NCSP Activities and Accomplishments in FY15

Analytical Methods (AM)

LANL AM

- Worked on thorough review of coding for adjoint-weighted tallies, sensitivity/uncertainty, and Whisper methodology (for USLs).
- Worked with PhD student at MIT on unresolved resonance improvements, PhD student at RPI on S(alpha,beta) improvements, PhD student at U. Michigan on fission matrix.
- MCNP 2020 - performance & structural improvements:
  - Work continues, with excellent results
  - Reports:
    - "MCNP6 Monte Carlo Code Optimization," for MC2015 conference, LA-UR-15-20019.
    - "MCNP6 Optimization and Testing for Criticality Safety Calculations," for ANS summer meeting.
    - "New Hash-based Energy Lookup Algorithm for Monte Carlo Codes", LA-UR-14-24530.
- Presentations at ANS 2014 Winter Meeting:
  - "New Hash-based Energy Lookup Algorithm for Monte Carlo Codes," LA-UR-14-27037.
  - "MCNP Sensitivity/Uncertainty Accomplishments for the Nuclear Criticality Safety Program," LA-UR-14-24458.
- User-support for criticality calculations:
  - MCNP Forum
  - Direct help to LANL NCS & other DOE labs
  - MCNP website
  - MCNP Reference Collection.
- Participated in Initial Meeting of the NCSP Analytical Methods Working Group held at Brookhaven in November and presented status and plans for modernization of NJOY and MCNP6.
- Shared preliminary NJOY2012 updates with a few advanced users prior to general release (to occur this quarter).
- Provided NJOY support to in-house, domestic and foreign users.
- NJOY2012 coding to include covariance data into MCNP ACE files is in progress and expected to be ready for in-house use during Q2.
- The NJOY21 Modernization Plan is progressing.
- Released a new update to NJOY2012, creating version 2012.50.
- Provided NJOY support to in-house, domestic, and international users.
- Established plans to visit IRSN following WPEC and will provide 2-days onsite NJOY instruction.
- Papers documenting NJOY21 Status and Future Plans, and the latest Jezebel critical assembly benchmark evaluation have been submitted and accepted for presentation at this Fall's ICNC'15 Technical Meeting.
- An NJOY modernization plan has been created.
- Conducted MCNP Criticality Class at LANL, 12 students.
- Support for MCNP website & Reference Collection - many additions.
- Provided lectures, hands-on assistance, and technical review of SQA reports to support LANL NCS Division.

- Entered Whisper software & documentation into the MCNP code repository. Worked with LANL NCS to resolve minor issues.
- Began R&D with Univ. New Mexico to investigate, verify, validate the use of fission neutron multiplicity in MCNP criticality calculations.
- Published reports & talks:
    - "MCNP 2020 – White Paper - Preparing LANL Monte Carlo for Exascale Computer Systems," LA-UR-15-22524
    - "MCNP 2020," presentation, LA-UR-15-22523
    - "MCNP Progress & Performance Improvements," presentation at NCSP Technical Review, LA-UR-15-21869.
    - "MCNP6 Criticality Calculations Verification and Validation Report", LA-UR-15-23266
- Presentations at ANS MC-2015, Nashville, TN, April 19-23, 2015.
    - "MCNP6 Monte Carlo Code Optimization", LA-UR-15-2278 (110 attendees).
    - "MCNP Workshop," LA-UR-15-2275 (60 attendees).
    - "Implementation of a Least-Squares Temperature Fit of the Thermal Scattering Law in MCNP6."
    - Direct, On-the-fly Calculations of Unresolved Resonance Region Cross-Sections in Monte Carlo Simulations."
- Continued to support NCSP user community -- email to MCNP Forum, direct email with some users, face-to-face with LANL NCS analysts.
- Provided lectures, hands-on assistance & technical review for LANL NCS.
- Initial improvements to Whisper package, including a few benchmark corrections.
- Prepared & submitted papers on MCNP for ICNC & ANS Winter Meeting.
- Initial results from testing explicit fission neutron multiplicity data in MCNP criticality calculations.
- The NJOY21 modernization plan has been completed and presented internally.
- Provided NJOY2012 user support to in-house, domestic and international users.
- Attended the Sub-Group 42 (Thermal Scattering Kernel) kick-off meeting during WPEC week and discussed the need for NJOY/LEAPR improvements with attendees.
- Provided a 2-day NJOY User Workshop to select IRSN staff.
- Attended the IAEA 2nd Research Coordination Meeting on Primary Radiation Damage Cross Sections and summarized NJOY capabilities for performing KERMA, Gas Production and Damage calculations.

Note: The following work tasks were begun with NCSP funding, but completed with entirely different funding sources:
- ICNC 2015 Conference and presentations "NJOY21: Making NJOY Suitable for the 21st Century."
- Achieved major milestone for MCNP-2020 initiative: MCNP6 is 100% compliant with ANSI Fortran-2003 standard.
- ICNC 2015 Conference and presentations: "MCNP6 Status and Plans for Criticality Safety Applications."
- Participated in OECD/NEA Expert Group on Advanced Monte Carlo techniques. Presentations on Monte Carlo optimization & MCNP-2020 plans.
- Physics R&D with summer grad students on unresolved resonances, free-gas scattering, and fission neutron multiplicity.
- Whisper software for NCS validation is now supported as part of MCNP package.
- User support via web, MCNP Forum, direct email, & 20 hrs. of lectures to LANL NCS.
- Participated in NCSP-AM working group during ICNC 2015.

- LANL AM experts met with IRSN during ICNC 2015 to discuss details of future collaborations.
- Participated in FY16 budget execution meeting in DC.

LLNL AM
- Final COG11.1 production baseline testing in progress, which includes 503 ICSBEP benchmarks run on LINUX, MAC and Windows platforms requiring ~16,000 CPU-hours.
- Completed SQA gap analyses for COG, MCNP and SCALE in accordance with the LLNL ISQAP for 10CFR830 software.
- Participated in meetings at BNL including:
    - WPEC SG38 on Oct. 29-31, 2014
    - NCSP Analytical Methods Working Group on Nov. 5, 2014
    - NDAG on Nov. 6, 2014
    - CSEWG/CIELO on Nov 3-5, 2014
- Provided COG11.1, COG LibMaker Codes, and 503 ICSBEP benchmarks to BNL (Dave Brown) for implementation in the ADVANCE project.
- Provided LLNL-TR-655365, Alpha Transport in COG, to CSEWG with the recommendation to add JENDL (α, n) cross section data validated in this report to the ENDF library.
- Staff member elected as a new member to NDAG.
- Presented Generalized Nuclear Data (GND) and Processing Needs to Support the New Nuclear Data Format in the New Nuclear Data Formats and Processing Capabilities session at the ANS Winter Meeting on November 11, 2014 in Anaheim, CA.
- COG11.1 production version testing completed and software submitted to LLNL Information Management for approval for release to the public as Export Control Information.
- Problems with several analytic benchmarks were reported in the presentation Analytical Methods Update at the NCSP TPR. LANL staff are working with U. Arizona to resolve and indicated that unpublished MCNP results are in agreement with COG results.
- Hosted the 2nd NCSP Analytical Methods Working Group Meeting on March 20, 2015 following the NCSP TPR.
- Provided assistance to the IAEA in testing and preparing the PREPRO 2015 package for unlimited distribution. PREPRO 2015 is described in IAEA-NDS-39, Rev. 16. Documentation and software are available to the public for download from https://www-nds.iaea.org/public/endf/prepro/.
- Created COG thermal scattering law libraries T.CAB2015.ENDF and T.CAB2015.ACE containing data for H_2O and D_2O from the Centro Atomico Bariloche, Argentina.
- Provided AWE and IRSN with (draft) documentation on the COG11.1 delayed fission gamma feature and (unpublished) testing results to enable their use of COG in criticality accident "slide rule" calculations.
- LLNL approved COG11.1 for release to the public as Export Control Information as LLNL-CODE-669776.
- COG11.1 available from RSICC as CCC-829/C829MNYCP00.
- COG11.1 and the COGLIBMAKER2014 data conversion programs are now available from the OECD NEA Data Bank as CCC-0829 and PSR-0607, respectively.
- LLNL-PROC-670304, COG11.1 Description, New Features, and Development Activities, accepted for presentation and publication in the ICNC 2015 conference proceedings.
- Provided updated processed ENDF/B-VII.1 temperature dependent, linearly interpolated cross-sections using PREPRO 2015. This POINT2015 data is available from RSICC as DLC-273/D00273MNYCP00, and available for download from: https://www-nds.iaea.org/point/.

- LLNL developed and approved a lab-to-lab license agreement with IRSN, which authorized direct distribution of COG11.1 to IRSN for use by employees who are French nationals.
- On May 13, provided IRSN personnel COG11.1 user training for criticality safety and delayed fission gamma dose calculations.
- On June 25, received training on the current status of the IRSN code Prométhée including its implementation using COG11.1.
- Hosted an IRSN visit to LLNL on September 10-11, 2015, for:
  - PROMETHEE training of LLNL users;
  - PROMETHEE changes for LLNL security environment; and,
  - PROMETHEE workshop dry run for ICNC 2015.
- Presented LLNL-PRES-676983, COG11.1 Description, New Features, and Development Activities, at ICNC 2015 in Charlotte, NC, on September 16, 2015.
- Updated the COG thermal scattering library, T.NCSU to include the latest thermal scattering law library for $C_5H_8O_2$ (Lucite) and commenced data testing.
- Completed ISQAP documentation for compliance with NQA-1.
- Participated in the 3rd NCSP Analytical Methods Working Group Meeting convened on September 13, 2015, at ICNC 2015; and, presented detailed (draft) results for the "benchmarks" indicating significant problems for benchmarks 3.1.5a, 3.1.5b, 5.1.3a, and 5.1.3b; and minor issues for problems 2.1.2 and 3.1.1.
- Participated in the Slide Rule Task Collaboration Meeting convened by IRSN on September 13, 2015, at ICNC 2015.
- Commenced multiphysics simulations in support of the KRUSTY critical experiments and reactor design.

ORNL AM
- RSICC activities: See rsicc.ornl.gov for monthly newsletters.
  - Distributed 832 software packages and updated 4 software packages.
  - 135 SCALE and 400 MCNP packages distributed.
  - RSICC quarterly report issued.
- SCALE activities:
  - Distributed FY14 SCALE Annual Report.
  - Three weeks of SCALE training courses at ORNL and two week at OECD/NEA scheduled for Winter 2015.
  - Modernization enhancements implemented in SCALE 6.2 Beta4:
    - Modern cross-section processing module (XSProc) implemented in several additional sequences—Impact example for facility CAAS analyses: cross-section processing for shielding sequence (MAVRIC) up to 2000 times faster than SCALE 6.1.
    - Extended continuous-energy TSUNAMI capabilities to address reaction rate sensitivity/uncertainty capabilities as needed to study irradiation experiments.
    - ENDF/B-VII.1 covariance data libraries available for testing.
    - Answered 288 requests for user assistance through scalehelp@ornl.gov.
- AMPX Maintenance and Modernization:
  - Added preliminary code to test reading of the new, modern ENDF data format—processed H1 evaluation as proof-of-principle.
  - Generated updated cross-section and covariance data libraries for testing with SCALE 6.2.
  - Participated in the CSWEG data meeting in BNL and in the ENDF format working group meeting to develop new, modern format.
- University of Tennessee sensitivity profile generation task for ICSBEP:

- Completed MST-010 evaluation.
- LCT-008, HMF-052, MST-007, and MST-010 submitted to VALID for QA review.
- Initiated work on MST-004, -005, and MIX-MISC-THERM-001.
- Performed comparisons of MG- and CE-TSUNAMI results for a range of different systems.
- Presented summary of NCSP sensitivity task at November 2014 ANS meeting related to KENO validation for MIX-SOL-THERM systems.
- RSICC activities: See rsicc.ornl.gov for monthly newsletters.
  - Distributed 1124 software packages and updated 3 software packages.
  - 152 SCALE and 614 MCNP packages distributed.
  - RSICC quarterly report issued.
- SCALE activities:
  - Attended NCSP FY14 Technical Program Review and presented:
    - Status of SCALE and AMPX Modernization Efforts at ORNL.
    - Development and Testing of Advanced S/U Methods for NCS Analyses.
    - Analytical Methods for Calculating Experimental Correlations.
    - Continuous-energy Sensitivity and Uncertainty Analysis.
  - Provided 3 weeks of SCALE training classes at ORNL and 2 weeks at OECD/NEA.
  - Distributed SCALE 6.2 Beta4 package that provides:
    - Modern cross-section processing module (XSProc) implemented in ~2/3 of SCALE sequences, resulting in speedups from 3x to 2000x for preparation of MG data.
    - Problem-dependent temperature corrections for CE KENO calculations, resulting in 600 pcm improvement in prediction of k_{eff} for SILENE benchmark.
    - CE TSUNAMI enhancements to provide reaction rate S/U capabilities needed to analyze irradiation experiments.
    - ENDF/B-VII.1 nuclear data and covariance data libraries.
    - Initial version of modern GUI user interface, Fulcrum.
    - Answered 274 requests for user assistance through scalehelp@ornl.gov
- AMPX Maintenance and Modernization:
  - Developed an application program interface (API) for resolved and unresolved resonance parameter and uncertainty processing—implemented API for use by appropriate AMPX modules.
  - Provided ENDF/B-VII.1 library support for SCALE 6.2 Beta4 package.
- University of Tennessee sensitivity profile generation task for ICSBEP:
  - UTK student successfully defended M.S. thesis and presented summary of sensitivity profile generation task for FY14 at the NCSP TPR.
  - Initiated VALID QA review process for HMF-052 case.
  - Performed sensitivity analysis for MMT-001, MST-004, MST-005.
- RSICC activities: See rsicc.ornl.gov for monthly newsletters.
  - Distributed 705 software packages and updated 6 software packages.
  - 91 SCALE, 260 MCNP, and 6 COG packages distributed.
  - RSICC quarterly report issued.
- SCALE activities:
  - Developed papers for ICNC 2015 on several topics including:
    - Criticality Safety Enhancements for SCALE 6.2 and Beyond.
    - Validation of Criticality Safety Calculations Using KENO V.a and KENO-VI.
    - Development of Neutron Cross Section Covariance Data for SCALE 6.2.
    - SCALE 6.2 Continuous-Energy TSUNAMI-3D Capabilities.

