United States Department of Energy

Nuclear Criticality Safety Program

Five-Year Execution Plan for the Mission and Vision

FY2018 through FY2022

National Nuclear Security Administration

October 2017

Department of Energy Nuclear Criticality Safety Program Five-Year Execution Plan for Fiscal Years 2018 through 2022, dated October 2017.

Approved:

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ACRONYMS AND DEFINITIONS

ACE	"A Compact ENDF" file
ADVANCE	Automated Data Verification and Assurance for Nuclear Calculations Enhancement (ADVANCE)
AM	Analytical Methods
AMPX	Nuclear cross-section processing code
ANL	Argonne National Laboratory
APRF	Army Pulse Reactor Facility
ARH	Atlantic Richfield Hanford
AWE	Atomic Weapons Establishment
BNL	Brookhaven National Laboratory
CAAS	Criticality Accident Alarm System
CALIBAN	Fast burst metal assembly in Valduc, France
CEA	Commissariat à l'Énergie Atomique
CIELO	Collaborative International Evaluated Library Organization
COG[1]	Lawrence Livermore National Laboratory Monte Carlo Computer Code
COMET	General Purpose Platform Lift Machine at NCERC
CritView	A plotting and interpolation software program designed to display criticality data from the ARH-600 Criticality Handbook
CRP	Coordinated Research Projects
CSCT	Criticality Safety Coordinating Team
CSEWG	Cross Section Evaluation Working Group
CSSG	Criticality Safety Support Group
DAF	Device Assembly Facility
DOE	Department of Energy
ENDF	Evaluated Nuclear Data File
EOC	Explanation of Change (for out-year peaks and dips in budget plots)
FLATTOP	Highly-Reflected Spherical Benchmark Assembly
FFTF	Fast Flux Test Facility
FUDGE	Lawrence Livermore National Laboratory nuclear data management infrastructure
FY	Fiscal Year
GELINA	Linear Accelerator in Geel, Belgium
GForge	Web-based collaborative development environment
GODIVA	Unreflected Fast-Burst Assembly

IAEA	International Atomic Energy Agency
ICSBEP	International Criticality Safety Benchmark Evaluation Project
IE	Integral Experiments
IER	Integral Experiment Request
IP&D	Information Preservation and Dissemination
IRMM	Institute for Reference Materials and Measurements
IRSN	Institut De Radioprotection et De Sûreté Nucléaire
$KENO^2$	Monte Carlo Criticality Computer Code
KRUSTY	Kilopower Reactor Using Stirling TechnologY
LA	Los Alamos (report)
LANL	Los Alamos National Laboratory
LINAC	Linear Accelerator
LLNL	Lawrence Livermore National Laboratory
MCNP	Monte Carlo N Particle (N currently equals 3) Computer Code
NA00-10	Office of Environment, Safety and Health
NCERC	National Criticality Experiments Research Center
NCS	Nuclear Criticality Safety
NCSET	Nuclear Criticality Safety Engineer Training
NCSP	Nuclear Criticality Safety Program
NCSU	North Carolina State University
ND	Nuclear Data
NDA	non-destructive assay
NDAG	Nuclear Data Advisory Group
NJOY	Nuclear cross-section processing code
NNDC	National Nuclear Data Center
NNSA	National Nuclear Security Administration
NNSS	Nevada Nuclear Security Site
NSTec	National Security Technologies
OECD/NEA	Organization for Economic Cooperation and Development/Nuclear Energy Agency
ORNL	Oak Ridge National Laboratory
POC	Point of Contact
PREPRO	Nuclear cross-section processing code
RPI	Renssalaer Polytechnic Institute

RSICC	Radiation Safety Information Computational Center
SAMMY[3]	R-matrix nuclear data evaluation computer code
SCALE[4]	A modular modeling and simulation system for nuclear safety analysis and design
SNL	Sandia National Laboratories
SQA	Software Quality Assurance
SRS	Savannah River Site
S/U	Sensitivity/Uncertainty
TACS	Training Assembly for Criticality Safety
T&E	Training and Education
TID	Technical Information Document (Los Alamos National Laboratory report)
TRG	Technical Review Group
TSUNAMI	Tool for Sensitivity and Uncertainty Analysis Methodology Implementation
US	United States of America
UT	University of Tennessee
V&V	Verification and Validation
WPEC	Working Party on International Nuclear Data Evaluation Corporation
WPNCS	Working Party on Nuclear Criticality Safety
Y-12	Y-12 National Security Complex

[1]COG was originally developed to solve deep penetration problems in support of underground nuclear testing. Variance reduction techniques are very important to these problems and hence the name COG was chosen as in "to cog the dice" or cheat by weighting.

[2]KENO is a family of Monte Carlo criticality codes whose name came from an observation of the KENO game in which small spheres, under air levitation, arbitrarily move about in a fixed geometry.

[3]SAMMY is a nuclear model code, which applies R-Matrix theory to measured data and produces resolved and un-resolved resonance parameters in Reich-Moore and other formalisms.

[4]SCALE is a system of well-established codes and data for performing nuclear safety (criticality, shielding, reactor physics and fuel irradiation) analyses.

United States Department of Energy
Nuclear Criticality Safety Program
Five-Year Execution Plan

1.0 Nuclear Criticality Safety Program Mission and Vision

The Nuclear Criticality Safety Program (NCSP) Mission and Vision, as stated in *The Mission and Vision of the United States Department of Energy Nuclear Criticality Safety Program for the Fiscal Years 2014-2023* (http://ncsp.llnl.gov/NCSP-MV-COMPRESSED.pdf), are:

> The NCSP mission is to provide **sustainable expert** leadership, direction, and the technical infrastructure necessary to develop, maintain, and disseminate essential technical tools, training, and data required to support **safe, efficient** fissionable material **operations** within the United States (U.S.) Department of Energy (DOE).
>
> The NCSP will be a **continually improving, adaptable,** and **transparent** program that **communicates** and **collaborates** globally to incorporate technology, practices, and programs to be **responsive** to the essential technical needs of those responsible for developing, implementing, and maintaining nuclear criticality safety.

The NCSP is funded by the National Nuclear Security Administration (NNSA). Dr. Angela Chambers (NA511) is the NCSP Manager. She is supported by the Criticality Safety Support Group (CSSG) and the Nuclear Data Advisory Group (NDAG), regarding technical matters, and by the Criticality Safety Coordinating Team (CSCT), consisting of Federal Criticality Safety Practitioners at the sites regarding DOE field criticality safety issues. Charters for the CSCT, CSSG, and the NDAG can be found on the NCSP website at: (http://ncsp.llnl.gov/). The NCSP Planning Calendar can also be found on the NCSP website at: (http://ncsp.llnl.gov/).

The NCSP Mission and Vision is achieved by identifying and accomplishing a set of five-year programmatic goals in five broad technical program elements that support identified ten-year goals. The NCSP Five-Year Plan defines tasks that are designed to accomplish specific goals identified in the NCSP Mission and Vision. The current Five-Year Plan has been developed to accomplish these Mission and Vision goals with the advice and assistance of **experts** appointed by the NCSP manager or working under charters approved by the NCSP manager. The five technical program elements are:

- Analytical Methods (AM)
- Information Preservation and Dissemination (IP&D)
- Integral Experiments (IE)
- Nuclear Data (ND)
- Training and Education (T&E)

The NCSP Mission and Vision provides specific goals for each program element. Each task in the current Five-Year Plan aligns with a specific NCSP Mission and Vision goal. The number of goals addressed by the current Five-Year Plan is provided in Figure 1.1. As shown in Figure 1.1, the FY18 work tasks will help address a number of NCSP Mission and Vision Goals, and additional goals will be addressed in FY18-FY22. Overall, the NCSP is on track to accomplish a significant number of Mission and Vision goals during the next five years. At this stage, the NCSP has

successfully completed key IE goals to investigate and document the feasibility of a vertical lift assembly and horizontal split table at SNL. In addition, the design and deployment of the dosimetry laboratory is currently in progress at NNSS. Also, the installation of the measurements laboratory at NNSS has been completed. These IE goals are completed and no further work is required. The majority of the remaining goals are ongoing tasks in perpetuity. The subsequent discussion provides a summary of the projected task accomplishments and technical gaps for each program element.

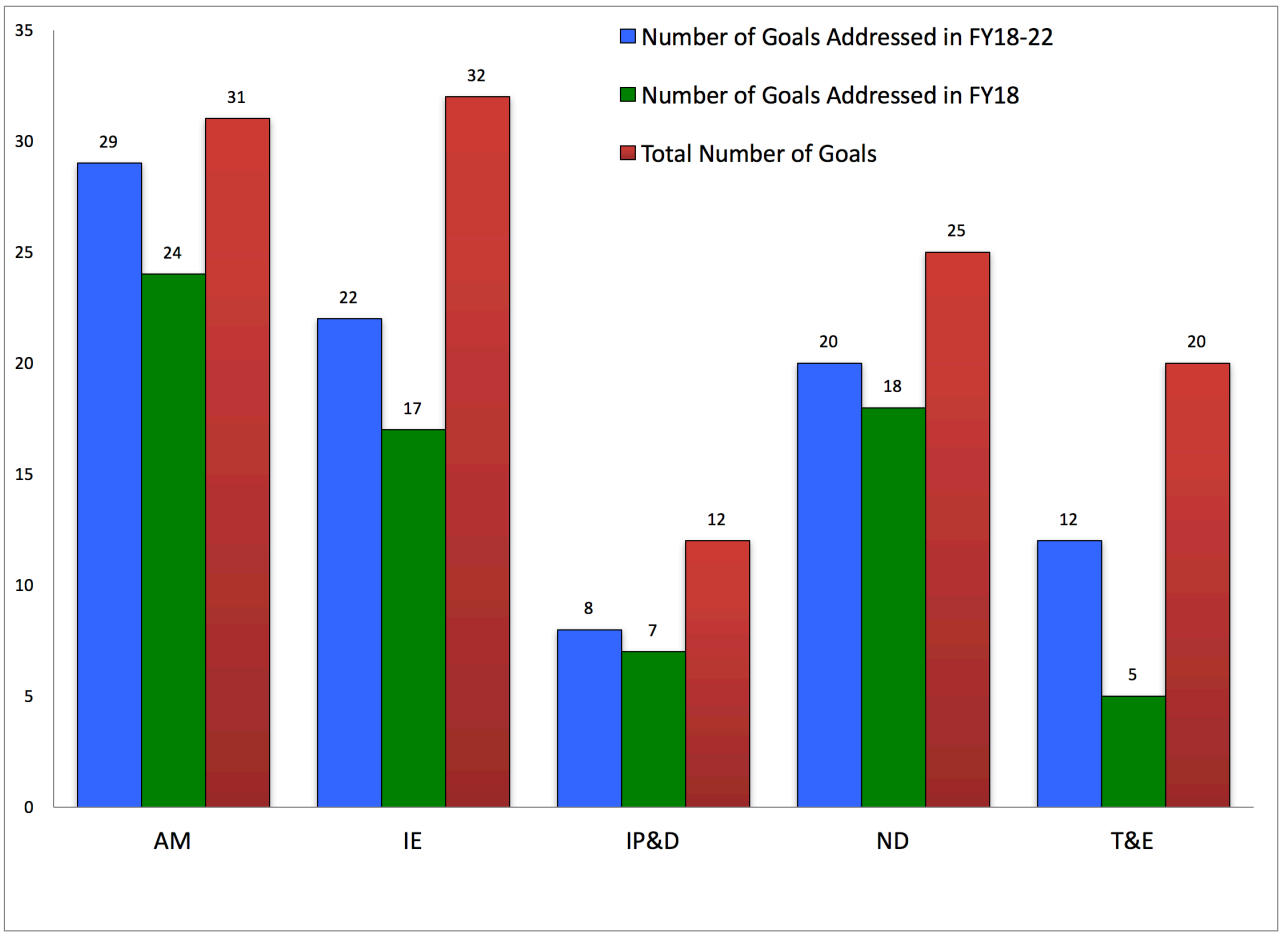


Figure 1.1 Number of NCSP Mission and Vision Program Element Goals Addressed by the NCSP Five-Year Plan

The **Analytical Methods** program element provides for the development and maintenance of state-of-the-art analytical capabilities for the processing of nuclear data from the Evaluated Nuclear Data File (ENDF) and the radiation transport analysis capabilities needed to perform nuclear criticality safety analyses. The Five-Year Plan tasks specifically support 29 of 31 AM goals required to develop and sustain state-of-the-art cross-section processing and radiation transport modeling capabilities and expertise needed for criticality safety analyses. Furthermore, FY18 work tasks will address 24 of the 31 AM goals. Examples of goals not addressed in FY18 but are addressed in the out years include: development and deployment of methods to provide correlation data for integral benchmark experiments; development and deployment of time-dependent radiation transport accident analysis capabilities. With regard to the overall AM technical gap over the next 5 years, the NCSP is continuing to make a minimal investment toward the development and deployment of time-dependent multi-physics analysis capabilities to support excursion analyses; develop and

maintenance of time-dependent geometry modeling capabilities; however, additional budget allocation would be needed to achieve these target AM goals during the next five years. Currently, the NCSP is not able to invest in coupling of modern NCS radiation transport software with CAD/CAE packages. Task proposals have been submitted for all of these goals, and these proposals will be considered pending increased NCSP AM budget targets.

The **Integral Experiments** program element maintains a fundamental capability for the DOE NCSP to be able to perform critical, subcritical, and fundamental physics measurements, to address specific-site needs on a prioritized basis, and this program element also supports maintaining a fundamental nuclear materials handling capability, which enables hands-on NCS training programs and various other programs for the DOE NCSP and other Government Agencies. The Five-Year Plan tasks specifically support 22 of 32 IE goals to assess, design, perform, and document integral experiments. FY18 work tasks will address 17 of 32 IE goals. Examples of goals not addressed in FY18 but are addressed in the out years include: develop the infrastructure to support dynamic experiments; design a neptunium critical experiment capability; design and build a small sample "rabbit" transfer system. Although a smaller set of goals is addressed in FY18, a significant number of IE goals are addressed during the next five years. However, there are some IE goals that cannot be addressed within the current five-year budget targets. Examples of goals not addressed include: expansion of the radiochemistry laboratory capabilities at NNSS; standup "hot"/"cold" machine shops at NCERC; design and deploy low scatter capabilities at NCERC; acquisition of Np metal at NCERC; and the construction of new critical assemblies (solution reactor and Np burst reactor). Task proposals have been submitted for these goals, and these proposals will be considered pending increased NCSP IE budget targets.

The **Information Preservation & Dissemination** program element preserves primary documentation supporting criticality safety [e.g., benchmark critical experiments from the International Criticality Safety Benchmark Evaluation Project (ICSBEP)] and makes this information available for the benefit of the technical community including international partners (e.g., IRSN, AWE, CEA and OECD) through the NCSP website (http://ncsp.llnl.gov). The Five-Year Plan tasks specifically support 8 of 12 IP&D goals for preserving and disseminating technical, programmatic, and operational information important for nuclear criticality safety. FY18 work tasks will address 7 of 12 IP&D goals. The goal to provide a long-term hardcopy archive of critical experiment logbooks will not be addressed in FY18. Overall, there are some IP&D goals that cannot be addressed based on current budget targets. Examples of goals not addressed include: maintaining and publishing (as an electronic newsletter) a U.S./international database of near misses, operational issues and lessons learned (historical/future); implementing a process to rapidly disseminate information (e.g., operational upsets, emergency response) to criticality safety professionals ("Crit spam").

The **Nuclear Data** program element includes the measurement, evaluation, testing, and publication of neutron cross-section data for nuclides of high importance to nuclear criticality safety analyses. The Five-Year Plan tasks specifically support 20 of 25 ND goals to improve and disseminate measured and evaluated differential cross-section and covariance data needed by the AM element to support NCS analyses. FY18 work tasks will also address 18 of 25 ND goals. Examples of goals not addressed in FY18 but are addressed in the out years include: identify and prioritize differential measurements beyond the next five years; identify and prioritize differential evaluations beyond the next five years. Overall, a large number of goals are addressed within the current ND budget targets; however, technical gaps do exist, and some ND goals cannot be addressed. Examples of

goals not addressed include: develop and utilize sensitivity/uncertainty (S/U) analysis capabilities to prioritize NCSP nuclear data needs and quantify target accuracies needed for differential measurement and evaluation tasks; develop new analysis tools to fully utilize new experimental capabilities such as the time project chamber (TPC), Chi-nu, and correlated data. Task proposals have been submitted for these goals, and these proposals will be considered pending increased NCSP ND budget targets.

The **Training and Education** program element identifies, develops, and facilitates training needs and educational resources (including hands-on training with fissionable material systems) in areas where no suitable alternative exists. The primary purpose of the T&E element is to maintain and enhance the technical abilities and knowledge of those who impact or are impacted directly by the practice of criticality safety. The Five-Year Plan tasks specifically support 12 of 20 T&E goals during the next five years and 5 of 20 T&E goals in FY18. The tasks primarily support the development and maintenance of the classroom and "hands-on" training courses at SNL and NNSS. FY18 work tasks will not address the Mission and Vision goal to provide a gap analysis of training needs based on an assessment of available training and education resources in the national and international community. Likewise, the T&E goal to cultivate and maintain university partnerships will not be addressed in the FY18 T&E work tasks. NCSP work to partner with universities is being performed under the AM and ND program elements; however, these NCSP-university work tasks are not focused on NCS T&E activities. Overall, there are number of Mission and Vision goals that extend beyond the current scope of hands-on T&E classes. For FY18, new proposals address the development of 7 new goals that align directly with the NCSP Mission and Vision goals. Examples of these new tasks include: developing a criticality simulator to demonstrate criticality physics fundamentals to process operators, a criticality simulator to simulate plant/process conditions and to simulate a process walk through to support the classroom portion of the 2-week hands-on courses. Further a proposal has been accepted for the development of a mobile CAT III/IV hands-on demonstration capability in the out years. Examples of goals not addressed include: develop an integrated compendium of training and education resources that is coordinated for consistency across US agencies and institutions and accessible to the criticality safety community; develop an integrated compendium of training and education resources that is coordinated with international partners to foster consistency on material and maximize use of unique resources; establish a sustainable program (internship, rotational assignments, etc.) to facilitate collaborative training and education opportunities (national and international); establish a multi-lab team to develop recommendations on a qualification program approach, complete with criteria, benefits, and required resources to ensure adequate implementation of the ANSI/ANS-8.26 standard, develop an NCSET module for the use of the NCS slide rule to support emergency response, and develop a mobile CAT 1 criticality hands-on critical or near critical demonstration capability. These goals will be considered pending increased NCSP T&E budget targets.

Although some technical gaps exist in each program element, execution of the NCSP Five-Year Plan will accomplish a significant number of Mission and Vision goals during the next five years. As a result, the NCSP will be able to accomplish the overall mission to provide sustainable expert leadership, direction, and technical infrastructure needed to support safe, efficient fissionable material operations within the DOE.

2.0 Technical Program Elements

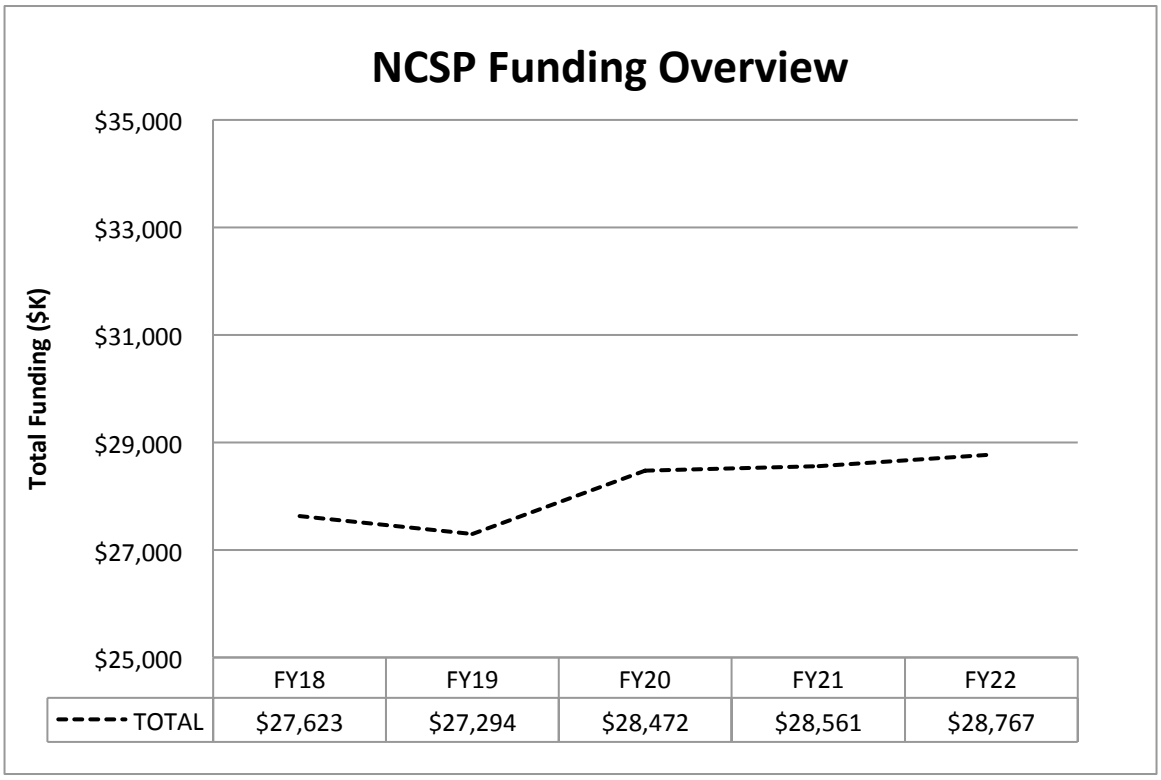
As mentioned above, the NCSP includes the following five technical program elements:

- Analytical Methods
- Integral Experiments
- Information Preservation and Dissemination
- Nuclear Data
- Training and Education

A description of how each of these elements contributes to the enhancement of criticality safety is contained in the NCSP Mission and Vision document. This Five-Year Execution Plan contains the road map for each of the five technical program elements, including a budget, tasks, and milestones for completing the work and achieving the NCSP Vision. All tasks are approved based on their contribution to the achievement of the five- and ten-year goals in the Mission and Vision document. Funding tables are provided for each program element section. The status of all milestones will be reported to the NCSP Manager in quarterly reports that are due no later than three weeks from the last day of the month following the end of the quarter.

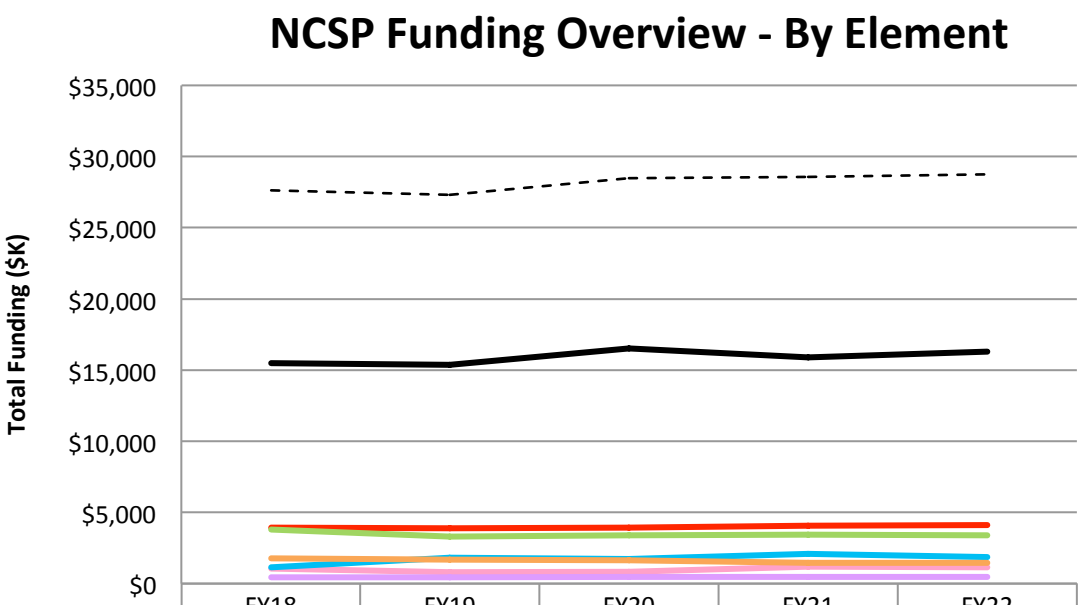
Funding for NCSP activities are shown in Tables 2.1, 2.2, and 2.3 (rounded to the nearest $K).

