significant Finding Notifications (SFN) in a timely fashion, and achieved a major technology upgrade of a new digital camera for detonator surveillance. LLNL supported expansion of Pantex Pit nondestructive examination (NDE) capabilities with work on development of the Confined Large Optical Scintillator Screen and Imaging System II (CoLOSSIS II). LLNL completed the FY 2015 National Hydrodynamic Test Plan (NHTP) and issued the "pre-budget" FY 2016 NHTP. LLNL performed focused hydrodynamics experiments to develop and quantify performance of additive manufactured (AM) materials and components, which was a major accomplishment supporting qualification of AM materials for future SSP applications. LLNL completed all scheduled surveillance activities, deliverables, and requirements in accordance with each applicable weapons system approved Integrated Weapon Evaluation Team (IWET) Plan, associated directive documents, and did so within budget. LLNL contributed to the successful W78 extended range GT-214GM flight test (deployed/recovered the rafts twice for this mission),

collected data from the Reentry Vehicle (RV) terminal events, and briefed the Intercontinental Ballistic Missile (ICBM) Joint Test Working Group in July. LLNL Enhanced Surety Program successfully met all deliverables on schedule, within budget while meeting or exceeding performance expectations. LLNL completed enhanced surety activities for material degradation studies and began analysis of the demonstration parts in the Building 131 High Bay Materials laboratory. LLNL completed the required proposals and preliminary work on future initiation systems work. Additionally, LLNL fabricated and assembled scaled demonstrator units for TRL 3 demonstration and for TRL 4 testing in FY 2016. LLNL completed the Integrated Surety Architectures (ISA) Comparison of Concepts (CoC) Study on schedule and within budget and delivered the results to the W88 Federal Program Manager. LLNL successfully completed all certification and safety objectives on schedule per Level 2 Milestone requirements, provided frequent input and feedback, and remained highly engaged in the mission scope. LLNL also contributed constructive solutions and participated in negotiations for current and emerging issues. In addition to the Weapon Component Development (WCD) activities, LLNL remained highly involved in Nuclear Safety Research and Development (NSRD) activities. LLNL completed FY 2015 material compatibility studies and surface science investigations and presented the results. LLNL successfully performed initiation systems scoping studies, which resulted in proposed FY 2016 R&D portfolio. LLNL successfully conducted hydro test to characterize AM-fabricated metals executed in early FY 2015 and presented findings at multiple internal and external seminars. LLNL finished development of cushion materials for upcoming tests. LLNL performed deflagration-to-detonation (DDT) experiments on Class 1 HMX powder with flash x-ray radiography and simultaneous fast camera imaging to show the transition process in unprecedented detail. Results demonstrated densification of the powder near the transition to detonation. For Electrostatic Discharge (ESD) Models, closed-form model solutions with new high fidelity capacitance scaling are progressing well. Updated methodology more accurately represents threats from small tooling which will facilitate the disposition of anomalous units at Pantex (PX). For the Brush Discharge Study, LLNL identified the facility to conduct the high voltage dielectric experiments and ensured the required safety review and authorization is in place. Lastly, LLNL completed testing of PX bond-wire configurations for lightning mitigation that confirmed subject matter expert expectations.

LLNL met expectations in executing stockpile work to deliver stockpile system maintenance, production, limited-life component exchanges, weapon containers, and dismantlements. LLNL fully executed all stockpile weapon systems maintenance project deliverables and requirements for each weapons program and did so within budget allotment and in compliance with directives. The W87 ALT 360 Team achieved a successful Baseline Design Gate Review six months ahead of the originally scheduled date. The Product Realization Team (PRT) executed the project plan with a high degree of success and competence.

LLNL also set all B83, W80, and W87 Limited Life Component Exchange (LLCE) deliverables and requirements within budget and in accordance with re-baselined directive documents. LLNL provided continued B83 Electronic Neutron Generator (ELNG) planning, development, qualification and production support. For the W87, LLNL delivered clear requirements for the Alt 360 project as required by the NNSA approved project plan and continued to serve in an advisory role as required. LLNL continued to provide support as needed for the W87 Firing Set rebuild activities. LLNL met all requirements for the Non-Nuclear Component Development activities on the Gas Transfer Systems (GTS), Arming, Fusing, and Firing (AF&F) and Neutron Generator (NG) components. LLNL continues Multi-Point Safety (MPS) material transfer testing in various delivery configurations as

well as material composition/refinement studies. LLNL met PBX 9502-1 and LX-21 production studies. LLNL fully supported the dismantlement program by making progress toward reducing legacy inventories of weapon parts. LLNL provided the technical leadership and engineering to ensure dismantlement met internal schedules and provided weapon responder solutions in spite of resource challenges. Accomplishments by weapon system are set forth below:

### **W80 SPECIFIC**

- Completed environmental testing baseline for DPP-3 development.
- Coordinated component shipments from the National Security Campus (NSC) to support LLNL testing activities.
- Completed radiography of W80 snowballs prior to firing at Pantex to support current schedule.
- Working with W80 personnel and Y-12 managers, created additional tests in support of core surveillance in FY16.
- Released IER20150105LL for Weapon Response to Code Blue.
- Provided subject matter experts and project personnel to support the MC4886 Design Review held at Sandia National Laboratory (SNL) in New Mexico on May 12, 2015. LLNL peer review comments were provided to SNL.

### **B83 SPECIFIC**

- Continued work with NSTec to develop evaluation capability. Performed demonstrations using a mock unit.
- Released requirements to LANL for second boost test in FY 2015.
- Released twenty-one engineering authorizations in April and May supporting B83 surveillance/production.
- Completed analysis of requirements for Electronic Neutron Generator (ELNG).
- Supported Y-12 with evaluations to provide confidence needed for them to perform surveillance on one component.
- Supported Pantex restart of operations following finding of anomaly.

### **W87 SPECIFIC**

- Continue to support Alt 360 Product Realization Team (PRT) meetings.
- Supported successful Qualification Engineering Release (QER) by SNL of Firing Set acceptance test at NSC.

LLNL exceeded expectations relative to the application of new strategies, technologies, and scientific understanding to support stewardship of the existing stockpile and future stockpile needs. LLNL obtained the first ever Equation of State (EOS) and kinetics measurements on overdriven, doubly shocked high explosive, LX-17. New Additive Manufacturing specific models have been developed in ALE3D to simulate lattice dynamic response under shock loading. Using polymer Direct Ink Write (DIW) and siloxane resin formulations, LLNL successfully printed a 4 layer hemispherical development part with 5 regions of different constant porosity. This coupled with a new optimized design for inline mixing will significantly advance LLNL's DIW fabrication options for new components. LLNL completed accelerated thermal and radiative aging studies of siloxane for Additive Manufacturing demonstrating results over target. In addition, components using Metal Additive Manufacturing techniques in support of future systems were fabricated this quarter for use in a Focused Experiment; AM tooling was fabricated for Y-12 and Pantex (Vacuum Chuck, Vacuum



Chuck Plate, Spring) and specialized AM plugs were fabricated to enable reuse of an expensive component in a hydro experiment. This effort not only supports the W78/88-1 LEP and W80-4, but also W87, B83, W80 and W84 programs, and potential future programs as well. In the area of Material Compatibility, the new laboratory and instruments are being brought on-line and full system compatibility testing has re-started. Refinements/fabrication of initiation system components are complete with testing in progress. In the area of NIF/ICF, LLNL qualified a new NIF experimental platform in support of the ICF Mix Campaign - self-backlighting x-ray radiography and qualified a new NIF experimental platform for Polar Direct Drive - ICF Hydrodynamics Campaign. In the area of Primary Nuclear Design, a physics-based cavity shape metric has been developed for primary performance assessments. The metric has been applied to a number of designs successfully. In Secondary Nuclear Design, design, fabrication and assembly of Focused Experiments using two different additive manufacturing components was completed, and the shot execution is on track for early Quarter 2 at the Contained Firing Facility (CFF); also, two of the three Underground Test (UGT) events were put into the standard secondary assessment methodology (SCAMP) suite. The third event is currently being updated. The first ever Cross-Joint Oversees Working Group (JOWOG) meeting specific to Additive Manufacturing was hosted by LLNL from October 28–30, 2014; over 130 participants attended from the various U.S. weapon design and production sites as well as the United Kingdom's (UK) Atomic Weapons Establishment (AWE) and NNSA. LLNL met all requirements for Advanced Simulation and Computing (ASC) L2 Integrated Codes (IC), Verification and Validation (V&V), Physics and Engineering Modelling (PEM), Computational Systems and Software Environment (CSSE), Facility Operations and User Support (FOUS), and Advanced Technology Development and Mitigation (ATDM) milestones (all ASC subprograms). In the ASC Physics and Engineering Models (PEM) subprogram, the tri-laboratory "PEM Days" meeting at LLNL June 8-9, 2015 covered integration of activities across PEM, across ASC, and outside ASC, as well as "deep dive" discussions on strength modeling, additive manufacturing, and equations of state. LLNL also exceeded expectations with its leadership successfully executing the tri-lab procurement of the Commodity Technology Systems (CTS)-1. LLNL is also meeting all requirements in the area of Advanced Certification, including efforts to develop secondary component options to support future LEPs. This work was advanced by the installation and proof-of-operation of a capability to scale new material production to weapons-relevant sizes. Progress also was made in efforts to develop alternative fire resistant materials, the development of a full-scale probe dome to support future stockpile experiments, and the development of a cavity shape metric. Dry run tests were performed in order to develop specific processes and procedures for the final tests and to validate hardware designs and critical materials issues have been fully resolved. All crucible tests were completed along with material characterization and documentation. In Quarter 2, two hydrotests using a hubcap design were executed successfully at the Contained Firing Facility to test additively manufactured (AM) materials for future stockpile applications. One experiment measured the dynamic property of a specific AM-produced metal; the other measured the performance of AM-produced mounts at relevant conditions. LLNL successfully overcame obstacles in completing milestone 5211, Assess Filtering Methodologies for Uncertainty Quantification, during Quarter 4 as researchers found unexpected technical results in their investigation. LLNL executed an exemplary program of work with the cooperation of the national indirect drive working group to plan and execute a program of experiments to understand the physics challenges associated with the point design executed in the National Ignition Campaign and developed alternative approaches. NIF concluded the high foot campaign and completed the first Beryllium cryogenic layered shot. LLNL executed numerous HED weapons science experiments on NIF to study radiation transport, high-Z diffraction, and multiple

other areas supporting Stockpile Stewardship. LLNL demonstrated leadership and collaboration with the ICF community in developing the national diagnostics strategy. Livermore also played a key role in supporting the comprehensive 2015 ICF/HED Sciences review.

LLNL successfully completed barrier testing and deflagration-to-detonation transition (DDT) in support of the Detonation Calorimetry series to determine detonation energy of LX-21. LX-21 is a newly developed explosive formulated with Lawrence Livermore Material (LLM)-105 and Viton-A binder. LLM-105 formulated explosives are shown to have the detonation performance of conventional high explosives while maintaining the safety characteristics of insensitive high explosives. LLNL provided documentation on synthesis and analytical techniques on material characterization to Pantex. This effort supported the W78/88-1 LEP and LRSO as well as future LEP programs. LLNL also obtained cyclic failure data for PBX 9502 and LX-17 in support of constitutive model development. LLNL continued to provide the environment and test platform to create and measure x-ray-driven system-generated electromagnetic pulse (SGEMP) currents in one- and two-dimensional test objects. LLNL performed a four-shot mini campaign investigating SGEMP with Sandia and the United Kingdom's Atomic Weapons Establishment (AWE). LLNL continued to develop, validate, and deploy improved predictive capabilities and diagnostics to assess performance and lifetime for nuclear and non-nuclear materials. LLNL developed and exercised finite element models (FEM) of mechanical response of foamed silicones in compression and compared to as-measured pore-size distribution, developed a simple mathematical method to track the kinetics of chemical phenomena (outgassing, diffusion, gas consumption) in environments with continuously varying temperatures, fabricated a second 10-inch diameter gadolinium-lutetium-oxide scintillator for testing in CoLOSSIS, reduced the "afterglow" of Gadolinium Lutetium Oxide (GLO) scintillator material to levels below that of standard scintillator (IQI glass) generated next-generation thermal/radiative response models for high-risk CSA materials based on accelerated aging tests, and incorporated next-generation source/sink models into universal secondary aging models. LLNL continued to meet all requirements for the R&D Certification and Safety, Weapon Component Development (WCD) work scope. LLNL performed ESD Threshold Experiments of re-designed test setup producing good results with improved threshold precision. Prompt Thermal Initiation experiments show promise to reveal first principle understanding of ESD initiation phenomena. LLNL continued to meet all requirements for the Non-Nuclear Component Development activities on the Gas Transfer Systems (GTS), Arming, Fusing, and Firing (AF&F) and Neutron Generator (NG) components. LLNL continued MPS material transfer testing in various delivery configurations as well as material composition/refinement studies; PBX 9502-1 and LX-21 production studies are being conducted and expected to remain on schedule, with technical seminars scheduled for presentation in Washington, D.C. Other accomplishments include:

- Obtained the first-ever Equation of State (EOS) and kinetics measurements on overdriven, doubly shocked LX-17 high explosive.
- Executed the second set of Drawbridge campaigns to study radiation transport in a complex configuration.
- Executed the second high-Z diffraction experiment and obtained scientific significant data.
- Executed 13 shock-shear experiments to map out model parameters relevant to assessment.
- Executed platform development shots with the 2-shock pulse, setting up the upcoming data campaign to study impact of mix on performance.
- Executed the first CD-Mix experiment with reduced scale using the 4-shock pulse shape.