- Investigation of Continuous-Energy Sensitivity Methods in SCALE 6.2 Using TSUNAMI-3D.
- Diagnosing Undersampling in Monte Carlo Eigenvalue and Flux Tally Estimates.
- Determination of Critical Experiment Correlations Using the Sampler Sequence within SCALE 6.2:
  - Planned 4 weeks of SCALE training in August 2015 at ORNL.
  - Continued distribution of SCALE 6.2 Beta4 package (>100 beta testers).
  - Completed updates for SCALE 6.2 Beta5 package to be released in Q4 prior to final SCALE 6.2 package distribution.
  - Answered 272 requests for user assistance through scalehelp@ornl.gov.
  - Completed OECD/NEA/WPNCS expert group benchmark analyses for July 2015 meetings—Incoming Chair of Expert Group on Uncertainty Analysis for Criticality Safety Assessment.
  - At request of Y-12, ORNL provided SCALE/Mavric CAAS/shielding training and automated variance reduction training using the ORNL-developed ADVANTG software in June 2015.
- AMPX Maintenance and Modernization:
  - Hosted IRSN for 2-weeks to provide AMPX training.
  - Submitted AMPX capability and modernization paper to ICNC-2015.
  - Updated covariance library and performed testing release with SCALE 6.2 code package.
- RSICC activities: See rsicc.ornl.gov for monthly newsletters.
  - Distributed 917 software packages and updated 6 software packages.
  - 157 SCALE, 395 MCNP, and 5 COG packages distributed.
  - RSICC quarterly report issued.
- SCALE activities:
  - Presented papers at ICNC 2015 on several topics including:
    - Criticality Safety Enhancements for SCALE 6.2 and Beyond.
    - Validation of Criticality Safety Calculations Using KENO V.a and KENO-VI.
    - Development of Neutron Cross Section Covariance Data for SCALE 6.2.
    - SCALE 6.2 Continuous-Energy TSUNAMI-3D Capabilities.
    - Investigation of Continuous-Energy Sensitivity Methods in SCALE 6.2 Using TSUNAMI-3D.
    - Diagnosing Undersampling in Monte Carlo Eigenvalue and Flux Tally Estimates.
    - Determination of Critical Experiment Correlations Using the Sampler Sequence within SCALE 6.2.
  - Provided 4 weeks of SCALE training in August 2015 at ORNL.
  - Continued updates for SCALE 6.2 Beta5 package to be released prior to final SCALE 6.2 package distribution, including improved installation package and extended V&V.
  - Answered 215 requests for user assistance through scalehelp@ornl.gov.
  - Hosted GRS for two days to discuss UACSA benchmark.
- AMPX Maintenance and Modernization:
  - Completed library generation and testing tasks to support SCALE 6.2 Beta5 package.
  - Hosted OECD/NEA Data Bank for 2-weeks to provide AMPX training—obtained valuable testing feedback on JEFF (European data files) to improve AMPX package for release with SCALE 6.2.
  - Delivered AMPX capability and modernization talk at ICNC-2015.

LANL IE
- Building Decontamination.
- DTRA Measurements.
- PASS Support.
- Radiography Measurements.
- NSTec annual MC&A inventory support.
- Material Moves.
- Dry Runs for Flat-Top resumption.
- Minimal training was performed mostly to ensure operator qualifications remained current.
- Preliminary analysis of data obtained in FY2014 began for inclusion and documentation in the CED-3B report.
- Measurement results were reviewed. Preliminary detailed models were created for the 8 benchmark configurations. Work on the sensitivity analysis was started.
- Participated in multiple conference calls to discuss and address comments for the CED-2 report.
- Talks were presented at the ANS 2014 Winter meeting:
  - "List-mode simulations of the Subcritical Thor Core Benchmark Sensitivity Experiments."
  - "Nickel-Reflected Plutonium Metal Sphere Subcritical Measurements."
  - "Deciphering the Binning Method Uncertainty in Neutron Multiplicity Measurements."
  - "Characterization of the NPOD3 Detectors in MCNP5 and MCNP6."
  - "GODIVA IV Startup at NCERC."
  - "A Review of Recent R&D Efforts in Subcritical Multiplication Measurements and Simulations."
- Design of the fixed system is almost complete. Still need to work on design details with the interface of the piping.
- Drawing package is nearing completion. Some components such as hardware and nuts and bolts still need to be added to the Pro/E Assembly.
- Detail drawings for major components are completed to Prototype stage.
- Prototype parts have been fabricated for the Send Station and parts are currently being fabricated for the Transfer and Air Stations.
- Met with NCERC Safety Basis analysts to answer questions about the design and intended use of the rapid pneumatic transfer system.
- CNEC/CVT Measurements.
- NCNS Measurements.
- Comet Ops - U-Hydride.
- Comet Ops – JAEA.
- Pu ZPPR verification measurements.
- Hex Pellets material receipt and confirmation measurements.
- U233 ZPPR Dry Runs.
- Critical Assembly maintenance.
- NA-22 Measurements.
- Hex Pellets verification measurements.
- IP-17 surveillance (LLNL Pu Oxide containers).
- ER Diagnostic Challenge.
- NCSP Class.
- ER Class.

- Comet Ops – JAEA.
- Material moves - provided Pu ZPPR to LLNL for measurements.
- Comet Ops – JAEA.
- Planet Ops (defuel from NCSP class).
- NPOD Certifications.
- ER Class (FL radiography).
- Startup Plan for Godiva (initial prompt burst).
- Critical Assembly maintenance.
- OJT was performed as opportunities arose to cross train and help qualify for new operators on Comet, Planet, and Flattop.
- Much effort was spent working towards getting operations resumed in the Godiva IV building.
- Operation of Comet (independent of Godiva IV operations) was authorized for resumption end of June/beginning of July.
- Hardware was installed on the Planet assembly to make it compatible for execution of. The excess reactivity of the critical configuration that is to be used for the irradiation was determined using the Planet assembly. Compared simulation and measurement for three configurations. Provided prediction of critical separation for planned foil irradiation. Prepared abstract/poster for presentation of results at NEDPC 2015 (19 - 23 October 2015).
- Participated in multiple conference calls to discuss the NASA space nuclear propulsion/ "KRUSTY" critical experiment design.
- Two legacy LANL fission chambers have been rebuilt and tested at LANL, with the eventual goal of utilizing their capabilities at the DAF.
- A special meeting was held at the ICNC 2015 conference to discuss joint IRSN/LANL areas of collaboration.
- Talks were presented at the ICNC 2015 meeting held in Charlotte, NC:
  - "Estimation of Uncertainties for Subcritical Benchmark Measurements."

  - "Joint Neutron Measurements on the FLAT-TOP HEU Critical Assembly Machine."

  - "A New Critical Experiment in Support of the Nuclear Criticality Safety Class."

  - "Stability of Fissile Solution Systems."

  - "Radiation Sources and Criticality Safety."

  - "National Criticality Experiments Research Center: Status and Update."
- WFO update:
  - Critical experiments were executed using the Comet assembly as part of the JAEA campaign of experiments (NA-21).
  - NCNS Experiments (Flat-Top irradiation).
  - MC-15 Measurement RTOs.
  - NA-22 Measurements RTOs.
  - Dry Runs for the CRAs.
  - Portable Radiography RTOs.
  - NPod Certifications RTO.
  - DTRA Measurements (FlatTop irradiation).
  - NSTec MC&A Inventory Support.
  - NA-22 Measurements RTOs.

- PASS Support RTO (three weeks).
- NCSP Class (Planet/Flat-Top/RTOs).
- CNEC/CVT Measurements RTOs.
- NCNS Measurements (Flat-Top irradiation).
- Comet Operations (Comet).
- In May, there were many activities associated with the CRA/FRA:
  - Demos – Routine Surveys, Flat-Top Operations (Real), and Godiva Operations (Simulated):
    - Interviews.
    - Evidence Packages.
    - MRCBs.
    - FRA requested Smoke Test.
    - NUCON testing of AFS.
    - AFS Face/Capture velocity testing.
- The formal bi-annual operator training and testing was performed in April. This is a major training event required to maintain current operator qualifications and to gain qualifications for new operators.
- Operation of Comet (independent of Godiva IV operations) was authorized for resumption.
- Third (3 of 4) critical configuration was completed after Comet operations were resumed.
- Talks were presented at the Summer ANS meeting held San Antonio:
  - Neutron Noise Measurements on HEU Foils Moderated by Lucite."
  - "Tungsten-Reflected Subcritical Measurements."
- Other NNSA and WFO work update:
  - Reaction rate sample irradiations were performed using Flattop for DTRA and NCNS (NA-22).
  - The Comet assembly was prepped for future use as part of the JAEA campaign of experiments (NA-21).
  - Various subcritical measurement campaigns were performed in support of NA-22, NA-42, NA-82, DTRA, and DOD programmatic initiatives.

LLNL IE
- PMMA slab phantoms and their support structures received from SNL for use in NAD exercises.
- A NAD Lab expansion meeting was held with all LLNL and NSTec disciplines and stakeholders on November 19, 2014. A detailed "punch list" was completed with NSTec to provide cost and schedule estimates.
- Experimenter and NDAG comments on TEX received and addressed in the Final Design (CED2) Report, which will be finalized in early January 2015.
- MC-15 measurements are scheduled for the week of February 9, 2015. These experiments will utilize national assets in LANL and LLNL custody.
- Preliminary design calculations completed for TEX-Hf critical experiments. A report is in development.
- Detailed reports describing the surplus ZPR U-233 fissile material have been obtained for TEX-23.
- Two NCSP TPR "best papers" were submitted to ANS as "Design of Two New Critical Experiments," for the November Winter Meeting.
- Two papers, "Optimization of Hafnium Dimensions for Thermal/Epithermal Experiments (TEX) with Highly Enriched Uranium Jemima Plates and Polyethylene," and "Final Design for the Thermal/Epithermal eXperiments (TEX) with ZPPR Plutonium/Aluminum Plates

with Polyethylene and Tantalum," were accepted for publication and presentation at ICNC 2015.

- Initiated (Godiva Radiation Field) procurements including BOMAB phantoms and stands. Coordinating with IRSN to receive their equipment in the Mercury NAD Lab.
- Initiated (TEX-Pu/Ta) procurements including polyethylene moderator and reflector parts and aluminum sheets for trays/heat sinks. Initiated SCR to commence inspection and subcritical (heat) measurements with ZPPR plates in DAF. This includes NCSE preparation and ALARA review.
- Finalized design for (BeRP/Composite Reflection) with input from LANL experimenters. CED-2 completion expected in Q4.
- Finalized preliminary design calculations for (TEX-Hf). CED-1 addendum on track for completion in Q4.
- Convened two video teleconferences with IRSN to discuss: (a) additional IRSN S/U calculations; (b) IRSN commencing S/U calculation; and (c) IRSN taking the lead on (TEX/MOX) starting with scoping calculations based on LLNL provided information.
- IRSN issued a report on the meetings held at LLNL on June 22-26, 2015, to discuss details regarding the "LLNL-IRSN collaboration exchange in the framework of the DOE/IRSN collaboration." This report addresses all current collaborations and has been provided to the NCSP Manager.
- Presented two papers at ICNC 2015:
  - "Optimization of Hafnium Dimensions for Thermal/Epithermal Experiments (TEX) with Highly Enriched Uranium Jemima Plates and Polyethylene."
  - "Final Design for the Thermal/Epithermal eXperiments (TEX) with ZPPR Plutonium/Aluminum Plates with Polyethylene and Tantalum."
- Participated in one video teleconference with AWE to discuss training, receipt, installation and operation of equipment for. Also began conceptual design for the first experimental campaign.
- Completed major procurements for (NAD exercise using Godiva) with LLNL shipments scheduled for FY2016 Q1.
- Addressed CEDT review comments on final design for (BeRP/ Composite Reflection). CED-2 completion expected in FY2016 Q1.
- Completed a series of calculations to determine room return as a function of distance for (PDV).
- Completed preliminary design for (TEX-Hf) and began addressing CEDT review comments for the CED-1 addendum for completion in FY2016 Q1.
- Began independent confirmatory k-eff, α, and POI calculations for (KRUSTY). Also began multi-physics simulations.
- Convened two video teleconferences with IRSN to continue detailed discussions on.