Table 2.1 NCSP Funding Overview
(NNSA Budget Baseline Requests)



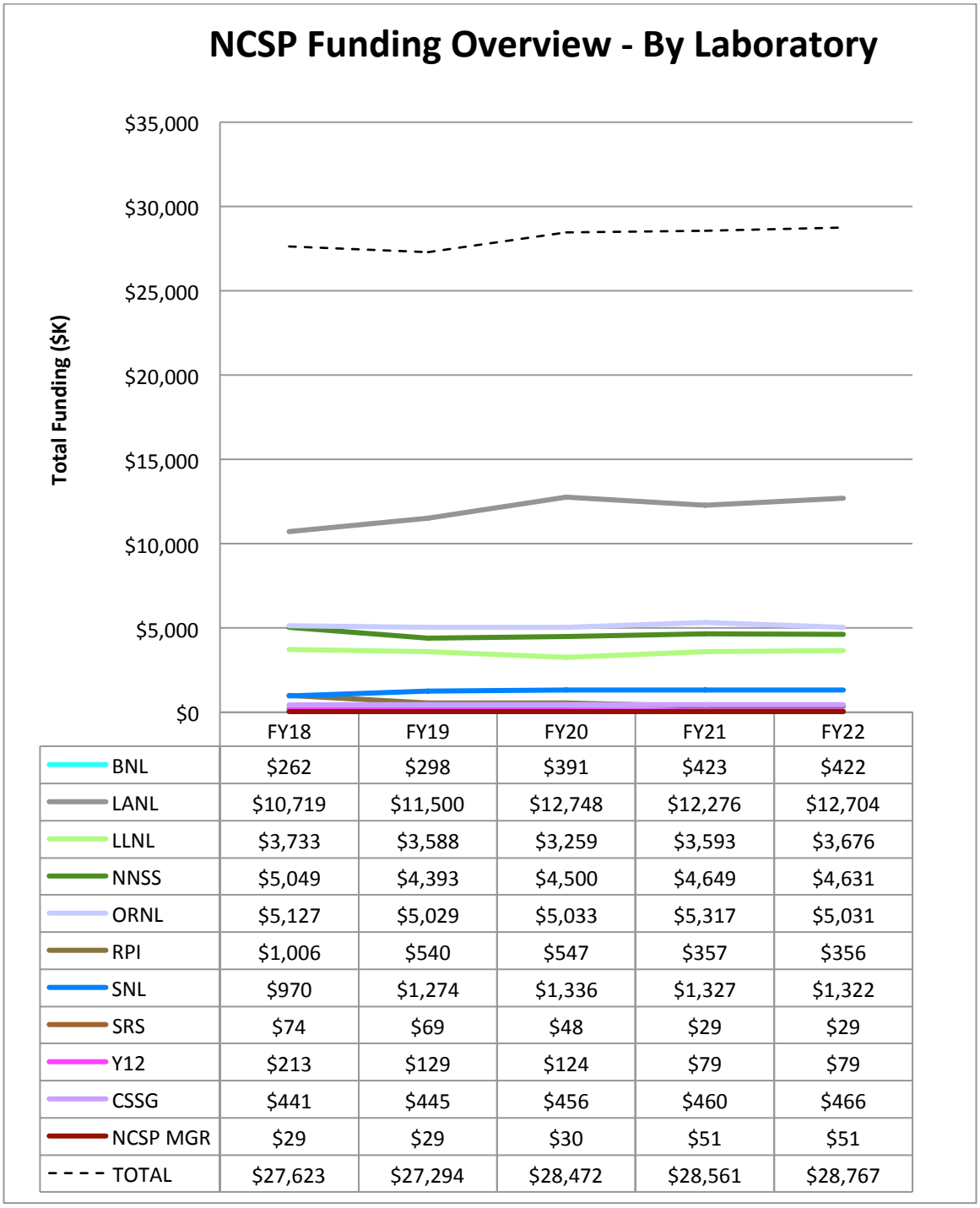
	FY18	FY19	FY20	FY21	FY22
TOTAL	$27,623	$27,294	$28,472	$28,561	$28,767

Table 2.2 NCSP Funding Overview – By Element



	FY18	FY19	FY20	FY21	FY22
AM	$3,932	$3,865	$3,912	$4,084	$4,111
IE	$15,487	$15,369	$16,542	$15,893	$16,292
IP&D	$1,058	$802	$811	$1,167	$1,162
ND	$3,791	$3,301	$3,398	$3,417	$3,408
T&E	$1,135	$1,837	$1,736	$2,085	$1,879
TS	$1,779	$1,675	$1,617	$1,455	$1,449
CSSG	$441	$445	$456	$460	$466
TOTAL	$27,623	$27,294	$28,472	$28,561	$28,767

Table 2.3 NCSP Funding Overview – By Laboratory
(Actual Funding)



	FY18	FY19	FY20	FY21	FY22
BNL	$262	$298	$391	$423	$422
LANL	$10,719	$11,500	$12,748	$12,276	$12,704
LLNL	$3,733	$3,588	$3,259	$3,593	$3,676
NNSS	$5,049	$4,393	$4,500	$4,649	$4,631
ORNL	$5,127	$5,029	$5,033	$5,317	$5,031
RPI	$1,006	$540	$547	$357	$356
SNL	$970	$1,274	$1,336	$1,327	$1,322
SRS	$74	$69	$48	$29	$29
Y12	$213	$129	$124	$79	$79
CSSG	$441	$445	$456	$460	$466
NCSP MGR	$29	$29	$30	$51	$51
TOTAL	$27,623	$27,294	$28,472	$28,561	$28,767

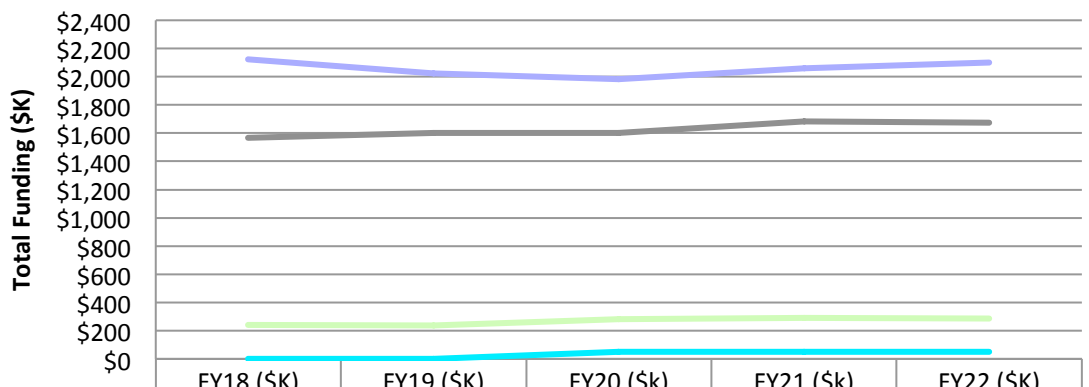
Finally, the goal of the NCSP is to provide "transparent responsiveness" for the DOE and Stakeholders. Therefore, this Plan and all accomplishments achieved under the auspices of the NCSP are posted in a timely manner on the NCSP website at: http://ncsp.llnl.gov/.

2.1 Analytical Methods (AM)

2.1.1 Program Element Description

The Analytical Methods program element provides development and maintenance of state-of-the-art analytical capabilities for the processing of nuclear data from the Evaluated Nuclear Data File (ENDF) and the radiation transport analysis needed to support Nuclear Criticality Safety (NCS) evaluations for subcriticality and shielding. An essential aspect of the AM capabilities is the human expertise required to develop the analytical software, provide software configuration control, and train and assist the user community.

Table 2.1-1 AM Budget (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
BNL	$0	$0	$48	$52	$52
LANL	$1,567	$1,603	$1,600	$1,683	$1,675
LLNL	$243	$237	$282	$291	$284
ORNL	$2,122	$2,025	$1,982	$2,058	$2,100

Explanation of Change (EOC) – for out-year peaks and dips in budget plots:

- BNL will be funded in FY20/FY22 to work with LLNL and universities to incorporate Thermal Scattering and Self-Shielding in GND/FUDGE.
- LANL's funding will not significantly increase in the out years, although there are some very modest increases in NJOY funding from FY20/FY22. Also, an MCNP enhancement will be funded in FY21/FY22 for criticality safety experiment simulations at high temperature.
- LLNL's funding will increase in the out years for the development of advanced nuclear data processing and multi-physics methods tasks. Also, work will begin in FY19 to perform a multi-laboratory inter-comparison benchmark study for nuclear criticality safety analytical methods tools in addition to collaborate with BNL incorporating Thermal Scattering and Self-Shielding in GND/FUDGE.
- ORNL's funding will increase in out years to support SCALE maintenance and modernization and to ensure that SCALE is available to support NCS analyses using modern computing platforms. Beginning in FY18, five new tasks will be initiated to perform inter-comparison studies of S/U analysis tools, NCS slide rule application, an analytical benchmark comparison study, nuclear data and cross section testing, and the development and addition of continuous energy sensitivity data files to SCALE's VALID library.

2.1.2 Approved Tasks

2.1.2.1 Los Alamos National Laboratory (LANL)

LANL AM1 ($1250K)
This is a continuing task for the maintenance of the basic capabilities for performing Nuclear Criticality Safety calculations with the Monte Carlo N Particle (MCNP®) computer code, including general code maintenance, user support, improved nuclear data libraries, Verification and Validation (V&V), documentation, user training, and implementation of limited new capabilities; focus on modernizing MCNP for next-generation computing hardware; continue to develop MCNP-Whisper for continuous-energy sensitivity-uncertainty analysis, and contribute to the Organization for Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA) Working Party on Criticality Safety. For all tasks, LANL reports will be issued and posted on the MCNP website.

LANL AM2 ($272K) [IRSN Area of Collaboration (See Appendix E**)]**
This is a continuing task to support development and maintenance of the NJOY nuclear data processing code system, implement capabilities as needed to process new general purpose nuclear data files in the continuously evolving ENDF-6 format, provide support to NJOY users, modernize NJOY to adapt to modern code practices, new data formats, and next-generation computing hardware, and contribute to the NDAG, the Cross Section Evaluation Working Group (CSEWG), CIELO, the Working Party on International Nuclear Data Evaluation Corporation (WPEC) and the International Atomic Energy Agency (IAEA) Coordinated Research Projects (CRP) as approved by the NCSP Manager. All NJOY updates will be distributed to users through a LANL maintained website.

LANL AM4 ($45K) [IRSN Area of Collaboration (See Appendix E)]
Sensitivity-Uncertainty Comparison Study with a Focus on Upper Subcritical Limits. LANL, ORNL, and IRSN will compare results from the various methods on a small set of benchmark problems. Collaboration with ORNL and IRSN. Results will be documented in a report. Also, the work progress on this task will be monitored by the NCSP Analytical Methods Working Group.

Table 2.1-2 LANL AM Budget Trend (FY2018-FY2022)

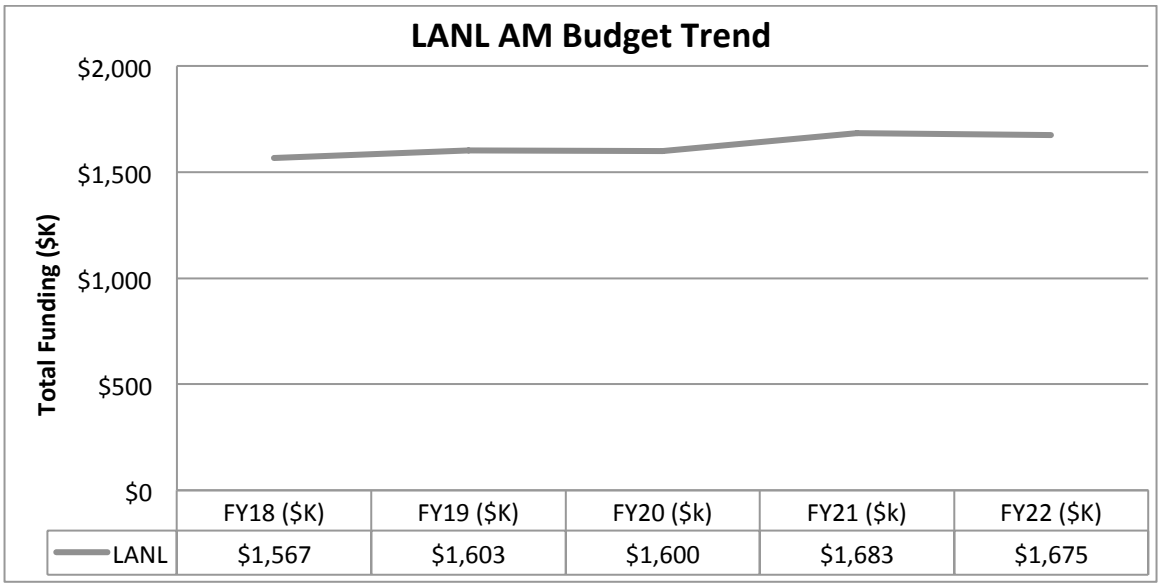
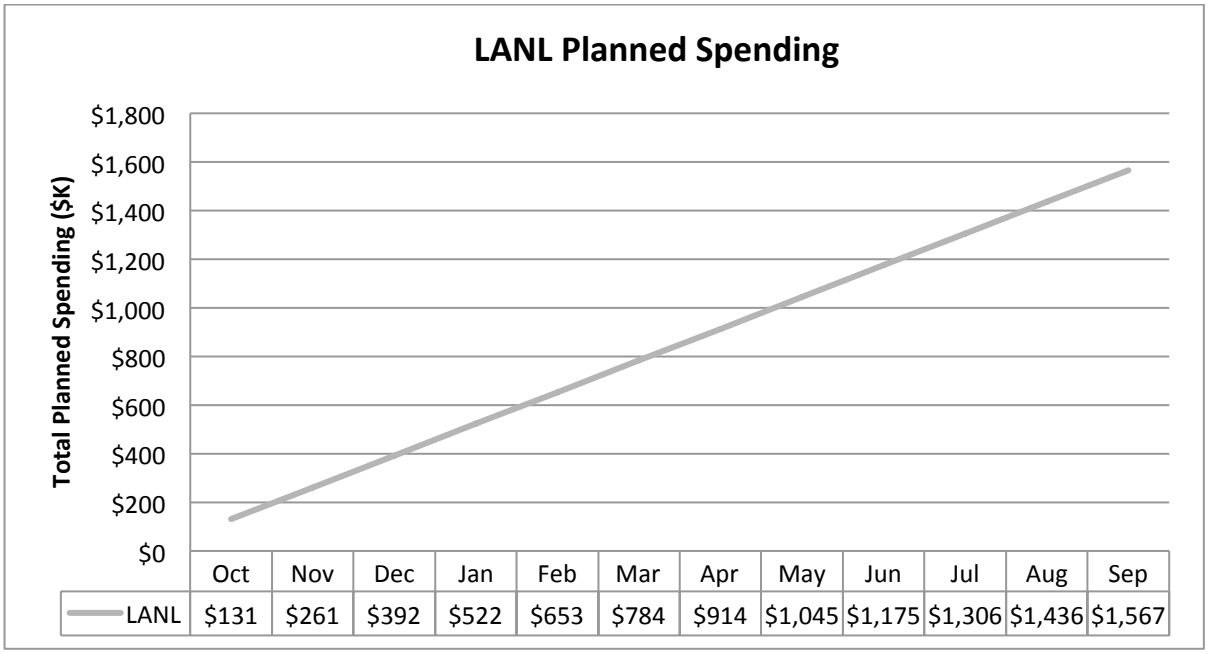


Table 2.1-3 LANL AM Planned Spending (FY2018)



LANL AM Milestones:

Occurs all 4 Quarters

- Support MCNP6 users (AM1)
- Support NJOY users (AM2)
- Provide status reports on LANL participation in US and International analytical methods collaborations (AM1, AM2)

Quarter 1

- Provide reports on summer intern work accomplished (AM1)
- Develop a plan to distribute ACE files independent of MCNP releases (AM1)

Quarter 2

- Issue an MCNP V&V report (AM1)

Quarter 3

- Provide training course on theory and practice of Monte Carlo criticality calculations with MCNP6 (AM1)
- Release MCNP ACE data libraries corresponding to ENDF/B-VIII.0 (AM1)

Quarter 4

- Develop Doppler broadening capabilities in NJOY21 (AM2)
- Issue report on the Sensitivity-Uncertainty Comparison Study (AM4)
- Develop a report for the NCSP manager on MCNP maintenance and modernization progress, the implementation of a parallel PTRAC capability, and the implementation of a Fission Matrix automated convergence checking capability (AM1).
- Issue a report on development and maintenance of the NJOY nuclear data processing code system (AM2).

Explanation of Change (EOC) – for out-year peaks and dips in budget plots:

Beginning in FY21, there is a modest increase in funding to enhance MCNP6 for NCS experiment simulations at high temperatures.

2.1.2.2 Lawrence Livermore National Laboratory (LLNL)

LLNL AM2 ($162K)

This is an ongoing approved task to support building upon existing LLNL state-of-the-art 3-D analytical multi-physics methods to develop and validate these methods for simulation of criticality excursions including participation in international collaboration efforts. The task also supports work to simulate the response of GODIVA, APRF, KRUSTY, and other systems to a fast reactivity insertion of various magnitudes. Further, this task provides maintenance, user support and minor upgrades to existing LLNL analytical methods including nuclear data processing, geometry modeling and Monte-Carlo and multiphysics methods. This task also supports on-going LLNL assistance to Brookhaven National Laboratory (BNL), the IAEA and North Carolina State University (NCSU) in developing and maintaining FUDGE, PREPRO and other nuclear data processing code systems as needed to process, distribute and test new general-purpose nuclear data files in evolving ENDF-6 and GND formats. The task also supports participation in NCSP activities including the Analytical Methods Working Group, C_EdT, CSEWG and NDAG.

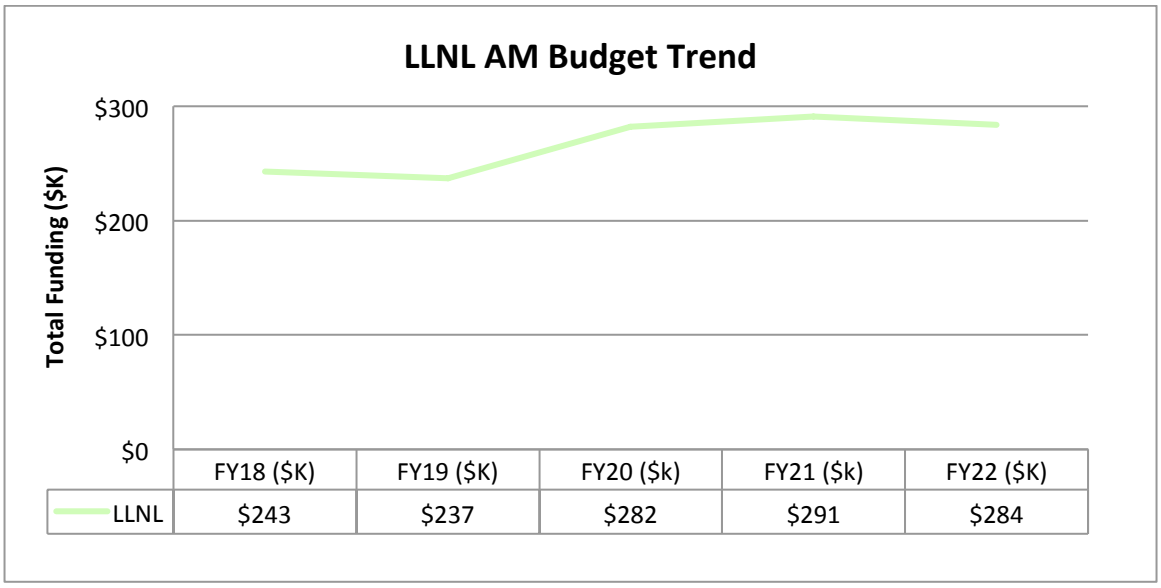
LLNL AM3 ($36K) [AWE and IRSN Area of Collaboration (See Appendix E and F**)]**

This is a continuing task to collaborate with IRSN and ORNL to modernize the existing SlideRule accident response tool. ORNL developed the initial SlideRule, and under this task, IRSN will update the SlideRule using modern radiation transport tools (e.g., SCALE, MCNP, COG, etc.) and expand the SlideRule capabilities. Funding for this task will enable ORNL and LLNL to consult with IRSN on the SlideRule modernization effort and perform review tasks as needed to assess the performance of the updated SlideRule capability. As a placeholder for discussion in future planning meetings and discussions, the "ownership" and distribution of the SlideRule in the future should be discussed as part of the IRSN and NCSP collaboration.

LLNL AM6 ($45K) [University of Arizona and ORNL Area of Collaboration]

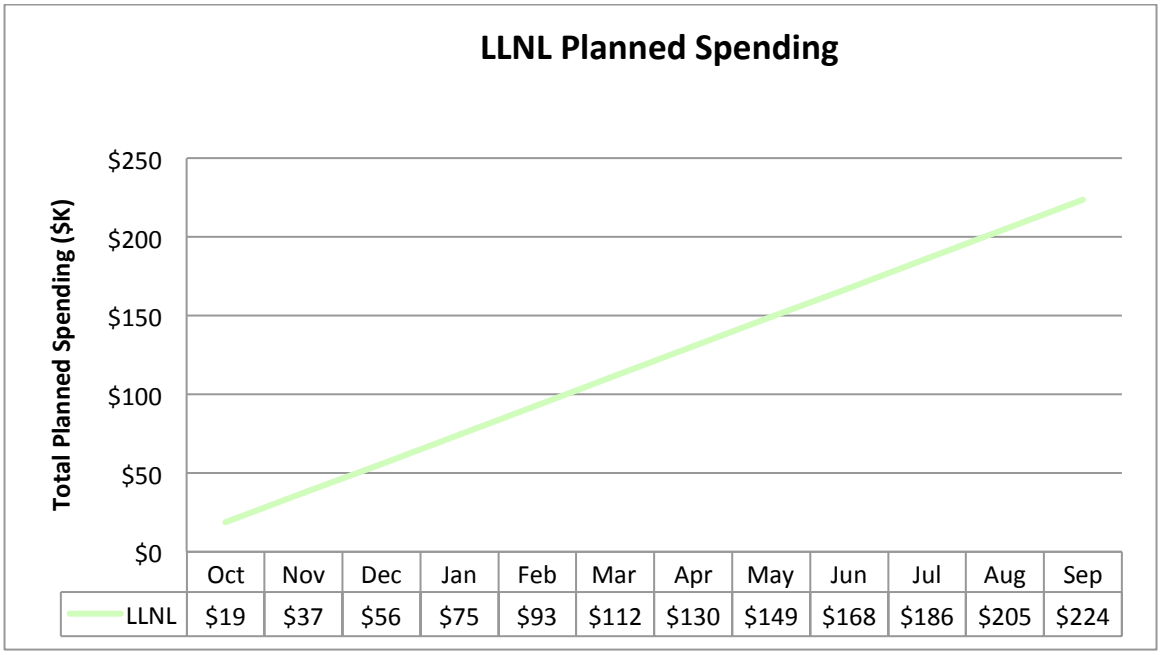
This task involves a comparison of several computational features of both NCSP Monte Carlo and U. of Arizona deterministic codes in the diffusion approximation. Since the analytical solution accommodates upwards of 500 energy points, a meaningful criticality comparison of codes and libraries becomes possible including resonance treatments. With a full heterogeneous solution, we can also study 1D assemblies as to their composition and including control rods and various fuel designs. With an overall comparison to a true analytical solution as a baseline, one can document biases, if any, in Monte Carlo codes. The University of Arizona (LLNL AM6) will establish the 1-D analytical benchmarks, LLNL will provide COG Monte Carlo results, and ORNL (ORNL AM11) will provide SCALE Monte Carlo results for this task. The work progress on this task will be monitored by the NCSP Analytical Methods Working Group.

Table 2.1-4 LLNL AM Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
LLNL	$243	$237	$282	$291	$284

Table 2.1-5 LLNL AM Planned Spending (FY2018)*



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LLNL	$19	$37	$56	$75	$93	$112	$130	$149	$168	$186	$205	$224

* LLNL Planned Spending reduced by approximately 8% to account for required laboratory hold-back during FY continuing resolution (CR) funding uncertainty.

LLNL AM Milestones:
Occurs all 4 Quarters

- Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, and AM6).
- Provide an annual report on the LLNL multiphysics capability development. (AM2).

EOC – for out-year peaks and dips in budget plots:
LLNL's funding will increase in the out years for the development of advanced nuclear data processing and multi-physics methods tasks. Also, work will begin in FY19 to perform a multi-laboratory inter-comparison benchmark study for nuclear criticality safety analytical methods tools in addition to collaborate with BNL incorporating Thermal Scattering and Self-Shielding in GND/FUDGE.

2.1.2.3 Oak Ridge National Laboratory (ORNL)

ORNL AM1 ($372K)
RSICC ongoing approved task to collect, update, package, and distribute software and associated nuclear data libraries to the criticality safety community (i.e., SCALE, MCNP, VIM, and COG and nuclear data processing (i.e., NJOY, AMPX and SAMMY). Also, test and disseminate processed nuclear data associated with the software.

ORNL AM2 ($1250K) [IRSN Area of Collaboration (See Appendix E**)]**
Ongoing, approved task to provide SCALE/KENO/TSUNAMI maintenance and user support for performing Nuclear Criticality Safety (NCS) calculations with the SCALE package. Work tasks include: sustaining and continually improving SCALE NCS features through user-driven enhancements, software quality assurance (SQA) and V&V; assuring adaptability to various computing platforms and compilers; providing improved user interfaces and user documentation consistent with modern engineering software; supporting responsive communication to SCALE criticality safety users through SCALE Newsletters, email notices, and updates on the SCALE website. The task also includes support for modernizing the software infrastructure and capabilities to improve quality and reliability and to ensure long-term sustainability of the NCS capabilities.

ORNL AM3 ($272K) [IRSN Area of Collaboration (See Appendix E**)]**
Ongoing, approved task to develop and maintain the AMPX nuclear data processing code system to provide cross-section and covariance data libraries for NCS radiation transport software such as SCALE. In addition, the task includes additional effort to implement new software enhancements needed to improve the quality and reliability of the nuclear data libraries that are produced by AMPX. The overall development and maintenance work effort will ensure the AMPX software is up-to-date and in conformance with ENDF/B formats and procedures. Moreover, the development and enhancements to the AMPX software will enable improved nuclear data processing capabilities needed to provide reliable nuclear data libraries to support radiation transport methods development and analyses.

ORNL AM6 ($36K) [AWE and IRSN Area of Collaboration (See Appendix E and F**)]**
This is a continuing task to collaborate with IRSN and LLNL to modernize the existing SlideRule accident response tool. ORNL developed the initial SlideRule, and under this task, IRSN will update the SlideRule using modern radiation transport tools (e.g., SCALE, MCNP, COG, etc.) and expand the SlideRule capabilities. Funding for this task will enable ORNL and LLNL to consult with IRSN on the SlideRule modernization effort and perform review tasks as needed to assess the performance of the updated SlideRule capability. As a placeholder for discussion in future planning meetings and discussions, the "ownership" and distribution of the SlideRule in the future should be discussed as part of the IRSN and NCSP collaboration.

ORNL AM9 ($45K) [IRSN Area of Collaboration (See Appendix E**)]**
This is a new task to examine various methods that have been developed recently to assist the Criticality Safety Analyst (CSA) determine a safe Upper Subcritical Limit (USL) for an application of interest. IRSN has developed the MACSENS tool which relies on Monte Carlo results from the MORET code. ORNL has developed the TSUNAMI package, which relies on Monte Carlo results from KENO (among various transport options), and LANL has developed the Whisper package which relies on Monte Carlo results from MCNP6.® The three Laboratories will compare results from the various methods on a small set of benchmark problems to be chosen. Differences in results

will be understood, and one or more of the methods may be improved as a result. The results for these benchmark problems, such as sensitivity profiles and individual components of the USL, will be compared. The NCSP AM Working Group will provide a forum for presenting and discussing results to ensure timely completion of the milestones. One of the three Labs will be responsible for consolidating and comparing calculated results and for preparing a summary report.

ORNL AM11 ($24K) [University of Arizona and LLNL Area of Collaboration]

This task involves a comparison of several computational features of both NCSP Monte Carlo and U. of Arizona deterministic codes in the diffusion approximation. Since the analytical solution accommodates upwards of 500 energy points, a meaningful criticality comparison of codes and libraries becomes possible including resonance treatments. With a full heterogeneous solution, we can also study 1D assemblies as to their composition and including control rods and various fuel designs. With an overall comparison to a true analytical solution as a baseline, one can document biases, if any, in Monte Carlo codes. The University of Arizona will establish the 1-D analytical benchmarks, LLNL will provide COG Monte Carlo results (LLNL-AM6), and ORNL will provide SCALE Monte Carlo results for this task. The work progress on this task will be monitored by the NCSP Analytical Methods Working Group.

ORNL AM13 ($89K) [University of Florida Area of Collaboration]

This is a new task to collaborate with the University of Florida to process the ENDF/B-VIII.0 evaluated cross section libraries using the AMPX code system to generate and test the continuous energy and problem-independent multigroup cross section libraries to be included in the next release of SCALE code system.

ORNL AM14 ($34K) [University of Tennessee Area of Collaboration]

This is a new task to collaborate with the University of Tennessee to convert all continuous energy (CE) CSAS or multigroup TSUNAMI-3D models from VALID into CE TSUNAMI-3D models. Model geometry and ICSBEP evaluation checking is complete. Sensitivity Data Files (SDF) would be gathered for all fast systems in VALID using CE TSUNAMI-3D (74 total). Likewise, the LEU cases within VALID consist of 19 LEU- SOL-THERM cases and 123 LEU-COMP-THERM cases, which would result in 142 new SDFs in VALID. This procedure would provide CE TSUNAMI-3D-generated SDFs and verified SCALE input files for distribution with the ICSBEP Handbook, as well as with the first set of verified CE sensitivities within VALID, in addition to training a next generation professional into various NCSP mission-oriented tasks.