- Executed series of strength platform development shots. Executed 7 opacity backlighter development shots.
- Executed first set of Menkar data shots.
- Conducted tests in support of alternate fire resistant materials.
- Completed analysis of the data from the AM hubcap experiments in January.
- Completed analysis software to reconstruct particle tracks from the 63TB fission Time Projection Chamber (TPC) dataset.
- Progressed on assembly of a new  $^{239}\text{Pu}$  fission Parallel Plate Avalanche Counter (PPAC) (for neutron spectrum measurements) with a total mass of no more than 50 mg (better specificity).
- Successfully transitioned the Phoenix program experimental campaign to LANL and executed the MG-10 and FFT-5 tests.
- Using the gas gun at the High Explosives Applications Facility (HEAF), made direct measurements of crystalline structures of weapon-related materials that will lead to reducing the uncertainties in our knowledge of these materials' characteristics and equations of state (EOS) and developed Intrinsic Use Control (IUC).
- For Enhanced Surety, completed and delivered the Integrated Surety Architectures (ISA) Comparison of Concepts (CoC) Study to the relevant federal program manager (FPM).
- Continued to develop LX-21 and LX-22, a new High Explosives (HE) based on LLM-105, in support of future systems.
- Developed a proposal with LANL and Pantex for improved Insensitive High Explosives (IHE) qualification testing, and the new explosive LLM-172.
- Produced additively manufactured WR shaped parts with new target features required for upcoming integrated assembly experiments. LLNL completed production lot for experiment by Quarter 4.
- Demonstrated in the laboratory resin formulation for direct ink write with both low temperature and low stiffness.
- Finite element simulations were completed on AM and cellular silicones which help explain better mechanical aging in the AM materials.
- Continued resin qualification activities have so far shown Dow Corning SE1700 resin to meet or exceed legacy resin performance properties.
- Presented at the JOWOG 28 main meeting on polymer AM highlighting recent progress at LLNL.
- Successfully executed a series of Focused Experiments at CFF using two different types of Additively Manufactured components.
- Completed the analysis of their dynamic behavior relative to conventionally made components.
- Developed new Additive Manufacturing specific models in ALE3D to simulate material lattice dynamic response under shock loading and successfully printed multilayer hemispherical parts for a hydrotest using AM (Direct Ink Write) technology, which demonstrated a significant advancement in LLNL's DIW fabrication options for new components.
- Completed accelerated thermal and radiative aging studies of siloxane for Additive Manufacturing. LLNL fabricated AM tooling for Y-12 and Pantex, fabricated specialized AM plugs for use in a hydro experiment rather than the more expensive stockpile return parts, and demonstrated the first ever AM of 21-6-9 stainless steel.
- Made significant progress in two special materials projects.
- Completed mid-year Tech Mat reviews. Scheduling seminars for NNSA/HQ.

- LLNL, LANL and SNL proposed, and NNSA accepted, a path forward for the FY15 Technical Basis for Stockpile Transformation and Planning (TBSTP). The three Design Agencies (DA) are preparing draft inputs which are due by July 1st. The W80-1, B83, W87, W80-4 LEP and General Technology Maturation POC are preparing their TBSTP inputs.
- Continued MPS material testing in various configurations. Material composition/refinement study is progressing. Equipment modifications to enable surface effect assessment has begun.
- Material Compatibility: New laboratory and instruments are being brought on-line. Full System Compatibility Test has re-started.
- Demonstrated the application of a wide range of new strategies, technologies, and scientific understanding to support stewardship of the existing stockpile and future stockpile needs.

LLNL exceeded expectations in sustaining and strengthening unique science and engineering capabilities, facilities and essential skills to ensure current and future Nuclear Weapons mission requirements will be met. LLNL made advances in capabilities for Stockpile Stewardship including improvements to the Confined Large Optical Scintillator Screen and Imaging System (CoLOSSIS) as scanning was improved with the addition of fiducials in the holding fixture to improve reconstruction time; LLNL classified computing capability to transfer CoLOSSIS data was upgraded from kbps to Gbps to speed the archival of Surveillance data; CoLOSSIS reconstruction software was revised and Software Quality Assurance (SQA) package was completed to use computers installed in FY 2014 and is running 10x faster. LLNL also developed a new nuclear magnetic resonance technique to assess the degree of crystallinity in fluoro-polymers, and installed new upgrades for environmental shakers in B334 and B131. LLNL met or exceeded all ASC L2 Integrated Codes (IC), Verification and Validation (V&V), Physics and Engineering Modelling (PEM), Computational Systems and Software Environment (CSSE), Facility Operations and User Support (FOUS), and Advanced Technology Development and Mitigation (ATDM) milestones (all ASC subprograms). LLNL overcame budget challenges in successfully completing critical work related to Primary Assessment Technologies, Advanced Radiography, and Secondary Assessment Technologies. LLNL successfully developed analysis software to reconstruct particle tracks from the fission TPC dataset and the full dataset was processed using two LLNL computer clusters and well as state-of-the-art big data techniques. LLNL completed Chi-Nu measurements and analysis of prompt fission neutron spectra completed as well as TPC cross section measurements and analysis. LLNL has done an exemplary job in leading the ICF community's efforts to develop a 10-year scientific strategic plan for the HED sciences in support of the Stockpile Stewardship Program. LLNL demonstrated its support of other national security programs by fielding a new platform for x-ray exposure experiments for National Security Applications. Working with the broader community, LLNL has re-engineered and is installing the new Advanced Radiographic Capability (ARC) front end. Preliminary testing has indicated that the pre-pulse problems have been corrected and that LLNL is well on its way to delivering this important diagnostic capability. Other accomplishments include:

- Executed 266 Stockpile Stewardship Program experiments in HED and ICF, which far exceeded the original FY 2015 goal of 300 total NIF shots (356 by the end of FY 2015).
- Executed 47 HED experiments in FY 2015, far exceeded the originally planned 34 shots.
- Progressed with the double pulse upgrade at Flash X-Ray (FXR).
- Progressed in the development of a new class of scintillators to achieve major efficiency improvements to the PX CoLOSSIS capability.

- Fabricated a second 10-inch diameter gadolinium-lutetium-oxide scintillator for testing in CoLOSSIS.
- Reduced the "afterglow" of GLO scintillator material to levels below that of standard scintillator (IQI glass) by adding 0.01 wt. % praseodymium (Pr) to the recipe.
- Progress continues in development of a Neutron Imaging Capability for use in the Nuclear Weapons Complex.
  - Conducted internal design review of neutron imaging apparatus and siting requirements.
  - Conducted design review with vendor of radio frequency quadrupole (FRQ) portion of deuterium ion accelerator for neutron imaging project.
  - Participated in LANL demonstration of neutron imaging on classified objects of interest.
  - Developed and presented resource loaded schedules for fielding a neutron imaging capability to match a variety of proposed delivery dates and technical readiness level (TRL) requirements.
- In support of Test Readiness, completed the finalization of the test equipment and subsequent testing on schedule at the Dense Plasma Facility (DPF) facility in Quarter 4.
- Executed the Capabilities for Nuclear Intelligence (CNI) System 2 hydrotest in June at the CFF facility at Site 300.
- Started development in FY 2015 on a metrology tool to inspect bare Alpha Pu in support of a Sound Speed experiment to be conducted in FY16 at the Joint Actinide Shock Physics Research (JASPER).
- Progressed with the double pulse upgrade at Flash X-Ray (FXR), contributing to Enhanced Capability for Subcritical Experiments (ECSE) planning and risk reduction for CD-1, contributing to the ECSE Panel Review, the Analysis of Alternatives (AoA) and Evaluation of Alternatives (EoA) efforts to facilitate the technology down-selection.
- Released Tripod Operating System Software (TOSS) 2.3-3 (based on RHEL 6.6) for General Availability on April 7th and includes:
  - Various bug fixes and security updates from Red Hat and LLNL.
  - This version fully deployed across both the Livermore Computing (LC) Open Computing Facility (OCF) and Secured Computing Facility (SCF).

LLNL exceeded expectations in executing product realization processes and activities in support of nuclear weapon life extension programs, modifications and alterations in accordance with NNSA requirements and Nuclear Weapons Council guidance. LLNL completed the W80-4 Phase 6.1 and transitioned the program Phase 6.2. LLNL provided excellent support through providing design concepts, supplying inputs to subgroup reports, supporting the FPM and Department of Defense (DoD) thus meeting the Getting the Job Done List (GTJDL) - Item 5 (Complete the W80-4 (Long-Range Standoff) "Phase 6.1 with the completion this Phase Concept Assessment") by supporting W80-4 LEP Program Review. This support included conducting presentations and a NIF target fabrication tour; supporting Technology Readiness Assessment review at LLNL; supporting the Cost Improvement Initiative (CII) Tech Mat briefing to NNSA/HQ; and supporting W80-4 LEP Project Officers Group (POG) Warhead Arming Working Group (WAWG), Systems Engineering and Integration Subgroup (SIESG), and Program Analysis Subgroup (PASG) meetings. LLNL provided numerous valuable comments and inputs to the draft Technology Readiness Assessment Report (NA-18), an unplanned activity, with extremely limited funding, provided W80-4 monthly activity updates to the NNSA FPM, meeting very aggressive due dates, and completed the site cost estimate for Nuclear Explosive Package (NEP) scope. LLNL consistently performed at a very high level in

support of the W80-4 as it accomplished unexpected work scope in the program within cost and schedule limits. LLNL demonstrated key aspects of NEP concept design development as part of the Phase 6.1 and 6.2 study activities, and supplied inputs to POG subgroups and to the federal program manager and DoD as requested. LLNL provided inputs to the Cost Improvement Initiative brief to focus tech mat investments (beyond scope of the 6.1 effort), provided input to the POG Phase 6.1 Report and Phase 6.2 Authorization Request, partnered with SNL to develop a LLNL-SNL Detonator Stronglink Memorandum of Understanding (beyond scope of the 6.1 effort) delineating laboratory roles and responsibilities, developed a preliminary draft Phase 6.2 plan and schedule, and assisted NNSA in the development of the draft NNSA W80-4 LEP Program Protection Plan (beyond scope of the 6.1 effort). For the B61-12 LEP, LLNL met all requirements and actively participated in Independent Peer Reviews (IPRs). LLNL updated the Phase 6.3 Independent Peer Review Plan to address FY 2015/FY 2016 baseline design review activities, completed tasks per the approved Phase 6.3 Independent Peer Review (IPR) tasking document, and briefed results to NNSA. LLNL participated in all Los Alamos National Laboratory (LANL) component Baseline and Final Design reviews in FY 2015 and briefed its IPR results for associated components at the Primary Baseline Design Review to the NNSA Gatekeeper for consideration in the Pre-Production Engineering Gate (PPEG) decision. An IPR report is planned to be provided in FY 2016 following the completion of Phase 6.3 of the LEP. LLNL met all requirements through its execution of product realization in support of LEPs, Alterations (Alts) and Modifications (Mods). LLNL completed W80 Weapons Complex & Integration (WCI) Annual Assessment Review for the W80 on May 6, 2015, supported the W80 INWAP discussion in August, and issued the Cycle 33 surveillance report in September. Additionally, LLNL completed the Computed Tomography of the W80 Surveillance Snowballs that initiated the Potential Significant Finding Notification (PSFN #62067) and found no major anomalies that would result in a performance issue. Analysis simulations of the PSFN were completed showing no impacts to performance. Pantex expected to test-fire the assets before FY 2016 Quarter 1. Subsystem testing continues in support of engineering model validation and testing will be conducted going into FY 2016. LLNL also conducted studies necessary to qualify new production M97, vinyl copolymer elastomer and fluoropolymer materials for use in LEP's. This process provides critical aging information on legacy and potential replacement materials to make informed decisions on long-term material/component behaviors including lifetimes. Additional accomplishments include:

#### **W80-4 PHASE 6.1**

- Matured design concepts;
- Conducted internal planning;
- Developed requirements;
- Supplied inputs to subgroup reports;
- Supported the NNSA federal program manager (FPM) and DoD with extremely limited funding.
- Provided numerous comments and inputs to the draft Technology Readiness Assessment Report (NA-18) with extremely limited funding.
- Provided W80-4 monthly activity updates to the NNSA FPM by the early due date.
- Developed LLNL site cost estimate for nuclear explosive package (NEP) scope.

#### **W80-4 LEP PHASE 6.2**

- Provided design concepts;
- Supplied inputs to subgroup reports; and

- Supported the federal program manager and DoD.

### **GETTING THE JOB DONE LIST - ITEM 1.5**

- Supported W80-4 LEP Program Review, including four presentations and NIF target fab tour;
- Supported Technology Readiness Assessment Review at LLNL;
- Supported CII Tech Mat briefing NNSA/HQ; and
- Supported W80-4 LEP POG WAWG, SIESG and PASG meetings.

### **B61 INTERLABORATORY PEER REVIEW**

- Attended Final Design Reviews (FDR) for Pit; misc. plastics; Stress cushion; and HE
- Attended deep dive at LANL on cushion downselect

LLNL exceeded expectations in executing shots on NIF in support of the Stockpile Stewardship Program in accordance with the NIF Governance Plan while improving the efficiency of NIF operations with a constrained operating budget. LLNL performed 356 shots at NIF, which exceeded the goal of 300 shots. Performing 356 shots was an 86% increase over FY 2014. Achieving the FY 2015 goals demonstrates that it is a credible plan to meet the FY 2016 goal of 400 shots. LLNL conducted a total of 226 Stockpile Stewardship Program (SSP) shots including successfully executing 4 special nuclear material (SNM) shots. NIF demonstrated significant achievements in support of the SSP while at the same time dramatically improving the shot rate capability and meeting obligations for other programs such as Discovery Science, facility readiness, and capability improvements. It executed 155 HED shots supporting burn, code validation, hydrodynamics, materials, and radiation transport. LLNL also demonstrated a new capability of quick-turnaround shots that led to a five-shot campaign being executed in just over 24 hours. LLNL executed the first high-Z experiment on NIF and completed the milestone "Complete High Energy Density (HED) experiments providing data on the behavior of materials in extreme regimes relevant for stockpile primaries" (5086) 3 months ahead of schedule. LLNL also completed other critical milestones including the NIF shock tube experiment (MRT 5140) and the Drawbridge experiment (MRT 5141).

LLNL exceeded expectations in executing stockpile relevant SNM and Integrated Experiments including, for example, material property experiments at the Joint Actinide Shock Physics Research (JASPER) Facility and High Energy Density (HED) facilities, and hydrotests at the Contained Firing Facility (CFF) and at the Dual Axis Radiographic Hydrotest (DARHT) facility, and strengthen the technical foundation for certification of pit reuse options including assessments of pit aging and potential impacts on pit lifetimes. LLNL successfully executed a Pit Reuse Integrated Weapons Experiment at the DARHT facility at LANL with five high-quality radiographs and 100% data return. In support of technology maturation options for the W80-4 LEP, LLNL made substantial progress on the design and fabrication for a hydrotest at the CFF scheduled for early FY 2016 and for the subsequent core punch hydrotest to be conducted at DARHT in the middle of FY 2016. The first hydrotest at CFF involved the design and development of the first full-scale, all optical probe dome using data obtained from a series of four prior focused experiments (FE) to quantify the dynamic behavior of optical pins and probes. LLNL executed an Integrated Weapon Experiment at CFF in June for the Capabilities for Nuclear Intelligence Program. LLNL also executed a very successful series of FE "hubcap" hydrotests at CFF. Furthermore, LLNL completed eight total shots at the JASPER Facility (three surrogate shots and four actinide shots for Defense Programs), which met the goal of firing the last phase of the planned Hugoniot shots at the JASPER Facility, and then executed

a fifth actinide shot for Global Security. LLNL completed and documented the simulation and analysis work for the Level 1 milestone on certification of pit reuse options, supported by an assessment of near- and far-term knowledge gaps in plutonium (Pu) aging. LLNL designed, fabricated, installed and tested the first prototype nano dilatometer to obtain more accurate data on dimensional changes that could occur in aged Pu. LLNL also measured the microstructure and helium bubble morphology of one of the oldest (50 years) naturally aged Pu alloys, demonstrating no dramatic difference in helium distribution compared to the previous transmission electron microscope (TEM) measurement taken at 40 years, and completed the calibration of an overall equation of state (EOS) model, which was specific to Pu aging studies. Of particular note, LLNL successfully executed four special nuclear material (SNM) NIF shots, followed by rapid returns to normal shot operations, thereby fulfilling a key Get-the-Job-Done-List (GTJDL) priority established by NA-10.