NNSS IE
NCSP/NCERC FY15 Accomplishments
- NSTec supported the following 19 Integral Experiment Requests (IERs) through 62 separate activities:
NCSP
- (2) Comet and Planet Operations
- (21) Material Moves (Godiva Restart) [7]
  - AFS DOP Test (Godiva Restart)
  - Demonstrations for Flattop Management Review
  - Hot Operations (2)
  - Material Receipt

- Material Un-packaging
- IP-17
- MC&A Measurement
- Critical Assembly Maintenance (2)
- Planet Operations
- Godiva Operations
- Dry Runs (Godiva Restart) [2]
- (3)   Nuclear Material Operations
  - NCSP Criticality Safety Course (2)
- (5)   LANL Hot Operations
  - NCSP Criticality Safety Course (4)

Non-NCSP
- (6)   NCNS Experiments
  - DTRA Measurements
  - RTO Measurements
  - Tumbleweed Support
  - DTRA Measurements
- (2)   Radiography Measurements
  - ER Diagnostic Challenge
  - CNEC/CVT Measurements
- (4)   LANL N-Pod Certifications
- (3)   LANL NA-22 Measurements
- (6)   Comet Operations
  - ER Demonstration
  - ER Class
  - ER Class
  - MC-15 Measurements

Other General NCSP/NCERC Accomplishments
- Provided operations, and experiment support to the Nuclear Criticality Safety Program (NCSP) and the National Criticality Experiments Research Center (NCERC) at the Nevada National Security Site (NNSS) per the NCSP Five-Year Execution Plan.
- Provided infrastructure support to the Los Alamos National Laboratory (LANL) for the Idaho National Laboratory (INL) Zero Power Physics Reactor (ZPPR) storage facility, Warehouse CP-150; the LANL packaging facility, Warehouse 6-911; and the Lawrence Livermore National Laboratory (LLNL) Nuclear Accident Dosimetry (NAD) Laboratory facility, Building 23-703.
- Continued support to the Flattop Resumption and Godiva Restart efforts. Provided resources, Project Controls and Program Direction to the Temporary Task Exhaust project. Supported compliance with the LANL Bioassay program.
- Supported the Flattop Management Review and demonstrations. Completed Flattop Resumption efforts.
- Continued Safety Basis development for NCSP/NCERC DSA/TSR Change Notice 8 in support of RABBIT and the MAR and Small Quantity revision.
- In concert with LANL and DAF management, began development of the activity introduction process and schedule for RABBIT installation.
- Received and distributed the estimate for the NAD Lab Expansion project.
- Completed the INL ZPPR Criticality Safety Evaluation (CSE).
- Supported two NNSS tours at DAF and P-Tunnel; one in support of KRUSTY (NASA) and one for the Institute for Radiological Protection and Nuclear Safety (IRSN).

- Per direction from the NCSP Federal Program Manager, stopped work and removed Rabbit Transfer System installation and Change Notice 8 Safety Basis effort from the FY 15 baseline. Remaining Rabbit funds were directed to be applied to the Godiva Restart effort
- Provided National Security Technologies, LLC (NSTec) resource support to Godiva Restart in the form of Readiness, MRCB, administrative support to the Contractor and Federal Readiness Assessments, demonstrations and issues management.
- Supported NAD Lab Expansion tasks with funds provided by LLNL.
- Completed the V&V measurements of the INL ZPPR material.
- Developed the estimate to complete the Safety Basis for the full scope of the Rabbit System, both fixed and mobile, in FY 16.
- Completed NAD Lab Expansion tasks. Returned unused funds to LLNL.
- Completed FY 16 Budget Planning.
- Provided input to the NCSP 5 Year Plan.
- Provided FY 13 through FY 15 Product Data for Non-NCSP Work For Others IERs conducted at NNSS.
- Began Safety Basis planning for KRUSTY.
- Began the development of the Safety Basis schedule and estimate for MAR/TEX/Small Quantity.
- Conducted NCSP PgIB meetings on a regular basis.
- Participated in NNSS Nuclear Material Review Board (NMRB) meetings in support of additional shipments of INL ZPPR material.
- Coordinated laundry and transportation support for modesty clothing for NCERC personnel.

ORNL IE
- Coordinated and hosted monthly video-conference calls with ICSBEP evaluators and reviewers (ORNL, CEA, LLNL, and IRSN).
- Initiated analyses of three experiment pulses for SILENE benchmark.
- SILENE benchmark:
  - Organized and hosted video-conference calls with ICSBEP evaluators and reviewers (ORNL, CEA, LLNL, and IRSN) on Jan. 21 and Feb. 16. Evaluators and external reviewers (ORNL, CEA, and IRSN) met in person on March 6 in conjunction with SCALE training in Paris.
  - Resolved most, but not all, issues concerning concrete compositions involved in experiments.
  - Updated Chapters 1, 3, and 4 of benchmark evaluation. Chapter 1 review completed.
- Completed CED-2 analytical methods support.
- SILENE benchmark:
  - Resolved all internal reviewer comments concerning evaluation of pulse 1 and most of the external reviewer comments—CED-4a complete for pulse 1.
  - Presented evaluation of pulse 1 to ICSBEP review committee on May 11th—evaluation accepted with required revisions.
  - Initiated evaluation updates to address all remaining external reviewer comments and ICSBEP committee review comments (CED-4b for pulse 1).
- Status of all ORNL AM support:
  - SILENE benchmark:
    - The first SILENE CAAS benchmark evaluation (pulse 1) has been accepted for publication by the ICSBEP and will be published in the 2015 edition of the Handbook.

SNL IE

- The capability and authorization of the Sandia Critical Experiments was maintained.
- Staff proficiencies were maintained by performing critical operations.
- The first benchmark-quality measurement of an approach-to-critical on moderator height was completed in December, 2014.
- The capability and authorization of the Sandia Critical Experiments was maintained.
- Working on a titanium rod replacement experiment in the 7uPCX assembly. Work on the titanium sleeve experiment in the BUCCX assembly will begin shortly.
- Procuring sets of titanium and aluminum rods for use in fuel-replacement experiments in the 7uPCX assembly.
- The evaluation of the experiments (LEU-COMP-THERM-096) was completed and submitted for publication.
  Began fuel-replacement experiments in the 7uPCX assembly using titanium and aluminum rods. Design work is underway on the sleeve experiment in the BUCCX assembly.

Information Preservation and Dissemination (IPD)

LLNL IP&D
ICSBEP Accomplishments
- Negotiated and received 70 copies of ICSBEP 2014 DVDs from OECD/NEA for distribution to NCSP users. 45 copies distributed upon receipt.
- Updated the downloadable and on-line versions of the ICSBEP handbook.
- Assisted ORNL and SNL as reviewers to complete two ICSBEP evaluations in time for the TRG meeting in May 2015:
  - SILENE CAAS benchmark.
  - 7uPCX 0.800 cm Pitch with Variable Depth Pure Water.
- Independent reviewer of the SILENE CAAS benchmark evaluation, which included independent COG calculations for all 47 activation foils and TLDs.
- Provided independent review comments for the SNL 7uPCX 0.800 cm Pitch with Variable Depth Pure Water evaluation.
- Independent (non-NCSP) reviewer for HEU-SOL-THERM-020, Unreflected Cylinders of Uranyl-Flouride Solutions in Heavy Water.
- SILENE CAAS benchmark is on track for completion in mid-August.
- SNL 7uPCX 0.800 cm Pitch with Variable Depth Pure Water benchmark is on track for completion by July 31.
- Provided COG11.1 sample results for (non-NCSP) IEU-SOL-THERM-005, Critical Dimensions of Aqueous Solutions of $U(37\%)O_2F_2$ in Spherical Geometry.
- Independent (non-NCSP) reviewer for HEU-SOL-THERM-020, Unreflected Cylinders of Uranyl-Flouride Solutions in Heavy Water.
- SILENE CAAS benchmark completed and delivered to OECD.
- SNL 7uPCX 0.800 cm Pitch with Variable Depth Pure Water benchmark completed and delivered to OECD.
- ICSBEP recommendations for FY-2016 provided to NCSP Manager on July 23, 2015.
- Co-authored LLNL-PROC-672875, "New NCSP Contributions to ICSBEP and DICE," which was accepted for presentation at the ANS Winter Meeting in Washington, DC.

Website and Red Net Accomplishments
- Renewed and recertified computer security plan (all Core Service Descriptions) for the unclassified NCSP website.
- Changed IER CED-0 to authorize new NDAG Chairperson to process pending new IERs requests.
- Re-assigned the Nuclear Data Request form to the new NDAG Chairperson as the Manager for the NDR approval for access.
- Implemented Google 'reCAPTCHA' anti-spam on user registration web page.
- Revamped the Training and Education's registration web page with the 'honeypot' technique to block spamming from LLNL CSP.
- Created a new NCSP Technical Program Review 2015 registration web page.
- Completed certification testing for the NTS-LAN classified network.
- Completed annual re-key of TACLANES supporting the LLNL and LANL classified networks.
- Upgraded LLNL laptops/desktops to Office 2013 and latest version of Entrust.
- Installed Lac Installed Lacie network storage device on NTS-LAN (Mercury) to support "off-site" storage of system backup.
- Completed triennial LLNL cyber security audit for the unclassified NCSP website.

- Provided the venue, computer support and coordinated user presentations and logistics for the 2015 NCSP Technical Program Review and associated NCSP meetings.
- Presented NCSP website statistics for calendar year 2014 at the 2015 NCSP TPR.
- Added a memorial web page for Adolf Garcia on the NCSP website.
- Fixed both classified and unclassified web servers' critical OS kernel security bugs as required by LLNL cyber security program.
- Fixed NCERC network outage that lasted over 6 hours by replacing a failed network switch in North Las Vegas (NSF).
- Upgraded the NTS-SLAN classified diskless images with 24 security patches to fix vulnerabilities on Windows 7, Server 2008, and Server 2012 systems.
- Configured and authorized user laptops to meet Cyber Security requirements.
- Provided Escort duties in NCERC and assisted uploading of all unclassified data collected to LANL and LLNL 'Yellow Network' file servers.
- Extended the NCERC classified network to support the underground U-1A facility with protected fiber network, new TACLANE encryptor, and two diskless classified desktop computers.
- Completed NCSP C$_E$dT Efficiency Improvement Meeting Action #36 – Change the website to allow people to see the status of the tasks.
- Assigned a new IRSN CEdT.
- Added a University Training web section for the University of New Mexico and an NCSP International Collaborations section containing the DOE-IRSN MOU on the NCSP website top left menu.
- Changed NCSP website cyber security posture to prevent further hacking attacks on the University of Michigan and Georgia Institute of Technology.
- Created NCSP Hands-On Criticality Safety Training Course class photos web page for calendar years 2013, 2014, and 2015.
- Updated the NCERC classified network images to ensure the latest Microsoft patches (118) were installed as required.
- Completed a new unclassified MAC laptop for NCERC manager; Training officer, including transferring all data/documents/email. This completes the planned transferring systems from Windows to Mac for NCERC personnel.
- Completed an electronic account process for the NTS-LAN network, replacing the current the paper-based signatures/snail-mailings process.
- Provided an updated design for the top-level NCSP webpage for NCSP Manager review. Commenced work on designing second-tier webpages for the major NCSP elements.
- Provided copies of all LLNL reports that were completed as NCSP milestones for inclusion in a new retrievable file sorting system (database).
- Installed critical security updates on both unclassified and classified NCSP websites to fix bind, nss, glibc, and firefox vulnerabilities.
- Completed testing of OpenAM interoperability on classified NCSP webserver as required for ESN Site OpenAM Production Deployments in December 2015.
- Presented full paper and viewgraph presentation title "The Official Website of the U.S. Department Of Energy's Nuclear Criticality Safety Program," at the ICNC 2015 Conference, Charlotte, NC, September 13-17, 2015.
- Completed the migration all classified NCSP webserver binaries for classified NCSP webserver upgrade as required by LLNL classified security plan.
- Updated the NCERC classified network images to ensure the latest Microsoft patches (43) were installed as required to avoid vulnerabilities identified by Microsoft.
- Completed the annual classified account renewal for stand-alone systems (59 accounts).

- Created 3 new NTS-LAN accounts in support of NCERC or SCE projects.
- Completed building electronic training course for NTS-SLAN. Training conducted through LANL UTRAIN system.

PNNL IP&D
- All available FFTF fuel test measurement data relevant to actinide integral cross sections were identified and compiled into the FY15 year-end deliverable report. The data include 120 measurements with burnups ranging from 0.01 to 11 atom% from post irradiation examination mass spectrometry measurements on FFTF driver fuel tests from startup through cycle 4 and two advanced mixed U-Pu oxide tests. Test descriptions, irradiation history, core loadings, assembly pin map, axial location of samples, and archive un-irradiated sample analysis or fuel batch data were included. Data collected from these tests includes isotopics of ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu and ^{234}U, ^{235}U, ^{236}U, and ^{238}U from mass spectrometry; burnup from ^{148}Nd mass spectrometry; and some ^{242}Cm, $^{243+244}$Cm, and ^{241}Am radiometric data. The evaluation indicates these data are benchmark quality.

SRS IP&D
- Prepared revised FY-16 Plan.
- Began efforts to develop out year plan.
- Plan drafted.