Table 2.1-6 ORNL AM Budget Trend (FY2018-FY2022)

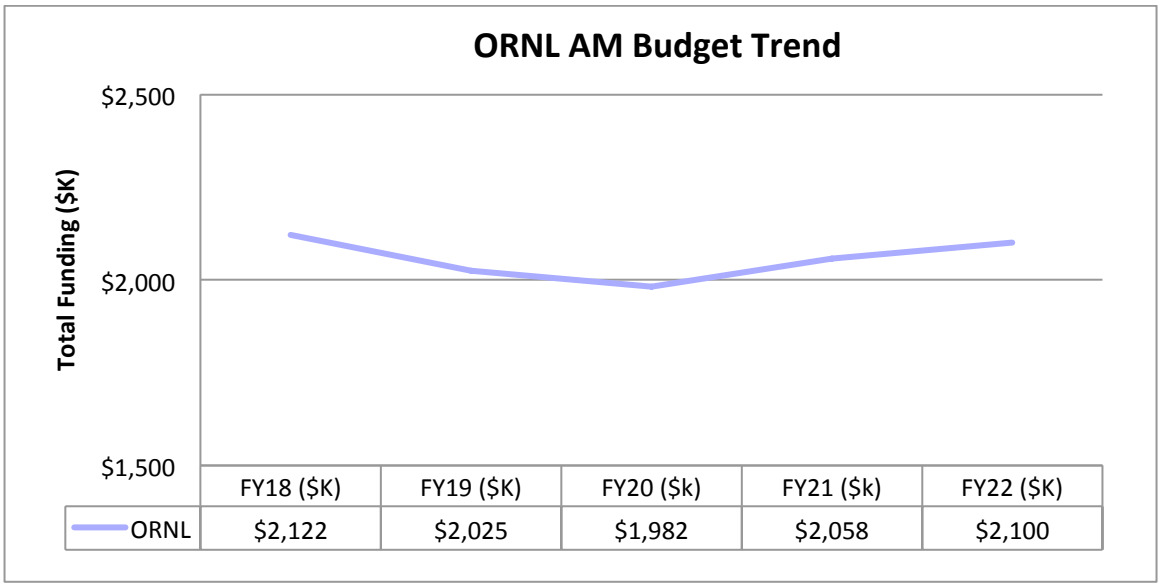
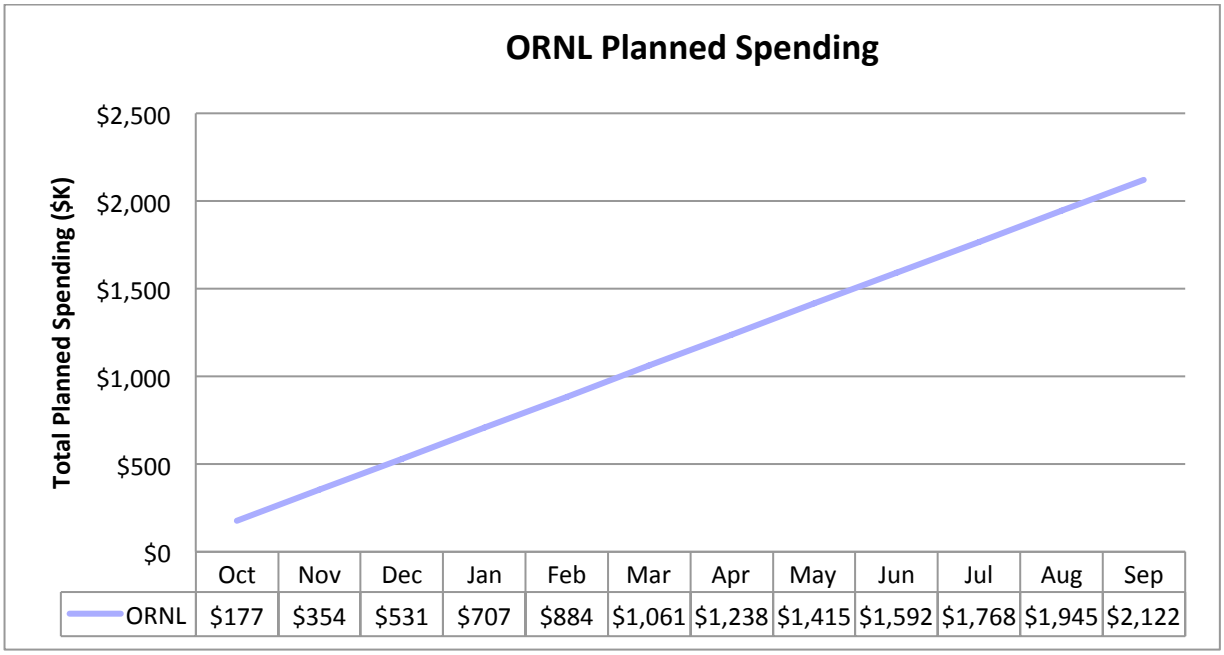


Table 2.1-7 ORNL AM Planned Spending (FY2018)*



* ORNL Planned Spending reduced by approximately 8% to account for required laboratory hold-back during FY CR funding uncertainty.

ORNL AM Milestones:

Occurs all 4 Quarters

- Continue distribution of available and newly packaged software to the NCS community requesters (at no direct cost to them) and provide distribution totals quarterly. (AM1)
- Provide status reports on ORNL participation in US and International Analytical Methods collaborations and provide brief trip summary report to NCSP Manager on items of NCSP interest. (AM2, AM3)
- Provide a status report on ORNL support on a new SlideRule accident response tool (AM6).
- Provide status on ORNL AM activities in NCSP Quarterly Progress Reports. (AM1, AM2, AM3, AM6, AM9)
- Provide a status report of the progress on the establishment of 1D analytical benchmarks (Univ. of Arizona); provide a progress report of providing COG Monte Carlo Results (LLNL); and Provide a progress report of SCALE Monte Carlo results (ORNL). (AM11)

Quarter 1

- Provide a status report of the progress on acquiring and processing the latest beta and official releases of ENDF/B-VIII.0 with AMPX. (AM13)
- Provide a status report of the progress with Identifying the VALID models for CE TSUNAMI-3D inclusion, obtaining models from VALID, reviewing and understanding inputs based on VALID documentation, and converting the CE CSAS or MG TSUNAMI-3D models to CE TSUNAMI-3D. (AM14)

Quarter 2

- Issue an annual SCALE maintenance report to the NCSP Manager. (AM2)
- Provide a status report about running the CE TSUNAMI-3D models, performing direct perturbation calculations to verify SDFs, editing and rerunning CE TSUMANI-3D models as necessary, and submitting a paper to summer ANS or professional conference. (AM14)

Quarter 3

- Provide a status report for running verification test cases and comparing to previous results. (AM13)
- Provide a status report for evaluating any additional sensitivity parameters, documenting generation, review and submission to VALID, repeating procedure for additional evaluations as time and budget permits, and submitting paper to winter ANS or NCSP professional conference. (AM14)

Quarter 4

- Publish annual newsletter to users to communicate software updates, user notices, generic technical advice, and training course announcements (AM2).
- Document AMPX modernization and technical support for SCALE CE, multigroup, and covariance libraries and report status annually to the NCSP Manager. (AM3)
- Complete annual IRSN-LLNL-ORNL status report on the SlideRule development and provide report to NCSP Manager (AM6).
- Issue a summary report that summarizes ORNL TSUNAMI results on chosen benchmark problems and a comparison of work by LANL and IRSN (AM9).
- Issue a summary report for nuclear data and cross section testing using ENDF/B-VIII.0. (AM13)
- Provide a status report for collecting lessons learned, results, and feedback for ORNL, and completing final report to provide to NCSP and ORNL. (AM14)

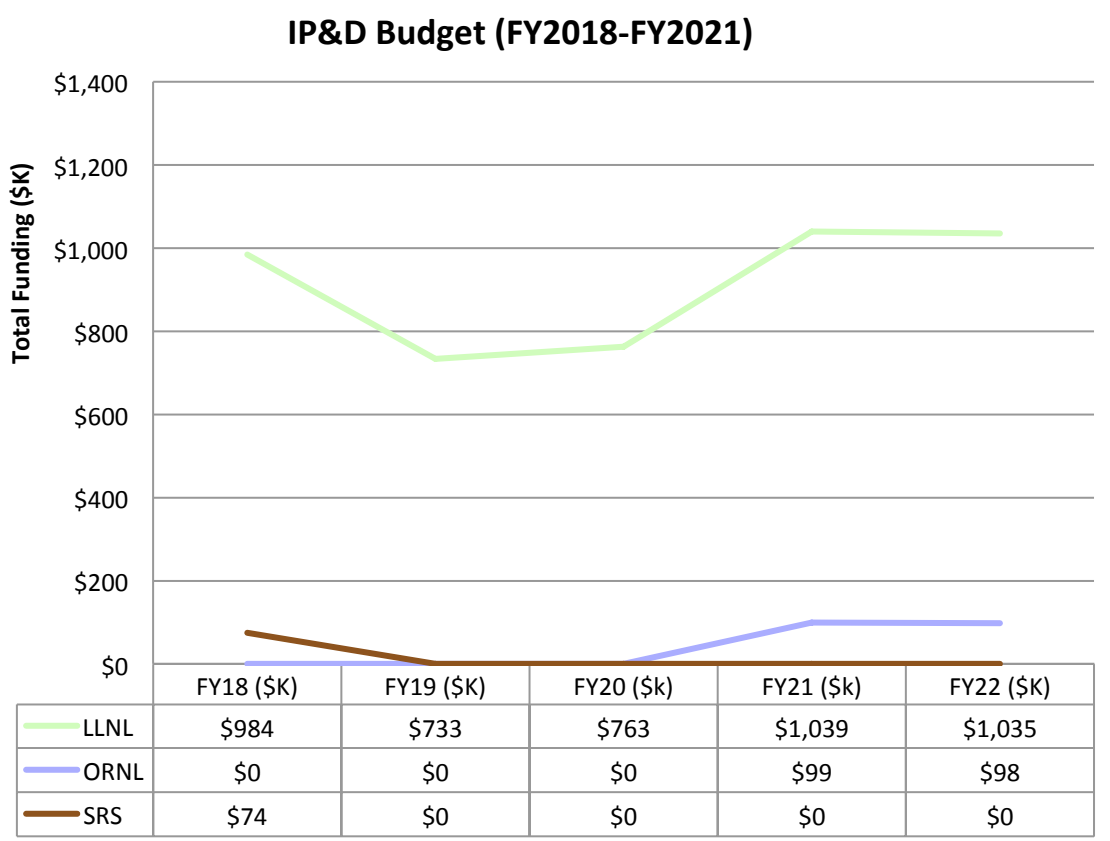
EOC – for out-year peaks and dips in budget plots:
ORNL's funding will increase in out years to support SCALE maintenance and modernization and to ensure that SCALE is available to support NCS analyses using modern computing platforms. Beginning in FY18, five new tasks will be initiated to perform inter-comparison studies of S/U analysis tools, NCS slide rule application, an analytical benchmark comparison study, nuclear data and cross section testing, and the development and addition of continuous energy sensitivity data files to SCALE's VALID library.

2.2 Information Preservation and Dissemination (IP&D)

2.2.1 Program Element Description

The Information Preservation and Dissemination program element preserves primary documentation supporting criticality safety and makes this information available for the benefit of the technical community. The NCSP website (http://ncsp.llnl.gov) is the central focal point for access to criticality safety information collected under the NCSP, and the gateway to a comprehensive set of hyperlinks to other sites containing criticality safety information resources.

Table 2.2-1 IP&D Budget (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
LLNL	$984	$733	$763	$1,039	$1,035
ORNL	$0	$0	$0	$99	$98
SRS	$74	$0	$0	$0	$0

EOC – for out-year peaks and dips in budget plots:

- LLNL's funding will increase in out years for additional ICSBEP capabilities, tasks, and milestones. The NCSP classified website will be discontinued starting in FY18.
- ORNL will be funded in FY21 and out years to develop experimental uncertainty correlation data needed to support modern validation data adjustment methods for nuclear criticality safety.
- SRS funding will restart in FY18 to continue support and maintenance for the CritView software that includes ARH-600 data, and funding for this task will decrease in the out years due to the transition from development to maintenance of the CritView software (it is expected that bugs and improvements will decline FY18-FY22.

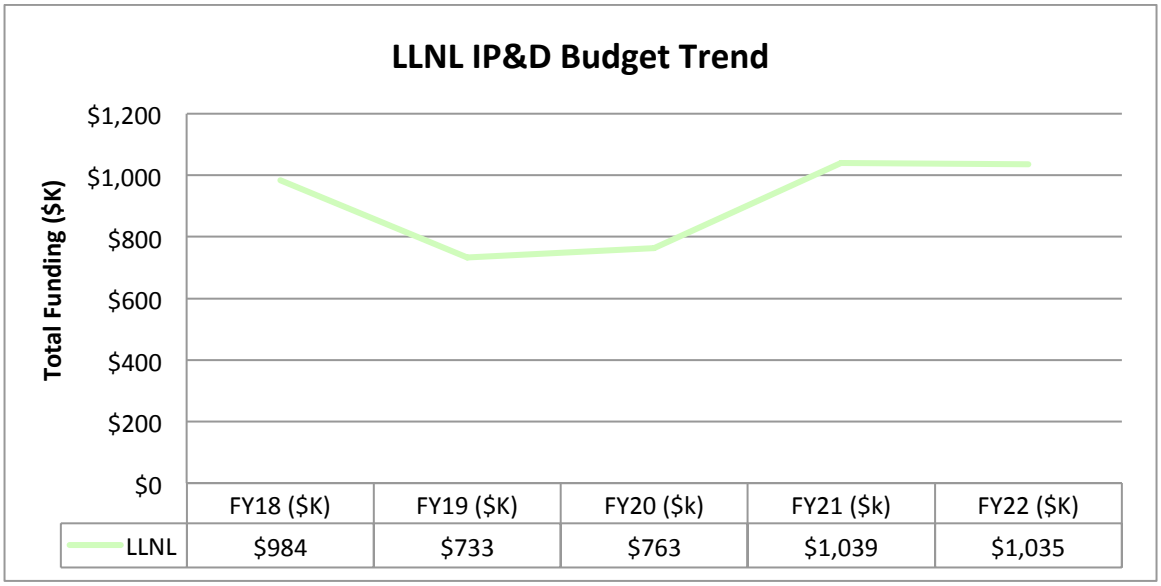
2.2.2 Approved Tasks

2.2.2.1 Lawrence Livermore National Laboratory (LLNL)

LLNL IP&D1 ($290K) [AWE and IRSN Area of Collaboration (See Appendix E and F)**]**
This is an ongoing approved task that provides independent and Technical Review Group (TRG) reviews for newly completed integral experiments for publication as NCSP contributions to the International Criticality Safety Benchmark Evaluation Project (ICSBEP). Priority historical experiments may also be evaluated and reviewed (internal, independent, and TRG) as resources allow. All NCSP funded experiments will be finalized and published on the NCSP website within two quarters of receipt of an Experiment Design Team reviewed and approved draft report (CED-4a). LLNL IP&D1 will also provide leadership, coordination, and publication support for the OECD/NEA ICSBEP.

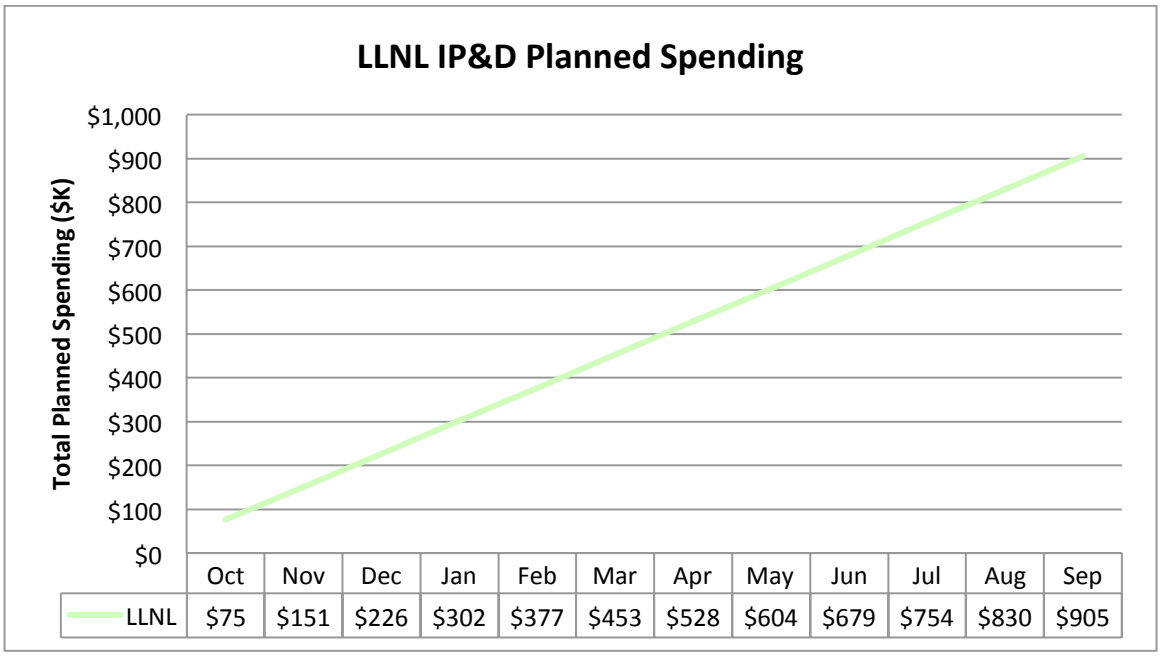
LLNL IP&D2 ($694K)
This is an ongoing approved task for operation, maintenance and modernization of the NCSP website. The NCSP website is the central focal point for access to criticality safety information collected under the NCSP, and is the gateway to a comprehensive set of hyperlinks to other sites containing criticality safety information resources.

Table 2.2-2 LLNL IP&D Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
LLNL	$984	$733	$763	$1,039	$1,035

Table 2.2-3 LLNL IP&D Planned Spending (FY2018)*



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LLNL	$75	$151	$226	$302	$377	$453	$528	$604	$679	$754	$830	$905

* LLNL Planned Spending reduced by approximately 8% to account for required laboratory hold-back during FY CR funding uncertainty.

LLNL IP&D Milestones:

Occurs all 4 Quarters

- Manage all aspects of the DOE NCSP participation in the ICSBEP as required to ensure the finalizing and publishing ICSBEP evaluations per IE schedule. (IP&D1)
- Provide status reports on LLNL participation in US and International IP&D collaborations (including ICSBEP) and provide brief summary report to NCSP Manager on items of NCSP interest. (IP&D1)
- Maintain, operate and modernize he NCSP website, databases, and provide user assistance as required. (IP&D2)

EOC – for out-year peaks and dips in budget plots:

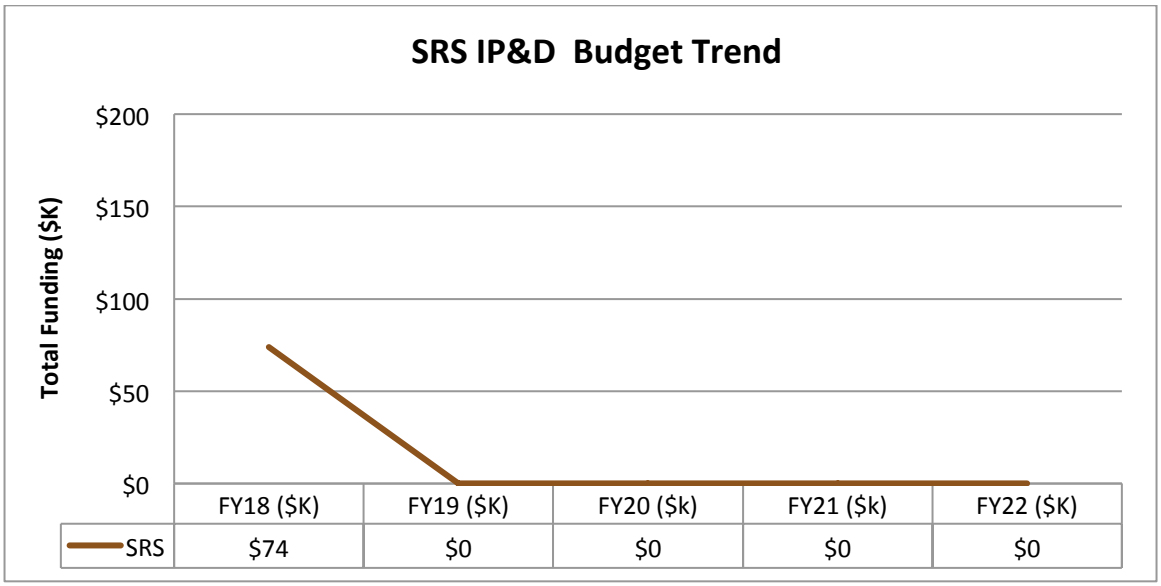
LLNL's funding will increase in out years for additional ICSBEP capabilities, tasks, and milestones. The NCSP classified website will be discontinued starting in FY18.

2.2.2.2 Savannah River Site (SRS)

SRS IP&D1 ($74K)

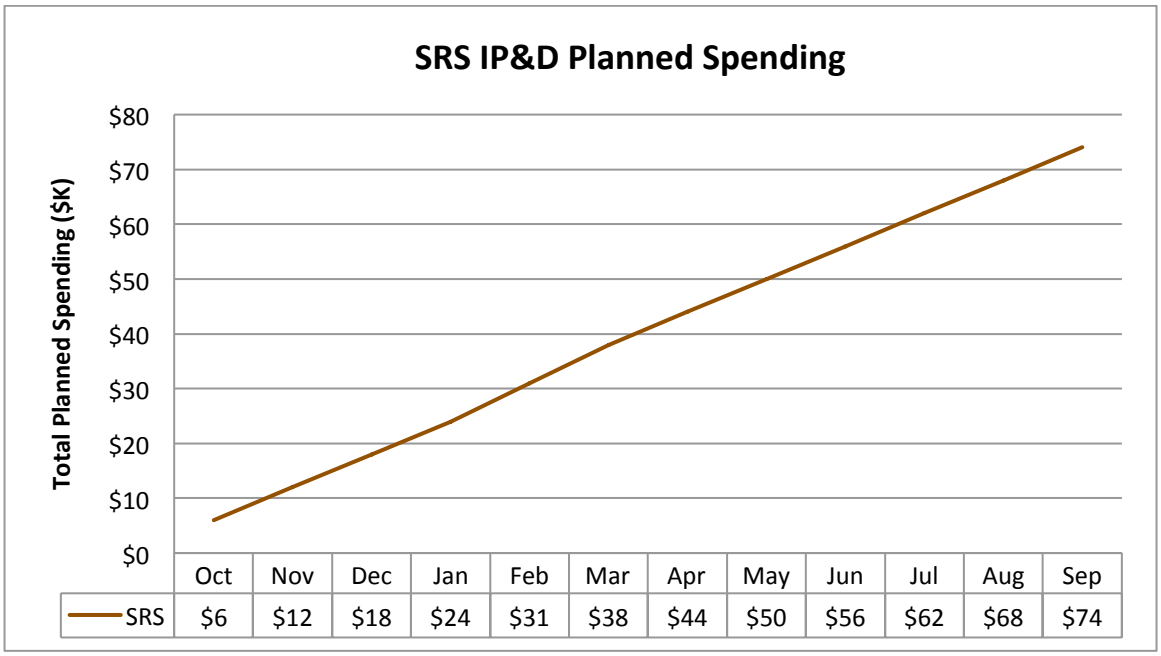
The updated CritView software and libraries will be a reliable tool for criticality safety analysts that can supplement computer calculations and other handbook values. This effort maintains capabilities and provides improved efficiencies in accessing criticality data to reduce safety risk. ARH-600, and other criticality safety handbook data, are being evaluated with MCNP and SCALE, will be peer reviewed and will be issued as an electronic handbook with unique search and visualization features. The current focus is to update CritView to 1) better handle large databases to support improved functionality and significantly more data, and 2) upgrade the user interface to provide a more efficient and user-friendly program. Also provide limited response to user queries, any error identification, and database management.

Table 2.2-4 SRS IP&D Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
SRS	$74	$0	$0	$0	$0

Table 2.2-5 SRS IP&D Planned Spending (FY2018)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SRS	$6	$12	$18	$24	$31	$38	$44	$50	$56	$62	$68	$74

SRS IP&D Milestones

Occurs all 4 Quarters

- Provide status reports on SRS progress. (IP&D1)

Quarter 2

- Develop QA documents for current version to meet current SRS/DOE requirements. (IP&D1)

Quarter 4

- Issue Preliminary (updated) CritView version for internal testing. (IP&D1)
- Issue Preliminary User Guide to support internal testing. (IP&D1)

EOC – for out-year peaks and dips in budget plots:

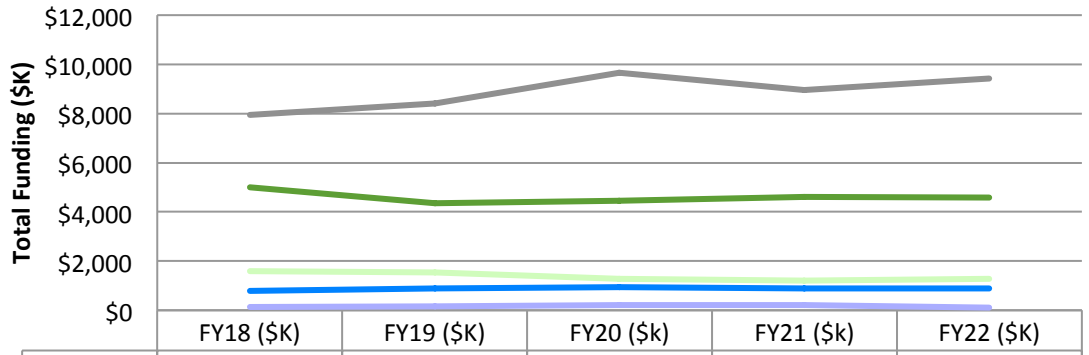
SRS funding will restart in FY18 to continue support and maintenance for the CritView software that includes ARH-600 data, and funding for this task will decrease in the out years due to the transition from development to maintenance of the CritView software (it is expected that bugs and improvements will decline FY18-FY22.

2.3 Integral Experiments (IE)

2.3.1 Program Element Description

The Integral Experiments program element maintains a fundamental capability for the DOE NCSP to be able to perform critical, subcritical, and fundamental physics measurements, within the limits of its resources, to address criticality physics needs, emerging data improvement needs by DOE programs, and specific-site needs on a prioritized basis. This program element supports the entire cost of the LANL NCERC permanent party staff and also supports maintaining a fundamental nuclear materials handling capability, which enables hands-on NCS training programs and various other programs for the DOE NCSP and other government agencies.

Table 2.3-1 IE Budget (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
LANL	$7,944	$8,422	$9,670	$8,962	$9,432
LLNL	$1,604	$1,536	$1,267	$1,207	$1,276
NNSS	$5,005	$4,353	$4,465	$4,614	$4,596
ORNL	$146	$160	$205	$218	$100
SNL	$788	$898	$935	$892	$888

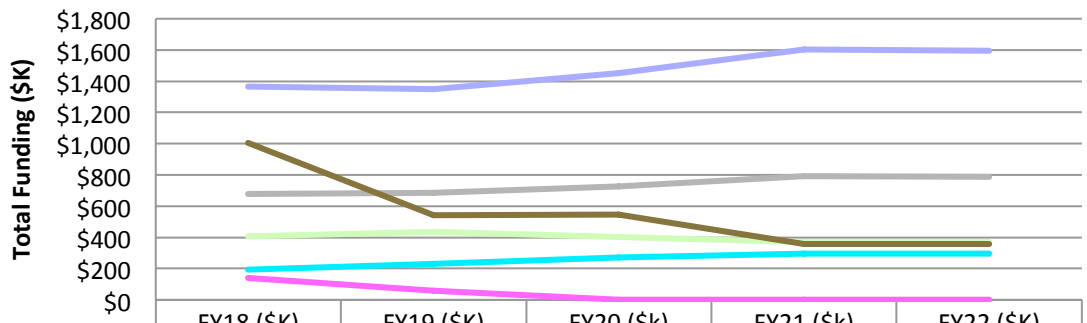
All Integral Experiment tasks and milestones are published as a standalone document. Contact the NCSP Program Manager, Dr. Angela Chambers, if you have a 'Need-to-Know.'

2.4 Nuclear Data (ND)

2.4.1 Program Element Description

The Nuclear Data program element includes the measurement, evaluation, testing, and publication of neutron cross-section data for nuclides of high importance to NCS analyses. The NCSP continues to improve coordination of ND activities by fostering a strong collaborative effort among all of the national and international resources in this highly technical area. The objective is to solve the highest priority ND problems relevant to criticality safety in a timely manner. This program element is essential for the NCSP because it provides the nuclear cross-section data required by the AM program element. Refer to Appendix B for the FY2018 through FY2022 schedule, milestones, and deliverables associated with specific nuclear data measurement, evaluation, and publication. Milestones not contained in Appendix B are delineated below.