LLNL exceeded expectations in investigating the implementation of multiple diverse hydrodynamic schemes within the context of a single full system code, define and pursue a viable computer science framework as the foundation of a next generation integrated design code, and manage the Sierra contracts effectively, execute the acquisition strategy, and meet all schedule milestones under program control while coordinating closely and regularly with Argonne National Laboratory and Oak Ridge National Laboratory. It began implementation of a second, diverse hydro scheme into the one of our multi-physics ASC codes. Initial integration is complete and LLNL successfully ran an Eulerian vortex test problem that exercises pure fluid hydrodynamics and advection with both the native hydro and the newly integrated high order Eulerian hydro. LLNL successfully completed an evaluation of existing benchmarking tools and laid out plans for the design of a Multi-purpose, Application-Centric, Scalable I/O proxy application called MACSio. LLNL briefed its plans to key stakeholders at Sandia and Los Alamos and has agreement to proceed with development. B453 Power Modernization project design is complete, and the 9-month construction contract is being awarded. The construction for advanced development of the Cooling Loop design project will start in FY 2016. LLNL excelled in the management of the Sierra contracts as previously noted. LLNL succeeded in ensuring the non-recurring engineering (NRE) and build contracts were signed-off for the ASC Sierra system, in addition to the Collaboration of Oak Ridge, Argonne and Livermore (CORAL) contract negotiations. This is significant because LLNL had to work through the complexity of synchronizing NNSA's approval process with DOE Office of Science's processes, on an aggressive timeline to meet the S-1 schedule (CSSE subprogram). LLNL met schedule on all Sierra contract activities. LLNL actively participated in various exascale planning workshops and document writing with DOE Office of Science/Advanced Scientific Computing Research (ASCR). Additional accomplishments include:

- Completed the B453 Power Modernization project design, and awarded the 9-month construction contract. Construction for advanced development of Cooling Loop design project is expected to start in FY16.
- Put in place a comprehensive suite of unit tests for testing of the Datastore, which is at the core of the CS Toolkit. A message logging and error handling capability has been implemented into the Datastore and Mesh API.
- Added equation of state callbacks to the modular high-order Eulerian hydro (HOEH) capability that has been integrated into ASC code.
- Maintained schedule on Sierra contract. Receive all long-lead equipment.



- Responded to a DOE Office of Science Request for Information (RFI) on Exascale Applications. LLNL submitted 13 papers.
- Attended Argonne's Collaboration of Oak Ridge, Argonne, and Livermore (CORAL) quarterly meeting for their Aurora system.

## Performance Objective 2: Reduce Global Nuclear Security Threats Mission

### Summary

Reduce Global Nuclear Security Threats Mission was rated as Very Good as LLNL exceeded many of NNSA's expectations in non-proliferation, emergency management, incident response, forensics, and nuclear counterterrorism. LLNL consistently provided high-quality project support on four key Russian nuclear security engagements as well as nuclear security best practices engagement with China and North Africa. LLNL was able to overcome significant barriers on performing work in the Russian Federation in a very short timeframe and was able to recover and repatriate four radioisotope thermoelectric generators (RTGs) from Antarctica to the Russian Federation for disassembly and final disposition. LLNL also made advancements in analyzing and modeling threat materials and completed nuclear threat device "task list" items ahead of schedule.

Accomplishments include:

- Supported four key Russian nuclear security engagements, as well as nuclear security best practices engagement with China, the International Atomic Energy Agency (IAEA), and North Africa.
- Provided high quality project support to the Global Material Security (GMS) International Nuclear Security Program.
- Responded to tasks, budget reporting, travel and project logistics, and contracts management in a timely and of high quality manner.
- Exceeded many program and technical requirements in advancing US capabilities for monitoring foreign nuclear weapons development activities.
- Performed high quality analysis of sources for the Uranium data base project and performed an excellent job preparing for and delivering verification training to International Atomic Energy Agency (IAEA) inspectors.
- Provided high quality technical support to nuclear safeguards engagement activities in North Africa, South America (ABACC), and Southeast Asia.
- Provided excellent technical support for cooperation with Japan including activities to address safeguards challenges at Fukushima, and with Republic of Korea on the Joint Fuel Cycle Study (JFCS).
- Contributed to several safeguards technology tasks including spent fuel non-destructive assay and unattended gamma emission tomography for spent fuel, and a subject matter expert (SME) from LLNL with specialized expertise contributed to high-level ongoing nuclear negotiations.
- Provided very good support through the conduct of export control technical reviews, and completed thousands of end-user reviews for DOCS export-license applications, as well as DOE Part 810 cases and nuclear software codes.
- Provided excellent SME support for engagements designed to build partner country capacity in the detection and prevention of illicit trafficking in strategic commodities.
- Contributed to key projects including the joint U.S.-UK Portal Monitor for Arms Control project, and the Chain of Custody Equipment Mapping project.
- Supported follow-on activities from the Comprehensive Nuclear-Test Ban Treaty (CTBT) large-scale on-site inspection (OSI) Integrated Field Exercise 2014 (IFE14).

- Provided experts as part of U.S. delegation to 45th session of CTBT Working Group B and P5 CTBT Experts meeting.
- Continued to maintain and operate the Organization for the Prohibition of Chemical Weapons certified laboratory.
- Collaborated and participated at disablement-related meetings and events, including the Render Safe Working Group and Standoff Disablement planning meetings
- Participated in TTMA-V Campaign 1 completion efforts, in support of the ongoing effort to predictively model disablement actions.
- Managed the assessment of open source nuclear threat device information, including a final draft report on the state of disclosure.
- Participated in Block 8 and related curriculum development meetings. Block 8 is a render safe training course for emergency responders.

LLNL met expectations in supporting efforts to remove, eliminate and minimize the use of proliferation-sensitive materials. LLNL provided key support to the challenging objective to remove and minimize sensitive materials in West Africa. Travel to West Africa was allowed in the latter part of the fiscal year, which allowed LLNL to engage some countries such as Gabon and Mauritius; however, the ongoing instability in the area have hampered the progress to provide training and security infrastructure improvements.

LLNL exceeded expectations in safeguarding and securing materials, technologies, and facilities. Despite continuing tensions with the Russian Federation, LLNL continued to support existing projects with the Russian Federation. LLNL provided leadership, expertise and activities in engaging and supporting other countries. LLNL consistently provided high-quality project support on four key Russian nuclear security engagements, as well as nuclear security best practices engagement with China and North Africa. The Global Material Security (GMS) International Nuclear Security Program receives consistently high-quality project support from LLNL. Responses to tasks, budget reporting, travel and project logistics, and contracts management have all been timely and of high quality. LLNL continued to provide high quality work for all nuclear nonproliferation verification (NNV) projects and has exceeded many expectations in many of the projects. It continued to perform high quality analysis of sources for the Uranium data base project and performed an excellent job preparing for and delivering verification training to IAEA inspectors. LLNL provided high quality technical support to nuclear safeguards engagement activities in North Africa, South America (ABACC) and Southeast Asia, where LLNL's steadfast interaction with Thailand helped maintain open channels of communication after a loss of traditional contacts, eventually helping to relaunch safeguards engagement efforts in Thailand. LLNL also provided excellent technical support for cooperation with Japan including activities to address safeguard challenges at and with Republic of Korea on the JFCS. LLNL SMEs also contributed to several safeguards technology tasks including spent fuel non-destructive assay and unattended gamma emission tomography for spent fuel, and an SME from LLNL with specialized expertise contributed to high-level ongoing nuclear negotiations. LLNL conducted an analysis and characterization of very high purity Pu-244 samples that were recently retrieved from Russia and is preparing to fabricate this into Pu-244 certified reference materials. In addition, LLNL provided very good support for multiple safeguards policy, concepts and approaches, and human capital development projects ranging from studies on Acquisition Pathway Analysis to facilitating a highly rated safeguards short course.

LLNL exceeded expectations in supporting efforts to detect and prevent the illicit trafficking of nuclear/radiological materials, technology, information and expertise. It provided and contributed to the advancement of technologies (nuclear weapon development and testing detection, active and passive sensing), processes (export control support) and expertise (training support) for meeting national nuclear nonproliferation goals. LLNL provided very good support through the conduct of export control technical reviews and completed thousands of end-user reviews for DOCS export license applications, as well as DOE Part 810 cases and nuclear software codes. The technical quality of the reviews continued to be excellent. LLNL worked to improve the timelines of reviews, increased efforts at sharing the reviews with Commerce's Information Triage Unit (ITU), and continued implementing a "tiering" of reviews to readily indicate proliferation risk. LLNL also provided excellent analyses in support of Weapons of Mass Destruction (WMD) interdiction activities to include resurrecting a proven and developed software system to fill a gap necessitated by shut-down of another system. LLNL provided excellent subject matter expertise for three events: a Taiwan Commodity Identification Training (CIT) Instructor Refresher and Exchange in Taipei, Taiwan, a CIT Instructor Training workshop in Qinhuangdao, China, and training for the UNSCR 1540 Points of Contact in the Asia and Pacific Region in Qingdao, China. LLNL provided robust technical analysis of foreign nuclear security concerns and routinely provided critical insights into challenging intelligence problem sets. LLNL made significant contributions to the presidentially directed Nuclear Materials Information Program (NMIP)--an interagency program managed by DOE's Office of Intelligence and Counterintelligence. Specifically, LLNL analysts provided input to numerous NMIP products used to support policymaker preparations for the 2016 Nuclear Security Summit. LLNL analysts also contributed to the NMIP-led US National Nuclear Forensics Library, which is a critical component of the US nuclear forensics and attribution program supporting law enforcement and intelligence efforts related to nuclear smuggling and related incidents. LLNL scientists analyzed key nuclear material samples of interest to NMIP to mitigate knowledge gaps in the US National Nuclear Forensics Library. LLNL scientists participated in a statistical study of forensics data and a reactor modeling study of worldwide plutonium production reactors.

LLNL exceeded expectations in providing R&D technology solutions for treaty monitoring. LLNL supported the successful execution of Source Physics Experiment (SPE) 4 and the planning for the successive experiments. LLNL continued to support the Comprehensive Test Ban Treaty Organizations through participations in training, conferences, and tests; for example, a LLNL Staff participated in the Airborne Techniques Field Test held outside Vienna on September, which was conducted with the Austrian military to simulate a Comprehensive Nuclear Test Ban Treaty on-site inspection: the suite of techniques used included ground and air-based measurements to test and refine visual observation, multispectral and infrared, and radiation monitoring techniques. LLNL provided excellent management response to execution issues in the End-to-End Demonstration Campaign and many impactful peer-reviewed publications and technical support, especially in ground-based detection. LLNL's performance for the Warhead and Fissile Material Transparency (WFMT) Program has been very good, providing important contributions to key projects funded by the office, including the joint U.S.-UK Portal Monitor for Arms Control project and the Chain of Custody Equipment Mapping project. The on-site support LLNL has provided is exemplary, including advancing Office of Nuclear Verification (NA-243) priorities.

LLNL met expectations in providing unique solutions and develop strategies to reduce nuclear dangers. LLNL continued to provide support and solutions to reduce nuclear danger by participating in significant activities: LLNL hosted DOE's Material Protection, Accountability and

Control Technologies (MPACT) campaign annual meeting on September 15th-17th; this campaign involves research to assure and improve the security of the nation's domestic nuclear material, from monitoring of potential reprocessing strategies to consequence assessments for breached spent fuel storage casks.

LLNL met expectations in supporting emergency operations, incident response and nuclear forensics mission. Overall, LLNL continues to improve many processes (communication, support, and training) and systems (servers, software) required for emergency response. While LLNL managed the Radiological Assistance Program (RAP) Team and identified some gaps in readiness, they did not provide sufficient attention to program management to ensure that readiness, budget and proficiency were maintained. LLNL needs to strengthen RAP 7 conduct of operations. RAP 7 supported the Papal visit to the U.S. and several training and outreach opportunities with the 9th CST, 95th CST, Sacramento FBI, Riverside Police Department (PD)/Fire Department (FD), State of Nevada and Los Angeles Sheriff Department (LASD)/Los Angeles (LA) FBI. Additional training has been given to Santa Clara County, City and other South Bay locals in support of the upcoming Superbowl 50. Positive feedback was received from our customers on all activities with the exception of the Rose Bowl. National Atmospheric Release Advisory Center (NARAC) continues to support operations and exercises and delivered products as expected. LLNL personnel participated in the consequence management exercise Southern Exposure 15. Render Safe personnel supported the Papal visit in three cities. Render Safe Stabilization participated in an aggressive training program with the FBI in designated cities.

LLNL provided exemplary support for nuclear forensics capabilities by participating in numerous activities including hosting the 2015 U.S. and U.K. Technical Nuclear Forensics Exchange Meeting in September at LLNL; the meeting included topics that range from a review of the Defense Threat Reduction Agency's (DTRA) Materials Identification and Debris Analysis Solutions (MIDAS) Nuclear Forensics projects to deep technical dive of the recently concluded DTRA-led MIGHTY SABER technical demonstration.

LLNL exceeded expectations in sustaining and improving nuclear counterterrorism and counter-proliferation science, technology, and expertise. LLNL continued to support nuclear counterterrorism and counter-proliferation science, technology, and expertise by participating in the first training session for the Uranium Verification Team (UVT) in September. The UTV is a multi-laboratory group that has been newly created by DOE's Nuclear Noncompliance Verification Program within NA-243 to maintain expertise to verifiably dismantle uranium fuel cycle facilities in countries of concern; the week-long training focused on process technology and hardware as well as measurement and verification methods. LLNL demonstrated excellent performance by proactively contributing to the tri-lab Nuclear Counterterrorism (NCT) High Explosives and Nuclear Materials roadmaps, which are being used to guide national programs and support specific NSC-directed projects. International support of, and material contribution to the NA-80 mission was well coordinated and executed, with active participation in multiple international meetings. Additionally, LLNL demonstrated strong collaboration and cooperation during disablement-related meetings in support of render safe research and development, including the Render Safe Working Group and Standoff Disablement planning meetings as well as strong participation in Block 8 and related curriculum development meetings.

LLNL exceeded expectations in working collaboratively with appropriate stakeholders to recover Radioisotope Thermoelectric Generators (RTGs). LLNL provided excellent support for recovering and repatriating four radioisotope thermoelectric generators (RTGs) from Antarctica to the Russian Federation for disassembly and final disposition despite ongoing work restrictions with the Russian Federation, which are beyond LLNL's control. LLNL consistently provided high-quality SME, contracts and financial management, and project support for NNSA's efforts to recover and eliminate radioisotope thermoelectric generators (RTGs) in the Russian Federation. The LLNL SMEs assigned to these projects, and the contracts and financial management personnel have consistently provided a high level of support. The GMS Radiological Security Program receives excellent project support from LLNL. Responses to tasks, budget reporting, travel and project logistics, and contracts management have all been timely and of high quality. LLNL has managed to make significant progress in their assigned areas despite the challenges of unstable regional governments and limitations enforced by the Ebola outbreak.