BNL ND
- Continue vetting new evaluation for CIELO (16O,56Fe).
- Added capability to verify processing of photo-atomic, electro-atomic and atomic-relaxation data.
- Verified new versions of photo-atomic, electro-atomic and atomic-relaxation sub libraries
- Summer student setting up COG to perform integral validation as part of testing regime; tp run COG using Python drivers on NNDC cluster & have indexed the set of benchmarks.

LANL ND
- Several Los Alamos staff attended the annual CSEWG meeting and reported on CIELO related evaluation progress and criticality data testing with ICSBEP benchmarks.
- Los Alamos staff also participated in the WPEC Subgroup 38 meeting held the week prior to CSEWG. This Subgroup was formed to develop a modernized nuclear data format structure.
- LANL staff member was assigned as new NDAG Chair and conducted the annual NDAG meeting.
- Performed Monte Carlo Hauser-Feshbach calculations of the prompt fission gamma-ray spectra for U235 and Pu239, using our CGMF code, for thermal neutron-induced fission reactions. The results compare well with recent experimental data obtained at LANSCE and at IRMM, Geel. Working on extending those calculations to higher incident neutron energies, up to 20 MeV, for which estimates are needed for the pre-neutron fission fragment yields. Contributions from multi-chance fission and pre-equilibrium reactions will need to be incorporated. The work is in progress.
- A status report on Cu-63,65 evaluations was produced, covering:
  - initial calculations, comparing with GEANIE data
  - collection of experimental data
  - implementation of Kunieda's deformed optical potential
  - calculations, some adjustment to the experimental data.
- New high energy evaluations for Cu-63 and Cu-65 were completed. The evaluations include updated cross sections, scattering angular distributions, energy-angle distributions, and gamma-ray production. Combined new high-energy work with ORNL resonance parameters. A problem in the resonance range was identified – the average capture cross sections appear too low from 100-300 keV. This problem will be reported at the mini-CSEWG meeting at NNDC.
- The copper evaluations were tested against ZEUS benchmarks. Calculated ZEUS critical assembly eigenvalues are closer to unity when using the latest LANL isotopic Cu evaluations (results were presented at the May, 2015 mini-CSEWG).
- "Evaluation of the ^{239}Pu Prompt Fission Neutron Spectrum Induced by Neutrons of 500 keV and Associated Covariances," was accepted for publication in Nuclear Instruments and Methods in Physics Research A.
- Three papers were presented at the annual NCSP Technical Program Review:
  - "Criticality Data Testing with CIELO Candidate Evaluations."
  - "NDAG Annual Meeting Review."
  - "Recent Advances in Detailed Modeling of Prompt Fission Neutrons and Photons."
- The CGMF code was extended to handle neutron-induced fission reactions up to 20 MeV incident energy for Pu-239. Preliminary prompt fission gamma-ray spectra from thermal up to 20 MeV for that isotope have been produced. Similar results for U-235 should be obtained in the near future. Final ENDF-formatted files were to be produced in Q4, but given the budget cuts, this task would have to be postponed.

- Data Validation Committee session at May's "mini-CSEWG" meeting was organized; LANL discussed data testing and noted that the latest Cu cross sections seemed to produce improved ZEUS calculated eigenvalues. Other Cu work, also reported at mini-CSEWG, noted where ORNL needed to make further Resolved Resonance Region improvements.
- Reported on CIELO related data testing at the WPEC Sub-Group 40 meeting during WPEC week.

Note: The following work tasks began with NCSP funding, but completed with entirely different funding sources:
- Thanks to the extension of our CGMF calculations up to 20 MeV incident neutron energy, the energy-dependence of different observables such as the average prompt neutron multiplicity, the total kinetic energy of the fragments, and the average total prompt gamma-ray energy can now be studied. Model input parameter space to find a consistent description for all three quantities for n+Pu-239 for which some data are available are being explored. This approach places new stringent constraints on the physics models present in CGMF.
- Completed new evaluations for the separated isotopes of carbon (12C, 13C). Preliminary data testing indicated little change from the previous natural carbon evaluation (good). However, the capture cross sections give improved agreement with the Kadonis (astrophysical) data base of Maxwellian-averaged cross sections (MACS).
- Completed a new evaluation for neutrons on 16O at energies up to 7 MeV for the Cielo project. This evaluation will be extended to 20 MeV and submitted for ENDF/B VIII.0 during the first quarter of FY16.
- Work on implementing the hyper spherical coordinate approach for multi-body breakup channels in EDA was suspended due to the NCSP funding cut. It will be resumed during FY16.
- Participated in FY16 budget execution meeting in DC.
- A paper was presented at the ICNC 2015 Conference: "Impact of New Prompt Fission Neutron Spectrum Evaluations and the Associated Cross-Correlations on Critical Assemblies using MCNP6."
- LANL ND experts met with IRSN during ICNC 2015 to discuss details of future collaborations.

LLNL ND
- During this quarter, an "effective" density of states (DOS) for Lucite was set based on the assumption that all hydrogen atoms in the structure belong to a single group and are surrounded by a similar atomic environment. The "effective" DOS was used in the LEAPR module of the NJOY code to generate the thermal scattering law data, S(a,b), for Lucite. In addition, the calculation was extended to generate the differential (ds/dE) and integral thermal scattering cross sections of Lucite. The generation of full thermal scattering library in the ENDF format is underway. To ensure completeness of the library, the incoherent elastic scattering component is currently being considered. Finally, examination of the accuracy of the generated data is being performed. Comparisons to other hydrogenous materials such as water and polyethylene are underway. Such comparisons are helpful in isolating biases especially when they are based on the examination of the fundamental data at the various steps of the cross section generation process.
- NCSU received funding through LLNL by means of Modification No. 1 to Subcontract No. B606928.
- The calculated total scattering cross section data for Lucite were compared to experimental measurements (Anna. Nucl. Energy, Vol. 18. No. 12, pp. 689-696, 1991). Extremely good

agreement was observed. The calculated data have been developed into ACE libraries that can be used in neutronic simulations.

- Classical molecular dynamics (MD) models have been initiated to simulate polyethylene. This material represents a polymer that is composed of chains of connected ethylene (CH2) monomers. The Dreiding force-field was used for building the polymer chains. Two models were constructed. The first model focused on studying single chain systems with the objective of parametrizing the dihedral barrier height in the potential function. In this case, the chain was 500 monomers long and the simulations were executed under NVT conditions at a temperature of 300 K and for dihedral barrier heights of 2 and 3 kcal/mole. At this stage, models are being set up to simulate multiple chain systems. A model representing 20 polymer chains each composed of 250 monomers is under investigation.

- The ENDF library for Lucite (file 7 for thermal scattering of H in C5O2H8) was generated and submitted to NNDC. During this process, it was noted that the current LEAPR module of the NJOY 2012 code system cannot produce a file 7 that is consistent with the ENDF manual for compounds containing more than one secondary scatterer. Remedies to this issue are being explored.

- Molecular dynamics analysis of polyethylene continued to achieve models that reflect physical characteristics such as density and the transition from amorphous to crystalline structure. Two models have been constructed representing a totally amorphous system and a system with a crystalline fraction that may reach 100%. Both models are composed of 20 polymer chains that are each 200 monomers. The density of both systems is approximately 0.8 g/cm^3. The models were created using the MAPS simulation software to construct and pack the polymer chains. The resulting system was exported to the LAMMPS code for MD calculations using the Dreiding force field. NPT conditions were used to equilibrate the system and establish the needed structure. In particular, to create the crystalline structure, a non-symmetric supercell was created and subjected to pressure (P) variation up to 1000 atmospheres in a given direction and temperature (T) annealing between 500 and 200 K and.

- The molecular dynamics model of polyethylene was further advanced. A supercell was simulated containing 20 polyethylene chains with each chain composed of 200 monomers, which results in a total of 24,000 atoms. This system was simulated in the LAMMPS code using the Dreiding force field. A modification was introduced to the model that implemented a weak harmonic interplaner force. Under NPT conditions (P = 1 atm, T = 300 K), the simulations resulted in a system with a density of nearly 0.96 g/cm^3 and a crystal fraction of nearly 70%. The density of states (DOS) was extracted from the simulation as the spectrum of the velocity autocorrelation function. Using the extracted DOS, calculations were performed using the LEAPR and THERMR modules of the NJOY 2012 code of the inelastic scattering, the incoherent elastic scattering, and the total scattering cross sections. Preliminary comparison of the calculated total cross section data to experimental measurements show good agreement.

- A paper was published and presented at the ICNC 2015 meeting. The paper described the generalized coherent elastic scattering formulation developed at NCSU and integrated into the LEAPR module of the NJOY 2012 code. This formulation allows treating all crystalline materials and avoids approximations that result in biases reaching 15% in the total scattering cross section.

ORNL ND
- ORNL experimentalist traveled to IRMM in Belgium in October and November to continue cross section measurements for the NCSP:
  - Performed transmission measurements on "thick" and "thin" vanadium (V) samples.
  - Performed neutron capture measurements using "thick" V sample.

- Continued data reduction tasks for data measured in FY14: "thick" natural Ce sample (n,g) data and "thick" Ca sample (n,g) data—required collaboration with IRMM staff and utilization of IRMM data analysis software.
- Started effort to reduce sorted (n,g) data from capture yield to cross section data for "thick" Ca sample.
- Prepared summary trip report for nuclear data measurements taken at the GELINA facility at IRMM.
- DOE Office of Science implemented new requirements to prove "no activation" of leased samples—performed analyses to calculate activation levels for ^{142}Ce sample including all sample impurities.
- New evaluations completed for ^{235}U, ^{56}Fe, and ^{16}O and efforts initiated to perform benchmark testing as part of NDAG and OECD/NEA CIELO working groups.
- Presented status of NCSP evaluation for ^{56}Fe at Workshop on Elastic and Inelastic Neutron Scattering in Dresden, Germany.
- Using new ORNL evaluations for ^{182}W, ^{183}W, ^{184}W, and ^{186}W (completed in FY14), prepared AMPX cross-section library for testing evaluations in resonance integral calculations.
- University Task with Georgia Tech:
  - Implemented R-Matrix limited routine in AMPX to calculate energy-differential and double-differential cross sections directly from the resonance parameters found in ENDF data files.
  - Validated implementation by benchmarking against SAMMY for several isotopes, including ^{16}O, ^{19}F, ^{35}Cl, and ^{56}Fe.
  - Generated pseudo-resonance ladders from ENDF average parameters in the unresolved resonance range and reconstructed cross sections as part of a new robust methodology for creating accurate probability tables using the R-Matrix formalism.
- ORNL experimentalist traveled to IRMM in Belgium in February and March to continue the following cross-section measurements initiated during Q1:
  - Transmission experiments on "thick" and "thin" V samples.
  - Completed neutron capture experiments using a thick V sample.
  - Conducted data sorting tasks for "thin" V sample (n,g) data—required IRMM staff support and utilization of IRMM data analysis software.
  - Performed data sorting tasks for thick & thin V transmission experiments.
- Hosted BNL/NNDC staff member at ORNL for 2 weeks to save and document ORELA experimental data for inclusion in international EXFOR measurement database—majority of ORELA data were measured by the NCSP.
- Initiated evaluation efforts for dysprosium (Dy) and gadolinium (Gd):
  - Collected needed information such as resonance data and EXFOR experimental data for stable Dy and Gd isotopes: ^{160}Dy, ^{161}Dy, ^{162}Dy, ^{163}Dy, ^{164}Dy, ^{152}Gd, ^{154}Gd, ^{155}Gd, ^{156}Gd, ^{157}Gd, ^{158}Gd, and ^{160}Gd.
  - Contacted RPI to obtain more details of the experimental data available for the Gd isotopes and the associated resonance analysis of the RPI data.
- ^{56}Fe evaluation status:
  - Contacted RPI to obtain measured capture data extending resonance range to 2 MeV— needed to improve ^{56}Fe capture above 850 keV.
  - As part of testing effort, prepared MCNP input for calculating IPPE self-indication measurements that have been made available to ORNL.
- ORNL evaluator traveled to France to meet with IRSN and BRC staff to complete ^{235}U evaluation—combined ORNL resonance evaluation with BRC high-energy evaluation (including covariance data)—new ^{235}U evaluation submitted to NNDC and OECD/NEA WPEC CIELO working group.