Table 2.4-1 ND Budget (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
BNL	$193	$229	$271	$297	$296
LANL	$678	$687	$726	$792	$789
LLNL	$408	$437	$403	$368	$370
ORNL	$1,367	$1,348	$1,451	$1,603	$1,597
RPI	$1,006	$540	$547	$357	$356
Y12	$139	$60	$0	$0	$0

EOC – for out-year peaks and dips in budget plots:

- BNL's funding will increase in out years to perform additional work on ADVANCE.
- LANL's funding will increase in out years to ramp up nuclear data evaluation and testing.
- LLNL's funding will decrease in FY19 due to the completion of the development and implementation of an advanced and rigorous computational platform for thermal neutron scattering analysis. LLNL work over the planning period also includes stable funding for the generation and testing of thermal scattering law data in collaboration with NCSU, delayed fission gamma multiplicity and spectra tasks and testing of the revised ^{233}U resonance-region cross-section evaluation by IRSN.
- ORNL's funding will increase in out years to support nuclear data measurement and evaluation work, including procurement of enriched isotopes samples needed for cross-

section measurements. In addition, a modest funding increase is provided in the out years to support the SAMMY modernization effort.

- RPI's funding level will taper off in out years, where support of the RPI LINAC 2020 Nuclear Data Capabilities Maintenance Plan efforts will decrease at the end of that investment period.

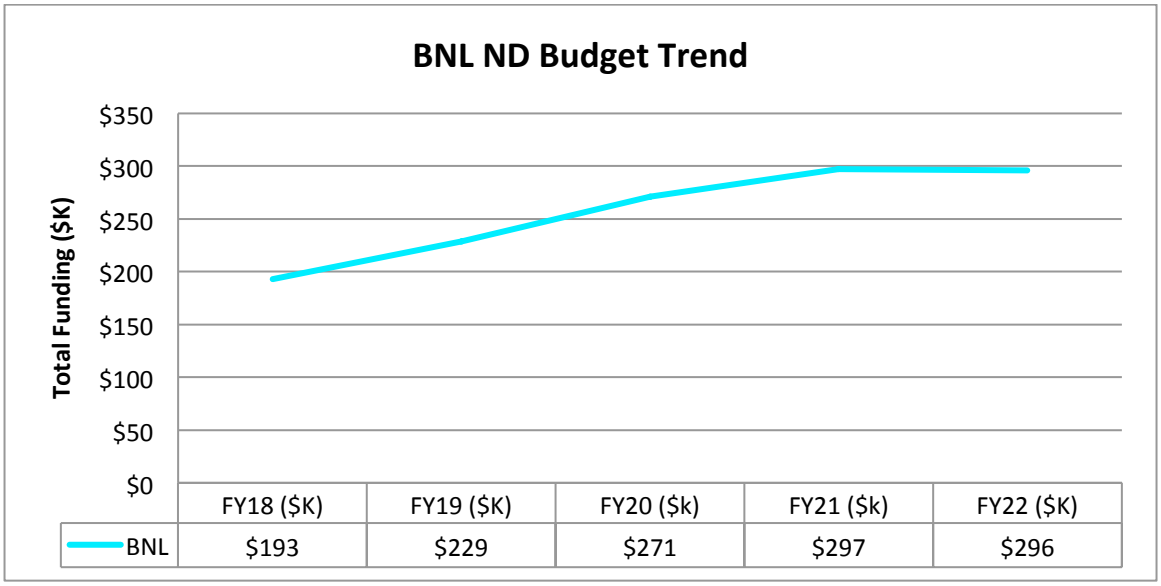
2.4.2 Approved Tasks

2.4.2.1 Brookhaven National Laboratory (BNL)

BNL ND1 ($193)

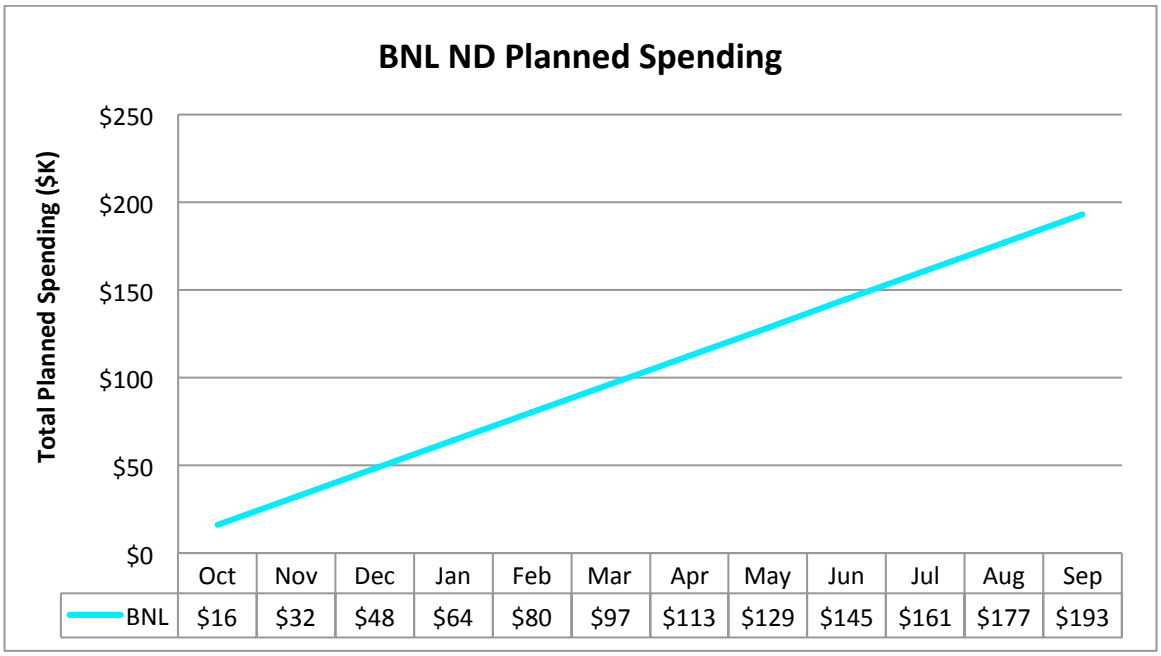
This is an ongoing approved task to provide technical support to the NCSP to ensure that NCSP cross-section evaluations are checked, processed, visualized, reviewed, archived, and made available through the National Nuclear Data Center (NNDC) GForge system as candidate evaluations for the future versions of the ENDF/B library. Maintain Atlas of Neutron Resonances as a unique resource of thermal and resonance data and their uncertainties.

Table 2.4-2 BNL ND Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
BNL	$193	$229	$271	$297	$296

Table 2.4-3 BNL ND Planned Spending (FY2018)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BNL	$16	$32	$48	$64	$80	$97	$113	$129	$145	$161	$177	$193

BNL ND Milestones:

Occurs all 4 Quarters

- Maintain and upgrade ADVANCE code system by performing data verification of new NCSP evaluations and performing quality assurance on the data as required and provide status reports on all nuclear data support activities to the NCSP Manager. (ND1)

Quarter 3

- If mandated by CSEWG, release new ENDF library. (ND1)

EOC – for out-year peaks and dips in budget plots:

Steady funding in FY18 due to a continuation of milestones for ADVANCE. Increase in funding in out-years for additional work on ADVANCE as defined in the NCSP Mission and Vision document.

2.4.2.2 Los Alamos National Laboratory (LANL)

LANL ND1 ($678K) [IRSN Area of Collaboration (See Appendix E)**]**

This is an ongoing approved task to provide differential data evaluation and covariance development in the energy region above the resonance range for heavy elements (often in partnership with resonance-range work from ORNL), and over the entire ENDF energy range for light elements. Particular focus will be on neutron fission. Perform data testing analysis with new evaluated sets. Contribute to NDAG, CSEWG, CIELO, WPEC, and IAEA CRP.

Table 2.4-4 LANL ND Budget Trend (FY2018-FY2022)

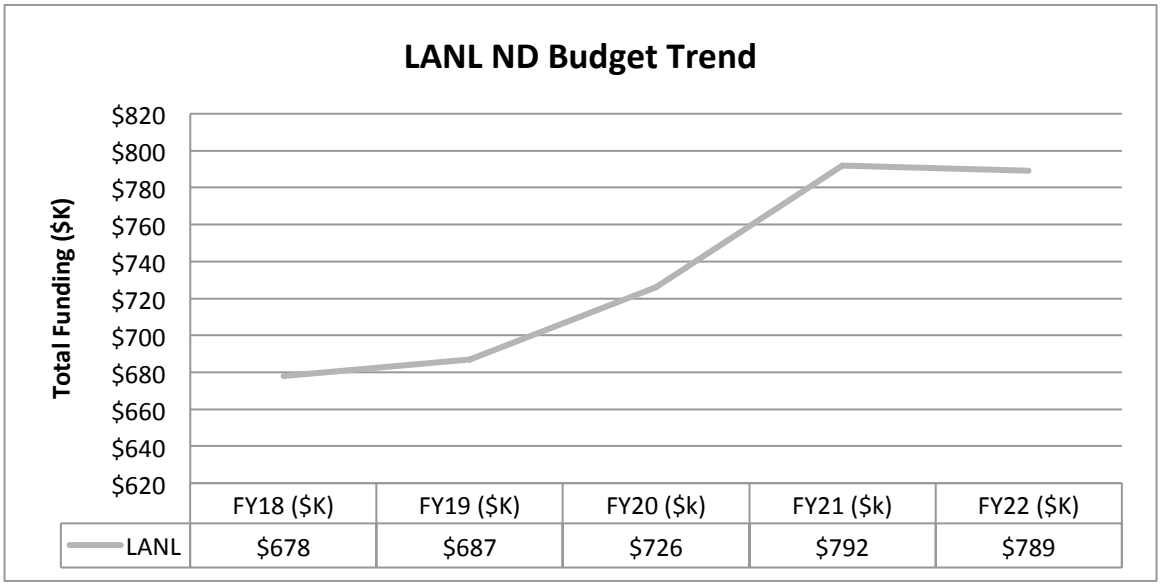
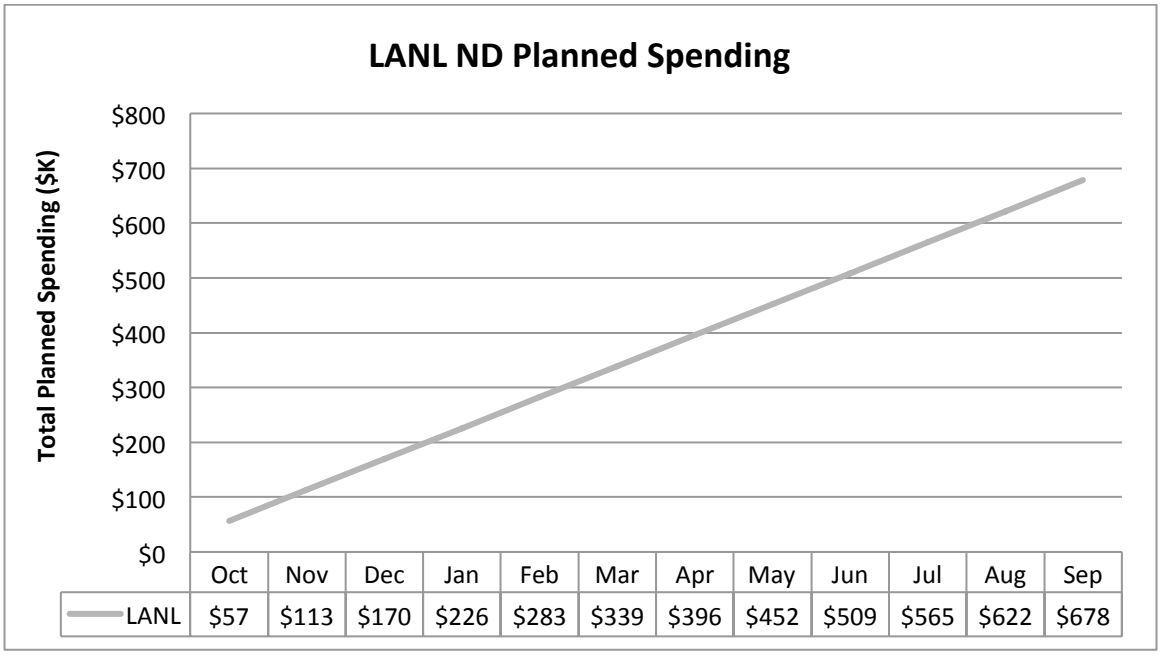


Table 2.4-5 LANL ND Planned Spending (FY2018)



LANL ND Milestones:

Occurs all 4 Quarters

- Provide status reports on LANL participation in US and International Nuclear Data collaborations. (ND1)

Quarter 1

- Conduct CSEWG Data Evaluation Committee session. (ND1)
- Report data testing results with ENDF/B-VIII.0 cross sections. (ND1)

Quarter 4

- Report planning status of LANL initiative focused on machine learning for nuclear data. (ND1)
- Deliver nuclear data evaluations as indicated in Appendix B of this document. (ND1)

EOC – for out-year peaks and dips in budget plots:

Increase in funding in out-years to ramp up nuclear data evaluation and testing planned per Appendix B and as defined in the NCSP Mission and Vision document.

2.4.2.3 Lawrence Livermore National Laboratory (LLNL)

LLNL ND1 ($88K) [IRSN Area of Collaboration (See Appendix E**)]**
This is an ongoing approved task to work with IRSN to develop, test, and document a first principles analytic method to determine the equilibrium and time-dependent emission of delayed gammas based on event-by-event modeling of the fission process and subsequent fission product decay. This task supports continued data testing as new experimental data becomes available from foil activation measurements and dosimetry testing using GODIVA, FLATTOP, and other assemblies.

LLNL ND2 ($72K) [North Carolina State University and Naval Nuclear Laboratory Area of Collaboration]
This is an ongoing approved task in collaboration with NCSU and NNL to refine and complete basic atomistic models for executing molecular dynamics simulations for the moderator materials specified in Appendix B. A potential function describing the atomistic interactions will be chosen and parameterized to reproduce its observed characteristics. Subsequently, the excitation spectrum (i.e., vibrations, rotations, etc.) will be calculated. This information will be used to develop LEAPR-THERMR modules in NJOY to calculate the scattering law, $S(\alpha,\beta)$, and the thermal neutron scattering cross sections at temperatures of interest. The libraries produced will account for both inelastic and coherent elastic scattering, when applicable. With LLNL assistance, these $S(\alpha,\beta)$ libraries in both ENDF File 7 and ACE ("A Compact ENDF" file) formats will be tested in NCSP analytic methods using relevant criticality safety benchmarks selected from the ICSBEP Handbook. Finally, the $S(\alpha,\beta)$ libraries in ENDF File 7 will be provided to the National Nuclear Data Center at Brookhaven National Laboratory. The NR Program (NNL) will match NCSP funding for this task.

LLNL ND3 ($99K) [North Carolina State University and Naval Nuclear Laboratory Area of Collaboration]
This is an ongoing approved task in collaboration with NCSU and NNL to develop and refine a "next generation" computational platform for calculating thermal neutron scattering cross sections and to assist in interpreting and processing related measured data. This tool will be based on rigorous physics and will abandon all simplifications such as the incoherent, cubic and Gaussian approximations that are implemented in current computer codes. In addition, it will include the option to accept as input phonon frequency spectra (as in the current practice), full dispersion relations (as needed to address strong coherent scattering materials such as carbon and beryllium), velocity autocorrelation functions (as the starting point for describing liquids and non-crystalline materials), and/or the van Hove correlation function (i.e., $G(\mathbf{r},t)$) for exact calculations of the full $S(\alpha,\beta)$ of a given material including the self and distinct components. Furthermore, advanced, physics based $S(\alpha,\beta)$ interpolation free analysis methods will be investigated. For completeness, the code will include a generalized capability for calculating the coherent elastic scattering cross section for crystalline materials that addresses any material and structure as specified by the user. Finally, method specific formulations for estimating covariance information for the data will be explored and included. The NR Program will match NCSP funding for this task.

LLNL ND5 ($99K) [North Carolina State University and Naval Nuclear Laboratory Area of Collaboration]
This is a new approved task in collaboration with NCSU and NNL to formulate, develop and implement a modern Doppler broadening of nuclear cross sections that abandons the free gas approximation and accounts for atomic binding effects.

LLNL ND6 ($50K) [Naval Nuclear Laboratory Area of Collaboration]

This is a new approved task in collaboration with NNL to evaluate available neutron radiative capture gamma production data for cadmium and revise the ENDF/B-VIII.0 evaluation to include the evaluated best values. This task also includes testing the revised evaluations for cadmium using the ICSBEP evaluation ALARM-TRAN-CH2-SHIELD-001 and providing the testing results and completed evaluation to BNL for inclusion in ENDF/B in ENDF-6 and GND formats. NNL will match NCSP funding for this task.

Table 2.4-6 LLNL ND Budget Trend (FY2018-FY2022)

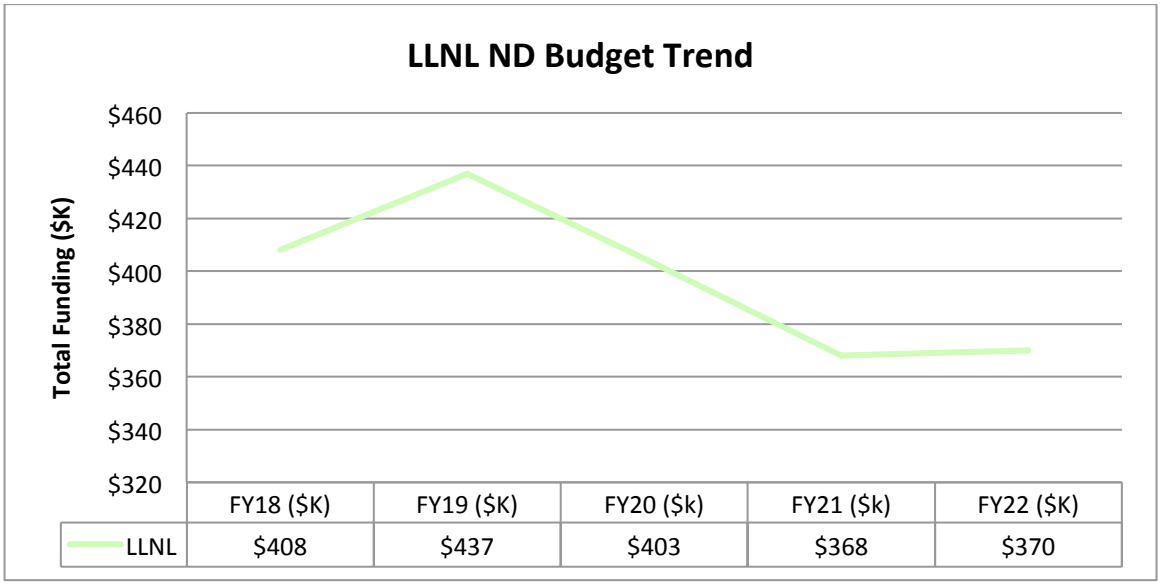
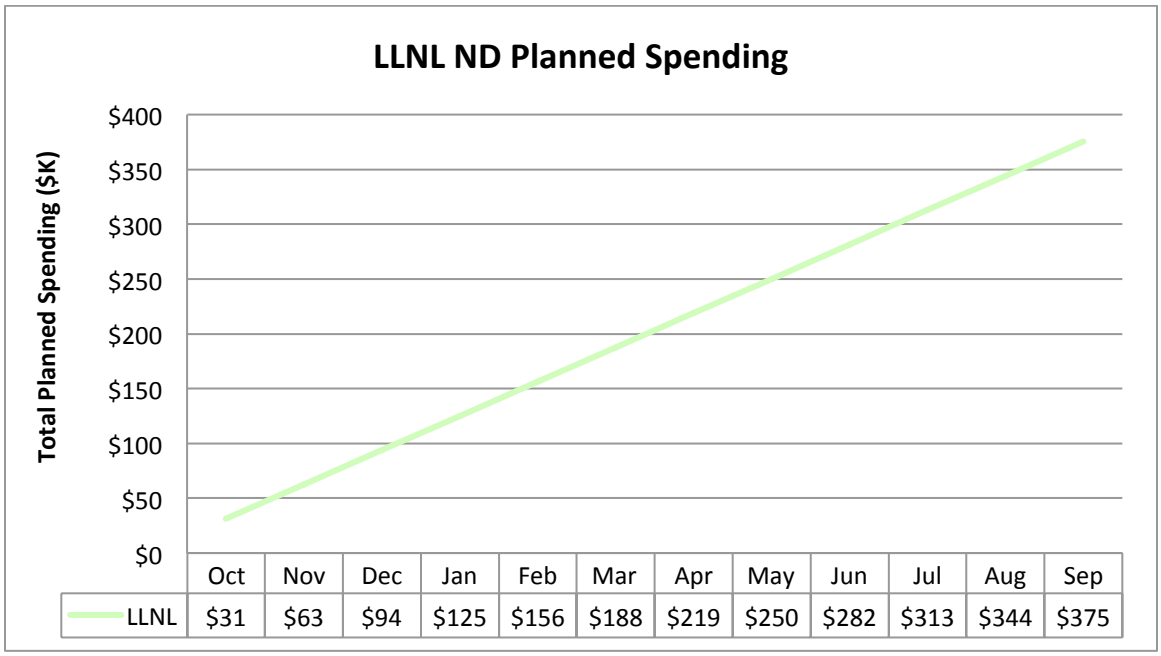


Table 2.4-7 LLNL ND Planned Spending (FY2018)*



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LLNL	$31	$63	$94	$125	$156	$188	$219	$250	$282	$313	$344	$375

*LLNL Planned Spending reduced by approximately 8% to account for required laboratory hold-back during FY CR funding uncertainty.

LLNL ND Milestones:

Occurs all 4 Quarters

- Provide status on LLNL ND activities in NCSP Quarterly Progress Reports (ND1, ND2, ND3, ND5, ND6)
- Provide status on LLNL/NCSU nuclear data activities to NCSP Manager. (ND2, ND3, ND5)
- Provide status on LLNL/IRSN nuclear data activities to NCSP Manager. (ND1)

Quarter 4

- Deliver thermal neutron scattering data evaluations as indicated in Appendix B of the 5-Year Plan. (ND2)

EOC – for out-year peaks and dips in budget plots:

LLNL's funding will decrease in FY19 due to the completion of the development and implementation of an advanced and rigorous computational platform for thermal neutron scattering analysis. LLNL work over the planning period also includes stable funding for the generation and testing of thermal scattering law data in collaboration with NCSU, delayed fission gamma multiplicity and spectra tasks and testing of the revised ^{233}U resonance-region cross-section evaluation by IRSN.

2.4.2.4 Oak Ridge National Laboratory (ORNL)

ORNL ND1 ($892K) [IRSN Area of Collaboration (See Appendix E**)]**
Ongoing task to conduct nuclear data measurement and evaluation activities in support of the NCSP. This subtask continues to primarily focus on the resonance-region and includes cross-section measurements and the production of new cross-section evaluations with covariance data. The ORNL nuclear data measurements and evaluations are performed in accordance with the milestone schedule in Appendix B.

ORNL ND6 ($387K)
This is a continuing task to modernize the SAMMY software that is an essential tool needed by nuclear data evaluators to analyze measured cross-section data and produce nuclear data evaluations with covariance data for the NCSP. SAMMY is primarily used to analyze differential data from the RPI Gaerttner linear accelerator, IRMM Geel Electron Linear Accelerator (GELINA), and Los Alamos Neutron Science Center (LANSCE) to produce nuclear data evaluations. An initial step toward modernization will be the merger of SAMMY under the SCALE continuous integration (CI) development framework. Once complete, SAMMY will be developed under the SCALE software quality assurance plan (SQAP) thereby providing increased confidence in the quality of the data evaluations developed and deployed by SAMMY. Once SAMMY is completely under SQA and integrated with the SCALE/AMPX CI development framework, the work will be performed to modernize SAMMY by utilizing modern computing frameworks and libraries that harness the emerging computing power of parallel architectures, and that enable a rapid development of new data analysis capabilities. The overall modernization work effort will ensure the SAMMY software is up-to-date and positioned for long-term sustainability in order to support NCSP nuclear data evaluation needs.

ORNL ND7 ($68K)
This is a new task to collaborate with the Georgia Institute of Technology to identify benchmark experiments and develop SCALE and MCNP models to evaluate and test nuclear data evaluations recently completed by the US Nuclear Criticality Safety Program (NCSP). In addition, the project task will be designed for a student to work under the guidance of an ORNL nuclear data and criticality safety expert. Upon completion of the project, the proposed project will provide feedback on the performance of the new nuclear data evaluations and help identify whether further data improvements are needed.

ORNL ND8 ($20K)
This task continues work to develop a detailed comprehensive assessment of the status of ^{233}U nuclear data and develop a data gap analysis to use to develop a comprehensive integrated plan including new integral measurements, differential measurements, and new data evaluations based upon those measurements to address deficiencies (^{233}U resonance structures, fission spectrum, Mubarak issues, etc.) and to develop a comprehensive roadmap for the future ^{233}U work for the NCSP. This work needs input from ORNL, LANL, RPI, IRMM, and IRSN to help as needed with this task.

Table 2.4-8 ORNL ND Budget Trend (FY2018-FY2022)

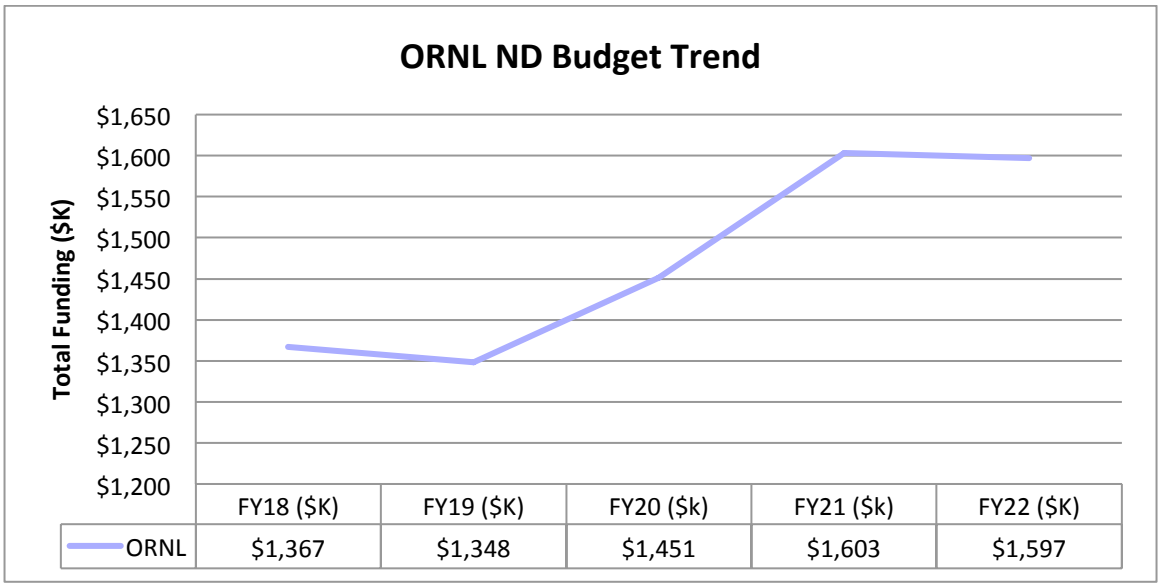
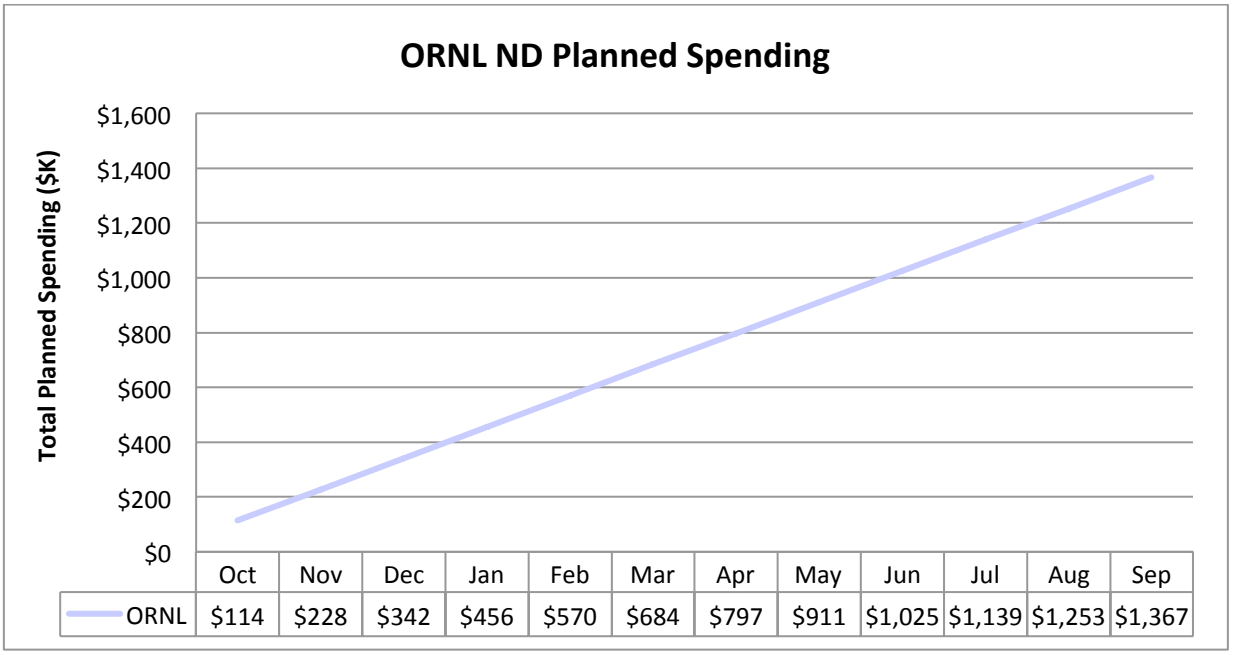


Table 2.4-9 ORNL ND Planned Spending (FY2018)



ORNL ND Milestones:

Occurs all 4 Quarters

- Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND6, ND7).
- Provide status reports on ORNL participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND1).
- Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B (ND1).