LLNL exceeded expectations in executing nuclear threat device "task list" and materials work and supporting selected standoff disablement experimental and modeling efforts. LLNL contributed and made significant accomplishments in efforts to execute the nuclear threat device "task list" and material works. LLNL made some advancements in analyzing and modeling threat materials. LLNL supported the standoff disablement experimental and modeling efforts including the development of methodologies to analyze and present technical information to the decision makers. LLNL continued to support the use of Open Source information along with collaboration efforts with our foreign partners. LLNL demonstrated an excellent level of performance and response ahead of schedule for all expected research on NCT's "task list" items, with completion of the assessment of specific nuclear threat devices. Additionally, LLNL made excellent progress in preparing test-plans, security plans, safety basis, and experimental design for proposed nuclear threat device tests in FY 2016. LLNL demonstrated strong leadership in the development of a standoff disablement experimental program by integrating laboratory expertise to develop a statistical framework for the predictive capability. Excellent participation in the TTMA-V effort, assisting in completion of the first Campaign and final report. Support for the NCT mission was also demonstrated by expedient response to multiple HQ requests for information assessment.

LLNL met expectations in fully supporting emergency operations. LLNL continues to improve the processes (communication support, training) and systems (servers, software) to support emergency operations. LLNL continued to maintain and improve the Radiological Assistance Program (RAP) Team by identifying gaps in readiness. NARAC continues to support operations and exercises and delivering products as expected. RAP 7 supported the Papal visit to the U. S. and several training and outreach opportunities with the 9th CST, 95th CST, Sacramento FBI, Riverside PD/FD, State of Nevada and LASD/LA FBI. Additional training has been given to Santa Clara County, City and other South Bay locals in support of the upcoming Superbowl 50. RAP 7 must provide more attention to program management in order to ensure that readiness, budget and proficiency is maintained. Positive feedback received on all activities with the exception of the Rose Bowl. LLNL needs to strengthen RAP 7 conduct of operations. CMRT participated as the main player in Exercise Southern Exposure 15. STAB continued an aggressive training program with the FBI in designated cities. Render Safe supported the Papal visit in three cities.

## Performance Objective 3: DOE and Strategic Partnership Project Mission Objectives

### Summary

DOE and Strategic Partnership Project Mission Objectives were rated as Excellent as LLNL exceeded nearly all NNSA expectations, pursuing and executing high-impact work for DOE and Strategic Partnership Project (SPP) mission objectives. LLNL earned numerous prestigious awards from US Government sponsors, including the Department, demonstrating the quality of this work and its strategic value. LLNL pursued and successfully executed numerous high impact projects for both the Department and other sponsors that strategically align with NNSA mission objectives. An example of such work performed under SPP program is research sponsored by DHS for the evaluation and testing of first responder preventative/nuclear detection (PRND) equipment to provide state and local agencies with guidance on how to best use radiological search and interdiction systems and equipment for consequence management and response after a radiological/nuclear release or detonation. Accomplishments include:

- Achieved numerous scientific and technical results, including
  - Reported a detailed structure for lipid-coated nanowires by x-ray microscopy.
  - Developed a new type of core-shell microcapsule containing sodium carbonate solution to capture CO<sub>2</sub>.
- Performed SPP work, including
  - Found that x-ray emissions taken with the Nuclear Spectroscopic Telescope Array (NuSTAR) show that a supernova explosion was highly asymmetric.
  - Developed large-scale, solid-state organic scintillators for fission neutron detection in support of a project sponsored by the Department of Homeland Security.
  - Upgraded the Ground Penetrating Synthetic Aperture Radar (GP-SAR) system of the Medium Tactical Vehicle for the Office of Naval Research.
  - Met an important Persistence milestone for work supporting the Air Force.
  - Created a method to determine source characteristics of near-earth-surface.
  - Visited the Fukushima evacuation zones to conduct a study on wide-area detection and radiation cleanup.
- Awarded the "Order of Nucleus" from the U.S. Air Force for their efforts in educating and mentoring Air Force personnel.
- Received an Award for Excellence from the Under Secretary of Defense for Acquisition, Technology, and Logistics for exceptional support in Strategic Portfolio Review (SPR) for Strategic Forces.
- Received the U.S. Air Force Award for Meritorious Civilian Service in recognition of work as the Air Force Under Secretary's principal adviser for nuclear matters.
- Received the 1906 Award from the International Electrotechnical Commission (IEC) in recognition for his efforts in international standards for nuclear instrumentation.
- Received approval of Critical Decision 3 for the Large Synoptic Survey Telescope (LSST) Camera.
- Received 13 awards from the DOE Office of Science Early Career Research Program. LLNL ranks 3rd among the 17 DOE national laboratories, and first among NNSA labs.
- Awarded one of six projects to receive funding for reducing the modeled price of algae-based biofuels to less than \$5 per gasoline gallon equivalent by 2019.

LLNL exceeded expectations in pursuing and performing high impact work that strategically integrates with the DOE/NNSA Mission, making significant accomplishments and developing unique solutions. Accomplishments include:

- Energy Secretary Ernest Moniz awarded seven LLNL scientists the DOE Secretarial Honor Award for their participation in the Office of Intelligence and Counterintelligence Analytic Team.
- Energy Secretary Ernest Moniz awarded an LLNL climate scientist the DOE Secretarial Honor Award for his leadership of the Accelerated Climate Modeling for Energy (ACME) project. The Secretarial Honor Awards are the Department of Energy's highest form of non-monetary employee recognition and are bestowed on a group or team of employees who accomplished significant achievements on behalf of the Department.
- DOE Energy Vehicles Technology Office awarded a scientist their Distinguished Achievement Award for accomplishments in truck aerodynamics research.
- Using energetic lasers, Lawrence Livermore researchers produced a record high number of electron-positron pairs. This opens several new areas of antimatter research.
- The LLNL/University of Washington team was awarded a new fusion project from the Advanced Research Projects Agency–Energy (ARPA-E). This award was based on LLNL science accomplishments with developing technologies to explore new pathways to fusion power and the University of Washington's Z-pinch reactor work.
- A team of scientists including, Lawrence Livermore researchers, found that x-ray emissions taken with the Nuclear Spectroscopic Telescope Array (NuSTAR) show that a supernova explosion was highly asymmetric, which confirmed heavy elements move at speeds several times higher than previous models. The results appear in the May 8, 2015, edition of the journal, Science.
- Completed manufacture of a subsystem for the Large Synoptic Survey Telescope in the on-site Optics Assembly Building for NIF. The core competency in optics allowed LLNL to deliver the camera optics.
- LLNL cover article on Nanoscale describes scanning transmission electron microscope probe of bilayer nanowires for medical use. This may produce a new class of materials for bioelectronic devices. Another cover article in Chromatography Techniques showed the new Atomic Mass Spectroscopy (AMS) work centered in LLNL's new AMS for medical research on cancer response in chemotherapy. This is unique equipment funded by the National Institutes of Health (NIH) because of LLNL success and Center for Atomic Mass Spectroscopy.
- LLNL together with an international team reported first of a kind measurements in fast ignition target experiments at Omega Laser funded by Office of Science Fusion Energy Sciences.
- LLNL scientists developed a new core shell microcapsule containing sodium carbonate to capture CO<sub>2</sub> in energy and industrial plants.

LLNL met expectations in pursuing and performing high-impact strategic partnership projects that strategically integrate with the DOE/NNSA mission. Examples of work performed in the Strategic Partnerships Projects program include research sponsored by DHS for the evaluation and testing of first responder preventative/nuclear detection (PRND) equipment to provide state and local agencies with guidance on how to best use radiological search and interdiction systems and equipment for consequence management and response after a radiological/nuclear release or detonation. Work sponsored by Navajo Transitional Energy Company to perform assessments of the Navajo Nation's energy portfolio include Tribal energy supply and consumption, CO<sub>2</sub> emissions from energy consumption, and water consumption. Two LLNL researchers named senior members



by the Optical Society of America an international society for optics and photonics. LLNL climate scientists met with California Governor Edmund G. (Jerry) Brown to discuss the purported post-1998 “warming hiatus”—in which the rate of globally-averaged surface temperature increase was purported to have slowed. The Museum of Science and Industry named a LLNL physicist the 2015 Early Career National Hispanic Scientist of the Year in recognition of his work on the electronic structure of materials using density-functional theory and quantum Monte Carlo methods. LLNL hosted spectroscopy workshops in support of high energy density science, work in this area is crucial to advancing LLNL/NNSA missions in areas such as stockpile stewardship, inertial confinement fusion, and the physics of Earth and planetary systems.

LLNL exceeded expectations in accomplishing work within the budget profile, scope, cost, schedule, quality and risk negotiated with the program. According to LLNL records, there is less than 1% of all active projects that reported a major issue on scope, schedule and budget over a two-month average. These statistics encompass over 400 projects with total costs of approximately \$280M for the ten months of FY 2015. Office of Science conducted a retrospective review of Early Career Research Program impacts and acknowledged the significant impact on improvements to LLNL scientific productivity.

## Performance Objective 4: Science, Technology, and Engineering (ST&E)

### Summary

Science, Technology, and Engineering (ST&E) was rated as Excellent as LLNL exceeded nearly all expectations to advance national security missions and advance the frontiers of ST&E in accordance with budget profile, scope, cost, schedule and risk while achieving the expected level of quality, safety and security. LLNL research consistently remains transformative, innovative, and of high quality as recognized by the ST&E community and validated through various internal and external reviews. LLNL researchers broke records for the number of awards received and their publication rate continues to climb along with their patents and records of invention. The DOE Secretarial Honor Award was presented to an LLNL team for participation in an Office of Intelligence and Counterintelligence Analytic Team that significantly contributed to understanding of a growing foreign nuclear threat. An example of such research includes innovative experiments on NIF that obtained crystal structures for high-atomic-number elements under conditions never before experimentally accessed for these highly program-relevant materials. LLNL also continued to provide leadership in additive manufacturing, developing processes that were implemented by the Kansas City Plant and Y12 that support the cost-effective modernization of a safe, secure, and effective stockpile. LDRD results included creating novel energy absorbing materials for sensitive components to combat the effects of temperature fluctuations and vibration, which can be used in helmets. Below are examples of LLNL effectively managing Laboratory Directed Research and Development (LDRD) and Technology Transfer programs to advance the frontiers of ST&E:

- Performed innovative experiments on NIF that obtained crystal structures for high-atomic-number elements under conditions never before experimentally accessed for these highly program-relevant materials.
- Provided new insight into the room-temperature performance of semiconductor thallium bromide (TlBr) radiation detectors.
- Developed an “uncrackable” code for nuclear weapons that uses the weapon’s fluctuating radiation fields to create a specific control number that can be used to protect the weapon and its components from unauthorized use.
- Achievements in advanced manufacturing with numerous applications to the nuclear stockpile.
- Elected (10 LLNL staff members) as American Physical Society (APS) fellows, which is a LLNL record for a single year.
- Received the 2015 Edouard Fabre Prize for pioneering research into energy transfer between crossing laser beams in National Ignition Facility (NIF) hohlraums.
- Received the DOE Secretarial Honor Award for his leadership of the Accelerated Climate Modeling for Energy project.
- Received an early career award from the Office of Science to join 12 previous award-winners.
- Awarded the 2015 Surety Transformation Initiative (STI) Award from NNSA’s Enhanced Surety Program.
- Received an International Electrotechnical Commission (IEC) 1906 Award in recognition for efforts in international standards for nuclear instrumentation.

- Received the DOE Secretarial Honor Award (7 LLNL scientists) for their participation in the Office of Intelligence and Counterintelligence Analytic Team, providing contributions to a technically challenging and high-priority Intelligence Community Assessment.
- Received DOE Distinguished Achievement award for work in drag reduction of heavy vehicles that resulted in major energy savings in transportation fleets.
- Received certificates of appreciation (3 LLNL staff members) from the Office of Defense Nuclear Nonproliferation for their R&D work.
- Received 10 NNSA Defense Program Awards of Excellence.
- Increased publication rates of LLNL researchers.
- Increased patents and records of invention stemming from research and development (R&D) activities.
- Expanded collaborations with industry and academia through the use of the Livermore Valley Open Campus (LVOC).

LLNL exceeded expectations in implementing a research strategy that is clear and aligns discretionary investments (e.g., LDRD) with the research strategy, and supports DOE/NNSA priorities. LLNL continues to align LDRD activities to its Science, Technology and Engineering (ST&E) Investment Strategy. The LLNL Investment Strategy ensures projects support their core competencies and mission areas. It is updated annually with the advice of an external advisory committee. The goals are to strengthen LLNL's ST&E base (infrastructure, capabilities, and people) and to ensure that LLNL remains capable of meeting the nation's needs. In Quarter 2, LLNL showed the Congressional Commission studying DOE national labs the processes to ensure projects are aligned with LLNL and DOE/NNSA priorities. On May 27-28 NA-114 conducted a programmatic review of the LLNL program. This review showed several best practices including the extensive involvement of postdocs in LDRD as well as early integration into the DOE/NNSA programmatic work. This review included a sample of 9 LDRD projects for which the Principal Investigators (PIs) briefed how the research was aligned with the LLNL and DOE/NNSA Strategic Plans. The Laboratory submitted the FY 2016 LDRD Program Plan on schedule, 45 days before the start of FY 2016. LLNL conducted technical and programmatic reviews of all LDRD projects to ensure projects have potential to produce high quality science and are aligned with LLNL research strategy and are relevant to DOE/NNSA missions.

LLNL exceeded expectations in ensuring that research is relevant, enables the national security missions, and benefits DOE/NNSA and the nation. One way this was demonstrated is through the documented results of the External Review Committee reviews. FY 2015 reviews included a Computation Directorate review of high-performance computing; a Global Security Principal Directorate and Physical and Life Sciences Directorate review focusing on LLNL's Energy and Climate programs as well as the underlying science and technology in these programs; an Engineering Directorate review of R&D; and a WCI Principal Directorate review of LLNL support for the NNSA nuclear weapons program and the ST&E underpinnings of LLNL work in this core mission. These Directorate reviews demonstrated that the work LLNL is performing remains vital to addressing the compelling core missions in national security for ensuring the safety, security, and reliability of the U.S. nuclear weapons stockpile without nuclear testing, as well as providing the nation with a critical advantage in meeting other national security challenges of the 21st century. Examples of cutting edge research relevant to the national security mission include:

- Performed innovative experiments on NIF that obtained crystal structures for high-atomic-number elements under conditions never before experimentally accessed for these highly program-relevant materials.
- Provided new insight into the room-temperature performance of semiconductor thallium bromide (TlBr) radiation detectors.
- Developed an “uncrackable” code for nuclear weapons that uses the weapon’s fluctuating radiation fields to create a specific control number that can be used to protect the weapon and its components from unauthorized use.
- Achievements in advanced manufacturing with numerous applications to the nuclear stockpile.