- Submitted trip reports to the NCSP Manager covering measurement and evaluation work performed in Q1 at IRMM and IRSN, respectively.
- Presented ORNL evaluation work accomplishments at NCSP TPR in March 2015
- University Task with Georgia Tech:
  - R-matrix limited formalism successfully implemented AMPX to perform cross-section reconstruction for resolved and unresolved resonance regions.
  - Leal-Hwang Doppler broadening routine integrated into resonance reconstruction routine to provide cross sections at user-defined temperatures.
  - Ga-Tech/ORNL Methodology to generate pseudo-resonance ladders can be used to provide URR data beyond existing ENDF/B specification and can be used to generate new ENDF/B evaluations for the URR—work in progress to test resonance reconstruction capability for ^{238}U.
  - Participated in NCSP TPR at LLNL and presented status of Ga Tech resonance evaluation methodology work.
- Performed data reduction tasks for NCSP experiments completed at IRMM:
  - Ca thick sample capture data for the B filtered run and B and S filtered run reduced to cross-section data.
  - Data reduction of the Fe neutron capture experiment for the B and S filter run was performed—normalization factor from Fe to be applied to Ca experimental data.
- Continued work with NNDC to save and document ORELA experimental data for inclusion in EXFOR. Most of the data were measured for the NCSP at ORELA.
- Publication in Physical Review C 91, 0646618 (2015): Cross section measurements for neutron inelastic scattering and the (n, 2nγ) reaction on ^{206}Pb.
- Continued work on the dysprosium (Dy) and gadolinium (Gd) evaluations:
  - Assessed exiting RRR evaluations for the Dy and Gd isotopes.
  - Worked with RPI to obtain details of the Gd experimental data.
- ^{56}Fe evaluation:
  - Fitted double differential angular data from RPI measurement.
  - Worked with IAEA to improve mu-bar representation above 850 keV.
  - Continue working on the capture cross section issue above 850 keV.
- Evaluation work on ^{40}Ca:
  - SAMMY used to analyze four experimental data sets to fit resonance parameters—particle-pair in the SAMMY inputs defined to account for alpha emission at thermal energy and proton emission at ~500 keV.
  - Produced preliminary resonance parameter evaluation up to 1 MeV using transmission data of four experimental data sets.
- Thermal scattering evaluation capability development:
  - Prototype evaluation framework developed around generalized least squares fitting of molecular interaction parameters to double differential scattering measurements of thermal moderators.
  - Molecular Dynamics simulations have successfully reproduced published thermal neutron scattering for light and heavy water.
- Completed two ICNC 2015 papers on the ^{56}Fe and W evaluation work performed for the NCSP – papers accepted for publication.
- University Task with Georgia Tech: R-matrix limited formalism successfully implemented AMPX for resolved and unresolved resonance regions.
- Data reduction to cross sections of ORNL experiments at IRMM for Q4:
  - Investigated inconsistencies of the (n,γ) experimental data of the boron (B) and sulfur (S) filtered run for the thick Ca sample—no solution identified for observed discrepancies compared to the B filtered Ca experiments. Further investigation at IRMM is needed.

- Natural Ce (n,γ) data for the 2mm sample obtained with the B and S background filters reduced to cross-section data.
- Natural Ce neutron transmission data for the 2mm sample obtained with the B, sodium and S background filters reduced to total data.
- Evaluated resonance parameter files for the Ce isotopes obtained from ENDF library and SAMMY input files produced (including all experimental effects)—in process of testing data.
- Completed draft ^{56}Fe and ^{16}O evaluations as part of OECD/NEA CIELO working group effort – evaluations undergoing testing.
- ^{63,65}Cu evaluations: corrected normalization error in experimental data for (n,γ) measurements above 220 keV and re-evaluated data to eliminate the issue identified by Kawano at MINI CSEWG 2015; matching of resolved resonance evaluation to high energy evaluation.
- ^{40}Ca Evaluation:
  - Definition of the channel related to the alpha-particle emission required a test of 1) the Coulomb functions in SAMMY and 2) the behavior of the (n,α) cross sections computed in the Reich-Moore approximation by SAMMY.
  - Mostly on the basis of transmission data, work on spin assignment of resonance parameters was performed in the upper limit of the resolved resonance region (800-900 keV).
- Thermal scattering evaluation capability development:
  - Improved convergence of computed $S(\alpha,\beta)$ with number of water molecules in molecular dynamics (MD) simulations and have found that ~800 molecules to be convergent—4x reduction.
  - Initiated sensitivities of $S(\alpha,\beta)$ w.r.t. MD interaction parameters to be used in generalized least-squares fitting of measured SNS data.
  - MD simulations in evaluation framework will be updated to include ab initio MD simulations in order to reproduce measured differential data and provide $S(\alpha,\beta)$ for H_2O thermal total cross-section data.
- University Task with Georgia Tech: completed quasi-resonance parameter evaluation for ^{238}U in URR (20 – 100 keV) using SAMMY.
- Published the following papers at the ICNC 2015 Meeting:
  - Benchmark Testing of a New ^{56}Fe evaluation for Criticality Safety Applications.
  - Evaluated ^{182,183,184,186}W Neutron Cross Sections and Covariances in the Resolved Resonance Region.

RPI ND
- Completed development of a new iron filtered beam method for neuron capture cross section measurements in the unresolved resonance region.
- Completed resolved/unresolved resonance region neutron capture measurements on Tantalum-181 in 2mm and 6mm sample thicknesses.
- Completed Fe elastic/inelastic data analysis and working on inclusion in new Fe evaluation.
- Hired a new Research Associate that will work on NCSP and SSAA tasks.
- Verified that spectrometer resolution that was found for polyethylene works for the light water sample at same chopper settings.
- Compared quartz to updated ENDF/B-VII.1 evaluations and found significant differences.
- Implemented a different approach to generating ENDF files for water simulations, in collaboration with ORNL, where thermal scattering data from both simulation and experiments will be incorporated into ENDF files manually.
- Improvement to experiment analysis:
  - Began implementing transmission-dependent weighting function in the data analysis code.

- Refined in-beam background subtraction method using natural lead sample.
- Completed detailed neutron sensitivity calculations using MCNP.
- Final steps of analysis of resolved/unresolved resonance region neutron capture measurements on Tantalum-181 in 2mm and 6mm sample thicknesses.
- Final steps of analysis of Fe capture data above up to 2 MeV.
- Submitted paper for publication at ICNC 2015 Conference.
- Validate the SNS data reduction procedure by comparing our polyethylene experiments from SEQUOIA and ARCS.
- Tested new independent light water evaluation from the Comision Nacional de Eneria Atomica (Argentina) that shows a quality of agreement between the experiment and evaluation that is similar to ENDF.
- Created logical algorithm to validate the process we use to compare the evaluations to experimental results.
- Klystron purchase is with the vendor and work began in Jan 2015.
- Completed stable release of DAQ system control and acquisition software with multi-threaded plotting and up to 64-channels (detectors) capability.
- Identified sources of background in the gamma-ray spectra of Fe, B_4C and Pb samples to improve flux measurements and time-dependent background normalization.
- Optimized data post-processing software to enable 10x speedup in pulse data processing and spectrum analysis.
- Designed new proton recoil detector for flux shape measurements for neutrons energy above 500 keV.
- Paper was submitted to ICNC 2015.
- Generated ENDF files directly from the experimental data for Polyethylene. The file was successfully processed with NJOY2012.
- Performed improved molecular dynamics simulation on water and polyethylene in format suitable to producing S(a,b) and phonon spectrum calculations.
- Created logical algorithm to validate the process we use to compare the evaluations to experimental results.
- Klystron purchase is with the vendor and work began in Jan 2015.
- Met the Thales representative at RPI, Klystron production is on schedule.
- Performed tests on the Total and Inelastic Cross Sections of the material evaluations and good agreement was found on most (H_2O, CH_2), except for differences in the SiO_2 files.
- Modulator vendors (ScandiNova, Directed Energy) visited RPI and preliminary quotes were then provided.
- Completed Fe-56 capture measurements, the data are being analyzed. Preliminary was exchanged with IRS.
- Presented work at ICNC 2015 in Charlotte, NC, "Capture Cross Sections in Nat-Fe and 181-Ta from 1 to 2000 keV Using a New C6D6 Detector Array."
- Developed software utilities to verify the statistical integrity of flux monitor and detector count rates during experiments.
- Using two approaches to produce a polyethylene evaluation based on experimental data:
  - Removed instrument resolution & elastic peak from double differential scattering data, Created and ACE file to be compared with the double differential scattering data.
  - Generated new S(a,b) file for polyethylene using LEAPR (NJOY2012) from the experimental phonon spectrum measured at ARCS (SNS). Observed good agreement with measured double differential data.
- Tested the new updated ENDF/B-VII.1 SiO_2 Thermal Scattering Law file and found it to still have significant differences with our experimental data.

- Signed the project contract with Naval Reactors (NRLFO).
- Klystron purchase is with the vendor and work began in Jan 2015.
- Submitted two papers to the ND session in AccApp 2015 part ANS Winter meeting.
- Visit to the factory for first klystron acceptance test is scheduled for 12/2015.

Training and Education (T&E)

LANL T&E

- Participated in regularly scheduled NCSP T&E conference calls.
- Prepared handouts for all course material for Week 1 at LANL of NCSP criticality safety training course for criticality safety practitioners.
- Coordinated LANL access, and enabled PF-4 specific access, for all course participants which included uncleared US citizens, an uncleared UK citizen, and three uncleared French citizens.
- Various training modules were updated as needed based upon student feedback and comments from the NCSP T&E team.
- Alternative demonstrations were being planned including the use of a new set of polyethylene plates for use with the class foils in the handstack/approach to critical demonstration.
- Participated in scheduled NCSP T&E conference calls.
- Coordinated LANL access, and enabled PF-4 specific access, for (week 1 of two week practitioner course) all course participants which included uncleared US citizens.
- Provided instructors for week 1 of two week practitioner course hosted at LANL in June.
- Provided instructors, escorts, and operators for NCERC "hands on" training class in June.
- Demonstrated use of a new set of polyethylene plates for use with the class foils in the handstack/approach to critical demonstration.
- Instructors helped upgrade the evaluation exercise.
- Participated in scheduled NCSP T&E conference calls.
- Provided instructors, escorts, and operators for NCERC "hands on" manager's class in August.

LLNL T&E

- Provided registration and logistics support for all NCSP courses including:
  - January 5-16 two-week course at LANL and SNL
  - January 26-30 one-week NCERC course portion
  - February 9-13 Manager's course at SNL
  - March 9-13 AWE course at NCERC
- Initialized content for AWE one-week NCERC course.
- Updated NMO Secondary Real Estate Operating Permit (REOP), Integration Work Sheets (IWSs) and Work Package for TACS training activities.
- Provided temporary funding to participate in a contractor readiness assessment (CRA) for NCERC.
- Participated in all T&E teleconferences.
- Provided registration and logistics support for all NCSP courses including:
  - January 5-16 two-week course at LANL and SNL
  - January 26-30 one-week NCERC course portion
  - February 9-13 Manager's course at SNL
  - March 9-13 AWE course at NCERC
- Provided instruction in Modules 1-4 for the two-week course at NCERC on January 26-30.
- Provided Introduction to Experimental Methods and TACS instruction for the AWE course.
- Coordinated with NSTec to provide AWE students with US DOE Radiation Worker (RWII) training.
- Coordinated with JLON and NFO to complete a security plan for AWE foreign nationals to access the NNSS, DAF, and stay overnight in the dormitories.

- Provided two security escorts for March 9-13 for the AWE course.
- In process of qualifying a new TACS instructor to support future NCSP courses.
- Participated in all T&E teleconferences.
- Provided registration and logistics support for the NCSP two-week course conducted at LANL, NCERC and SNL on June 15-26.
- Provided instruction for Modules 1-4 for the two-week course at NCERC on June 22-23.
- Two LLNL potential future instructors completed the two-week NCSP course at LANL and SNL as part of their training and qualification program.
- Updated NMO/TACS Radiation Work Permit, which now allows student handling with only Radiation Worker I qualification. This change was accomplished in order to accommodate Admiral Richardson (NR-1).
- Prepared for the one-week Managers' course at NCERC scheduled for August 24-28 (Q4).
- Provided registration and logistics support for the NCSP one-week Managers course conducted at NCERC on August 24-28, 2015.
- Provided instruction for the one-week Managers course at NCERC on August 24-28, 2015, on:
    - Module 9, Experimental Methodology
    - Module 10, TACS Methodology
    - Module 11, TACS "Hands-On" Training
- One LLNL instructor-in-training assisted in the conduct of the LLNL course portions.
- In conjunction with the T&E Management Team, LLNL worked on new course logistics and updated course materials on nuclear criticality safety evaluations as part of the transition of the two-week course from LANL to NFO.
- Updated T&E portions of the NCSP website to include new course dates for FY-2016.

ORNL T&E
- Initiated development of procedure to standardize the T&E course registration, course materials/changes, logistics, and evaluation.
    - Content is being solidified and will contain procedural information from all T&E POCs relevant to conducting the course.
- Continued development of two draft modules: 1) Validation and 2) Heterogeneous Systems (includes potential new experiment at NCERC using the Planet Handstack/foils experiment)—new modules may be added to the T&E classes pending approval by NCSP Manager.
    - Validation module reviewed by ORNL and LLNL—comments provided and efforts in process to update module.
    - Heterogeneity module draft completed—learning objectives added to the class slides. Proposed experiment to accompany module will be conducted once experiment is approved and operations approved for restart in the Flattop/Planet building at the DAF.
- Organized and led weekly T&E conference calls to coordinate execution of the FY15 training courses.
- Additional telecons and phone discussions conducted to enhance NDA and Human Factors integration efforts for the January LANL class.
    - NDA discussions about the types of NDA equipment present in PF-4 and their function is planned prior to the PF-4 tour.
    - PF-4 tour may include the NDA lab, if available.
    - NDA topics have also been incorporated into new evaluation exercise.
    - Human factors discussion is intended to be included throughout the week and included in the discussions on fundamentals, standards, and criticality accidents.