Quarter 3

- Complete nuclear data work plan for ^{233}U and provide plan to NCSP Manager (ND8).

Quarter 4

- Document SAMMY modernization progress and report status annually to the NCSP Manager (ND6).

EOC – for out-year peaks and dips in budget plots:

ORNL's funding will increases in out years to support nuclear data measurements and evaluation work, including procurement of enriched isotopes samples needed for cross-section measurements. In addition, funding will also increase to provide support to the SAMMY modernization effort.

2.4.2.5 Renssalaer Polytechnic Institute (RPI)

RPI ND1 ($340K)

This is an ongoing approved task in collaboration with ORNL to support the resonance region Nuclear Data Measurement Capability at RPI and to perform cross-section measurements and qualification of the new capabilities.

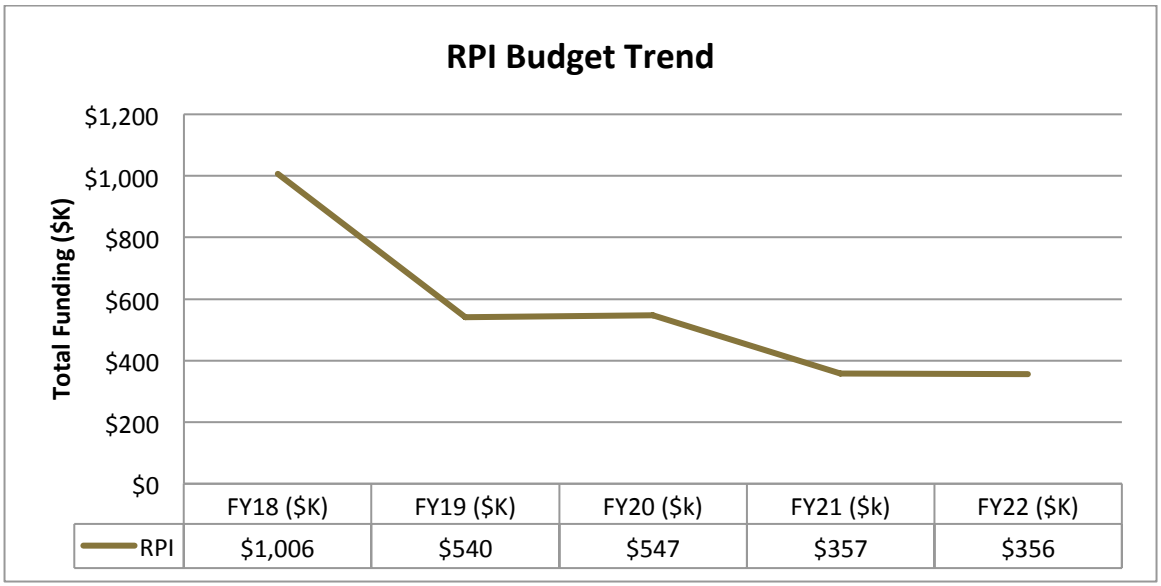
RPI ND2 ($126K)

This is an ongoing approved task in collaboration with ORNL to support the thermal Neutron Scattering Measurement for Improvement of Criticality Calculations and Propagation of Scattering Kernel Uncertainties. This task also supports the work to broaden and maintain the U.S. capabilities to support NCSP experimental nuclear data needs by providing priority NCSP thermal scattering law data.

RPI ND3 ($540K)

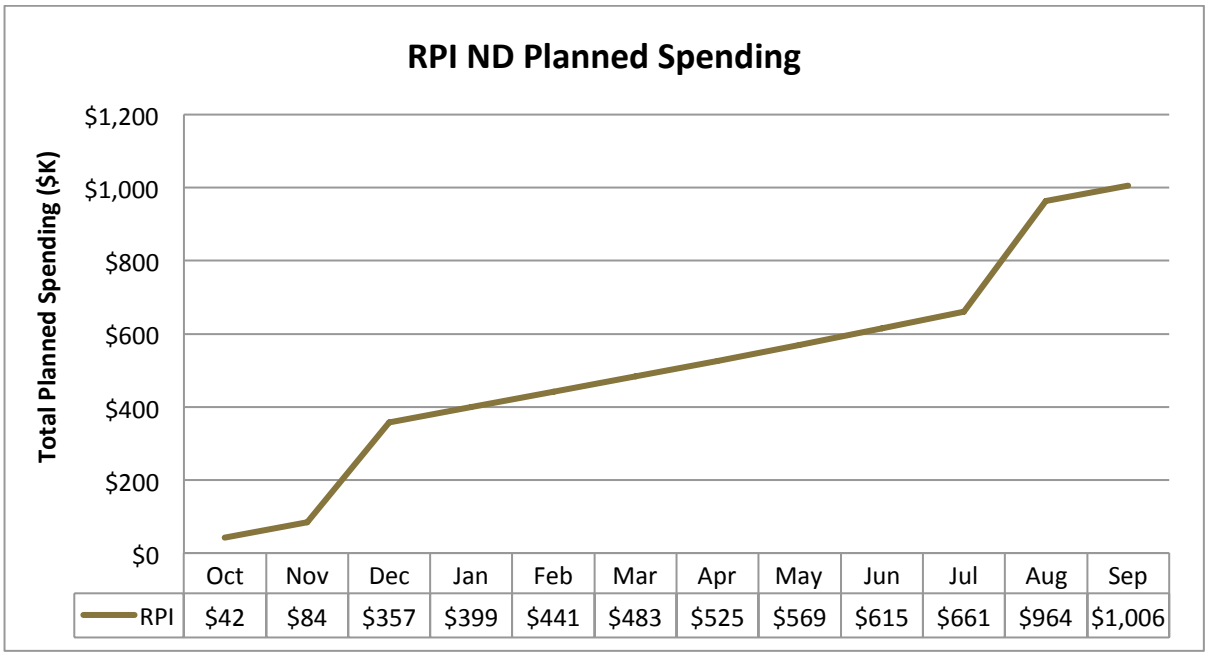
This is an ongoing approved task to support the RPI/ORNL: Linear Accelerator (LINAC) 2020 Nuclear Data Capabilities Maintenance Plan in collaboration with Naval Reactors (NA-30) who is co funding 2/3 of the total refurbishment costs. In order to be able to continue to deliver a reliable neutron beam with the proper conditions required for these experiments, a long-term maintenance and update plan is being implemented.

Table 2.4-10 RPI ND Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
RPI	$1,006	$540	$547	$357	$356

Table 2.4-11 RPI ND Planned Spending (FY2018)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
RPI	$42	$84	$357	$399	$441	$483	$525	$569	$615	$661	$964	$1,006

RPI ND Milestones:

Occurs all 4 Quarters

- Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND1, ND 2, ND3)
- Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest. (ND1)

Quarter 1

- Complete analysis of measurement from FY17. (ND1)
- Place accelerator sections contract with vendor. (ND3)

Quarter 2

- Complete modulator factory test in coordination with NR. (ND3)

Quarter 3

- Complete transmission measurement per the nuclear data schedule in Appendix B. (ND1)
- Complete capture measurement per the nuclear data schedule in Appendix B. (ND1)
- Complete thermal scattering data measurement per the nuclear data schedule in Appendix B. (ND2)

Quarter 4

- Complete modulator(s) factory test in coordination with NR. (ND3)
- Complete accelerator section(s) factory test in coordination with NR. (ND3)
- Complete data analysis for transmission and capture measurements and provide the data to ORNL as needed to support the evaluation effort per the nuclear data schedule in Appendix B. (ND1)
- Complete thermal scattering data analysis and provide the data to ORNL as needed to support the evaluation effort per the nuclear data schedule in Appendix B. (ND2)

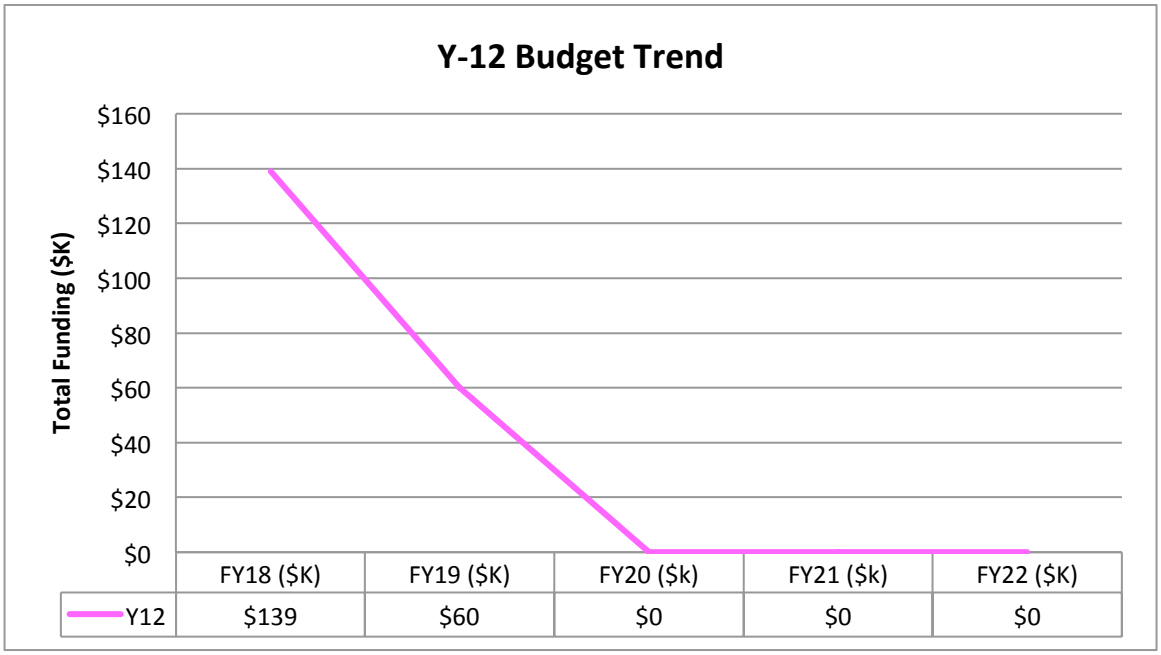
EOC – for out-year peaks and dips in budget plots:
High funding level tapering off in FY19-22 supports the RPI LINAC 2020 Nuclear Data Capabilities Maintenance Plan co-funded by Naval Reactors for an initial investment period of approximately 3 years with a decrease of funding at the end of that investment period.

2.4.2.5 Y-12 National Security Complex

Y12 ND1 ($139K)

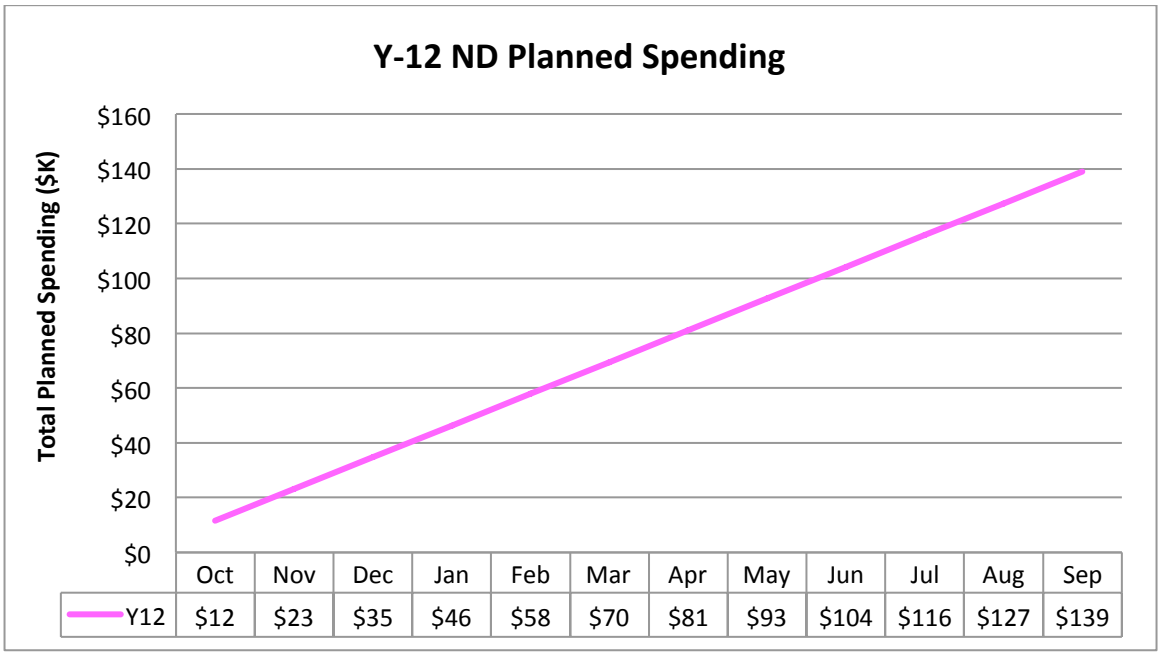
This task involves the development of a cost estimate and fabrication, if funding is remaining, of a new uranium target for IRMM/GELINA for cross section measurements. If funding is not available, plan for additional funds as necessary. As part of the IRMM collaboration, this task will ensure continued availability of the accelerator for NCSP nuclear data measurements.

Table 2.4-12 Y-12 ND Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
Y12	$139	$60	$0	$0	$0

Table 2.4-13 Y-12 ND Planned Spending (FY2018)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Y12	$12	$23	$35	$46	$58	$70	$81	$93	$104	$116	$127	$139

Y-12 ND Milestones

Quarter 1

- Provide a detailed cost estimate for a uranium target for use at IRMM/GELINA and provide to the NCSP Manager. (ND1)

Quarter 4

- Provide a status report of the fabrication of a uranium target per IRMM/GELINA specifications to the NCSP Manager. (ND1)

EOC – for out-year peaks and dips in budget plots:

Y-12 funding to estimate target fabrication costs and target fabrication will be completed by the end of FY19. There are currently no other Y-12 ND tasks proposed beyond FY19.

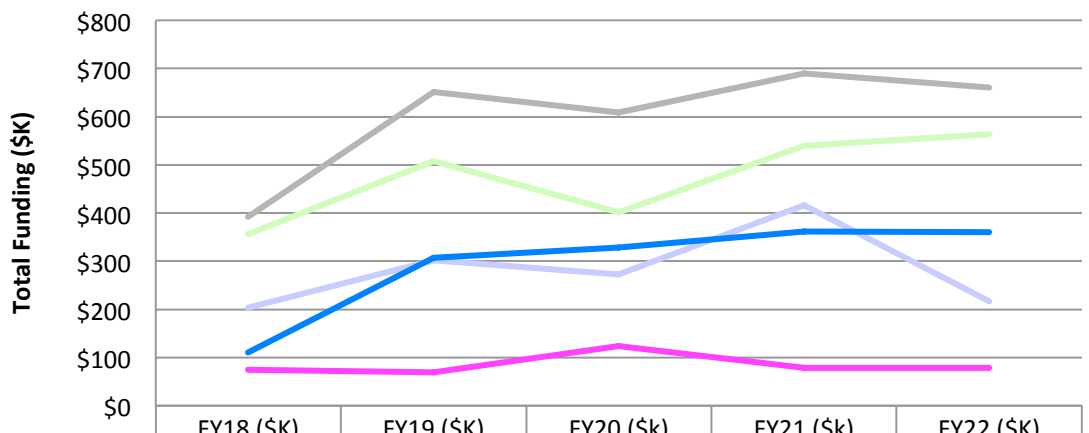
2.5 Training and Education (TE)

2.5.1 Program Element Description

The Training and Education (TE) program element continues to offer hands-on training courses as needed by DOE and identify training needs and develop training resources in areas where no suitable materials exist. The primary purpose of the TE element is to maintain the technical capabilities of criticality safety professionals and provide for the training and education of people entering the criticality safety discipline from related scientific fields. A significant portion of the TE work effort is to provide both the 2-week hands-on criticality safety courses for criticality safety engineers and 1-week hands-on criticality safety courses for supervisors and managers.

Each year, at the annual Budget Execution Meeting, the NCSP Manager will review and determine the location of the Classroom portion of the Hands-on Training course. Out-year budget profiles will be revised at that time, and funding profiles will not be increased until the location of the course is determined.

Table 2.5-1 TE Budget (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
LANL	$392	$651	$609	$690	$660
LLNL	$356	$508	$401	$539	$563
ORNL	$203	$302	$273	$416	$217
SNL	$110	$307	$329	$361	$360
Y12	$74	$69	$124	$79	$79

EOC – for out-year peaks and dips in budget plots:

- LANL funding to support hands-on criticality safety training class and 1-day site introductory S/U training in collaboration with ORNL. Out year budget increases to support development and deployment of 1-week hands-on criticality safety course for criticality safety officers and fissile material handlers.

- LLNL funding increases to support development of two criticality safety simulators for 1) plant/process conditions and 2) to demonstrate criticality physics fundamentals to process operators; develop and deploy mobile CAT III/IV hands-on critical or near critical demonstration capability; and development of tutorial for subcritical methods and benchmark interpretation for NCS users.
- ORNL funding to support coordination of hands-on training courses in addition to 1-day site introductory S/U training class in collaboration with LANL. Out year funding increases to support development of SlideRule NCSET module and training tutorials on CAAS detector placement, and D&D of facilities. Funding also increases in FY21 to develop an expanded and improved version of the hand-calculation primer to support NCSP training and education needs.
- SNL's funding is modestly increased in out years to help mitigate the increased cost for conducting Hands-on Training courses.
- Y12's funding will increase in FY20 (and drop in FY21), in order to develop criticality safety tutorials to incorporated NCS into design.

2.5.2 Approved Tasks

2.5.2.1 Los Alamos National Laboratory (LANL)

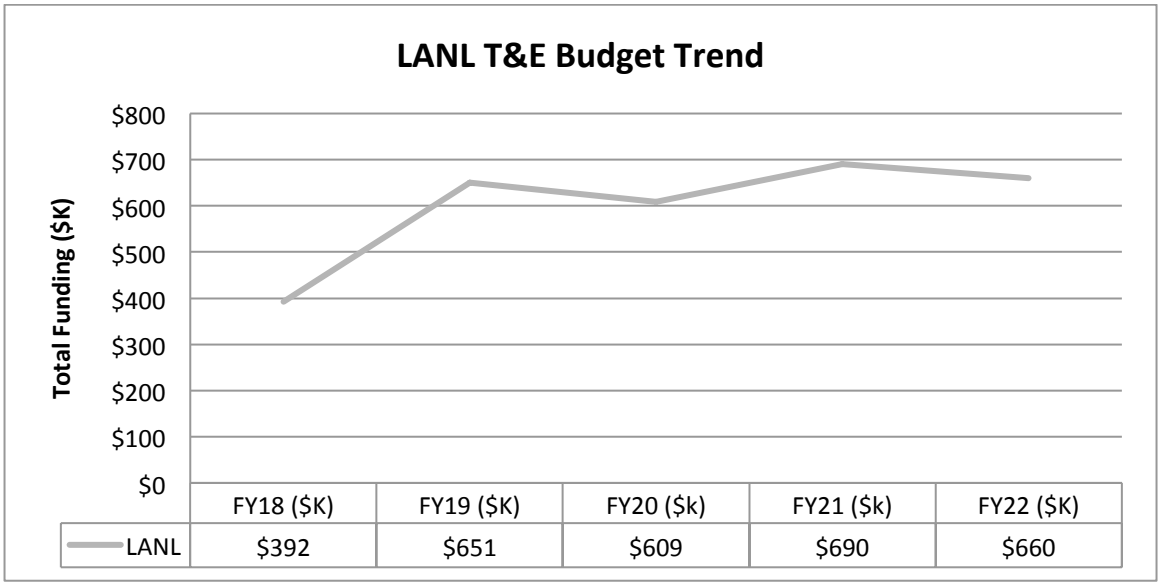
LANL TE3 ($363K)

This is an ongoing approved task to conduct criticality safety hands-on training at NCERC according to an integrated schedule developed by ORNL and approved by the NCSP manager. This task will also involve the resolution of comments from CSSG tasking 2016-01 and course material updates by the end of FY2018.

LANL TE4 ($29K)

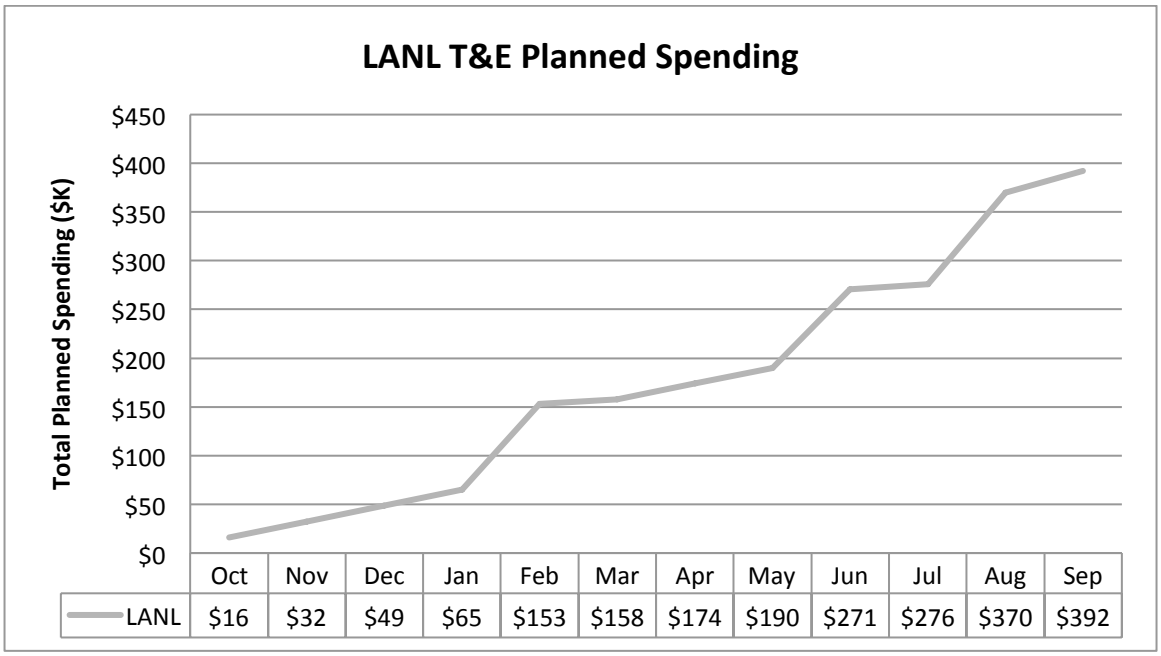
This is an ongoing LANL task in collaboration with ORNL to facilitate the increased usage of modern sensitivity/uncertainty (S/U) tools and practices in DOE-site validation efforts. The objective of this task is to provide a 1-day onsite introductory validation training class to multiple DOE sites that are selected by the NCSP Manager. The training will be "code agnostic" and will expand upon the 1.5-hour validation-training lecture provided in the current NCSP 2-week hands-on training class for NCS practitioners. The overarching objective is to familiarize DOE sites with the power of S/U tools for validation and help address questions/concerns for implementation of S/U tools for validation at each specific DOE site.

Table 2.5-2 LANL TE Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
LANL	$392	$651	$609	$690	$660

Table 2.5-3 LANL TE Planned Spending (FY2018)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LANL	$16	$32	$49	$65	$153	$158	$174	$190	$271	$276	$370	$392

LANL TE Milestones:

Occurs all 4 Quarters

- Provide training in accordance with the approved schedule and provide status reports on all training activities to the NCSP Manager. (TE3)
- Provide a status report to the NCSP Manager on the resolutions to CSSG comments and course material updates for the CSSG 2016-01 tasking report. (TE3)

Quarter 4

- In collaboration with ORNL, provide introductory 1-day S/U workshop training to one or more DOE sites in FY2018. (TE4)

EOC – for out-year peaks and dips in budget plots:

Funding to support hands-on criticality safety training class and 1-day site introductory S/U training in collaboration with ORNL. Out year budget increases to support development and deployment of 1-week hands-on criticality safety course for criticality safety officers and fissile material handlers.

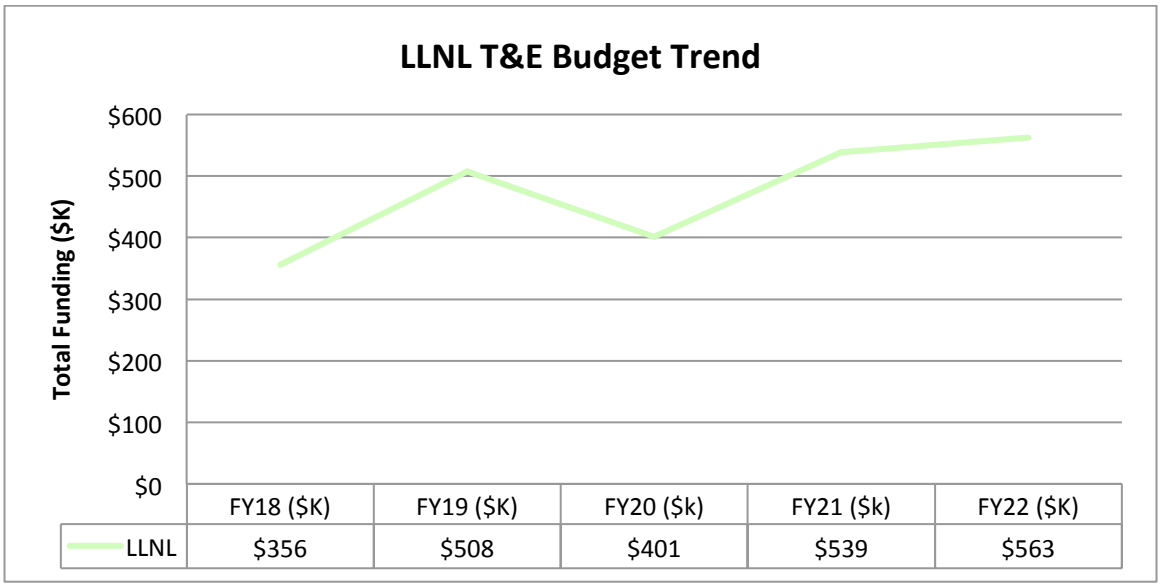
2.5.2.2 Lawrence Livermore National Laboratory (LLNL)

LLNL TE1 ($233K)
This is an ongoing approved task to provide unique "hands-on" training at the Device Assembly Facility (DAF) using the Training Assembly for Criticality Safety (TACS). This task also supports continued LLNL coordination of the course registration process for all courses at NSF, NATM, NCERC and SNL.