Recognition of performance by DOE and NNSA demonstrates that LLNL research enables the national security missions and benefits DOE/NNSA and the nation. The DOE Secretarial Honor Award was presented to an LLNL team for participation in an Office of Intelligence and Counterintelligence Analytic Team significantly contributing to understanding of a growing foreign nuclear threat. Three LLNL staff members received certificates of appreciation from the Office of Defense Nuclear Nonproliferation for their R&D work. Ten NNSA Defense Program Awards of Excellence received in FY 2015 provide clear evidence of high quality in innovation. LDRD created novel energy absorbing materials for use in helmets, protective materials for sensitive components to combat the effects of temperature fluctuations and vibration. Another example is first compliant 3D cushion component created by processes developed by LDRD is a new manufacturing process for cost-effective modernization of a safe, secure, and effective stockpile. This technology was transferred to Kansas City Plant and Y12. An example in the Journal of Radiation Nuclear Chemistry, Oct 2014, involves an LDRD fallout melt glass formation from a near surface nuclear test. It indicated that vaporized, residual fuel was incorporated into the melts prior to solidification and glassy fallout materials may be of high value for nuclear forensics. An example of how LDRD has supported a broad array of efforts to defeat biological threats is the “Microbial Detection Array” which has potential use as an Ebola rapid diagnostic (24 hrs.). It detected bacterial pathogens in soldiers’ wounds missed by other technologies. LLNL reported on work that was based on 2012 LDRD project investigating equation of state of polymers under extreme conditions with quantum accuracy. The research was applied to simulations of exotic high-pressure phases of carbon, and yielded results with a small fraction of computational effort of standard quantum simulation approaches. The work is being continued by DOE and DoD Joint Munitions Tech Development Program, and LLNL received programmatic funding to study polymers related to additive manufacturing. LLNL provided input of several exemplary project examples for the Briefing to Congress including the X-ray technology developed for nuclear weapon pit inspection and became dual-use for treatment of cancer. The LLNL LDRD Program Plan for FY 2016 included a highlight on an LDRD project entitled, “Predicting Weapon Headspace Gas Atmosphere for Modeling,” which was performed to more closely examine the fundamental chemical transformations that contribute to component aging. LDRD researchers developed a reactive transport model for assessing the compatibility and chemical kinetics of materials inside nuclear weapons systems.

LLNL exceeded expectations in ensuring that research is transformative, innovative, leading edge, high quality, and advances the frontiers of science and engineering. The publication rates of LLNL researchers continue to climb; additionally, increased patents and records of invention stemming from research and development (R&D) activities document the level of state-of-the-art achievements in multiple fields of scientific and engineering work. External awards, prizes, and

recognition for ST&E accomplishments provide external validation of activities that advanced the frontiers of science and engineering. Examples of LLNL achievements that demonstrate the transformative work advancing the frontiers of science and engineering are as follows:

- In an article appearing in *Nature Geoscience*, LLNL researchers answered a longstanding question about why Mercury's surface is darker than the Moon's, implicating carbon as the "stealth" darkening agent.
- New experiments determined for the first time, the behavior of high strength materials under extremely high pressure impacts such as hypervelocity impacts of meteors that demonstrate changes in theoretical behavior under standard models.
- Using energetic lasers, LLNL researchers produced a record high number of electron-positron pairs, opening exciting opportunities to study extreme astrophysical phenomena such as black-hole formation and gamma-ray bursts.
- LLNL researchers reported advancements in graphene-based supercapacitors, which may open the door to more efficient electrochemical energy storage systems.
- LLNL researchers, working with UC Davis, discovered that covering an implantable neural electrode with nanoporous gold could eliminate the risk of scar tissue forming over the electrode's surface.
- Experiments at the LLNL Jupiter Laser facility revealed for the first time a new electron ring formation produced by the interaction of high intensity lasers with gas.
- New laser driven shock compression experiments provided thermodynamic and electrical conductivity data for silica providing information on properties of rocks inside large planetary bodies.

An article by LLNL researchers, "Taming Plasma—Material Interface with Snowflake Divertor" appeared on a shortlist of 11 papers nominated for the 2014 Nuclear Fusion Award, which is presented by the journal *Nuclear Fusion*. This work was started as an LDRD in 2008 to explore innovative divertors for future fusion devices, a possible solution for plasma-material interface problems in magnetically confined fusion plasma devices. NA-114 reviewed 9 projects at the on-site programmatic review in May 27-28, 2015 which showed that the LDRD research is advancing the frontiers of ST&E. The new materials discovered at LLNL have advanced and improved the manufacturing of NW and the work on computation advancement in Countermeasures for emerging Bio-Threats is at the forefront of science and technology. NA-114 staff members wrote a review report on this project, "Deterministic Multifunctional Materials and Manufacturing Initiative." The report explained how this project is advancing the frontiers of science and engineering by using Additive Manufacturing to create new mixed-material components desired by the Nuclear Security Enterprise. This project will provide needed solutions for qualification and certification of components in the stockpile stewardship arena because of the speed, flexibility, and cost improvements being made to materials.

LLNL exceeded expectations in maintaining a healthy and vibrant research environment that enhances technical workforce competencies and research capabilities. LLNL maintains a vigorous postdoc program of scientists and engineers selected from among the nation's most prestigious universities. This program continues to serve as an extremely important element of the Laboratory's ST&E pipeline; in FY 2015, 65% of the postdocs were converted to staff positions at the conclusion of their postdoc positions. Additionally, LLNL successfully engages in developing the

pipeline for the future ST&E workforce through student internships and other programs, such as the "Cyber Defenders," "Data Heroes," and Institute for Scientific Computing Research. External awards and selections continue to demonstrate the technical workforce competencies. Ten LLNL staff members were elected as American Physical Society (APS) fellows, which is a LLNL record for a single year. A physicist was awarded the 2015 Edouard Fabre Prize for pioneering research into energy transfer between crossing laser beams in National Ignition Facility (NIF) hohlraums. A climate researcher received the DOE Secretarial Honor Award for his leadership of the Accelerated Climate Modeling for Energy project. Another researcher received an early career award from the Office of Science to join 12 previous award-winners. A LLNL scientist/engineer was awarded the 2015 Surety Transformation Initiative (STI) Award from NNSA's Enhanced Surety Program. An LLNL scientist was presented with an International Electrotechnical Commission (IEC) 1906 Award in recognition for his efforts in international standards for nuclear instrumentation. Seven LLNL scientists received the DOE Secretarial Honor Award for their participation in the Office of Intelligence and Counterintelligence Analytic Team, providing contributions to a technically challenging and high-priority Intelligence Community Assessment, the results of which will have a direct impact on DOE and NNSA policy and budgetary decisions. DOE awarded a scientist a Distinguished Achievement award for work in drag reduction of heavy vehicles that resulted in major energy savings in transportation fleets. LLNL scientists remain at the forefront of technical societies and research. LLNL researchers demonstrated a strong record of publication in high-profile peer-reviewed journals and conference proceedings. A number of FY 2015 publications and news agencies (including the American Physical Society, BBC News, Scientific American, and Physics World), recognized LLNL research results among their "top 10" breakthroughs or achievements of the year. These results included NIF ignition experiments, confirmation of the discovery of a new element (Element 117, Uus) by LLNL scientists and their international collaborators, and search for dark matter in the "Axion Dark Matter experiment" (ADMX-Gen2). These publications demonstrate the vibrant research environment that exists at LLNL. LDRD has helped prepare young principal investigators (PIs) to compete for external funding in their research field. For example Miguel Morales-Silva, a Presidential Early Career Award for Scientists and Engineers recipient, performed LDRD in first-principles descriptions of materials at high pressure and temperature using density functional theory and quantum Monte Carlo techniques. Steven Myers, seismologist, conducted work in national security and non-proliferation. LLNL LDRD is critical for workforce development from students and postdoc support to retention of the best and brightest. More than half of all technical staff members start at LLNL as postdocs; and over 50% of postdocs are supported by LDRD. External recognition of technical staff is mostly based on work performed on LDRD projects. About 50% of the lab's patents and R&D awards are attributed to LDRD investments. LLNL is successfully integrating the best and brightest postdocs and fellows into the DOE/NNSA programmatic work (NA-114, Institutional R&D Programs). The FY 2016 LDRD Program Plan stated that of the ten Laboratory researchers named as 2014 fellows of the American Physical Society, nine have served as investigators for LDRD projects.

LLNL met expectations in performing research to accomplish the high priority objectives and technology transfer advance ST&E, and develop technologies for the public good through technology transfer. In FY 2015, LLNL signed a high number of new Cooperative Research and Development Agreements (CRADAs) while also expanding entrepreneurship development activities, initiatives, and garnering awards. Some notable CRADAs include the large CES-21 CRADA with California utilities for cybersecurity and grid integration, as well as open source HPC software development with Intel. Additive manufacturing has been another area of high activity; General

Electric Research collaborated with LLNL to develop new techniques for metal additive manufacturing, while Autodesk leveraged LLNL's additive manufacturing design techniques for next-generation helmets. The Agreements for Commercializing Technology (ACT) project with the Czech Republic reached a major project milestone with the completion of key subsystems in the HAPLS diode pump laser system. Building on this success, LLNL was selected to help develop another beamline at the same European Union laser facility under a subcontract. LLNL participated in a number of partnerships to develop entrepreneurship skills among laboratory staff and transfer technology to small businesses, including the National Labs Entrepreneurship Academy (NLEA), the DOE Lab-Corps program in conjunction with the i-GATE Innovation Hub, and the LabSTAR partnership sponsored by the Energy Efficiency and Renewable Energy (EERE). LLNL also joined the CalCharge consortium for energy storage R&D along with Berkeley Lab and Stanford Linear Accelerator Center (SLAC). The HPC4 Manufacturing program sponsored by EERE is also taking shape and beginning to submit proposals. LLNL garnered an exceptional six nominations to the final round for the 2015 R&D 100 award cycle for all six submitted projects. The Federal Laboratory Consortium also awarded LLNL with an Interagency Partnership award. Annemarie Meike, a Business Development Executive at LLNL, was named one of 500 top IP Strategists in the world by a prestigious IP trade journal.

LLNL exceeded expectations in demonstrating that institutional investments are being used effectively, pursuing and performing high impact work with innovative R&D results. LLNL performed work for DOE/NNSA sponsors as well as other federal agencies that leveraged existing capabilities and supported future national security missions by enhancing ST&E competencies at LLNL. Noteworthy accomplishments include:

- LDRD researchers at LLNL have developed a reactive transport model for assessing the compatibility and chemical kinetics of materials inside nuclear weapons systems. This model has been developed based on absorption, adsorption, and pooling in a sealed environment and has better prediction of the long-time behavior of weapons materials. This model also has additional applications for munitions technology, shale-gas production, and countering chemical warfare agents.
- LDRD researchers at LLNL published a paper in an online edition of Nature Communications that reported on the fabrication of engineered graphene aerogel micro lattices using three-dimensional direct ink writing. These aerogel are lightweight, extremely compressible, and highly conductive with possible applications from energy storage to chemical separations to stockpile stewardship.
- LDRD researchers at LLNL developed Lawrence Livermore Microbial Detection Array (LLMDA) that could help detect diseases for the commercial pork industry. LLMDA can detect about 8,100 microorganisms cheaper and faster than DNA sequencing. LLMDA has applications for animal husbandry in treating complex syndromes caused by multiple pathogens. LLMDA can be used for early detection of disease outbreaks which is crucial to the effective surveillance of emerging infectious diseases to safeguard both animal and human health.

The Livermore Valley Open Campus (LVOC) continued to create an effective venue for expanding Laboratory collaborations with industry and academia. To date, this campus-like environment has hosted more than 25,000 visitors and held more than 3,000 events. LLNL demonstrated that institutional investments are being effectively used to assure the successful execution of LLNL's strategic ST&E plan. LLNL's strategic investment plan is aligned with the national security mission

and FY 2015 LDRD investments continued to provide results that support existing capabilities as well as build new ones. LDRD continued to strengthen DOE/NNSA's National Security Mission with award-winning science, publications, scientific leadership, and collaborations. The 2014 S&T Advisory Panel stated, "One thing is clear; LDRD funding is a key element to the long term success of the ST&E endeavor." The DOE Office of Inspector General (OIG) audit of the LDRD Program in CY 2014 produced a final report stating, "Nothing came to our attention to indicate that controls were not in place over initial LDRD project approval and subsequent project management as required by Department Order 413.2B and LLNL's internal procedures." This was a clean report on LDRD. The NA-114 review on October 22, 2014 and the review of the LLNL LDRD Program Plan concluded that the LDRD Program is aligned with LLNL missions. For example, LDRD researchers created a new method for making strong, ultralow density materials with novel composition. These materials have wide-ranging applications in energy, the environment, and high-energy-density physics for stockpile stewardship. LLNL continued to be engaged in problems confronting the Nation. For example, Livermore LDRD researchers are developing a device that will combine human cells, tissue engineering and microfluidics that will reproduce human physiological response to chemical and biological agents. Ultimately, this platform can be used to rapidly assess and predict the toxicity, safety, and efficiency of countermeasures against chemical and biological agents for rapid mitigation of evolving and unknown threats. During the NA-114 review, we found that the LDRD projects we reviewed showed a strong connection to the national security missions. For example the work on high-explosive components using advanced manufacturing methods can be transferred to DP.



## Performance Objective 5: Operations and Infrastructure

### Summary

Operations and Infrastructure was rated as Very Good as LLNL exceeded many expectations in effectively and efficiently managing the safe and secure operations of the Laboratory while maintaining an NNSA enterprise-wide focus. It demonstrated accountability for mission performance and management controls, assured mission commitments were met with high-quality products and services, and maintained excellence as a 21st century government-owned, contractor-operated facility. LLNL maintained effective and efficient quality, security, and environment, safety, and health programs and achieved an excellent record of safety for the year. LLNL continued to implement long-term work planning and control improvements to ensure safe work execution. While LLNL provided new strategies and investments to achieve superior facility management results and has become NNSA's "go to" Site for many critical infrastructure initiatives, significant long-term challenges remain in deferred maintenance and work order backlogs, especially at Site 300. LLNL continued to deliver efficient and effective business systems, exceeding the overall goal for small business and producing excellent personal property inventory results, and provided outstanding legal management as it successfully settled very high profile and complex litigation. LLNL exceeded expectations in delivering effective ES&H management. This includes the areas of Worker Safety and Health, Environmental Protection, and Occupational Medicine, Nuclear Operations, and Emergency Management, which exceeded expectations, and Radiation Protection, which met expectations.