- New agenda has been created to address this reorganization of the training material to better integrate the NDA and HF topics throughout the week.
- Coordinated and held LANL/SNL 2-week hands-on course 1/5-1/16/15.
- Coordinated and held 2nd week NCERC hands-on course 1/26-1/30/15.
- Coordinated and held Sandia 1-week manager course 2/9-2/13/15.
- Continued development of procedure to standardize the T&E course registration, course materials/changes, logistics, and evaluation.
  - Content is being solidified and will contain procedural information from all T&E POCs relevant to conducting the course.
- Continued development of two draft modules: 1) Validation and 2) Heterogeneous Systems (includes potential new experiment at NCERC using the Planet Handstack/foils experiment)—new modules may be added to the T&E classes pending approval by NCSP Manager.
  - Validation module draft completed – NCSP Manager requested that information about S/U techniques such as Whisper and TSUNAMI be added to module—revised draft will be sent to CSSG for review.
  - Heterogeneity module draft completed—learning objectives added to class slides. Proposed experiment to accompany module will be conducted once experiment is approved and operations approved for restart in the Flattop/Planet building at the DAF. As of April 15, 2015, a dry run for the experiment has not been performed because of the Godiva restart activities.
- Organized and led weekly T&E conference calls to coordinate execution of the FY15 training courses.
- Additional telecons and phone discussions conducted to enhance the NCS class exercise with respect to consistency, student interaction, and instructor (NDA and Human Factors) interaction for the June course.
  - LANL course agenda has been modified to include new CSED exercise workshops and moving human factors introductions to Monday morning after the Process Accident Lessons Learned Module.
  - The status of the NCSP Training and Education courses was presented by the course coordinator at the Technical Program Review Meeting at LLNL on March 19, 2015.
- Coordinated and conducted LANL/SNL/NCERC 2-week hands-on course 6/15-6/26/2015
- Started planning process for August NCERC Manager course.
- Continued development of procedure to standardize the T&E course registration, course materials/changes, logistics, and evaluation.
- Completed the development of two draft modules: 1) Validation and 2) Heterogeneous Systems (includes potential new experiment at NCERC using the Planet Hand stack/foils experiment)—new modules may be added to the T&E classes in FY16 pending approval by NCSP Manager.
  - Validation module draft completed – NCSP Manager requested module include modern S/U techniques such as Whisper and TSUNAMI—ORNL plans to complete Validation module update in Q4.
  - Heterogeneity module draft completed—dry run of the experiment is pending.
- Organized and led weekly T&E conference calls to coordinate execution of the FY15 training courses in Q3.
- Prepared T&E status report for NCSP Management meeting in June 2015. As a result of this meeting, preliminary efforts initiated to relocate the LANL classroom portion of the 2-week course to the Nevada Field Office starting in FY16.
- Coordinated and conducted NCERC 1-week manager course 8/24-28, 2015

- Summarized student feedback and provided the results to the course POC.
- Archived all FY2015 NCSP T&E course materials, student feedback forms, and course exams on the SharePoint Site.
- Completed a draft procedure to standardize the T&E course registration, course materials/changes, logistics, and evaluation:
  - Initial procedure outline was provided.
  - Course coordinator received feedback from course POCs to develop a draft. A review is being conducted.
- Completed the development of two draft modules:
  - Validation module– NCSP Manager requested module include modern S/U techniques such as Whisper and TSUNAMI. Currently in final review.
  - Heterogeneity module draft completed—dry run of the experiment is pending.
- Organized and led regular T&E conference calls, as needed, to coordinate execution of the FY15 training courses in Q4.
- Organized and began transition efforts for the LANL classroom portion of the 2-week hands-on course to the Nevada Field Office in FY16:
  - The course coordinator organized and led routine telecons to coordinate work assignments for the NFO course.
  - The course coordinator met with NFP POCs to discuss the LANL classroom transition to NFO in Feb./Aug. 2016.
  - The course coordinator is working with new course instructors regarding training assignments and course material modifications. Conducted turnover activities with LANL classroom POC and instructors.
  - Developed an updated course agenda to reflect needed changes for the course transition.
  - The T&E team is augmenting the course evaluation module into a formal set of workshops to enhance NCSE training. The workshops will replace the time typically filled by the LANL PF-4 tour. NDA and Human factors instructors are heavily involved to enhance these components of the course.
    - Draft workshop course materials have been developed and are under review by the NFO instructor team.
  - The NCSP T&E website is being updated for impacts related to the transition of the classroom training to NFO, e.g., prerequisites, brochures, logistics, registration, etc.
    - A new accident module for the 1978 Idaho accident is being developed.
- Prepared a formal paper and presented a NCSP T&E poster at the International Conference of Nuclear Criticality in Charlotte, NC, on September 15, 2015.

SNL T&E
- Preparations were completed for the NCSE class to be presented in January, 2015.
- Preparations are underway for the Managers class to be presented in February, 2015.
- A hands-on criticality safety class for Nuclear Criticality Safety Engineers was presented in January, 2015
- A hands-on criticality safety class for Fissile Material Managers was presented in February, 2015
- Preparations for a class for NCSEs at the end of June, 2015.
- A hands-on criticality safety class for Nuclear Criticality Safety Engineers was presented in June, 2015.
- A hands-on criticality safety class for Fissile Material Managers at NCERC in August, 2015 was supported.

NCSP TECHNICAL SUPPORT

- Provided management and performed oversight/coordination efforts for the following NCSP Program Elements:
  - Information, Preservation, and Dissemination
  - Integral Experiments
    - Includes coordinating and scheduling integral experiments and oversee execution of the integral experiments per the NCSP IER and CEdT processes (including classified reports).

- Information, Preservation, and Dissemination Accomplishments:
  - Initiated and worked on collecting NCSP past work products (non-NCSP IER documents, papers, reports, evaluations, etc.) and foreign trip reports to be posted on the NCSP Website.
  - Worked with NCSP Website manager to initiate development of a searchable database for easy retrieval of these products.

- Integral Experiments Accomplishments:
  - Participated as task team members to the Critical Subcritical Experiment Design Team (CEdT) to improve the process and activities associated with new and progressing Integral Experiment Requests (IERs).
  - Generated final draft of the C_EdT Manual. NCSP MGT team reviewed the manual and comments were incorporated.
  - Worked with AWE on coordinating discussions on their neutron spectrometry capabilities in support of KRUSTY.
  - Coordinated and scheduled integral experiments and oversaw execution of the integral experiments per the NCSP IER and C_EdT processes.
  - Managed and provided oversight/coordinate efforts for the NCSP IER and C_EdT processes, including classified reports.
  - Finalized IE Section of the 5-Year Plan including a 5-year NCERC schedule with several new facility milestones and projects added.
  - Finalized all FY 2015 IER initiations, CED-0 approvals, team assignments, website updates, and prioritization. Updated all IE GANTT Charts appropriately. Closed out all FY 2014 IERs and uploaded appropriate information for archive.
  - Opened all FY 2015 IERs, updated team members and priority for all IERs, uploaded appropriate information for archive.

- Training and Education Program Accomplishments:
  - Coordinated efforts to invite potential new customers (WestPoint) to take part in our Hands-on Training Program
  - Monitor efforts for NCSP T&E support for an US military training program.
  - Worked on the TEP action list for Classroom Training being moved from LANL to NFO.

- Five-Year Plan Accomplishments:
  - NCSP FY15 5-Year Plan:
    - Performed multiple tasks related to new emergency budget numbers for client.
    - Completed mid-year revision to the NCSP 5-Year Plan, due to budget impacts.
    - Prepared task list budget for new FY 2015 NCSP budget (MASTER Task List).
    - Generated new mid-year FY 2015 5-Year IE Section Plan for CR.

- Performed multiple tasks related to new emergency budget numbers for client.
  - Finalized Budget for FY 2015 NCSP (MASTER Task List).
  - Finalized NDAG prioritization of FY 2015 Task List and ND GANTT Charts.
  - Prepared new WAS for finalized Budget for FY 2015 NCSP (MASTER Task List).
  - Finished and published a mid-year revision to the NCSP 5-Year Plan in April 2015.
  - Reviewed/revised task list as needed.
- NCSP FY16 5-Year Plan:
  - Prepared for FY 2016 NCSP task list for new proposals coming in.
  - Started work on FY 2016 budget.
  - Completed university proposal task list, worked with CSSG on prioritization.
  - Completed new work proposal task list and worked with NCSP manager on first-cut list.
  - Worked on Task list budget for new Budget for FY 2016 NCSP including funding distributions (MASTER Task List/WAS).
  - Worked with CSSG on first cut at reduction of funding for FY16 tasks and supplemental task prioritizations.
  - Prepared task list for international collaboration efforts with AWE and IRSN, including meeting with international colleagues.
  - Prepared task list for international collaboration efforts, including meeting with international colleagues.
  - Finalized NCSP Out year NCSP funding profile prediction for out years as reflected in the Master Task List (major budget changes for out-years).
  - Worked on Task list budget for new Budget for FY 2016 NCSP including funding distributions (MASTER Task List/WAS).
  - Coordinating efforts with Task Managers on priority of tasks, budget limits, etc.
  - Generated plan Appendices including all associated GANTT charts for 5-year plan
  - Finalized FY 2016 Task List and all out year funding based on base support numbers and new information from the NCSP Manager in regards to out year funding.
  - Created multiple sites splits and task lists for various continuing resolution scenarios as requested by the NCSP Manager.
  - Finalized 5-Year Plan Charts from Master Task List.
  - Maintained communication with Task Managers for final budget data for Task List.
  - Gathered first round of information for the IE Section of the Five-Year Plan. Started modifications of IER GANTT Charts.
  - Reviewed/revised task list as needed.

- International Collaboration Coordination Accomplishments:
  - Manage and provide oversight/coordinate efforts for the NCSP International Collaboration with IRSN and AWE—includes continued work establishing/reinforcing the NCSP International Collaboration Technical Exchange Agreements for AWE and IRSN and with LLNL, SNL, and LANL.
  - Continued work on multiple individual tasks for the NCSP International Collaboration Meeting with IRSN and AWE.
  - Continued work for establishing/reinforcing the NCSP International Collaboration Technical Exchange Agreements for AWE and IRSN and with SNL and LANL.
  - Coordinated effort for AWE visit with DOE, LANL, and LLNL.
  - Continued work on multiple individual tasks for the NCSP International Collaboration Meeting with IRSN and AWE.
  - Continued work for establishing/reinforcing NCSP International Collaboration Technical Exchange Agreements for AWE and IRSN and with LLNL, SNL, and LANL.

- Traveled to AWE and IRSN in June 2015 to discuss joint tasks and prioritization of those tasks, funding, personnel manpower, etc.
- Monitored efforts for the NCSP International Collaborations with IRSN and AWE.
- Held NCSP International Collaboration Meeting with IRSN and AWE and began work on Appendix E and F of 5-Year Plan.
- Continued work for establishing/reinforcing the NCSP International Collaboration Technical Exchange Agreements.

- NCSP General Accomplishments:
  - Met with NCSP Manager at DOE HQ to prepare for the BEM, June 25, 2015, DC.
  - Initiated work on the NCSP action list.
  - Prepared agendas, task list, prioritization lists (International Collaborations, ICSBEP, NDAG Appendix B, Foreign Travel), etc. for all meetings at the FY 2016 Budget Execution Meeting.
  - Coordinated efforts to plan annual NCSP Budget Execution Meeting (BEM), to be held in Washington, DC July 28-30.
  - Worked logistics for various side meetings to be held at the annual 2016 Budget Execution meeting.
  - Prepared for and executed the Budget Execution Meeting in Washington DC (July 2015). Finalized agendas, task list, prioritization lists (International Collaborations, ICSBEP, NDAG Appendix B, Foreign Travel), etc., for all meetings at the FY 2016 Budget Execution Meeting.
  - Collected and Reviewed FY 2014 Q4 Quad Charts.
  - Collected and Reviewed FY 2015 Q1, Q2 and Q3 Quad Charts.
  - Lead FY 2014 Q4 QPR call.
  - Lead FY 2015 Q1, Q2 and Q3 calls.
  - Started logistics for various side meetings to be held at the annual 2015 TPR meeting.
  - Attended and participated in the Winter ANS meeting. Co-chaired NCSP FY 2014 Accomplishments Session.
  - TPR Closeout Actions: Finalized details from annual 2015 TPR meeting, including notifying Best Paper Award Winners, who will present papers at the Winter ANS meeting.
  - Supported NCSP Manager in meetings with Nevada DOE and NSTec to work on Godiva and NCERC restart issues. Also, provided joint NCSP-IRSN briefing to IRSN Director General, NFO, and NCSP staff.
  - Coordinated meetings with international colleagues for Task List reviews and prioritization.
  - Participated in several NCSP management team and other NCSP-related meetings as required by the NCSP Manager.
  - Participated in ANS Summer Meeting in San Antonio, TX June 2015 and performed work for ANSI/ANS-8.28 Technical Working Group.
  - Participated in International Conference for Nuclear Criticality (ICNC) Meeting in Charlotte, NC, September 2015
  - Met with NCSP Manager at ICNC to discuss topics related to publishing the NCSP 5-year plan.
  - Coordinated efforts for the annual ANS Winter meeting session for the NCSP Technical Accomplishments.
  - Participated in several NCSP management team and other NCSP-related meetings as required by the NCSP Manager.
  - Prepared and posted the FY 2014 list of NCSP Accomplishments to NCSP website.