LLNL TE3 ($74K)
This is an ongoing approved task to provide LLNL support for FY2018 classroom instruction at the Nevada Site Facility and participation in T&E development activities.

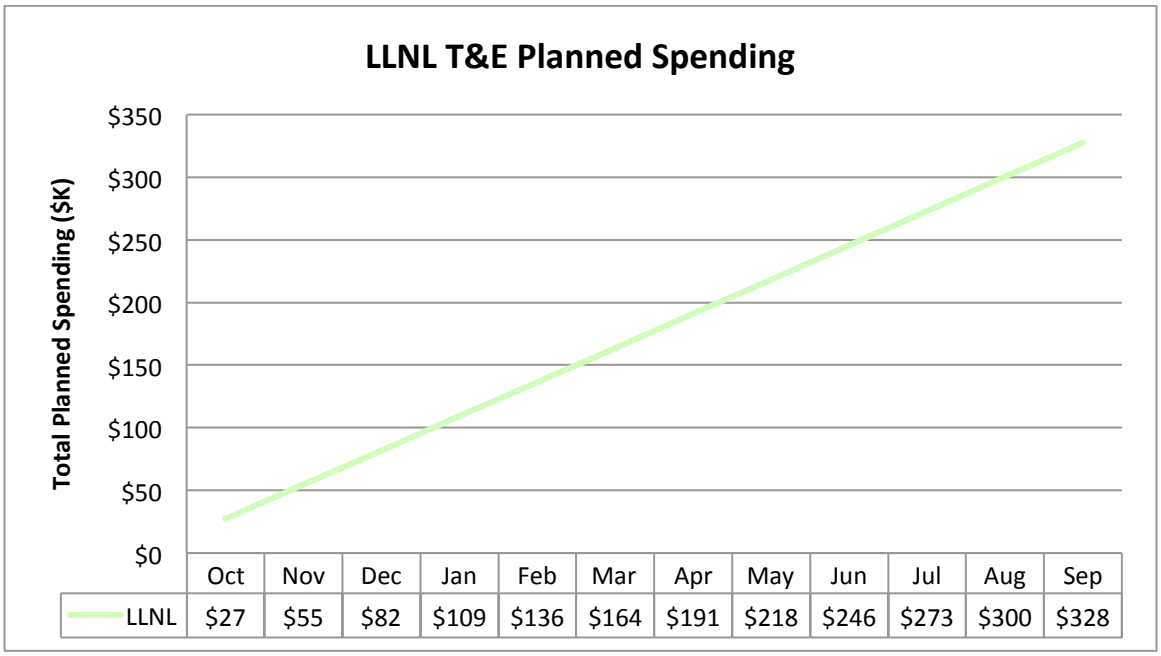
LLNL TE8 ($49K)
This is a new approved task to incorporate superior reflectors into the "hands-on" training using the Training Assembly for Criticality Safety (TACS) including assessing available beryllium metal shells, developing training materials and updating the safety and authorization documents.

Table 2.5-4 LLNL TE Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
LLNL	$356	$508	$401	$539	$563

Table 2.5-5 LLNL TE Planned Spending (FY2018) *



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LLNL	$27	$55	$82	$109	$136	$164	$191	$218	$246	$273	$300	$328

* LLNL Planned Spending reduced by approximately 8% to account for required laboratory hold-back during FY CR funding uncertainty.

LLNL TE Milestones:

Occurs all 4 Quarters

- Update, maintain and support the registration process and provide classroom and "hands on" TACS training in accordance with the schedule approved by the NCSP Manager. (TE1)
- Provide LLNL support for FY2018 classroom instruction at the Nevada Site Facility or National Atomic Testing Museum and participation in T&E development activities in accordance with the schedule approved by the NCSP Manager. (TE3)

Quarter 4

- Evaluate the TACS with Be shells and provide a status report in the FY2018 Q4 quarterly status report to the NCSP Manager. (TE8)

EOC – for out-year peaks and dips in budget plots:

LLNL funding increases to support development of two criticality safety simulators for 1) plant/process conditions and 2) to demonstrate criticality physics fundamentals to process operators; develop and deploy mobile CAT III/IV hands-on critical or near critical demonstration capability; and development of tutorial for subcritical methods and benchmark interpretation for NCS users.

2.5.2.3 Oak Ridge National Laboratory (ORNL)

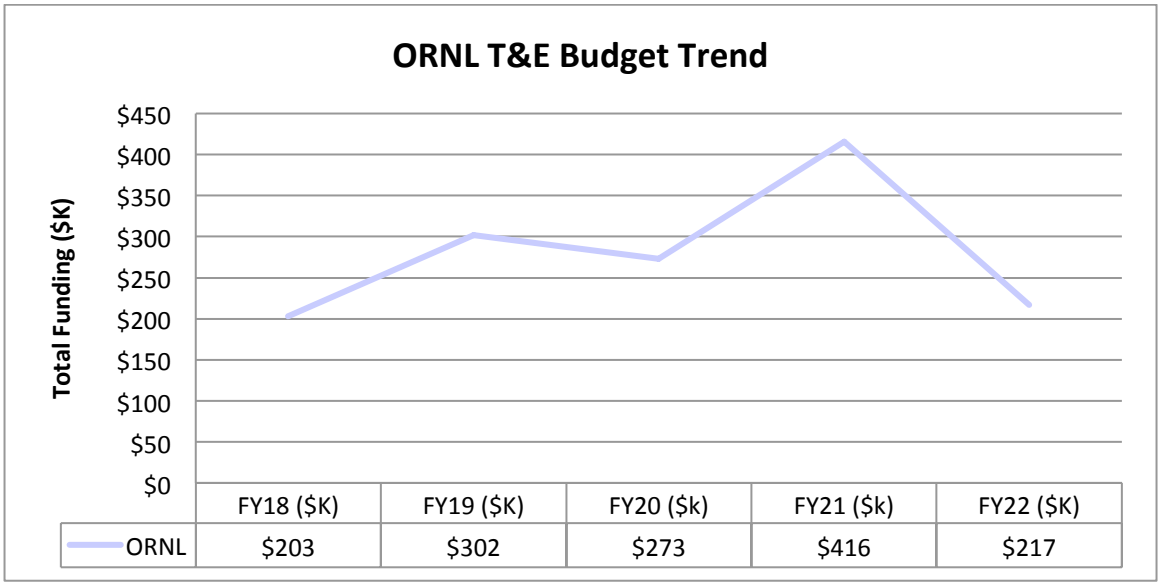
ORNL TE1 ($174K)

Ongoing ORNL task to manage the collaborative multi-laboratory development, designing, and scheduling of the multi-faceted and phased NCSP training program and manage the execution of the program. The task also includes support for an ORNL nondestructive assay (NDA) expert, an NCS expert, and an NCS expert with federal experience to support the 2-week hands-on and manager courses. This task will also provide leadership and support necessary to complete resolution of the CSSG Training and Education assessment conducted in FY2016 under CSSG tasking 2016-01.

ORNL TE5 ($29K)

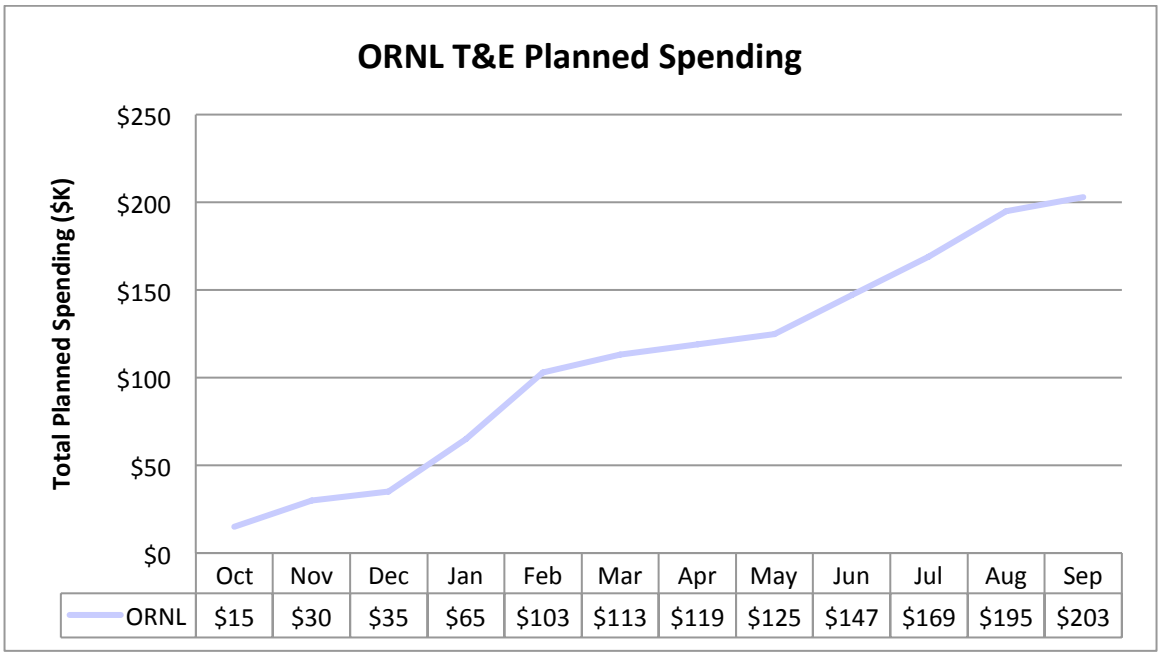
As part of an effort to facilitate the increased usage of modern sensitivity/uncertainty (S/U) tools and practices in DOE-site validation efforts, the objective of this task is to collaborate with LANL to provide a 1-day onsite introductory validation training class to multiple DOE sites that are selected by the NCSP Manager. The training will be "code agnostic" and will expand upon the 1.5-hour validation-training lecture provided in the current NCSP 2-week hands-on training class for NCS practitioners. The overarching objective is to familiarize DOE sites with the power of S/U tools for validation and help address questions/concerns for implementation of S/U tools for validation at each specific DOE site.

Table 2.5-6 ORNL TE Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
ORNL	$203	$302	$273	$416	$217

Table 2.5-7 ORNL TE Planned Spending (FY2018)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
ORNL	$15	$30	$35	$65	$103	$113	$119	$125	$147	$169	$195	$203

ORNL TE Milestones:

Occurs all 4 Quarters

- Provide a status report in NCSP Quarterly Progress Reports on implementation of the NCS training program and resolution of CSSG comments from CSSG tasking 2016-01. (TE1)
- Provide status reports in NCSP Quarterly Progress Reports on improvements/modifications to baseline NCS course training materials based on CSSG assessment report 2016-01, self-evaluation, and feedback from reviewers, observers, trainers, and the NCSP manager. (TE1)
- Provide a status report in NCSP Quarterly Progress Reports on the progress of 1-day onsite introductory validation training conducted at one or more DOE sites. (TE5)

EOC – for out-year peaks and dips in budget plots:

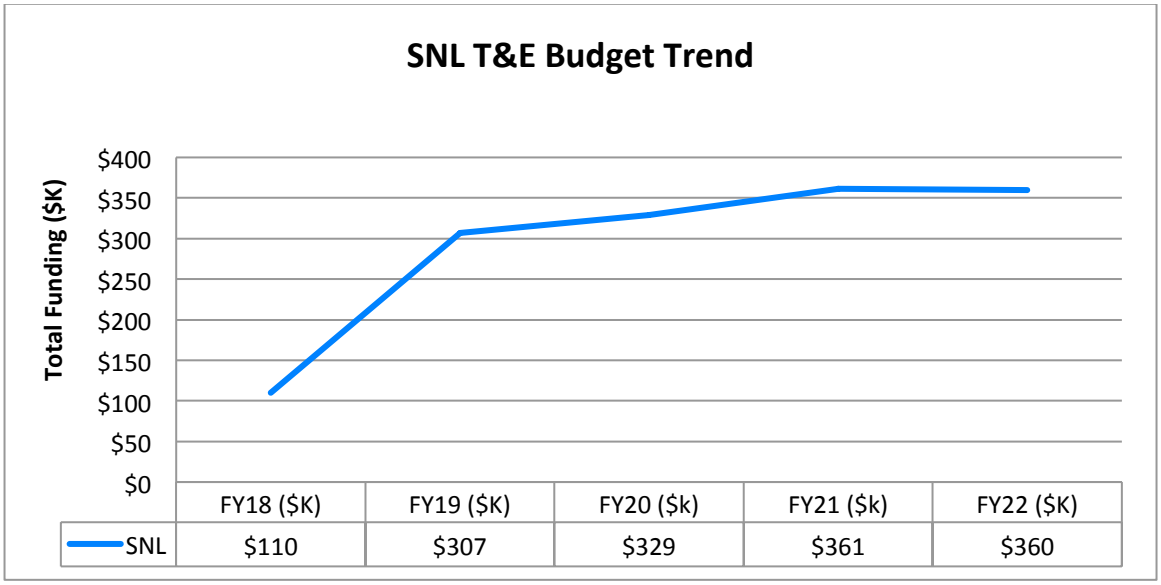
ORNL funding to support coordination of hands-on training courses in addition to 1-day site introductory S/U training class in collaboration with LANL. Out year funding increases to support development of SlideRule NCSET module and training tutorials on CAAS detector placement, and D&D of facilities. Funding also increases in FY21 to develop an expanded and improved version of the hand-calculation primer to support NCSP training and education needs.

2.5.2.4 Sandia National Laboratories (SNL)

SNL TE1 ($110K)

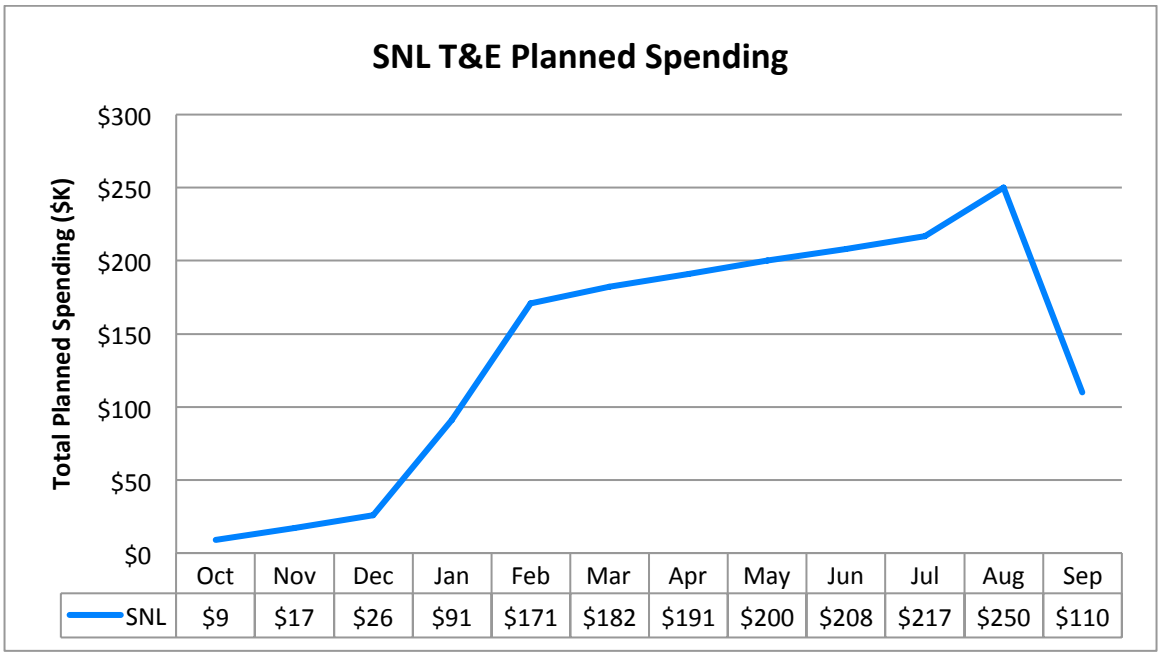
This is an ongoing approved task to conduct criticality safety training classes at SNL according to an integrated schedule developed by ORNL and approved by the NCSP Manager. Provide Human Factors and Equipment Reliability module support to the NCSP training courses. This task will also involve the resolution of comments from CSSG tasking 2016-01 by the end of FY2018.

Table 2.5-8 SNL TE Budget Trend (FY2018-FY2022)



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
SNL	$110	$307	$329	$361	$360

Table 2.5-9 SNL T&E Planned Spending (FY2018)



SNL T&E Milestones:

All Quarters

- Conduct hands-on training classes at Sandia and provide Human Factors and Equipment Reliability module support to the to the NCSP training courses in accordance with the approved schedule. (TE1)
- Provide a status report to the NCSP Manager on the resolution of Sandia course materials and resolutions to CSSG comments provided in the CSSG 2016-01 tasking report. (TE1)

EOC – for out-year peaks and dips in budget plots:

Very modest increases in out-years to help mitigate increased cost of doing business.

2.5.2.5 Y-12 National Security Complex

Y12 TE1 ($74K)

This is an ongoing integrated, approved task for Y12 to assist in conducting the current criticality safety training classes at NFO and NCERC (as necessary). This task will also involve assisting with generating new training materials at the NFO classroom portion of the course as necessary.

Table 2.5-10 Y12 TE Budget Trend (FY2018-FY2022)

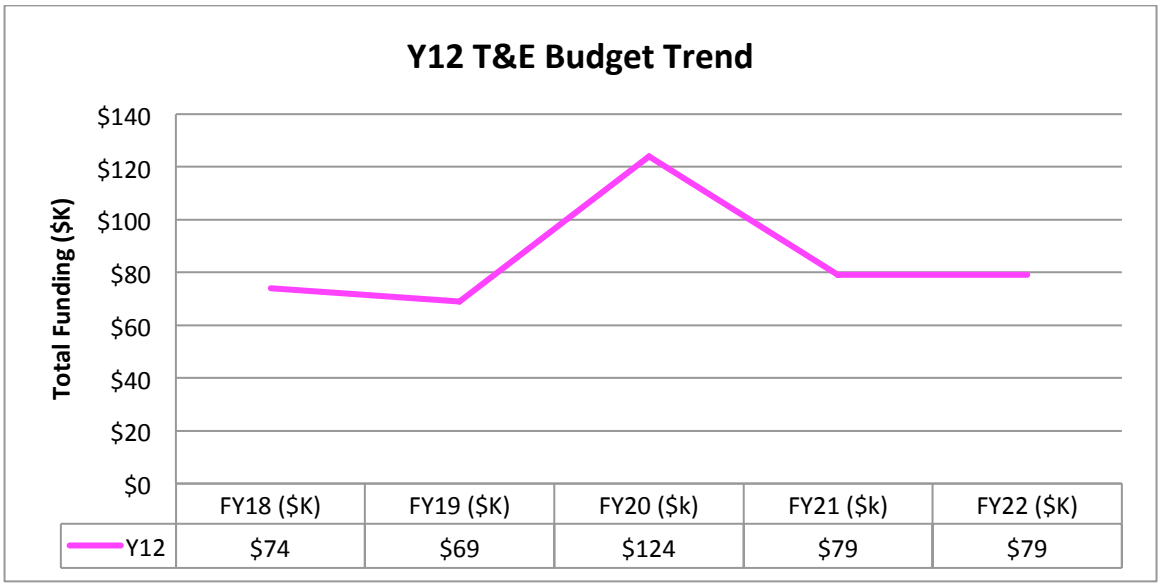
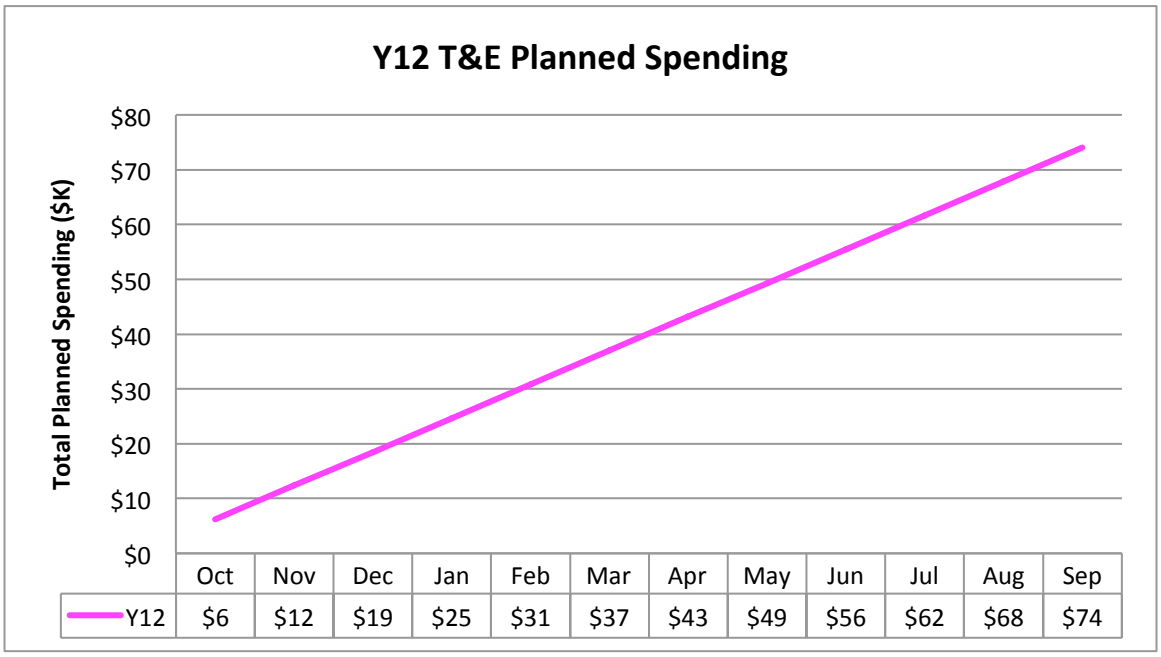


Table 2.5-11 Y12 TE Planned Spending (FY2018)



Y12 TE Milestones:

All Quarters

- Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1)

EOC – for out-year peaks and dips in budget plots:

Funding will increase in FY20 (and drop in FY21), in order to develop criticality safety tutorials to incorporated NCS into design.

3.0 Criticality Safety Support Group (CSSG)

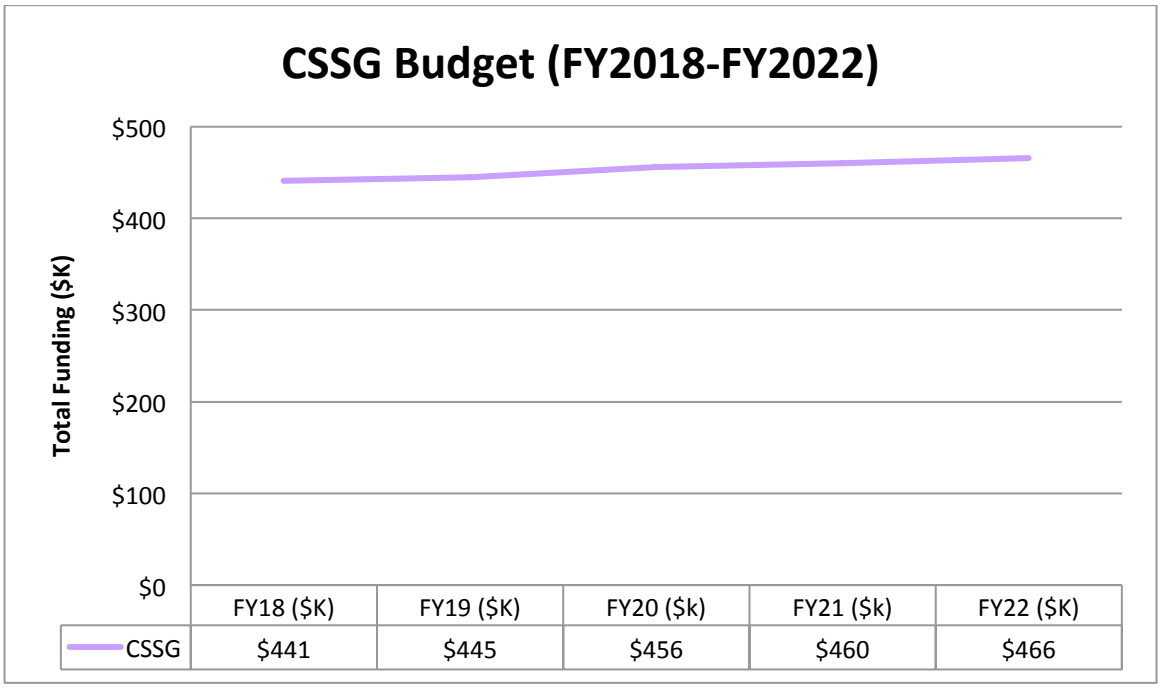
The CSSG is comprised of recognized criticality safety experts from DOE offices and contractor organizations. The primary function of the CSSG is to provide operational and technical expertise to the DOE through the NCSP Manager. The CSSG also provides the NCSP Manager with technical reviews of orders, standards, rules, and guides issued by DOE related to criticality safety. In addition, the CSSG responds to requests from the NCSP Manager for information, technical reviews, and evaluations of criticality safety issues throughout the complex.

There are normally 10 CSSG members (periodically there could be additional members in order to support new member transition and overlap). Only contractor members of the CSSG are modestly funded. One CSSG member is funded by DOE-EM and another member from ANL is not funded by the NCSP.

NCSP TS1 ($441K)

This is an ongoing approved task to provide Technical Support as tasked by NCSP Manager through approved CSSG Taskings as documented and provided on the NCSP Website.

Table 3.1 CSSG Budget Trend (FY2018-FY2022)



EOC – for out-year peaks and dips in budget plots:
Increase in out year to fill available vacant member slots and help mitigate increased cost of doing business.

4.0 NCSP Technical Support

NCSP Technical Support to assist the NCSP Management Team in the program management and execution of the NCSP and funding for the succession planning of key program elements as defined in the 10-year Mission and Vision.

NCSP TS2 ($595K) - ORNL

Ongoing ORNL task to support the NCSP Management Team in the program management and execution of the NCSP.

NCSP TS3 ($72K) - SNL

In accordance with the ten-year Mission and Vision, the NCSP has identified the need to develop and implement succession plans for key staff expert capabilities to support continued execution of the NCSP Mission. At SNL, there is a need to maintain the integral experiment expertise using the SNL critical experiment capabilities. The work associated with this task is to develop and execute IE Succession Planning for new experimentalists at SNL.

NCSP TS4 ($138K) - LANL

In accordance with the ten-year Mission and Vision, the NCSP has identified the need to develop and implement succession plans for key staff expert capabilities to support continued execution of the NCSP Mission. There is a need to maintain expertise in the analytical methods, integral experiments and nuclear data capabilities that currently exist at LANL. The work associated with this task is to develop and execute AM, IE, and ND Succession Planning at LANL as defined in the NCSP Mission and Vision document for cross-section processing developers, radiation transport methods developers, experimentalists, and nuclear data evaluators.