**Industrial Safety** - In 2015, LLNL experienced lower total injury/illness rates. LLNL increased Industrial Program staffing by hiring two additional Industrial Safety Professionals, which will increase the breadth of the program. LLNL hosted an annual Energy Facility Contractors Group (EFCOG) Electrical Safety Workshop in July, gathering about 150 Professionals complex-wide covering both R&D and infrastructural technical areas. LLNL continued to improve training by providing OSHA, electrical safety, and cryogenic safety classes. The industrial safety and work control interface was improved through the training of work planners on five work planning modules. A total of fifteen source documents for Risk-Assessment and Controls in the industrial safety area were completed, providing upgraded tools for safety personnel to use when evaluating hazards and controls. LLNL completed a Management Review of an incident where an employee fell five feet from a storage shelf resulting in back injuries and is currently evaluating recommendations. Various external and internal assessments, such as OHSAS 18001, Functional Management Review (FMR), Field/Lab Observational Safety Sampling (FLOSS) and Livermore Field Office (LFO) Review, were conducted as planned and the results showed that overall the Program is implemented satisfactorily.

**Industrial Hygiene** - The Industrial Hygiene Program has shown continued improvement based on establishing consistent industrial hygiene procedures via new Field Operation Manual, improving the Ear Plug Fit Testing Program, sponsoring 27 webinars; publishing four Safety News Flashes, completing seven assessments, and meeting or exceeding all key metrics in the areas of sample reporting and turn-around times.

**Explosives Safety** –The DOE Explosives Safety Committee reviewed and accepted several LLNL suggested improvements to the DOE STD 1212 Explosives Safety Standard. There were no significant adverse findings in this fiscal year. There is adequate oversight based on the number of LLNL assessments and closure of previously identified issues were on schedule; LLNL and LFO successfully developed a new optimized joint master assessment plan and schedule for FY 2016. Additional continuous improvements in explosives training were implemented. LLNL successfully completed a high profile and fast-tracked experiment (SPE-4 Prime) with no safety adverse incidents.

**Laser Safety** - LLNL continued to issue the Laser Lessons Learned newsletter for national distribution and label lasers so that they will be tracked in an inventory database improving control over usage. LLNL completed self-assessments of operations involving 45 Class 3b or 4 lasers. Seven of the assessments were rated as outstanding.

**Bio-Safety** - The LLNL Biosafety Program's formal Biogovernance structure is characterized by specific and detailed roles and responsibilities and its Team-based approach to operations, management, oversight and communication. It completed all requisite individual laboratory inspections and pathogens inventory reviews (~100) with no deficient findings and in tandem with updating all operating procedures and processes including Best Management Practices (BMP) Policies and Standard Operating Procedures (SOP). The Select Agent Program was awarded its 4<sup>th</sup> consecutive 3-year permit and registration from the Centers for Disease Control and Prevention (CDC) to operate the only BSL3 Facility within the DOE Complex. The Biological Research Animal Care and Use Program was also re-accredited and facilities recertified by the Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC). AAALAC is an international, private, nonprofit, and highly prestigious organization that promotes the humane treatment of animals in science through voluntary accreditation and assessment programs. The Program maintained its facility and equipment needs by diligently replacing/servicing and ensuring certifications via external and expert State or sub-contractor certification services (e.g., Biosafety Cabinets and autoclaves) on an annual basis. The Program continued its work with external auditors (GAO) in responding to and completing several on-going multi federal agency biosafety-related audits without incident, and responded expertly and swiftly to a CDC-initiated National investigation related to the Department of Defense incident associated with shipments of live select agent material to over 86 domestic research institutions and 3 countries. LLNL was one of the affected Institutions and was able to successfully identify and recall all material in question, as well as institute the required dispositioning activities for these materials, including a moratorium on all non-DoD materials in question. As part of its dedication to excellence, LLNL has had in place several BMP Policies not the least of which is a viability testing policy to ensure pathogen inactivation.

**Environmental Protection** - LLNL's staff promptly responded, on short notice, for information from federal staff working in the DOE's Migratory Bird Working Group. LLNL personnel provided LFO with timely updates of activities taking place within their respective fields of expertise. LLNL staff identified previous gaps in their drinking water monitoring and reporting schedule and informed the California State Water Resources Control Board, who subsequently sent two enforcement letters for failure to conduct drinking water monitoring and to provide the results to the Board. LLNL's staff is currently communicating with the Board to provide them with information on the drinking water monitoring and reporting procedures to ensure future compliance. LLNL staff submitted environmental data, and the Annual Site Environmental Report,

to LFO for review and approval in a timely manner. LLNL staff completed important regulatory documents for natural resources-benefitting projects, including biological evaluations for flood maintenance (storm drain replacements), endangered species recovery plans (for the endangered large-flowered fiddleneck), and biological amendments for habitat enhancements (benefitting the threatened California tiger salamander and California red-legged frog species) at LLNL's Site 300.

**Occupational Medicine** - Occupational Medicine demonstrated continued improvement in the Electronic Health Record database with a goal to complete Webchart and MASS/HSIS retirement by the end of calendar year 2015. The program continues to meet or exceed all metrics in the customer satisfaction surveys, work station evaluation visits, early ergonomic intervention program visits, and the working well program.

**Nuclear Operations** - Early in FY 2015, notable areas included LLNL's interactions with the Defense Nuclear Facilities Safety Board (DNFSB) regarding the Waste Storage Facilities (WSF) and successful resolution of WSF Documented Safety Analysis (DSA) technical issues enabling LFO Safety Evaluation Report (SER) approval, completion of the contractor readiness assessment for the B331 Tritium Science Station (TSS) West Wing Glovebox, and completion of risk grading the Monte Carlo codes COG, MCNP and SCALE in compliance with software quality assurance requirements (SQA). LFO noted the following areas for improvement: better definition/implementation of Equipment Important to Safety (EITS), re-evaluation of the designation of systems with inherent safety interfaces/functions as programmatic equipment, and coordination of safety basis submittals. LLNL has recognized issues with EITS and is developing a path forward. In light of the increasing safety basis work load, LFO has seen progress in coordination of safety basis documents. LLNL showed progress in balancing the mission need with safety considerations based on LFO's observations of LLNL project resources utilization, design reviews, facility work, and handling of emerging issues. Nuclear training was noted for demonstrating a focus on continuous improvement by driving for consistency and improvement of training for Superblock and RHWM. In the safety basis arena, Radioactive and Hazardous Waste Management implemented the approved WSF DSA and Technical Safety Requirement (TSR). The WSF IVR identified some observations, but no TSR implementation deficiencies or other deficiencies; this also closes out the WSF Justification for Continued Operation (JCO). LLNL completed the B332 Legacy Review, which identified a number of findings that resulted in a Potential Inadequacy of the Safety Analysis (PISA). This PISA along with another PISA for the B332 TSR Fire Door SR was self-identified by LLNL; the timeliness of declaration and notification of LFO is a significant improvement in implementation of the USQ process. LLNL continues to show significant improvement in the design review process for nuclear facility programmatic equipment. Two design reviews were completed in quarter three; both reviews had a high level of participation across the disciplines, which included facility engineering staff, Environmental, Safety and Health (ES&H) staff, facility management, safety basis staff, and program personnel. LLNL staff demonstrated exceptional capability during the materials compatibility review and Failure Modes and Effects Analysis (FMEA). LLNL showed proactive judgement and evaluation with regard to issues identified in a report on transuranic waste containers, containing pipe overpacks. DSA and TSR annual update reviews showed efficiency to address and resolve issues, which allowed the annual updates to be reviewed and approved within schedule. In addition, an external review was completed that highlighted a number of improvements in the LLNL safety basis program and its execution. LLNL self-identified a number of PISAs this fiscal year as part of a critical legacy review. A number of modifications were successfully accomplished within the nuclear facilities: completion of a modification to a wall for easier egress,

shipments of special items, installation of an electron beam welder, and modifications to the safety-class fire suppression system. LLNL completed the decontamination and removal of gloveboxes and equipment from a laboratory allowing for future installation of a proposed recovery line in B332. A beryllium/radiation contaminated lathe was decontaminated and removed from B332 this quarter. It was clear that personnel involved with the lathe removal process were well aware of and effectively utilized the lessons learned from the recent B191 lathe toppling-over event. Effective use of lessons learned and suggestions were observed during the unloading of shipments of special items delivered using a 10-160B Cask. Improvement in process efficiency and safety were obvious with each succeeding shipment.

**Packaging and Transportation Safety** - Program continues to be implemented effectively. An Independent Internal Assessment of the LLNL Packaging and Transportation Quality Assurance Plan confirmed that transportation quality expectations are effectively implemented by user organizations. In response to identified issues, LLNL worked closely with the assessor and an SQA Subject Matter Expert from DOE Headquarters to refine the LLNL SQA graded approach and to create an equivalency to NQA-1-2008 using IEEE software standards. This effort resulted in a comprehensive, uniform SQA program implemented across all organizations. Following LFO approval, LLNL ES&H Manual Document 52.3 (Nuclear Packaging for Storage) was made available to the Los Alamos National Laboratory and NNSA/HQ Office of Packaging and Transportation for use.

**Criticality Safety** - Continues to excel as demonstrated through a comprehensive set of 15 performance metrics as well as having no criticality safety infractions, completing a management self-assessment of criticality safety for LLNL activities at the National Nuclear Security Site (NNS), and hosting the 2015 DOE Nuclear Criticality Safety Program Technical Program Review. The Nuclear Maintenance Management Program provided exemplary availability of the safety SSCs.

**Emergency Management** - All deliverables required by the LFO-approved Emergency Readiness Assurance Plan (ERAP) were completed on schedule. Specifically, notable deliverables included the Emergency Plan, Hazards Survey, three Emergency Planning Hazards Assessments for Buildings 131 High Bay and 322 and the Waste Storage Facilities, and an updated Composite Emergency Planning Zone. The annual Full-Scale Exercise and site-wide building evacuation exercises were planned, conducted, and evaluated in addition to the completion of eight facility-specific institutional exercises. Emergency Programs continued efforts to advance command and control, event situational awareness, and information management within the command center via improvements in the Emergency Operations Center (EOC) layout. These improvements supported greater EOC habitability characteristics (filtered air supply), more reliable EOC hardware, and better ergonomics/human factors. The average performance index rating for fire protection, which includes fire department response times, is currently 95.6%.

**Radiation Protection** - The program dedicated exceptional efforts into implementing the Corrective Action Plans (CAPs) developed to abate the 2014 onsite assessment findings by the Office of Enterprise Assessment. NIF survey database transitioned from a local Survey Information System (SIMS) to the site wide Institutional Survey Information Management System (ISIMS). The number of unexpected events, including personnel and area/equipment contamination events, radiological work control issues, etc. continues to remain within stated goals.

LLNL met expectations in accomplishing capital projects in accordance with scope, cost, and schedule baselines. LLNL in the 4th Quarter of FY 2015 continued to support all activities for line

item projects. The Emergency Operations Center (EOC) is now anticipating funding in FY 2018 and the Independent Project Review (IPR) for CD-1 has been postponed to FY 2017. LLNL has continuously supported this review by providing the necessary documentation and has been fully engaged for the review activity. The Expand Electrical Distribution System (EEDS), formerly named Electrical Upgrade Infrastructure Project (EUIP), is anticipated to receive funding in FY 2017. EUIP has received CD-1. The lab continues to support the preparation of project documentation for the upcoming CD-2/3 IPR in late FY 2016. LLNL continues to execute authorized GPP and IGPP and operates projects consistent with baseline scope, cost and schedule. In particular, the B654 is tracking green and is close to the margin of SPI .95 and CPI .94 against the baseline. The Protective Force (PF) armory building (275) is tracking to all baselines. Even more challenging projects, such as the East Side Infrastructure Project, B151 Air Balance project, B341 code compliance project and B341 Turf finder, are tracking on the stoplight margin and have active corrective actions in place to ensure completion.

LLNL met expectations in delivering effective, efficient, and responsive safeguards and security. LLNL met mission and operational requirements including overall cost, schedule, and technical performance requirements. LLNL delivered effective, efficient, and responsive safeguards and security (S&S) performance. LLNL's security program governance provided a stable operating environment, enabling successful mission execution. There were no issues that resulted in a negative effect on S&S performance, however, LLNL required corrective actions to address some issues with S&S compliance and performance. These issues were identified as a result of both internal and external evaluation. All LLNL's S&S performance evaluation criteria (PEC) were implemented on or ahead of schedule. FY 2015 PEC included timely submission of quarterly assurance reports; annual operating plans (AOP) and supplemental reports, and FY 2016-2020 site FYSNP budget requests. LLNL updated and revised its S&S policies, plans, and operating procedures required by implementation of DOE S&S Orders. LLNL submitted quarterly AOPs, and physical security and protective force supplemental reports on schedule. LLNL revised its Site Security Plan (SSP) according to schedule. The SSP better aligns with its threat mitigation activities, and implements new requirements of 10 CFR 1046. LLNL also updated its Material Control and Accountability (MCA) Plan for Category III Operations and Strategic Rollup Area Security Plan. These FY 2015 deliverables met LFO/NNSA expectations. LLNL developed and implemented a procedure for requirements and change management as part of its Conduct of Security Program, which is designed to strengthen its formal governance of security operations. In support of the NNSA initiative to consolidate security operations with Sandia National Laboratory/California (SNL/CA), LLNL provided services in three key areas: MCA measurement support; back-up for Locks and Keys operations; and SNL/CA rifle range usage. LLNL conducted DOE Training Approval Program (TAP)-compliant training for its Protective Force (PF), Information Security (IS) and Physical Security (PS) Programs. LLNL monitored staffing requirements and filled key security vacancies, in areas such as IS, PS and PF operations. LLNL was successful in implementing a firearms "shoot/no shoot" training simulator that presents PF officers with life-size judgmental shooting scenarios using inert, air-actuated weapons to simulate engagements. LLNL conducted informative weekly assurance briefings which included the results of self-assessments conducted by non-SO personnel. Finally, LLNL completed construction of a new PF armory. LLNL initiated the project to replace the antiquated existing armory facility in order to meet required building standards and to conduct security operations in a safe and secure manner. Construction started in April 2015 and the new facility was completed on schedule and under budget. LLNL effectively managed its FY 2015 Institutional Assessment Plan and achieved 100 percent on-time completion of

its scheduled S&S self-assessments and reported quarterly performance ratings to LFO. Deficiencies and observations were self-identified by LLNL and the corrective actions are being managed in LLNL's Issues Tracking System (ITS).