- Coordination and logistics for the annual 2015 TPR meeting including numerous side meetings-- Participated in FY 2015 TPR.
- Prepared various charts and information for the September 2015 CSSG meeting as requested by NCSP Manager.
- Performed work for ANSI/ANS-8.28 Technical Working Group.
- Performed work for ANSI/ANS-8.20 Technical Working Party.
- Finalized C_EdT Section of DOE NNSA NCERC Update presentation ("Management Perspective on Recent Accomplishments and Future Plans for NCERC") for the 2015 ANS Winter Meeting.
- TS7 Succession Planning Task:
- ORNL successfully completed ND succession planning task to train an ORNL student:
  - Student completed PhD (2013) and ORNL postdoc assignment (2015).
  - Student completed ^{63,65}Cu evaluations and developed SAMINT evaluation tool that couples resonance parameter analysis with integral data analysis.
  - Student became ORNL staff member on October 1, 2015.

Criticality Safety Support Group (CSSG)

- CSSG Chair/Deputy Chair duties
- Support of Tasking 2014-02 (Validation) (Completed)
- Support of Tasking 2014-03 (Pu Handbook) (Completed)
- Support of Tasking 2014-04 (Solution Reactor)
- Support of Tasking 2014-05 (Evacuation and CS)
- Support of Tasking 2015-01 (UPF CTA Interpretation) (Completed)
- Support of Tasking 2015-02 (Revision to DOE-STD-3007) (Ongoing)
- Support of Tasking 2015-03 (AA Handbook) (Completed) (Ongoing)
- Support of Tasking 2015-04 (STD-1020 Handbook) (Completed)
- Attend CSSG/NCSP Meeting at LLNL
- General review of normal CSSG correspondence
- Support CSSG Telecons & Leadership Telecons
- CSSG/CSCT liaison activities
- CSSG New Member Candidate Selection and Telecons
- Support for ANS meeting attendance
- CSSG Face-to-Face in Aiken
- Review of NNSA Technical Bulletin
- CSSG Retrospective paper for EFCOG/CS SAWG
- Support for PF-4 Readiness Red Team

Summary Report on LLNL Participation in
US and International Analytic Methods Collaborations in FY-2015

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September 30, 2015

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Auspices

Disclaimer

Executive Summary

This document fulfills a specific analytic methods milestone given in the 2015 Five-Year Execution Plan for a summary report of LLNL participation in US and international analytical methods collaborations.

Table of Contents   **Page**

0.0   Introduction

This document fulfills a specific analytic methods milestone given in the 2015 Five-Year Execution Plan for a summary report of LLNL participation in US and international analytical methods collaborations. Part 1.0 of the report addresses collaborative work with other elements of the Lawrence Livermore National Laboratory. Part 2.0 addresses collaborations with other US national laboratories, US universities, and foreign laboratories.

1.0   Internal Collaborations

1.1   OFFICE OF THE DIRECTOR

1.1.1   Environment, Safety and Health (ES&H)

LLNL analytic methods used to develop the databases for the delayed fission gamma (DFG) feature in COG11.1 under DOE NCSP auspices are also used to calculate the concentration of fission product isotopes per fission as a function of time. This data, together with fission product activities identified and measured by Dr. Dave Hickman (ES&H) in irradiated ^{235}U foils, was used to estimate Godiva-IV excursion yields in IER-147, and this important analytical methods capability will be maintained for use in FY-2016 to support IER-148 and IER-252, and IER-175, IER-252, IER-253, IER-268, and IER-406 in the out-years.

1.1.2   Institutional Quality Program

In FY-2015, the COG code development team continued to collaborate significantly with Darrel Whitney, LLNL Software Quality Assurance (SQA) Manager, to upgrade COG (risk level 3 with major developmental control) software to meet all Institutional Software Quality Assurance Program (ISQAP) requirements for compliance with 10CFR830, DOE O 414.1D and NQA-1. Per Whitney, COG is now fully compliant and well positioned for inclusion in the DOE Safety Software Quality Assurance Central Registry[1] as a "toolbox" code.   In FY-2016, additional work may be required for compliance with changes to NAP-24, Weapon Quality Policy.

Note that MCNP and SCALE are not developed nor maintained to 10CFR830 or NQA-1 standards by LANL and ORNL, respectively, as confirmed directly with the code team leaders. Therefore, the NCS Division applied the LLNL NQA-1 program to qualify MCNP equivalent to commercial grade dedication. SCALE and TRIPOLI may be similarly qualified as time and funding permits.

1.2   ENGINEERING

1.2.1   Chief Electronics Engineer

In 2012, the Planet and Flattop critical assembly machines at NCERC experienced two control system anomalies resulting in uncommanded movements of the machines. Joe Galkowski, Chief Electronics Engineer, in collaboration with the NCS Division Leader, dispatched Albert Lee, Robert Reed, Mathew Brown and David Milhouse to trouble-shoot and fix the electronics and programmable logic control (PLC) systems enabling these machines to return to service[2]. In FY-

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[1] http://energy.gov/ehss/safety-software-quality-assurance-central-registry
[2] Dr. Jerry McKamy, letter to Monya Lane, Associate Director for Engineering, August 28, 2012.

2015, Doug Modlin[3] replaced Joe as Chief Electronics Engineer. Should NCERC require LLNL electronics engineering support including software (i.e., analytic methods) relating to PLCs, the NCS Division Leader will coordinate this support through Doug.

1.2.2   Computational Engineering Division

Bob Ferencz, Computational Engineering Division Leader, in collaboration with the NCS Division Leader, continues to provide high-priority access to Soon Kim, John Scorby et al., on unclassified and classified Livermore Computing high performance machines. This access is essential for multi-physics simulations in support of IER-299, Kilowatt Reactor Using Stirling TechnologY, accident analysis, in addition to computationally challenging problems such as IER-126, Silene CAS Benchmark.

1.3   GLOBAL SECURITY N-PROGRAM

The NCS Division and N-Program continue to collaborate in the application and development of analytical methods (i.e., SrcSim, BIGFIT, and their successor codes) to analyze experimental and simulated subcritical (multiplicity) benchmark count distributions including:

- IER-143, Benchmarking Multiplication Calculations with Neutron Multiplicity Measurements
- IER-160, Plutonium Sphere Reflected with Tungsten
- IER-161, Plutonium Sphere Reflected with Nickel (complete)
- IER-407, ISSA Subcritical Multiplicity Benchmark
- IER-422, Plutonium Sphere Reflected with Copper

In FY-2007, at the request of N-Program, the NCS Division[4] enabled sampling of the fission multiplicity distribution (as opposed to just nu-bar) in COG to enable analog Monte-Carlo calculations simulating the measured count distributions so that both measured and simulated data could be analyzed using the same analytical methods (e.g., BIGFIT). This approach utilized the user-specified source and user-specified detector options in COG. In FY-2016, these features will be reviewed and standardized with funding support from N-Program.

1.4   NIF AND PHOTON SCIENCE

The NCS Division continues to work with Dr. Jim Hall to add high-fidelity nuclear resonance fluorescence cross-sections for additional materials of interest and maintain "… COG, which is now the sole code that contains correct physical modeling for the accurate prediction of nuclear resonance fluorescence detection scenarios" as stated in the FY-2014 LDRD Annual Report, UCRL-TR-113717-14, pp. 299-301.

In FY-2016 and beyond, NIF is expected to continue to provide financial support to further develop COG as the "premiere nuclear photonics simulation tool."

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[3] https://pao-int.llnl.gov/news/memos/2015/po-45.23.pdf
[4] http://cog.llnl.gov/UCRL-PROC-231582.pdf

1.5 PHYSICS AND LIFE SCIENCES

1.5.1 Equation of State and Materials Theory Group

In FY-2014, the NCS Division (John Scorby) collaborated with Phil Sterne et al. to develop new equations of state for uranium with detailed metal-metal phase transitions in support of the ROMEO Project. This capability may be required in future.

1.5.2 Nuclear Data and Theory Group

In FY-2015, the NCS Division (Dave Heinrichs) continued to collaborate with Bret Beck and Caleb Matoon on FUDGE, which is LLNL's advanced nuclear data processing code being developed in support of the proposed Global Nuclear Data (GND) format under WPEC SG38. Dave Brown (BNL) is also an active collaborator in this project.

1.5.3 Nuclear Security Physics Group

Essential N-Program (see Section 1.3) subject matter experts reside in the Nuclear Security Physics Group including Les Nakae (Deputy Group Leader), Greg Keefer, Phil Kerr, Jerome Verbeke and Sean Walston.

1.5.4 Rare Event Detection Group

Nathaniel Bowden (Deputy Group Leader) provides subject matter expertise in radiation detector design, manufacturing, development and deployment. In FY-2016, or in the out-years, the NCS Division will collaborate with Bowden to develop independent analysis software to support LLNL's long-term use of the new AWE-developed Passive Neutron Single Sphere Spectrometer, which will require Monte Carlo calculation of the detector response as a function of energy and development of spectrum unfolding software.

1.6 WEAPONS AND COMPLEX INTEGRATION

1.6.1 Nuclear Materials Technology Program

SBK-08-085, Memorandum of Understanding between the Nuclear Materials Technology Program (NMTP) and Nuclear Operations (NucOps), assigns responsibility for 10CFR830 software used in criticality safety evaluations supporting WCI nuclear facilities to the NCS Division Leader. A portion of the NMTP budget for criticality safety support is available for maintenance and limited development of COG and other analytical methods.

1.6.2 Weapons Simulation and Computing Program

The NCS Division (John Scorby) is working closely with computational physicists to develop, maintain and apply modern LLNL-developed multi-physics analytical methods on high-performance computing machines supporting:

- IER-268, PDV Measurements of Godiva for Validation of Multi-Physics Simulations
- IER-299, Kilowatt Reactor Using Stirling Technology

1.6.3 Weapon Technologies and Engineering Program

The Weapon Technologies and Engineering Program supports Directed Stockpile Work managed by the Defense Technologies Engineering Division. This work includes criticality safety evaluations for work involving nuclear weapons, nuclear weapon components, and their transport outside nuclear facilities, and in facilities at NNSS and other NNSA Defense Program sites. In FY-2016, NAP-24 is expected to be revised, which may require the LLNL ISQAP to be updated in which case the activity level SQAPs, SCMPs, etc., may need to be revised as well. In this case, the WTE Program should provide additional funding support.

2.0 External Collaborations

2.1 US NATIONAL LABORATORIES

2.1.1 Bettis Atomic Power Laboratory (BAPL)

LLNL (Dave Heinrichs) and Bettis Atomic Power Laboratory (Mike Zerkel) are partners with North Carolina State University (Ayman Hawari) in developing new thermal scattering laws and associated data processing tools under the Nuclear Data element of the DOE NCSP; however, testing the new data is performed under the Analytical Methods element.

In FY-2015, NCSU developed a new thermal scattering law for poly-methyl-methacrylate (PMMA) (or $C_5H_8O_2$ with trade names: Lucite, Plexiglas, Acrylite, Perspex). This data has been provided by NCSU to LLNL and Bettis for testing using COG and MC21. Preliminary analyses identified no ICSBEP benchmarks sensitive to the thermal scattering law. This was a surprise! However, pulsed neutron data is available which ranges from no sensitivity in (large) low leakage systems to very high sensitivity in (small) high leakage systems. MC21 is unsuitable for analyzing experiments of this type; hence, COG is being relied upon for testing this data in ACE and ENDF-6 File 7 formats.

Preliminary results indicate the most thermal TEX experiment is sensitive to the thermal scattering law. Consequently, it may be desirable to compare this TEX configuration with polyethylene to a similar configuration where Lucite replaces the polyethylene, as the necessary procurements should be relatively inexpensive.

In FY-2016, preliminary thermal scattering law data and testing results will be presented at the NDAG meeting at BNL on November 4, 2015, at the request of chairman. Final testing results will be presented to WPEC SG42, when available.

In FY-2016, LLNL will test the thermal scattering law developed by BAPL for solid water (i.e., ice) against measured pulsed neutron die-away experiments.

2.1.2 Brookhaven National Laboratory (BNL)

LLNL (Dave Heinrichs, Chuck Lee, and Ed Lent) is collaborating with BNL (Dave Brown) on the Automated Data Verification and Assurance for Nuclear Calculations Enhancement (ADVANCE) Project[5]. In FY-2015, LLNL provided BNL with COG11.1 and the COG Library Maker Codes together with 503 ICSBEP HEU and PU benchmarks to get started.

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[5] https://ndclx4.bnl.gov/gf/project/checkendf/

2.1.3 Los Alamos National Laboratory (LANL)

LLNL (Dave Heinrichs, Ed Lent) are collaborating with LANL (Forrest Brown) to resolve issues associated with the Ganapol analytic benchmarks. In FY-2015, issues associated with the half-space problems 3.2.2a, 3.2.2b and 3.2.3 were resolved as published by Forrest Brown in ICNC 2015 and provided in a draft document by E. Lent to the NCSP Analytical Methods Working Group Meeting at ICNC 2015.