NCSP TS5 ($138K) - LLNL

In accordance with the ten-year Mission and Vision, the NCSP has identified the need to develop and implement succession plans for key staff expert capabilities to support continued execution of the NCSP Mission. There is a need to maintain expertise in the analytical methods and integral experiment capabilities that currently exist at LLNL. The work associated with this task is to develop and execute AM and IE Succession Planning at LLNL as defined in the NCSP Mission and Vision document for integral experiment equipment Support, facility support, and radiation transport methods developers.

NCSP TS6 ($69K) - BNL

In accordance with the ten-year Mission and Vision, the NCSP has identified the need to develop and implement succession plans for key staff expert capabilities to support continued execution of the NCSP Mission. There is a need to maintain expertise in the nuclear data analysis capabilities that currently exist at BNL. The work associated with this task is to develop and execute ND Succession Planning at BNL as defined in the NCSP Mission and Vision document for nuclear data analysis capabilities needed to support operations at the National Nuclear Data Center.

NCSP TS7 ($138K) - ORNL

Task to address key nuclear data and analytical methods succession planning needs for the NCSP. As part of this task, junior ORNL staff (e.g., post-doctoral staff member or entry-level staff member) will work with key ORNL ND and AM specialists to complete NCSP ND and AM work tasks thereby training the next generation of experts to perform key NCSP nuclear data and analytical methods tasks.

NCSP TS8 ($396K) - ORNL

This task continues work initiated in FY2017 to develop a program management tool that will improve the overall efficiency of managing the NCSP. Conceptual planning for this new system is currently underway. Specifically, the tool will streamline the tasks to develop the NCSP Five Year Plan as well as manage and track the annual site work tasks, especially integral experiment tasks. As a longer-term objective, an additional task is proposed to develop a NCSP management tool to streamline management and tracking of NCSP IE tasks and machine schedule availability at NCERC.

NCSP TS9 ($29K) – NCSP MANAGER

Provide support for NDAG Chair activities, participate in relevant Working Groups and domestic and international nuclear data meetings as the nuclear data lead for the NCSP, and coordinate NCSP ND element work program with current and future DOE needs. Support the development of the 5-year plan by coordinating and planning nuclear data prioritization meetings and working with the NCSP management team for tracking progress nuclear data tasks over the course of the year.

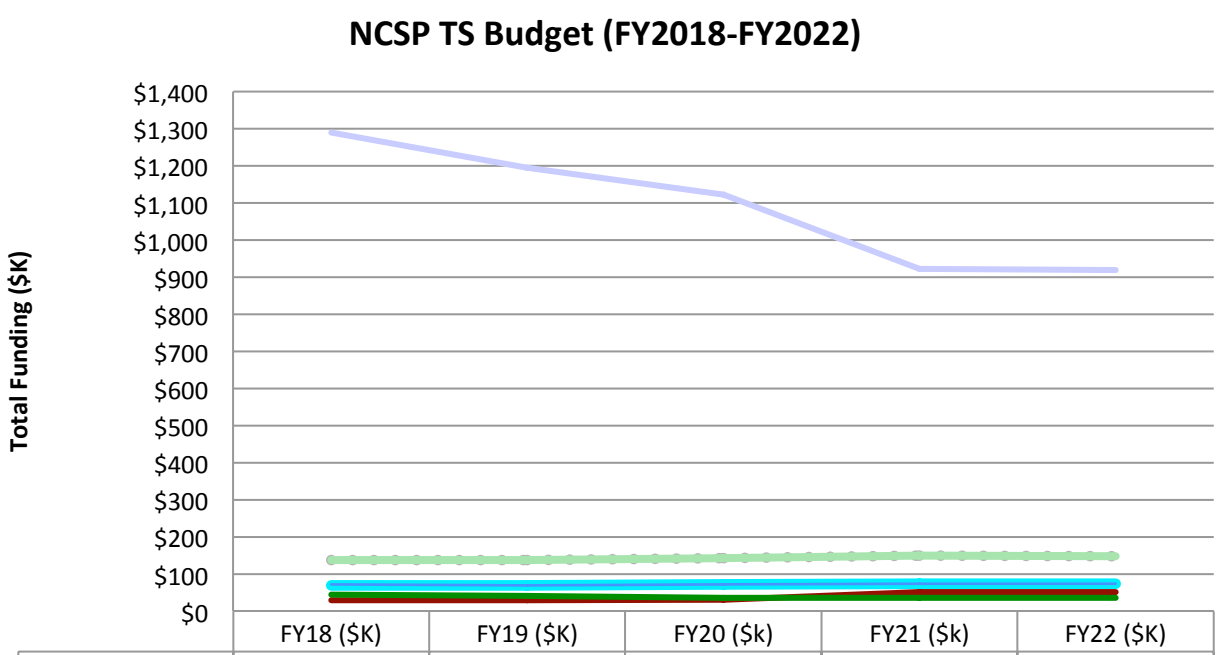
NCSP TS10 ($44K) - NNSS

Provide AM and ND support at the discretion of the NCSP and execution managers, e.g., NDAG and AM working group activities, C_EdT design support, and to provide support at the annual budget execution meeting and the review of main and integral experiment 5-year plans.

NCSP TS11 ($160K) – ORNL

Activities for this task include integral experiment request (IER) tracking, experimental facility metrics, C_EdT duties, Work for Others tracking/approval, keeping the NCSP management team informed about DAF NCSP activities, 5YP IE plan support, working with task MGRs to submit BCR forms, conduct integral experiment (IE) telecons to track IE NCSP work, availability of NCERC and Sandia critical assemblies for NCSP work, and other tasks at the discretion of NCSP manager or execution manager.

Table 4.1 NCSP Technical Support (FY2018-FY2022) - by Laboratory



	FY18 ($K)	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)
BNL	$69	$69	$72	$74	$74
LANL	$138	$137	$143	$149	$148
LLNL	$138	$137	$143	$149	$148
NCSP MGR	$29	$29	$30	$51	$51
ORNL	$1,289	$1,194	$1,122	$923	$919
SNL	$72	$69	$72	$74	$74
NNSS	$44	$40	$35	$35	$35

NCSP TS Milestones:

Occurs all 4 Quarters

- Provide the NCSP manager with a summary of CSSG activities, meetings, and tasks. (TS1)
- Manage C_EdT process and coordinate execution of planned IERs each FY. (TS2)
- Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization effort by the NCSP Management Team. (TS2)
- Provide the NCSP manager with a summary of NDAG chair activities, meetings, and tasks. (TS9)
- Provide the NCSP manager with a summary report of AM, ND, and document review tasks conducted each quarter in the ORNL quarterly reports. (TS10)
- Provide the NCSP manager with a summary of NCSP IE task TS11 as described in the task description. (TS11)

Quarter 4

- Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY. (TS2)
- Publish final Five Year Plan. (TS2)
- Provide NCSP Manager annual report of succession planning efforts. (TS3, TS4, TS5, TS6, and TS7)
- Provide NCSP Manager a status report of progress on the development of a program management tool. (TS8)

EOC – for out-year peaks and dips in budget plots:

Increase in FY18 to fund development of NCSP program management tools with corresponding decrease in funding beginning in FY21 with completed development of program management tools.

Appendix A
Work Authorization Statements for
Nuclear Criticality Safety Program Funding for Execution Year FY2018
Provided to the NA-50 Budget Office in October 2017

Brookhaven National Laboratory (BNL): $262K

Task: Nuclear Data

Reflects funds to continue supporting nuclear data activities, including shepherding new data evaluations through the Cross Section Evaluation Working Group (CSEWG) process, subsequent publication of these data in the United States Evaluated Nuclear Data File (ENDF), and nuclear data succession planning, as delineated in the Nuclear Criticality Safety Program (NCSP) FY18 Five-Year Plan dated October 2017, or as directed by the NCSP Manager.

BNL POC: David Brown (631-344-2814), dbrown@bnl.gov
DOE POC: Angela Chambers, NNSA (806-477-6407)

Los Alamos National Laboratory (LANL): $10,844K

Tasks: Analytical Methods, Integral Experiments, Nuclear Data, Training and Education, and the Criticality Safety Support Group

Reflects funds to continue analytical methods; integral experiments; nuclear data; and training and education support, as delineated in the Nuclear Criticality Safety Program (NCSP) FY18 Five-Year Plan dated October 2017, or as directed by the NCSP Manager; succession planning for cross-section processing developers, radiation transport developers, experimentalists, and/or nuclear data developers/evaluators; and for participation in the Criticality Safety Support Group (CSSG), as it provides technical support to the NCSP Manager regarding planning and execution of the NCSP.

LANL POC: Robert Margevicius (505-665-8965), margevicius@lanl.gov
DOE POC: Angela Chambers, NNSA (806-477-6407

Lawrence Livermore National Laboratory (LLNL): $3,783K

Tasks:* *Analytical Methods, Information Preservation and Dissemination, Integral Experiments, Nuclear Data, Training and Education, and the Criticality Safety Support Group

Reflects funds to continue support for analytical methods; information preservation and dissemination; integral experiments; nuclear data; training and education, as delineated in the Nuclear Criticality Safety Program (NCSP) FY18 Five-Year Plan dated October 2017, or as directed by the NCSP Manager; succession planning for equipment support, facility support, and/or radiation transport developers; and for participation in the Criticality Safety Support Group (CSSG), as it provides technical support to the NCSP Manager regarding planning and execution of the NCSP.

LLNL POC: David Heinrichs (925-424-5679), heinrichs1@llnl.gov
DOE POC: Angela Chambers, NNSA (806-477-6407)

Nevada National Security Site - NSTec (NNSS): $5,049K

Task:* *Integral Experiments, Analytical Methods, and Nuclear Data Support

Reflects funds to continue support for integral experiments, nuclear data, analytical methods tasks as delineated in the Nuclear Criticality Safety Program (NCSP) FY18 Five-Year Plan dated October 2017.

NNSS POC: Jeff Lewis (702-524-0647), lewisjm@nv.doe.gov
DOE POC: Angela Chambers, NNSA (806-477-6407)

Oak Ridge National Laboratory (ORNL): $5,257K

Tasks:* *NCSP Technical Support, Analytical Methods, Information Preservation and Dissemination, Integral Experiments, Nuclear Data, and Training and Education

Reflects funds to continue support for analytical methods; information preservation and dissemination; integral experiments; nuclear data; and training and education, as delineated in the Nuclear Criticality Safety Program (NCSP) FY18 Five-Year Plan dated October 2017, or as directed by the NCSP Manager; Technical Support for NCSP management; and for succession planning for cross-section processing developers, radiation transport developers, and/or nuclear data evaluators/experimentalists/developers, and for support to the Criticality Safety Support Group (CSSG).

ORNL POC: Douglas G. Bowen (865-576-0315), bowendg@ornl.gov
DOE POC: Angela Chambers, NNSA (806-477-6407)

Renssalaer Polytechnic Institute (RPI): $1,006K

Task: Nuclear Data

Reflects funds to conduct differential measurements as delineated in the Nuclear Criticality Safety Execution (NCSP) FY18 Five-Year Plan dated October 2017 and continue work, as defined in the RPI LINAC 2020 Nuclear Data Capabilities Maintenance Plan, or as directed by the NCSP Manager.

RPI POC: Yaron Danon (518-276-4008), danony@rpi.edu
DOE POC: Angela Chambers, NNSA (806-477-6407)

Sandia National Laboratories (SNL): $970K

Tasks: Integral Experiments and Training and Education

Reflects funds to continue support for integral experiments; training and education; and succession planning for experimentalists as, delineated in the Nuclear Criticality Safety Program (NCSP) FY18 Five-Year Plan dated October 2017, or as directed by the NCSP Manager.

SNL POC: Gary Harms (505-845-3244), gaharms@sandia.gov
DOE POC: Angela Chambers, NNSA (806-477-6407)

Savannah River Site (SRS): $124K

Tasks: Information Preservation and Dissemination and the Criticality Safety Support Group

Reflects funds to update and maintain ARH-600 as delineated in the Nuclear Criticality Safety Program (NCSP) FY18 Five-Year Plan dated October 2017, or as directed by the NCSP Manager, and to continue support as the CSSG Chair during FY18, as directed by the NCSP Manager and for participation in the CSSG, as it provides technical support to the NCSP Manager regarding planning and execution of the NCSP.

SRS POC: David Erickson (803-557-9445), david.erickson@srs.gov
DOE POC: Angela Chambers, NNSA (806-477-6407)

Y-12 National Security Complex (Y-12): $253K

Tasks: Training and Education, Nuclear Data, and the Criticality Safety Support Group

Reflects funds to support the training and education program and the fabrication of a uranium target needed for nuclear data measurements as delineated in the Nuclear Criticality Safety Program (NCSP) FY18 Five-Year Plan dated October 2017, or as directed by the NCSP Manager and for participation in the CSSG, as it provides technical support to the NCSP Manager regarding planning and execution of the NCSP.

Y-12 POC: Kevin Kimball (865-576-6675), kevin.kimball@cns.doe.gov
DOE POC: Angela Chambers, NNSA (806-477-6407)

NCSP Manager: NDAG Chair ($29k) and CSSG Hold Back ($46k) – $75k total

Reflects funds to for NDAG Chair NCSP travel support for FY18 and DOE HQ Hold Back for the CSSG ($46k) that will be held as HQ reserve funds.

DOE POC: Angela Chambers, NNSA (806-477-6407)

Appendix B
Nuclear Data

Priority Needs */ Additional Needs	Thermal scattering (Paraffinic Oil, HF, Silicone Oil, UO_2F_2, PuH_2, UH_3, Paraffin, U_3O_8, U_3Si_2, UC, PuO_2, etc.), ^{239}Pu, Fe, Cr, ^{237}Np, Pb, ^{55}Mn, Ti, ^{240}Pu/ ^{233}U, Th, Be, ^{51}V, Zr, F, K, Ca, Mo, Na, La
Completed Evaluations (FY)	Minor Actinides (13), SiC(17), SiO_2 (17), $C_5O_2H_8$ (16), CH_2 (17), Be (17), BeO (17), Graphite (17), UO_2 (17), UN (17), ^{55}Mn (12), ^{58,60}Ni (14), ^{180,128,183,184,186}W (14), Ca (16), ^{59}Co (17), ^{63,65}Cu(17)

	Materials	Pre FY2018	FY2018	FY2019	FY2020	FY2021	FY2022	Post-FY2022		
Measurements	**Calcium (Ca)**									
	Cerium (Ce)									
	Iron (Fe)									
	Molybdenum (Mo)									
	Tantalum (Ta)									
	Vanadium (V)									
	Zirconium (Zr)									
	Polyethylene (CH_2)	H_2O / CH_2								
	Lucite ($C_5O_2H_8$)									

	Materials	Pre FY2018	FY2018	FY2019	FY2020	FY2021	FY2022	Post-FY2022		
Evaluations	**Calcium (Ca)**									
	Cerium (Ce)									
	Cobalt (Co)									
	Copper (Cu)									
	Dysprosium (Dy)									
	Gadolinium (Gd)									
	Iron (Fe)									
	Lead (Pb)									
	Oxygen (O)									
	Rhodium (Rh)									
	Plutonium-239									
	Tantalum (Ta)									
	Uranium-234									
	Uranium-235									
	Uranium-236									
	Uranium-238									
	Vanadium (V)									
	Zirconium (Zr)									
	Lucite ($C_5O_2H_8$)									
	Polyethylene (CH_2)									
	Beryllium (metal)									
	Beryllium Oxide (BeO)									
	Crystal Graphite									
	Reactor Graphite									
	Silicon Carbide (SiC)									
	Silicon Dioxide (SiO_2)									
	Uranium Dioxide (UO_2)									

Priority Needs */ Additional Needs	Thermal scattering (Paraffinic Oil, HF, Silicone Oil, UO_2F_2, PuH_2, UH_3, Paraffin, U_3O_8, U_3Si_2, UC, PuO_2, etc.), ^{239}Pu, Fe, Cr, ^{237}Np, Pb, ^{55}Mn, Ti, ^{240}Pu/ ^{233}U, Th, Be, ^{51}V, Zr, F, K, Ca, Mo, Na, La
Completed Evaluations (FY)	Minor Actinides (13), SiC(17), SiO_2 (17), $C_5O_2H_8$ (16), CH_2 (17), Be (17), BeO (17), Graphite (17), UO_2 (17), UN (17), ^{55}Mn (12), ^{58,60}Ni (14), ^{180,128,183,184,186}W (14), Ca (16), ^{59}Co (17), ^{63,65}Cu(17)

	Materials	Pre FY2018	FY2018	FY2019	FY2020	FY2021	FY2022	Post-FY2022		
	Uranium Nitride (UN)									
	Ice (H_2O)									
	Yttrium Hydride (YH_2)									
	Paraffinic Oil									
	Hydrofluoric Acid (HF)									
	Hydraulic Fluid (Silicone Oil)									
	Paraffin (C_nH_{2n+2})									
	Triuranium Octoxide (U_3O_8)									
	Uranium Silicide (U_3Si_2)									
	Uranium Carbide (UC)									
	Plutonium Oxide (PuO_2)									
	Plutonium Hydride (PuH_2)									
	Uranium Hydride (UH_3)									
		ORNL	RPI	LANL	LLNL/ NCSU	IRSN	NNL			

- **Requests for additional IE measurements: Ni, Mo, Cr (Fe-Cr alloys), Mn in intermediate energy range (VNIITF, NCERC).**
- **Continuing need for thermal scattering data.**

***Note: work has been completed for some priority needs (e.g., ^{55}Mn, Ti, and Cr), and these isotopes/nuclides are maintained on the list for reference. Furthermore, the table represents the list of materials that can be addressed during the next five years under the current budget target. The additional priority needs will be addressed beyond the next five years.**

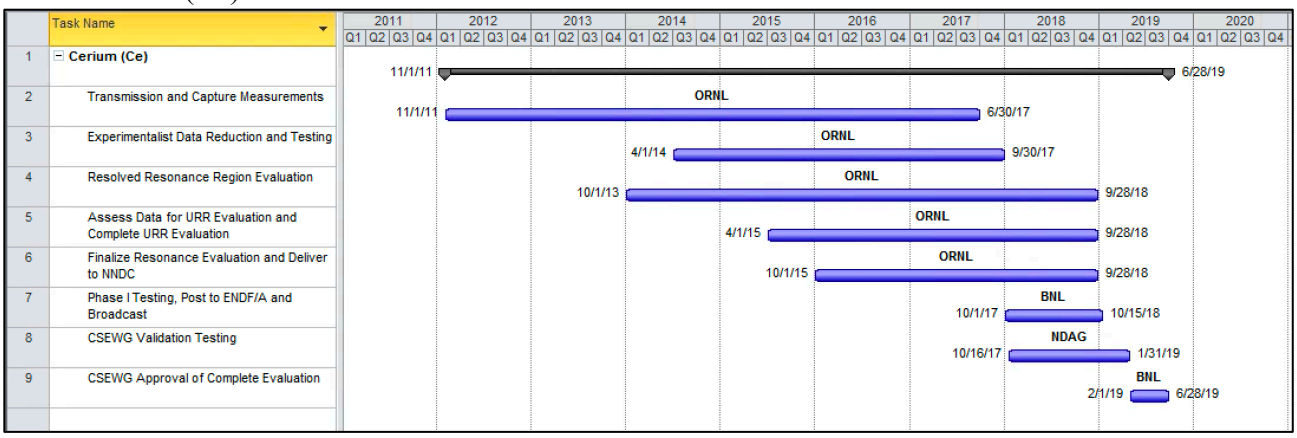
B-1 Differential Measurements and Evaluations – Elements
(The following list provides the specific GANTT chart to refer to for each element work schedule)

B-1.2 Cerium (Ce)
B-1.4 Dysprosium (Dy-161, 162, 163, 164)
B-1.5 Gadolinium (Gd-155, 156, 157, 158, 160)
B-1.6 Iron (Fe-54,56)
B-1.7 Lead (Pb-208)
B-1.8 Oxygen (O-16)
B-1.9 Rhodium (Rh-103)
B-1.10 Plutonium (Pu-239)
B-1.11 Tantalum (Ta)
B-1.12 Uranium (U-235)
B-1.13 Uranium (U-238)
B-1.14 Vanadium (V-51)
B-1.15 Zirconium (Zr-90, 91, 92, 94, 96)
B-1.19 Uranium (U-234)
B-1.20 Uranium (U-236)

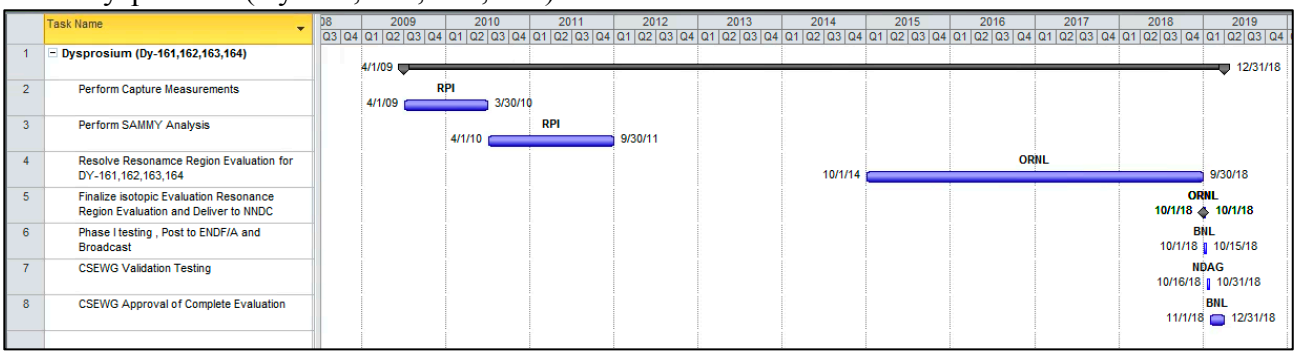
Completed Work

B-1.1 Calcium (Ca)
B-1.3 Cobalt (Co-59)
B-1.16 Copper (Cu-63, 65)
B-1.17 Nickel (Ni-58, 60)
B-1.18 Tungsten (W-182, 183, 184, 186)

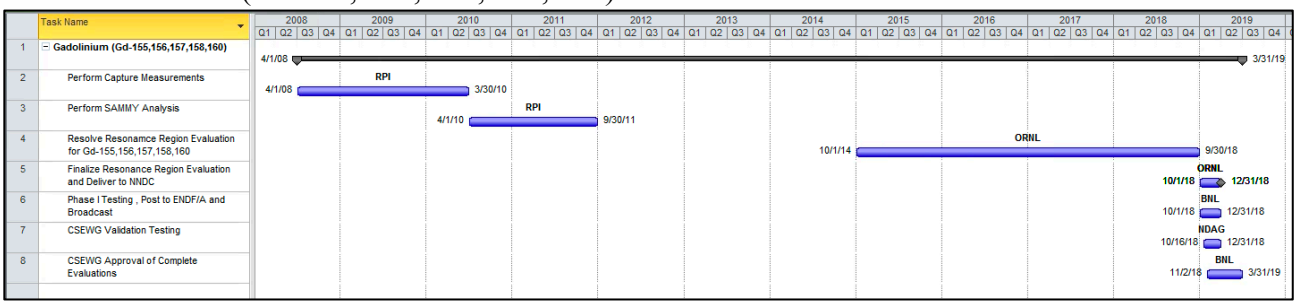
B-1.2 Cerium (Ce)



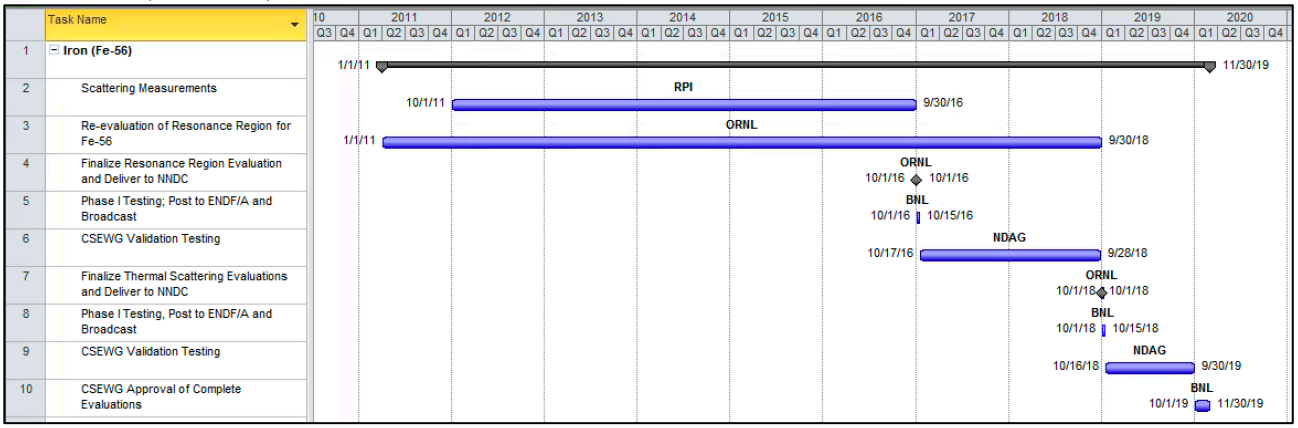
B-1.4 Dysprosium (Dy-161, 162, 163, 164)



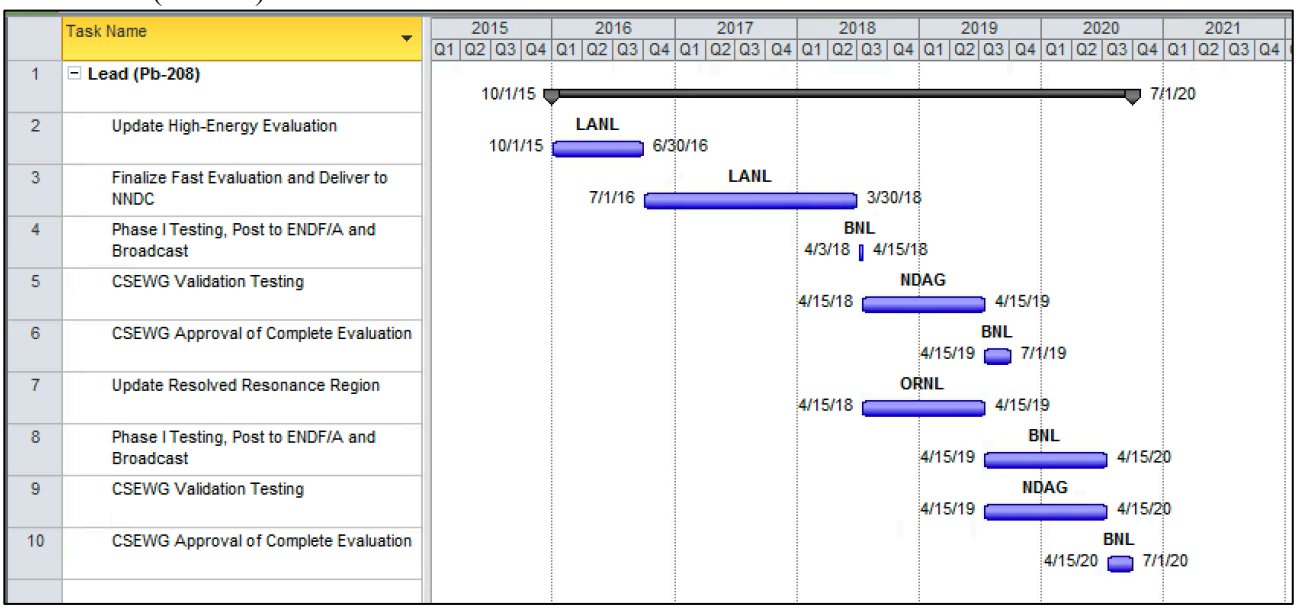
B-1.5 Gadolinium (Gd-155, 156, 157, 158, 160)