Implementation of LFO's FY 2015 Integrated Assessment Plan (IAP) was successful. Results from completed IAP assessments indicate effective and efficient security performance. Four findings issued in the areas of physical security, personnel security and foreign visits and assignments. These findings are compliance issues LLNL need to resolve, but do not have a material adverse impact on mission or security risk. Corrective actions for these findings are being implemented. LFO will rate all LLNL security topical areas as satisfactory (the highest rating available) for the S&S Periodic Survey. Overall, final results from FY 2015 S&S program reviews and FY 2015 S&S performance indicate effective and efficient security performance, which is supported by the fact that there were no incidents of security concern in FY 2015 that resulted in negative impact on security operations or mission execution. For the security incidents that did occur, LLNL identified the root causes and implemented the necessary corrective actions to minimize recurrence. For the events and demonstrations that occurred in FY 2015, LLNL's PF responded in an effective and professional manner and conducted security operations in accordance with established policies and procedures.

LLNL met expectations in maintaining, operating, and modernizing facilities and infrastructure in an effective and energy efficient manner. LLNL continued to provide new strategies and invested millions of dollars in the short-term to achieve superior facility management results in the long-term and continues to be NNSA's "go to" Site for many NNSA critical infrastructure initiatives. For example, during the second quarter LLNL reported to LFO that a much greater maintenance investment will be made for Site 300 in order to address equipment and operational issues associated with Preventative Maintenance (PM), Corrective Maintenance (CM), and equipment and general operational efficiencies. LLNL set in motion the hiring of additional maintenance staff. LLNL continued to implement and improve its "Deployment Teams" initiative and implemented maintenance engineering analyses to develop PM improvements to reach a PM to CM ratio of about 55/45. LLNL continued to provide a very high level of service and support to LFO and NA-52 as a Center of Excellence for the Knowledge-Based Condition Assessment (BUILDER) initiative. LLNL continues to provide a best in class Condition Assessment Survey program, very high utility availability and reliability, timely monthly Balance Scorecard Reports, exceptional Quarterly Maintenance Reports, and very good Facility Condition Index (FCI) for its Mission Critical facilities. LLNL's electric breaker preventative maintenance program was deemed a Best Management Program. LLNL was the lead NNSA Site for the Heating Ventilation and Air Conditioning Asset Management Program (AMP) and completed key Program deliverables (program plan and final contract documents), which will greatly expand the capability for NNSA to provide infrastructure at a better price and faster than traditional methods.

However, due largely to LLNL institutional funding shortfalls for which the above mentioned initiatives are desperately needed, the deferred maintenance and work order backlogs continued to grow in the third quarter. The Contractor has delayed much of this work and sustainment has not been achieved. The LLNL FCI's have stabilized. LLNL must reinstate PMs for roll-up doors, water utility system, and Site 300 infrastructure in general. LLNL continues to execute its maintenance program given a constrained institutional budget. LLNL's maintenance spending was estimated to be approximately 1.7%, below the best management industry goal of 2% Replacement Plant Value

for Enduring Facilities. LLNL is not the only NNSA site falling short of reaching the 2% goal. These issues are not only an indicator of an institution that may be underinvesting in maintenance and recapitalization, but also one that must determine where to focus its limited investment. Because of the constrained budget, LLNL has determined that issues regarding standardized maintenance for general plant equipment and systems require a reliability centered approach to determine where resources should be invested. LLNL has hired a maintenance engineer to help address these issues. LLNL also experienced a significant water line failure at Site 300 in March 2015. The failure led to a loss of several thousands of gallons of water and equipment damage. Investigations by LLNL determined that failures in management over several years created a dysfunctional work environment in the Maintenance and Utilities Services Department (MUSD), under Facilities and Infrastructure (F&I), that significantly contributed to this accident. Similar events related to the Site 300 water system have occurred including recurring permit violations, an asbestos exposure event, and a chlorine exposure event. Also, in an LFO/LLNL joint assessment this year indicates that LLNL failed to address long standing issues related to boiler maintenance at Site 300. LLNL management has indicated that their assurance system failed and management's failure to address the basic functional requirements for promoting an effective facility maintenance management program at Site 300, and that failure must be addressed. LLNL has identified issues to be resolved but did not produce a Corrective Action Plan and has not established a timeline to resolve the underlying causes.

In quarter four, LLNL's facility maintenance management continued to develop and implement improvements to increase efficiencies. The Deployed Teams implementation have received positive reviews. A promising computer based asset management program, Enterprise Asset Management System which was partially direct funded by DOE, has been stalled before full implementation to ensure compliance with Work Planning and Control requirements. This system promises to optimize maintenance planning and investment and we recommend LLNL take this on as a top priority. LLNL continued to be the "go to Lab" for all of the NA-50 infrastructure initiatives: CRISP, BUILDER, Mission Dependency Index (MDI), AMP, Maintenance Managers Working Group, Predictive Maintenance Users Group, and G2. LLNL participation has been critical to the progress of the Core Infrastructure Risk Informed Strategic Planning effort. LLNL provided leadership in the planning and execution of a meeting that provided a valuable opportunity for infrastructure planning subject matter experts to share information, lessons learned, and work towards development of the NNSA Master Asset Plan. By effectively participating in all meetings (WebEx and face-to-face), LLNL identified critical infrastructure areas that could be improved, facilitated productive conversations on these topics, and provided valuable input to development of the deferred maintenance/repair needs definition realignment. LLNL has a high understanding and stability of requirements, although there is some concern with the use of planning funds as project reserve funding as it relates to Recap projects. The Mission Critical FCIs still exceed the NNSA goal of 5%. LLNL continued to provide excellent Quarterly Maintenance Reports. Despite funding shortfalls, LLNL focused on increasing its preventive maintenance activities. This increased corrective maintenance, which significantly increased the Work Order and Deferred Maintenance (DM) backlogs. Improvements were made to include Site 300 water systems in the DM baseline, air conditioning systems are receiving regular preventative maintenance, cryogenic systems are now managed as real property, control systems have regular preventative maintenance, and fire alarms and emergency voice announcement systems issues are now included in the total DM baseline. LLNL's drive to address the maintenance gaps are commendable. LLNL's 4<sup>th</sup> quarter response to findings from both LFO and internally, such as S300's boiler program and water isolation valves,

was good, as the response was an immediate increase in resources. NNSA/LFO is concerned that without an even greater investment the LLNL DM levels will continue to increase regardless of efficiencies gained by LLNL and NNSA initiatives.

Overall, LLNL met sustainability goals (reduction of greenhouse gases (Scope 1, 2, 3), use of renewable energy, and reduction of fleet petroleum use). However, LLNL continues to lag meeting the DOE goals for energy intensity reduction, natural gas metering, and High Performance Sustainable Buildings. In addition, LLNL needs to improve performance by continuing datacenter closure and consolidation and metering of core datacenters. LLNL is currently at 24% energy intensity reduction as compared to the DOE goal of 30% versus the 2003 baseline. In response to the state's severe drought and Governor Brown's 25% potable water reduction, the contractor has reduced the irrigation of turf and expanded the area of reduced (or no) irrigation. LLNL reduced potable water used for irrigation by more than 70% from 2013. Overall, LLNL achieved a reduction of potable water intensity that currently exceeds the DOE/NNSA target for FY15 (-16%) at -21%. California continues to suffer an unprecedented severe drought. LLNL continues to support the onsite solar project which has moved into the design phase and will start construction in early FY 2016.

LLNL exceeded expectations in delivering efficient and effective business operations, systems and information technology. LLNL's procurement and personal property systems performed at a very high level against established metrics and exceeded nearly all important goals. In the area of Supply Chain Management, LLNL exceeded many requirements such as goals for Supply Chain Management Center (SCMC) cost savings, socioeconomic, customer satisfaction, cost to spend and information availability and is expected to earn an Objective Matrix score in the outstanding range for the year. However, it is noted that its self-assessment of PO's/subcontracts disclosed several failed files due to the recent high attrition amongst the Supply Chain Management's (SCM) most senior personnel and the large number of new, relatively inexperienced contract administrators. SCM stated it will be increasing its emphasis on employee development activities, which should result in improved documentation. In the area of Property Management, LLNL demonstrated strong metrics performance and exemplary inventory results. It successfully accounted for 100% of its firearms, 100% of its precious metals by gram, 99.93% of its equipment items by acquisition value and 99.89% of its attractive items by count, as validated by NNSA. LLNL was awarded a three-year approval of its Personal Property System as a result of a system review by NNSA. In the area of Fleet Management, LLNL introduced the Plug-In Electric Vehicle (PEV) Program that allows LLNL employees to utilize government charging stations to charge personally owned electric vehicles. The program started with 6 stations and 15 participants and has grown to 21 stations and 27 participants. LLNL exceeded some expectations in human resources based on its metrics performance, with nearly all dashboard metrics being reported as green, and piloting an expanded suite of quarterly metrics in the form of a balanced scorecard at the suggestion of NNSA. LLNL also fully transitioned retiree benefits administration and actuarial services to new vendors to increase efficiency, implemented a talent generation tool to more easily find and contact qualified job candidates, and led the planning and execution of the first National Laboratory Directors Committee (NLDC) Diversity and Leadership Workshop. While LLNL continues to meet its recruitment and retention metrics, the hiring organization employment cycle time remains well in the caution range and the diversity compliance rate dipped slightly into the caution range. LLNL must reduce its hiring cycle time in order to better compete in the job market. Additionally, LLNL could improve the timeliness of implementing changes to its personnel policies in response to audit findings and the



quality of supporting data. LLNL exceeded some expectations in financial management, earning high marks on the Office of Field Financial Management's (OFFM) Financial Performance Measures for Quarter 4. Financial management internal controls, reporting and reconciliations have generally been adequate. LLNL met DOE/NNSA budgetary certifications, data calls and routine ad hoc reporting requirements in a timely manner. An area of concern being addressed through corrective actions and an internal audit review is Time and Effort Reporting. The LLNL Budget Office has been working on the Institutional Planning System (IPS) requirements and path forward as part of its financial system strategy. LLNL participated in a Functional Management Review for its IPS and the final report and recommendations were issued during Quarter 4. Due to retirements of financial personnel, the Chief Financial Officer (CFO) has been able to hire financial professionals who possess the right mix of education, leadership and growth potential. In addition, the CFO training program to develop financial skills include job rotation and cross-training opportunities. LLNL met NNSA Chief Information Officer (CIO) expectations set forth in the NNSA Information Technology (IT) Guidance for FY 2015, including the Office of Management and Budget (OMB) mandated implementation and 2NV strategy implementation factors.

LLNL exceeded expectations in delivering efficient and effective management of legal risk and incorporation of best practices. LLNL effectively managed and vigorously defended complex employment litigation, successfully reaching settlement at the end of the year. It also effectively managed complex business, contracting and employment issues, including some raised by the OIG involving allowable costs, employee misconduct, and other highly sensitive and potentially controversial topics. LLNL Office of General Counsel is responsive and effectively communicates and coordinates with NNSA Counsel on all issues in a timely manner. Additionally, LLNL Office of General Counsel has incorporated best practices into its retention agreements and into many of LLNL'S administrative practices.

LLNL met expectations in delivering effective, efficient, and responsive cyber security. LLNL met mission and operational requirements including overall cost, schedule, and technical performance requirements. LLNL delivered adequate and responsive cyber security performance. LLNL's Cyber Security Program (CSP) provided a stable and responsive cyber operating environment, enabling successful mission execution. In addition, LLNL's CSP continues to manage the CSP in accordance with the approved Risk Management Framework (RMF). LLNL was required to initiate corrective actions to address some compliance issues. These issues were identified as a result of both internal and external evaluations. All LLNL CSP's PECs were implemented on or slightly ahead of schedule. Examples of PEC implementation include: timely submission of quarterly assurance reports and the CSP AOP; updates and revisions to cyber RMF processes; and assessment of classified and unclassified IT system core services. Overall, the content of these deliverables received met NNSA/LFO expectations. Specifically the CSP AOP incorporated all of the baseline cyber security program work activities, performance objectives, and implementation factors, as outlined in the NNSA FY 2015 Cyber Security Program Execution Guidance. LLNL updated its *Common Controls Catalog*, a key element of its RMF, to remain current with two national standards: the *National Institute of Standards and Technology Special Publication 800-53* for unclassified information systems; and the *Committee for National Security Systems Instruction 1253* for classified systems. LLNL made several revisions to its *Cyber Security Program Plan*. LFO approved LLNL's *Information Security Continuous Monitoring Strategy and Implementation* document which describes CSP's current mechanisms for continuous monitoring of its information systems, and how these mechanisms support LLNL and LFO in making risk management decisions. LLNL completed its

required TEMPEST threat assessment and special review process which revealed no significant changes with respect to LLNL's overall TEMPEST posture. LLNL provided useful metrics in support of cyber security goals, objectives, and implementation factors that were derived from FY 2014 NNSA Chief Information Officer (CIO) program guidance. These metrics were consistently reported to the NNSA CIO in quarterly assurance reports. LLNL obtained Office of the Associate Administrator for Information Management and Chief Information Officer (NA-IM) approval to apply collections from Strategic Partnership Projects to strengthen controls on classified networks and enhance continuous monitoring of cyber systems. LLNL effectively managed its FY 2015 Institutional Assessment Plan and achieved 100 percent on-time completion of its scheduled CSP self-assessments and reported quarterly performance ratings to LFO.

LLNL self-identified deficiencies and observations as a result of its self-assessments and the corrective actions are being managed in LLNL's ITS. Implementation of LFO's FY 2015 IAP was successful. Results from completed IAP assessments indicate satisfactory cyber security performance. In May 2015, NA-IM conducted a Command Cyber Readiness Inspection (CCRI). The purpose of the CCRI was to evaluate LLNL's implementation of Department of Defense (DoD) requirements for connection to SIPRNet. The number of issues identified resulted in the assignment of an unsatisfactory rating which resulted in a failure of the inspection. A majority of the issues were corrected during the inspection. LLNL submitted an After Action Plan (AAP) to address all the remaining issues and to improve its operational processes. LFO approved the AAP and the corrective action plan (CAP). Residual risk of LLNL's information systems and networks remains manageable and LLNL retained connectivity to DoD classified information systems allowing continued accomplishment of mission work. LLNL was successful in implementing the corrective actions and LFO provided closure to the issues. LLNL is expected to pass a CCRI re-inspection in early FY 2016.

During FY 2014, LLNL's CSP was subject to several comprehensive cyber security reviews by Enterprise Assessments (EA), the Office of Inspector General (OIG), and the NNSA CIO. Reports of these inspections issued in FY 2015. EA concluded that LLNL had implemented many components of an effective CSP, several of which are implemented to protect against the insider threat. EA identified two compliance issues that resulted in findings. LLNL was successful in closing these findings. As part of its FY 2014 Financial Statement Audit, the OIG reviewed the unclassified CSP, which revealed some issues in the areas of configuration management and access control. Five findings were issued to LLNL, corrective actions were effectively implemented, and all five are closed. LFO IAP results revealed that overall LLNL's cyber program was effective and compliant. One finding for deficiencies in LLNL oversight of Interconnected Network Security Agreement requirements was issued. Corrective actions are underway. LFO expects to rate LLNL's Cyber Security topical area as satisfactory (the highest rating available) for the S&S Periodic Survey. Overall, results from FY 2014/2015 CSP inspections and reviews, and FY 2015 CSP performance indicates adequate performance, which is also supported by the fact that there have been no cyber security incidents in FY 2015 that have resulted in negative impact on cyber operations or mission execution. LLNL did fail its CCRI and was rated as "below expectations" in this CF for third quarter. However, LLNL's performance in resolving these issues and in preparing for the upcoming CCRI has shown resiliency with notable effort to meet mission and operational requirements.