In FY-2016, LLNL hopes Barry Ganapol will continue to work with Forrest Brown and Ed Lent to resolve the significant discrepancies identified by Lent for problems 3.1.5a, 3.1.5b, 5.1.3a and 5.1.3b; and, resolve or clarify the minor issues associated with problems 2.1.2 (at high lethargy), 3.1.1 (near $x \approx 0$). Note that LLNL results for problems 2.1.3b, 2.1.4, 3.1.2a, 3.1.2b, 3.1.3, 3.1.6, 3.2.2a, 3.2.2b, 3.2.3, 3.3.1a, 3.3.1b, 3.3.2a, 3.3.2b, 5.1.1, 5.1.2, 5.1.4a, and 5.1.4b are in excellent agreement.

Los Alamos also plans to publish additional (new) analytic benchmark results based on original recent work by Gonzales. LLNL is very interested in this work.

2.1.4 Oak Ridge National Laboratory (ORNL)

In FY-2015, LLNL provided the following software to the Radiation Safety Information Computational Center (RSICC) for external distribution as Export Control Information:

- CCC-829, COG11.1 Multiparticle Monte Carlo Code System for Shielding and Criticality Use
- PSR-607, COG LibMaker - Data Conversion Utility

Also in FY-2015, LLNL (Soon Kim) provided independent COG11.1 calculational results to ORNL (Thomas Miller) in support of IER-126, SILENE CAS Benchmark, approved for publication in the 2015 edition of the ICSBEP Handbook as ALARM-TRAN-AIR-SHIELD-001, Neutron Activation Foil and Thermoluminescent Dosimeter Responses to a Bare Pulse of the CEA Valduc SILENE Critical Assembly. Note that the COG11.1 calculations were unbiased "one step" criticality and shielding calculations with and without delayed fission gammas (DFG).

In FY-2016, LLNL plans to provide similar calculational results for additional SILENE CAS benchmarks in which the SILENE reactor is shielded with lead or (cadmium-lined) polyethylene.

Note that a new criticality detector variance detector variance reduction (CritDetVR) feature was added by Rich Buck to COG11.1 to enable "one step" calculation interleaving unbiased criticality batches with biased shielding cycles (enabling use of all variance reduction options). While this feature is working correctly in serial mode, it needs full parallelization to be of practical use.

2.1.5 Sandia National Laboratories (SNL)

In FY-2015, Bettis Atomic Power Laboratory (Mike Zerkel) introduced LLNL (Dave Heinrichs) to a United Kingdom counterpart at Rolls-Royce[6] (James Lam) at ICNC-2015. Dr. Lam expressed interest in IER-407, ISSA Subcritical Multiplicity Benchmark, and its associated detectors, data acquisition system, and count distribution (multiplicity) analysis methods. In

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[6] http://www.rolls-royce.com/customers/nuclear/submarine-nuclear-propulsion.aspx

addition to the low multiplication ($M \leq 20$) measurements at ISSA, Dr. Lam was interested in applying these techniques for higher multiplication measurements. Consequently, Heinrichs and Gary Harms (SNL) discussed the possibility of deploying LLNL instrumentation for use with 7uPCX at SNL. This work, if performed, would follow completion of IER-407.

The analytical methods needed to analyze the experimental (and simulation) results include BIGFIT and its successor codes developed by Sean Walston, LLNL, N-Program, for another Government Program Manager (see Sections 1.3 and 1.5.3).

2.2 US UNIVERSITIES

2.2.1 North Carolina State University (NCSU)

As noted in Section 2.1.1, LLNL and BAPL are collaborating with Professor Ayman Hawari (NCSU) to develop new thermal scattering laws for moderator materials. In FY-2015, a new thermal scattering law was completed for Lucite and work began on polyethylene complimenting experimental work by Rensselaer Polytechnic Institute.

In FY-2016, new collaborative work will begin to develop modern analytical methods for generating thermal scattering law data from physical parameters that are more general and accurate than current processing codes (e.g., AMPX and NJOY).

2.2.2 South Carolina State University (SCSU)

In FY-2016, LLNL plans to continue work with Dr. Kenneth Lewis, Dean of the College of Science, Mathematics, and Engineering Technology, to identify a summer student interested in performing Criticality Slide Rule calculations as part of an AWE-IRSN-LLNL-ORNL collaboration.

2.2.3 Texas A&M University (TAMU)

TAMU is a university partner for the LLNL NIF and Photon Science Directorate using COG11.1 for "nuclear photonics" simulations under the auspices of another GPM (see Section 1.4).

2.2.4 University of Arizona

Professor Barry Ganapol, University of Arizona, Department of Aerospace and Mechanical Engineering, published the compendium "Analytic Benchmarks for Nuclear Engineering Applications: Case Studies in Neutron Transport Theory," which is available from the OECD NEA Databank as NEA No. 6292 (© 2008) and on-line[7].

In FY-2015, Ed Lent (LLNL) and Forrest Brown (LANL) corresponded with Professor Ganapol to resolve calculational discrepancies identified by Lent for the half-space problems. The cause of the discrepancies was confusion relating to boundary conditions and the equivalent source specification as now published by Forrest Brown in ICNC 2015.

It is hoped the remainder of the discrepancies identified in Section 2.1.3 can be resolved for these valuable (exact) analytic benchmarks in FY-2016.

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[7] https://www.oecd-nea.org/databank/docs/2008/db-doc2008-1.pdf

2.2.5   University of Michigan (UM)

Professor Sara Pozzi, or a student under her supervision, is a possible analytic methods participant in IER-407, ISSA Subcritical Multiplicity Benchmark, using MCNPX-PoliMi[8].

2.3   FOREIGN LABORATORIES

2.3.1   Atomic Weapons Establishment (AWE)

In FY-2015, AWE (Richard Jones, Chris Wilson – JOWOG30 CS POCs) requested COG user training and the latest version of COG, COG11.1. Due to funding constraints, LLNL deferred training to a later date but will deliver COG11.1 software to Leo Clark (AWE) by hand at the KRUSTY meeting scheduled for October 27-28, 2015, at the University of California Washington Center in Washington, DC.

LLNL is collaborating with AWE in analytical methods and other areas as identified in the JOWOG30 Criticality Safety Task Specification and NCSP Five-Year Execution Plan. These activities include development of an updated criticality accident slide rule as part of an AWE-IRSN-LLNL-ORNL consortium.

2.3.2   Canadian Nuclear Laboratories (CNL)

In FY-2015, LLNL (Dave Heinrichs, Ed Lent) began to collaborate with CNL (Danil Roubtsov) on testing a new thermal neutron scattering law for heavy water[9] (D_2O) developed by CAB (see Section 2.3.3) for CNL. Face-to-face meetings occurred at CSEWG and WPEC SG42.

2.3.3   Centro Atomicó Bariloche (CAB)

LLNL (Dave Heinrichs, Ed Lent) is collaborating with José Ignacio Márquez Damián (CAB) under the auspices of WPEC SG42.   In FY-2015, LLNL (Ed Lent) created the libraries T.CAB and T.CAB.ACE containing CAB thermal scattering laws for H_2O and D_2O[10] and commenced testing the D_2O scattering law using the same ICSBEP benchmarks as Roubtsov (CNL). This work will continue throughout FY-2016 until complete.

2.3.4   Commissariat à l'Énergie Atomique (CEA)

In FY-2015, in his capacity as an ICSBEP Internal Reviewer, Soon Kim (LLNL) collaborated with Evaluators from ORNL (Thomas Miller), CEA-Saclay (Yi-Kang Lee, Emmanuel Gagnier), and CEA-Valduc (Nicolas Authier, Jerome Piot, Xavier Jacquet and Guillaume Rousseau) to complete IER-126, "Silene CAS Benchmark," published in the ICSBEP Handbook as ALARM-TRAN-AIR-SHIELD-001, "Neutron Activation Foil and Thermoluminescent Dosimeter Responses to a Bare Pulse of the CEA Valduc Silene Critical Assembly."

In FY-2016, LLNL (Dave Heinrichs, Jerome Verbeke) may begin evaluation of the CEA code TRIPOLI for possible qualification and inclusion in the LLNL 830 safety software registry.

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[8] http://dnng.engin.umich.edu/mcnpx-polimi-training-workshop/
[9] https://www.oecd-nea.org/science/wpec/sg42/Meetings/2015_May/SG42_8_DR.pdf
[10] https://www.oecd-nea.org/science/wpec/sg42/Meetings/2015_May/SG42_3_JIM.pdf

2.3.5   International Atomic Energy Agency (IAEA)

Dr. Dermott "Red" Cullen develops and maintains the PREPRO nuclear data processing code for IAEA. In FY-2015, LLNL (Chuck Lee) assisted Dr. Cullen in testing PREPRO baselines on various hardware/software computational platforms prior to the release of a new software baseline, PREPRO2015[11].

In future, LLNL (Dave Heinrichs) may provide additional support to Dr. Cullen for using the PREPRO software to independently process nuclear data parameters (from ENDF/B, JEFF, JENDL, etc.) into useable cross-section libraries at various temperatures in ENDF-6 format. The latest ENDF/B-VII.1 libraries are available for download from IAEA as the POINT2015 Data[12].

Note that the LLNL Nuclear Theory and Data Group have incorporated Cullen's RECENT and SIGMA1 codes (from PREPRO) in their FETE[13] (production) data processing code. AMPX and NJOY also use SIGMA1.

2.3.6   Institut de Radioprotection et de Sûreté Nucléaire (IRSN)

In FY-2015, in his capacity as an ICSBEP Internal Reviewer, Soon Kim (LLNL) collaborated with Evaluators from ORNL (Thomas Miller), CEA (see Section 2.3.4) and IRSN (Matthieu Duluc, Francois Trompier, Marie Anne Chevallier, Sylvain Beytout) to complete IER-126, "Silene CAS Benchmark," published in the ICSBEP Handbook as ALARM-TRAN-AIR-SHIELD-001, "Neutron Activation Foil and Thermoluminescent Dosimeter Responses to a Bare Pulse of the CEA Valduc Silene Critical Assembly."

In FY-2015, LLNL (Dave Heinrichs) provided IRSN (Eric Letang) with an (unlimited) multi-user license for COG11.1 for inclusion in IRSN's PROMÉTHÉE software application and use in criticality accident slide rule calculations. LLNL (Heinrichs) also provided COG11.1 criticality safety training to IRSN users.

In FY-2016, LLNL (Chuck Lee, Jerome Verbeke) and IRSN (Gregory Caplin) will utilize COG11.1 and other analytical methods in analyzing IER-407, ISSA Subcritical Multiplicity Benchmark, experimental and simulated data.

2.3.7   Japan Atomic Energy Agency (JAEA)

LLNL (Song Huang) corresponded with JAEA (Toshiro Yamamoto) for assistance in obtaining, modifying and using the RHEINGOLD[14] two-dimensional higher-harmonic analysis code under Institutional (G&A) auspices. Note that this software may be useful in analyzing ISSA (IER-407).

2.3.8   Organisation for Economic Co-operation and Development (OECD)

In FY-2015, Dave Heinrichs (LLNL) continued to liaise with OECD (Jim Gulliford, Ian Hill, John Bess, Lori Scott) regarding NCSP contributions to ICSBEP and DICE. This included

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[11] https://www-nds.iaea.org/public/endf/prepro/
[12] https://www-nds.iaea.org/point/
[13] http://nuclear.llnl.gov/CNP/fete/userguide.pdf
[14] http://www.tandfonline.com/doi/pdf/10.1080/18811248.2003.9715336

writing a joint paper with Ian Hill on "New NCSP Contributions to ICSBEP and DICE" to be published in the proceedings of the ANS Winter Meeting in November 2015.

Also in FY-2015, Dave Heinrichs (LLNL) participated in the kick-off meeting of WPEC SG42[15] with subsequent correspondence furthering this project on "Thermal Scattering Kernel S(α,β): Measurement, Evaluation and Application."

Due to funding constraints, LLNL did not participate in FY-2015 in any of the OECD Nuclear Energy Agency (NEA) Working Party on Nuclear Criticality Safety (WPNCS[16]) Expert Groups including those on Advanced Monte Carlo Techniques, Criticality Excursions Analyses, and Uncertainty Analyses for Criticality Safety Assessment. Similarly, no NCSP funds were used to participate in WPEC SG38[17] activities pertaining to "Beyond the ENDF format: A modern nuclear database structure."

In FY-2015, Dave Heinrichs (LLNL) discussed inclusion of COG11.1 in the NDEC Project with Carlos Javier (OECD). NDEC is similar to ADVANCE (see Section 2.1.2) with the exception that its focus is on JEFF rather than ENDF/B data.

2.3.9 Rolls-Royce

In FY-2015, LLNL entered into discussions with Rolls-Royce as described in Section 2.1.5.

3.0   Meetings

In addition to site visits, the following meetings have been useful venues for technical information exchanges:

- American Nuclear Society Annual Conference (in June)
- American Nuclear Society Winter Conference (in November)
- Cross Section Evaluation Working Group Meeting (in November)
- International Criticality Safety Benchmark Evaluation Project Meeting (in April/May)
- JOWOG30 (Criticality Safety)
- NCSP Nuclear Data Advisory Group Meeting (in November)
- NCSP Analytical Methods Working Group Meeting
- OECD NEA WPNCS Expert Group Meetings
- OECD NEA WPEC SG38 and SG42 Meetings

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[15] https://www.oecd-nea.org/science/wpec/sg42/
[16] https://www.oecd-nea.org/science/wpncs/
[17] https://www.oecd-nea.org/science/wpec/sg38/