LLNL met expectations in continuing to improve its institutional work planning and control (WP&C) process. LLNL developed an ambitious schedule for FY 2015 to implement a revamped the WP&C

process laboratory-wide. LLNL largely met its schedule for the first quarter. However, LLNL slipped in meeting its second quarter schedule and did not engage LFO in timely discussions regarding the need to change the prior commitments. LLNL implemented a revised schedule that meets the original goal and improved communications. For the second quarter, LLNL proposed 1) Execute Alpha Pilot – WCI, 2) Execute Beta Pilot, 3) Implement Site-Wide Service Providers Process, 4) Develop F&I WP&C Process. Each of these proposals had sub-elements. LLNL has made significant progress in each of these proposals but experienced some delays. LLNL met over 90% of their Quarter 3 milestones, made significant progress on the balance of the milestones and achieved some Quarter 4 milestone activities. Of note, the Beta Pilot commenced with conversion of initial work packages to the new process. Training is in full production for the new roles. Importantly, LLNL management has shown commitment to implementing a new WP&C process. LLNL demonstrated leadership in work control in Quarter 4 by developing infrastructure and driving the directorates to take ownership in implementation of the new work control program. As with Quarter 3, milestone achievement was mixed. Development of the training/qualification infrastructure, and training workers in new roles continues at a strong pace. Software development was robust but some challenging elements were delayed until FY 2016. The new Room Responsible Person roles have been identified, and training developed, but implementation of the new role will be a major undertaking early in FY 2016. Identifying the sequence of work control documents to be transitioned was noteworthy. Development of the F&I/Site-Wide Service Provider processes is nearing completion. Implementation has taken longer than expected. Overall, LLNL continues to make strong progress on transforming a foundational element of work safety at the laboratory.

LLNL met expectations in continuing to implement improvements in facility level nuclear safety. On the B332 Fire Water Tank modification, LLNL completed closeout of LFO and EA-31 design review comments to convert from the 2500 -gallon tank to the 7500 -gallon tank. LLNL submitted the B332 DSA and TSR annual update, providing the analysis to support the request to re-designate the 2500-gallon water tank from safety class to safety significant. It also provided a safety basis for the tank capacity of the 7500-gallon tank upon completion of the fire water tank modifications. LFO approved the submittal on July 17, 2015. Subsequently, LLNL submitted a request for a deviation of a limiting condition for operation to support final system tie-in, which LFO approved on September 8. LLNL commenced the final system tie-ins, testing and operability verification on September 11 and completed the transition on September 21, supporting JCO closure in quarter one of FY 2016. On the closure of B332 Loft JCO, modifications were completed to isolate the non-safety-class components connected to safety-class ducting in the B332 loft and were verified via a line management review with LFO shadowing the process. LLNL completed implementation of the configuration management of the modifications and exited from the loft JCO. On the Corrective Action Plan from EA Report, EA issued the final report for the vital safety system review on February 10, 2015. LLNL completed the development of a corrective action plan and has hired additional system engineers. In addition, 26 of 89 actions have been completed per the established schedule.

LLNL met expectations in developing a continuous monitoring implementation strategy and implementing Enterprise Continuous Monitoring to the fullest extent possible to manage security impacts resulting from changes to the operational environment of information systems and networks, consistent with principles and deliverables outlined in the NNSA Enterprise Continuous Monitoring Project Charter. LLNL was successful at implementing a combination of continuous monitoring activities that established an automated enterprise continuous monitoring activity also

referred to as enterprise Governance, Risk, and Compliance based on guidelines in NIST Special Publication (SP) 800-173. LFO approved LLNL's continuous monitoring strategy.

LLNL exceeded expectations in strengthening its security area protection through the use of technology to enhance detection and assessment of barrier penetrations by employing existing life-cycle management and risk management processes. This was implemented through the following nine key performance evaluation criteria (PEC): investigate locations and options for augmenting existing security closed-circuit television (CCTV) camera coverage; develop an overall CCTV plan for migration of the LLNL's legacy analog CCTV system to an enhanced digital system; evaluate the Los Alamos National Laboratory's Foreign National Tracking System for LLNL's implementation; upgrade select security cameras and deploy a new control mechanism (in this case a portion was not fully implemented as a result of budget prioritization; two security cameras were not upgraded at site 300); deploy and implement the use of mobile video trailers; reconfigure Argus to route a secondary alarm path; prototype and implement a digital video solution that allows PF the view of camera-feeds in real-time; and investigate technology for the development of an electronic dispatch tracker for LLNL's central alarm station. Overall, significant progress was made in strengthening LLNL's ability to detect and assess barrier penetrations by completion of these initiatives and the use of technology.

## Performance Objective 6: Leadership

### Summary

Leadership was rated as Excellent as LLNL exceeded nearly all expectations providing leadership in support of the direction of the DOE/NNSA mission, improving safety culture, the responsiveness of the Laboratory leadership team to issues and opportunities for continuous improvement internally and across the Enterprise, and parent company involvement/commitment to the overall success of the Laboratory and the Enterprise. LLNL demonstrated strategic leadership through its participation and key role in numerous enterprise initiatives, councils, working groups, and collaborations that addressed issues and led to performance improvements. Changes in key personnel were well coordinated with DOE/NNSA leadership and LLNL continued to provide improved transparency, communication, and customer focus, especially with respect to work performed by the NIF organization.

LLNL exceeded expectations in defining a realistic vision for the Laboratory through its LLNL Multi-Year Performance Strategy, which provided an overview of the Laboratory's strategies, efforts, and priorities covering the 2015–2019 timeframe. LLNL's vision is influenced by extensive strategic discussions with DOE/NNSA as well as through LLNL participation in other national and international forums. Examples of these strategic discussions and LLNL participation include:

- Facilitated Air Force Synchronization meetings including the U.S. Strategic Command (STRATCOM), DoD, NNSA, and NNSA Laboratories and Plants to address the modernization of strategic forces
- Hosted Stocktake 38 including representatives from NNSA, DoD, UK Ministry of Defense (MoD), AWE and NNSA Laboratories and Plants focusing on strategic collaborations, program alignment and technical engagements
- LLNL conducted a first of its kind seminar on cross-domain deterrence as part of the "Nuclear Crossroads" Initiative. Organizations represented included the State Department, DoD, Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), Lawrence Berkeley National Laboratory (LBNL), and several policy institutes, universities, and consulting organizations. Subjects covered included competing concepts of cross-domain deterrence, regional conflicts, and the role of space, cyber, intelligence, surveillance, and reconnaissance (ISR) in deterrence.
- LLNL employees serve on many scientific advisory boards of the military services and National Academy of Sciences studies in support of US Government policy and technology considerations
- LLNL Director serves as the vice chair on the Executive Council of the National Laboratory Directors Council (NLDC), meets quarterly with the DOE Lab Policy Council chaired by the Secretary of Energy, attends Mission Executive Committee (MEC) meetings, and is the NLDC representative on the DOE Cyber Council. The Secretary of Energy (S-1) relies on NLDC to increase enterprise-wide activities.
- Participated in the re-write of the NNSA Stockpile Stewardship Management Plan (SSMP) for FY 2016

LLNL exceeded expectations in promoting a culture of critical self-assessment and transparency. It sustained improvements in transparency, communication, and customer focus, especially in the NIF

Directorate. The LLNL Director conducts a Management Performance Review (MPR) each month that provides a regular forum for sharing status, concerns and lessons learned Lab-wide and is evolving to better focus on key issues and trends. LLNL's senior management team as well as LFO management attend this review. For FY 2015, 14 of 23 noncompliance reports LLNL submitted to the DOE Noncompliance Tracking System (NTS) were self-identified (61%). This rate for self-identified non-compliances in NTS is well above the DOE wide average of 40% and close to the challenging goal of 67% set by the DOE Office of Enforcement. For all deficiencies in the Issues Tracking System identified during the same 12-month period, 79% are self-identified. LLNL has added rigor to the Nuclear Stockpile Annual Assessment process by adding a Black Team review, which is a more challenging and constructive evaluation. Additionally, LLNL chartered the NIF Management Advisory Committee (MAC), which includes external experts, to advise on issues including implementing the 120-day study, the High-Energy-Density science (HED) Plan, advanced radiographic capability (ARC), optics, and target fabrication. Guests from NNSA, universities, and other laboratories are invited to observe.

LLNL exceeded expectations in demonstrating performance results through the Institutional Management Assurance System (MAS). This included the continued registration of the ISO 9001-2008 Quality Management System Certification and submission of the revision to the LLNL Quality Assurance Program document (DES-0115) that is a part of the improved alignment of the LLNL institutional plans and procedures. LLNL also continued to utilize and evaluate the performance of the Management Assurance System. In FY 2015, LLNL completed self-assessments of the MAS effectiveness within line organizations in accordance with the CAS Effectiveness and Sustainability Plan and executed Functional Management Reviews in accordance with the Parent Oversight Plan. The joint LFO-LLNL Assessment Integration effort met all FY 2015 milestones, a significant achievement. LLNL worked closely with the LFO to develop a totally new, joint assessment planning process based on establishing common functional areas and elements and a common risk model for assessment planning. This allowed LFO oversight and Laboratory self-assessment schedules to be synchronized, reducing redundant assessments, reducing costs, improving efficiency and effectiveness, and increasing cooperation and transparency. A Joint Assessment Plan (JMAP) and Schedule (JMAS) for the Waste Management functional area were completed and assessments were conducted in accordance with the FY 2015 JMAS. A final report for the Pilot Project – Waste Management functional area was completed in the 4th Quarter and submitted to LFO. All seven program areas targeted for joint assessment planning in FY 2015 were completed. JMAPs and JMASs were successfully developed for the Conduct of Operations, Emergency Management, Management Assurance System, Occupational Medicine, Packaging and Transportation, Radiation Protection, and Worker Safety and Health functional areas. All JMASs were reviewed, jointly agreed to, and approved. All parties were well prepared to begin implementing the JMAS for their functional areas beginning in FY 2016. The net result of these efforts has demonstrated a reduction in the number of total assessments, as well as an increase in coordination and cooperation between LFO and LLNL in the conduct of joint, risk-based assessments.

LLNL exceeded expectations in developing, integrating, and implementing enterprise solutions within the DOE/NNSA complex. LLNL leadership is developing strategies, initiatives, programs, and activities that promote the creation of a diverse and inclusive workforce and work environment. The Director is the NLDC co-chair and is focusing on diversity efforts. LLNL is also partnering with NNSA on a \$25m initiative with Historically Black Colleges and Universities in Cyber Security, actively participating in the Department's Minorities in Energy and the Science, Technology,

Engineering and Mathematics (STEM) initiatives supported by the Secretary, and sponsored the first “My Brother’s Keeper” event at lab for over 100 middle school children in direct support of White House Initiative. The following are several noteworthy examples of LLNL efforts to develop, support and implement enterprise solutions:

- Led the CORAL procurement, which is collaboration between NNSA and Office of Science to further the state-of-the-art in high performance computing for the next generation of supercomputers for Oak Ridge, Argonne, and LLNL, and awarded the contracts.
- Taken a leading role in the Joint Technology Demonstrator (JTD) Project, which includes AWE, LANL, and SNL. Risks and opportunities for advancing technologies are being explored for development of IW-1 LEP.
- Led the Additive Manufacturing (AM) Initiative and demonstrated value added to the mission by collaborating with Y-12 and fielding AM tooling and exploring applications for Long-Range Standoff (LRSO) and LEPs.
- Manages FASTForward 2 Program with seven labs and four companies participating to address extreme-scale supercomputing' technologies.
- Selected as lead lab to address complex-wide facility solutions included in the DOE Infrastructure initiative as well as the pilot site for Mission Dependency Index (MDI) and Knowledge-Based Condition Assessment (BUILDER).
- Selected to lead complex-wide HVAC Asset Management Program.
- Hosted and organized the NLDC Diversity and Leadership Workshop, which included the participation of 14 national laboratory directors, more than 55 staff from 17 national laboratories, several university deans, and distinguished members of societies addressing diversity issues. Featured were several best practice presentations. Break-out work groups addressed diversity issues and made recommendations for individual and collective consideration by the laboratory directors.
- Significantly improved the capability of the NIF Facility and shared that capability within the NIF enterprise, as well as other users, e.g., discovery science experiments. Priorities are established through the High-Energy-Density (HED) Council.

LLNL exceeded expectations in exhibiting professional excellence through executing both its programmatic work as well as its operations at a very high level. LLNL provided many opportunities for continuous learning for its high quality workforce. Examples of learning opportunities include:

- LLNL enables employees to pursue opportunities in continuing education ranging from obtaining professional certificates to programs for Ph.D. degrees through a formal program.
- Livermore's Professional Research and Teaching program is an effective tool for developing the workforce and forging collaborative ties with prestigious universities and research organizations.
- A new veterans hiring initiative, which provides training and internships, has proven to be a valuable tool for enhancing the workforce.
- Developed a new mentoring program as well as an employee educational activity known as Lab 101 taught by senior laboratory managers for the benefit of relatively new employees.
- Completed several leadership development projects including maintaining agility, embracing Gen-Y, employee rotation, and matrix management.

Postdoc program consistently recruits top candidates from among the world's most prestigious universities, and it serves as a vital element of LLNL's Science, Technology, and Engineering (ST&E) pipeline, with about 66% of postdocs converted to staff positions in FY 2015.

Additionally, Laboratory employees continued to receive prestigious awards and receive recognition from technical and scientific organizations for their professional excellence, with LLNL developed technologies and capabilities that continue to be recognized as unique and state-of-the-art. Examples include:

- Members of LLNL's technical staff received prestigious external awards and assumed leadership positions in professional societies as detailed in Objective 4.
- LLNL launched a new Early- and Mid-Career Recognition (EMCR) Program to reward employees who made outstanding technical and programmatic contributions early in their careers. Program goals include career development and retention of key technical staff members.
- LLNL received the DOE Green Buy Gold Award for excellence in sustainable acquisitions as well as three awards from DOE for novel water conservation efforts.
- An LLNL scientist received the only International Electrotechnical Commission's 1906 Award that was given to an American scientist in the field of Radiation Protection.
- Seven LLNL scientists were awarded the DOE Secretarial Honor Award for their participation in the Office of Intelligence and Counterintelligence Analytic Team.
- An LLNL scientist was awarded the DOE Secretarial Honor Award for the Accelerated Climate Modeling for Energy (ACME) project.
- Two scientists were awarded the "Order of Nucleus" from the Air Force.