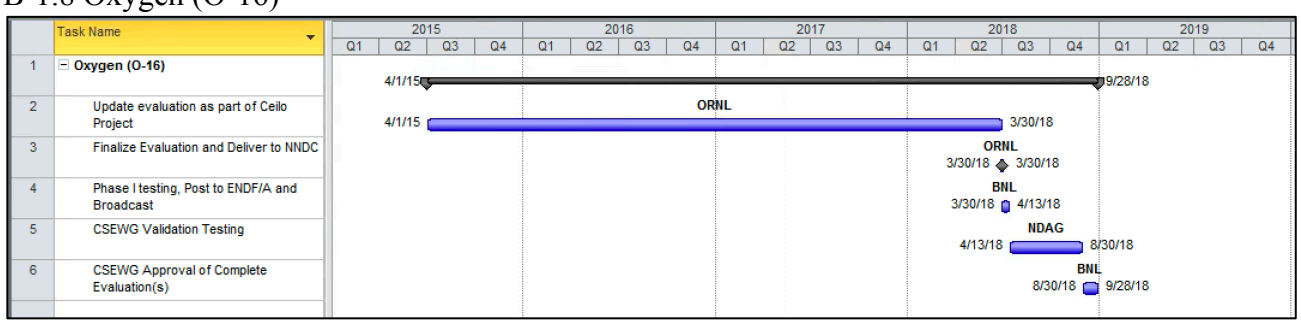
B-1.6 Iron (Fe-54,56)



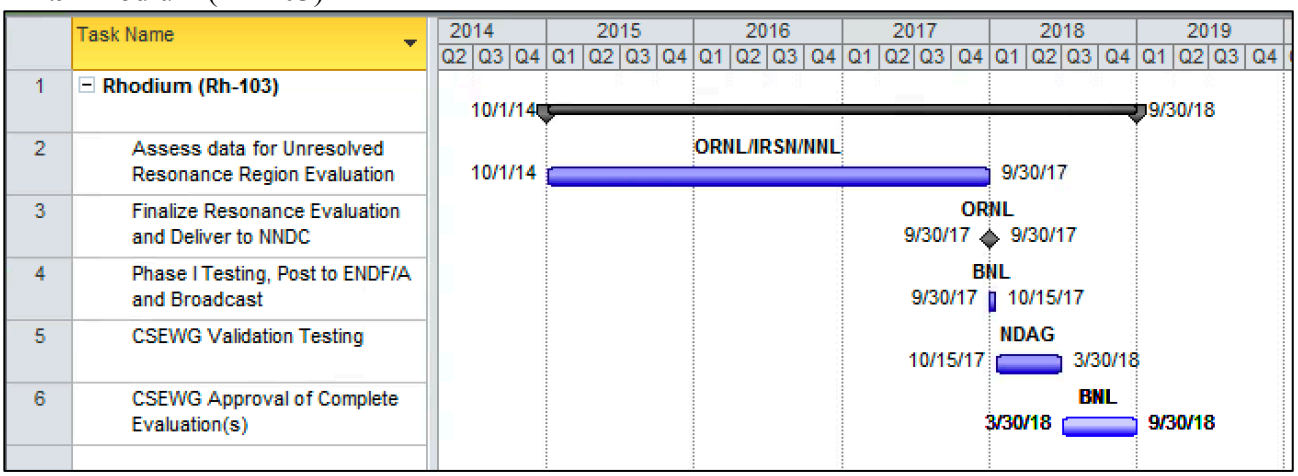
B-1.7 Lead (Pb-208)



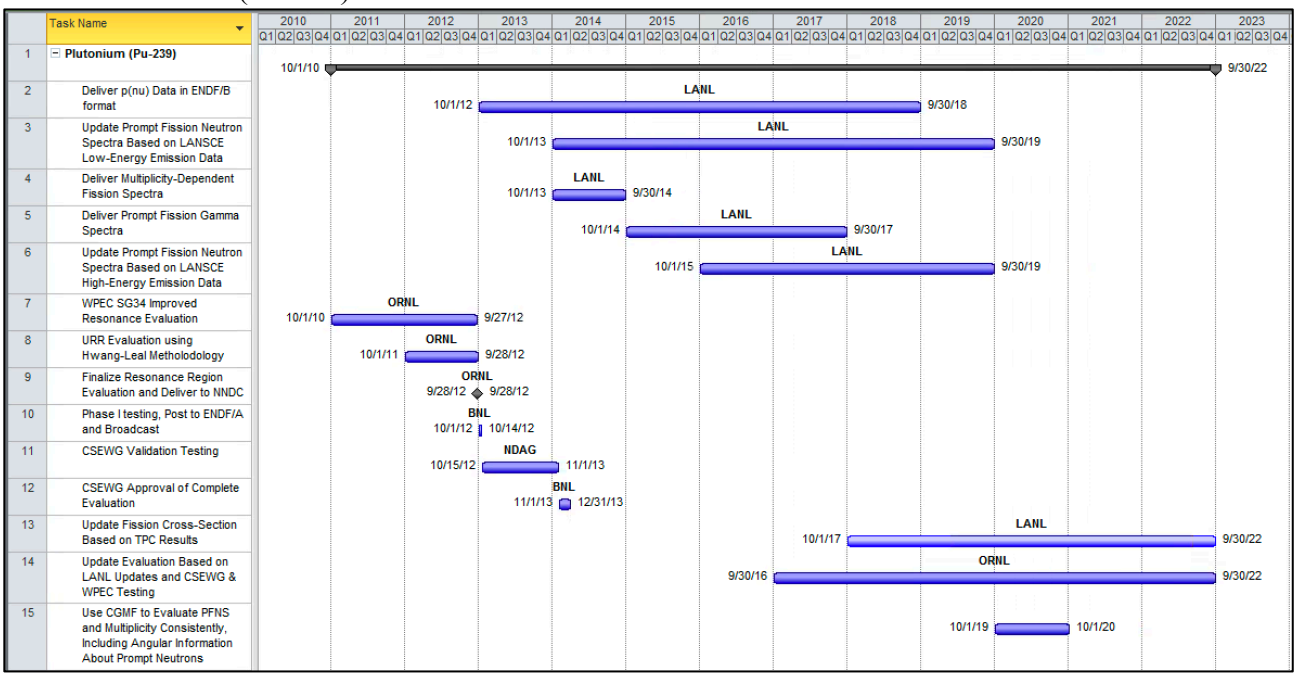
B-1.8 Oxygen (O-16)



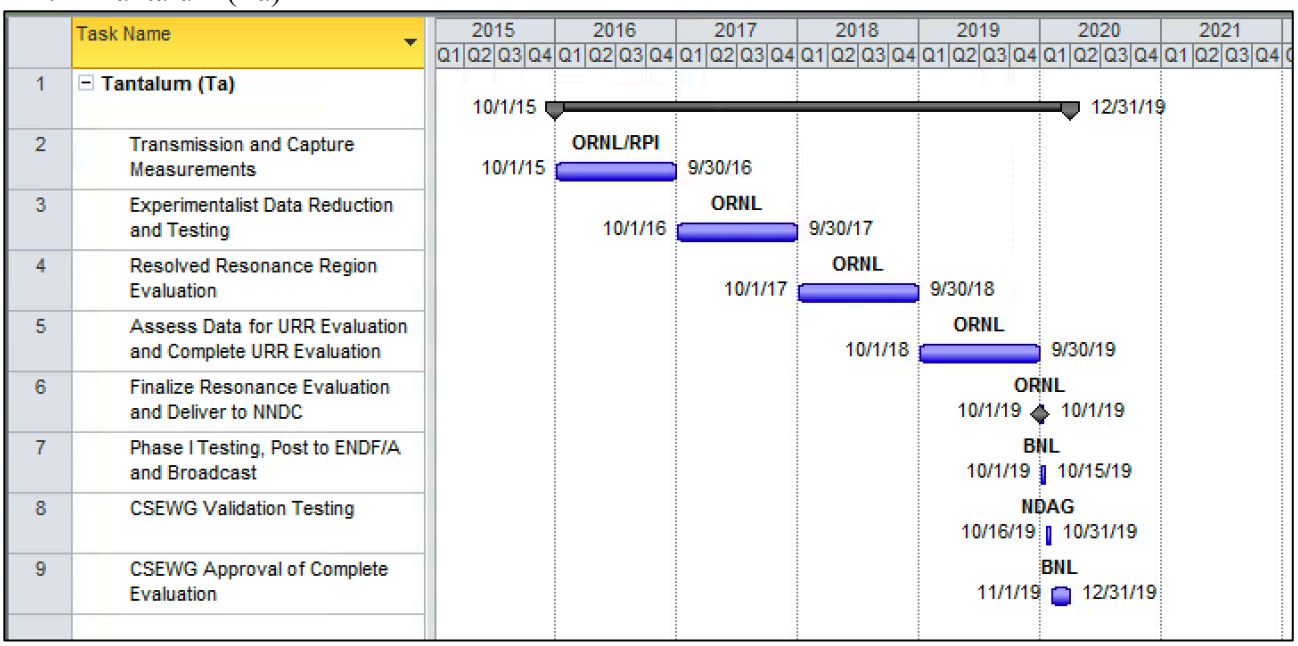
B-1.9 Rhodium (Rh-103)



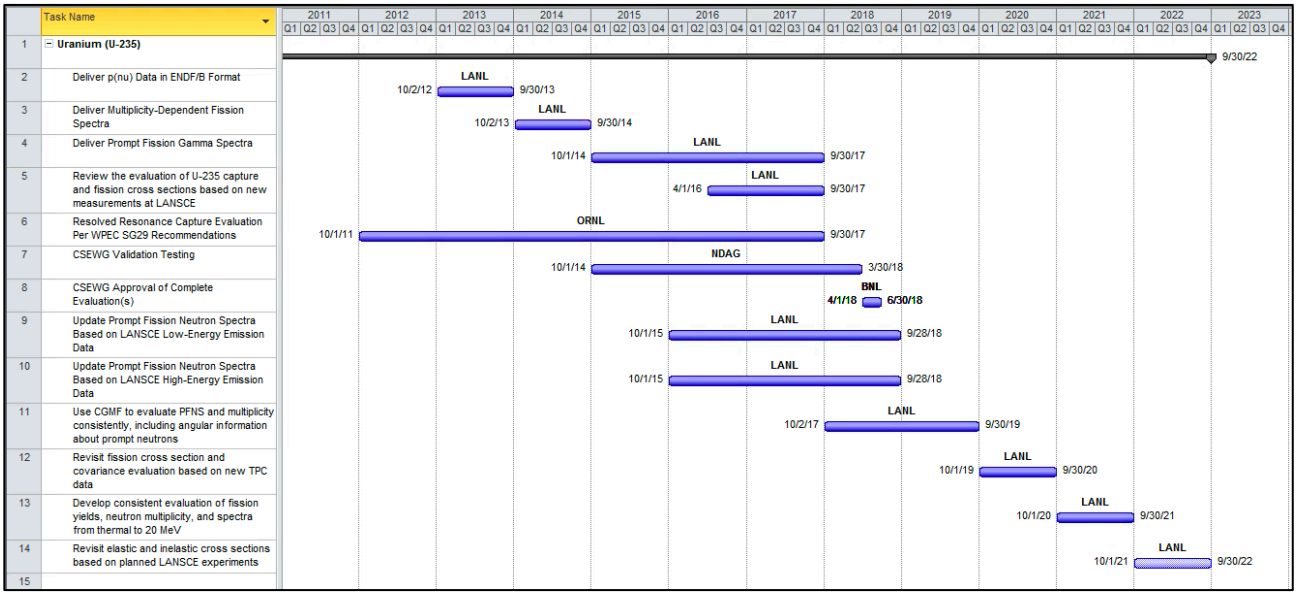
B-1.10 Plutonium (Pu-239)



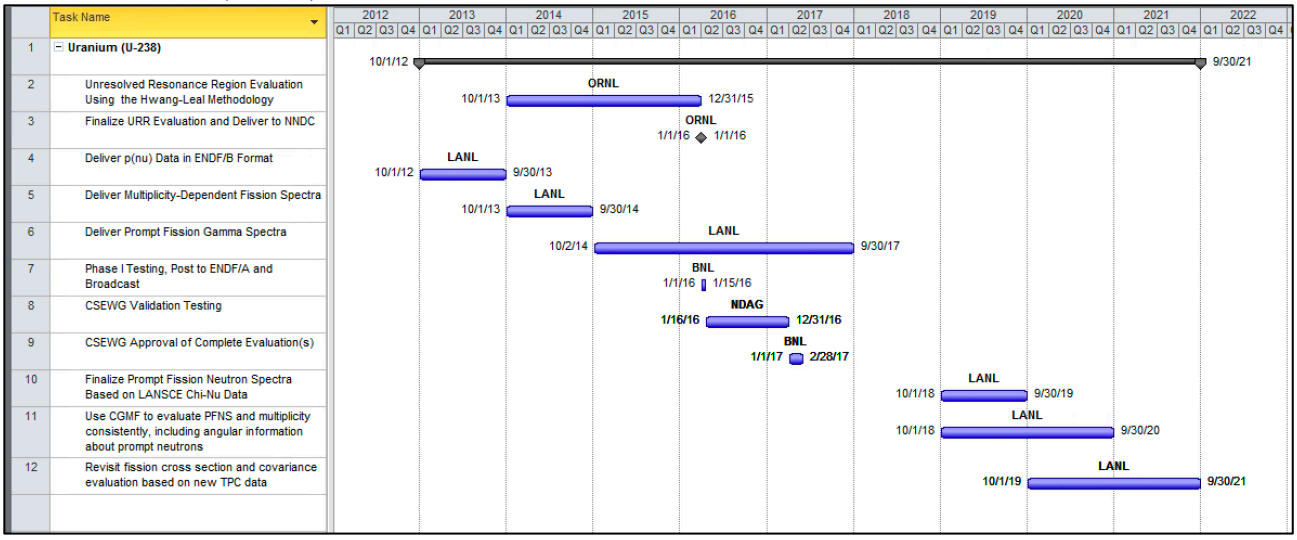
B-1.11 Tantalum (Ta)



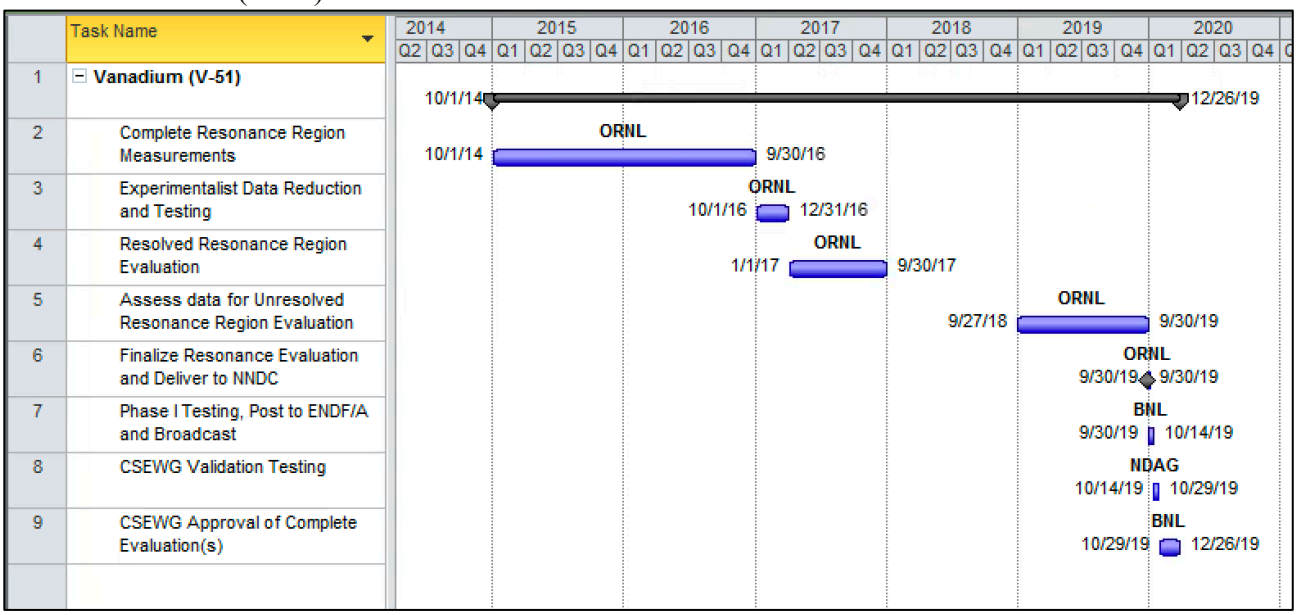
B-1.12 Uranium (U-235)



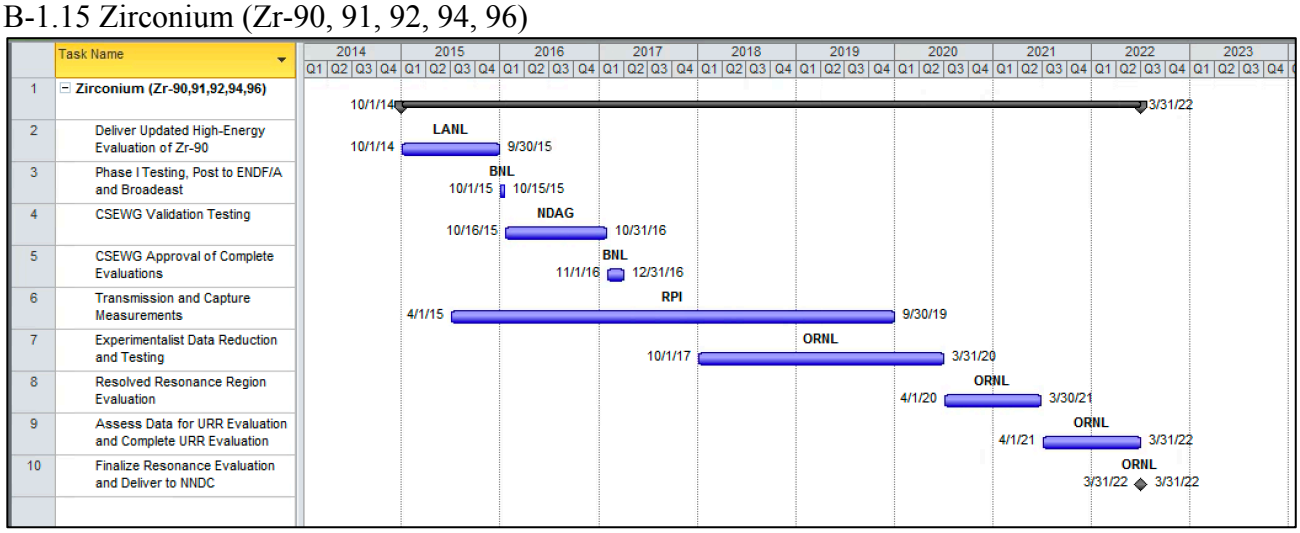
B-1.13 Uranium (U-238)



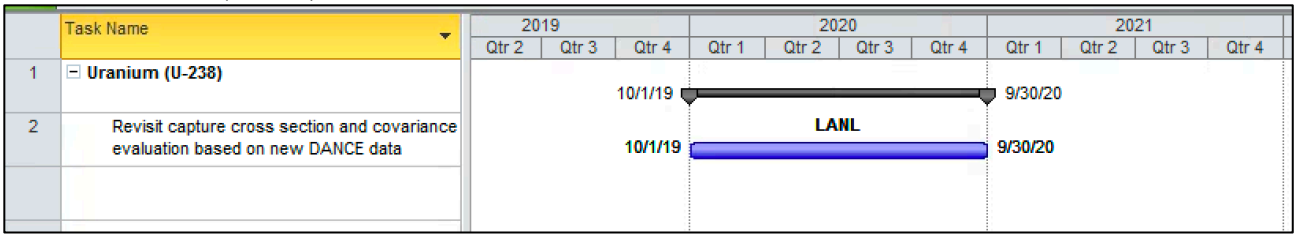
B-1.14 Vanadium (V-51)



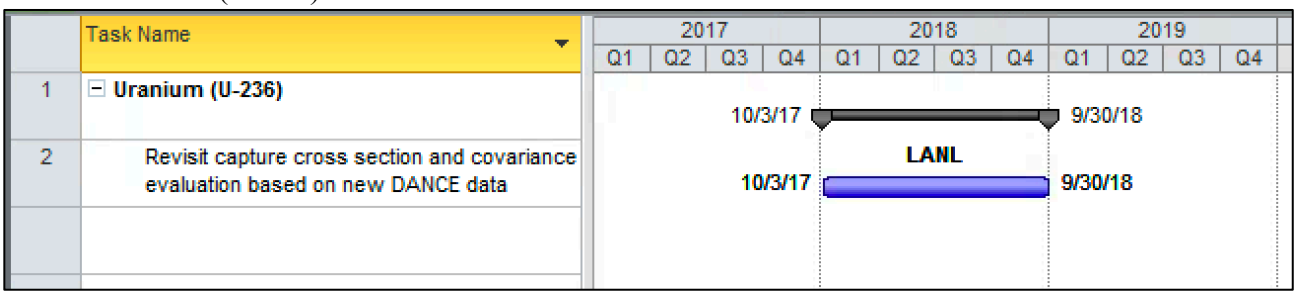
B-1.15 Zirconium (Zr-90, 91, 92, 94, 96)



B-1.19 Uranium (U-234)



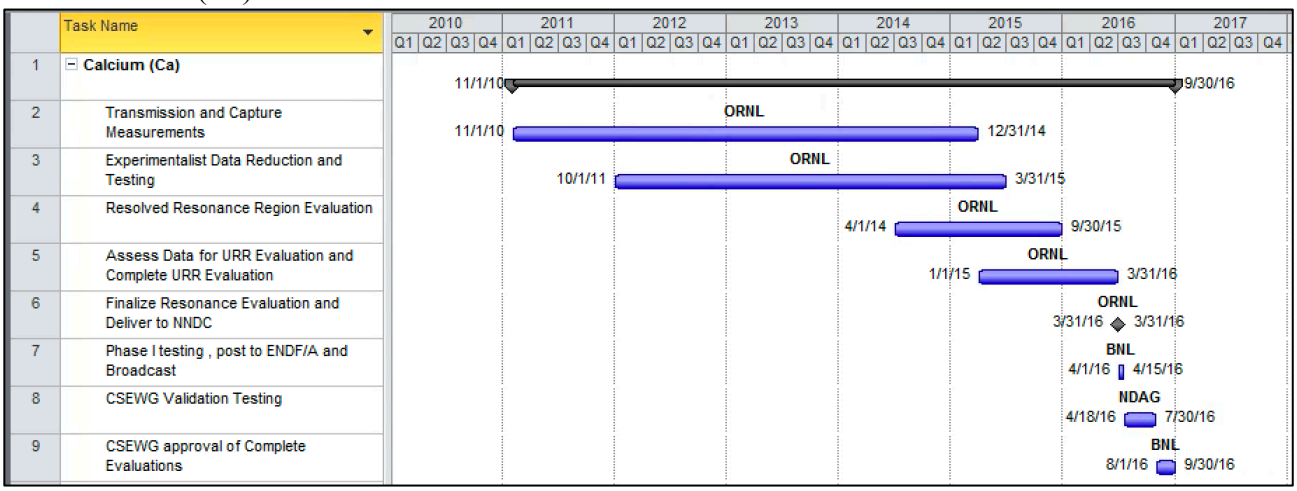
B-1.20 Uranium (U-236)



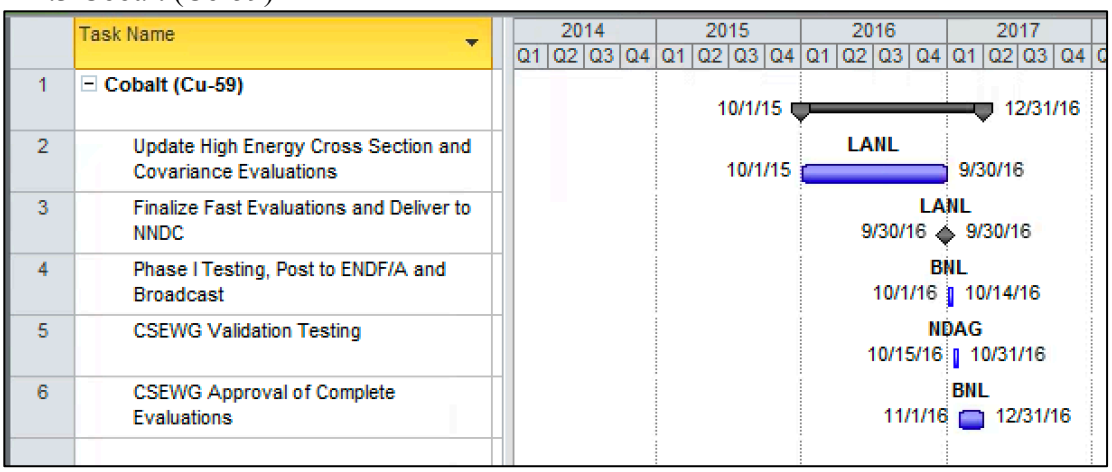
Completed Differential Measurements and Evaluations – Elements

(Evaluations have been submitted to NNDC and are candidates for the next ENDF release. Testing will be performed as part of ENDF release effort, and additional revisions may be requested by NNDC before evaluations are formally released. The GANTT charts are retained in the Five Year Plan pending release of the new evaluations by NNDC.)

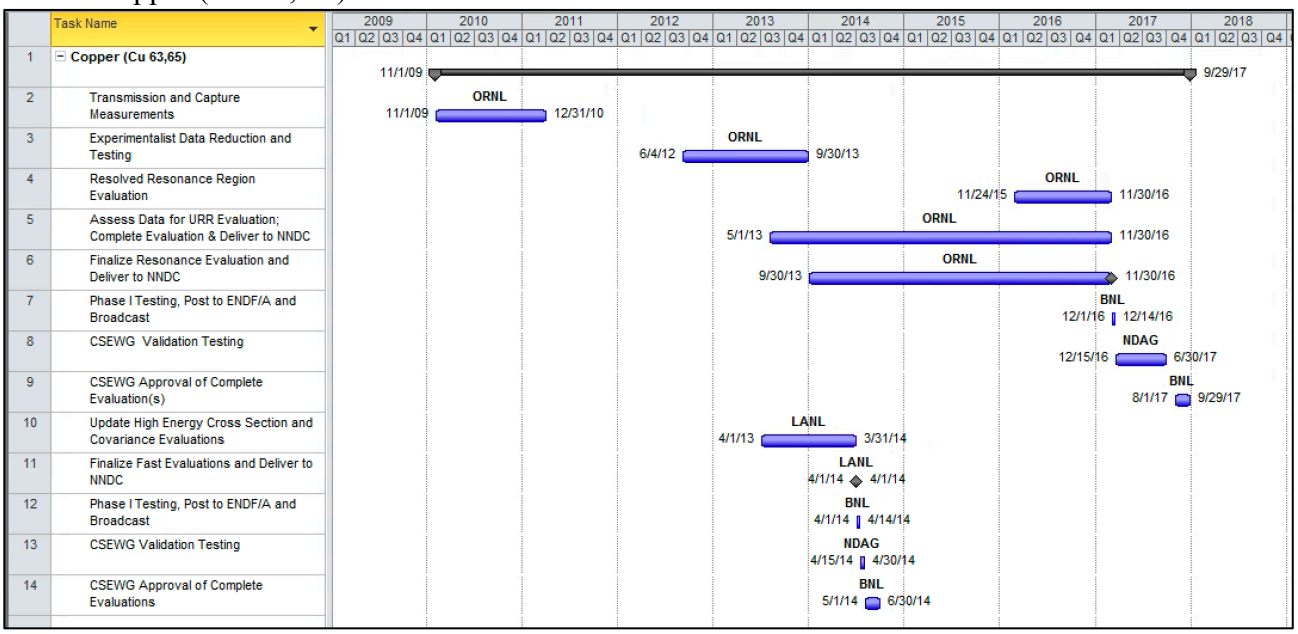
B-1.1 Calcium (Ca)



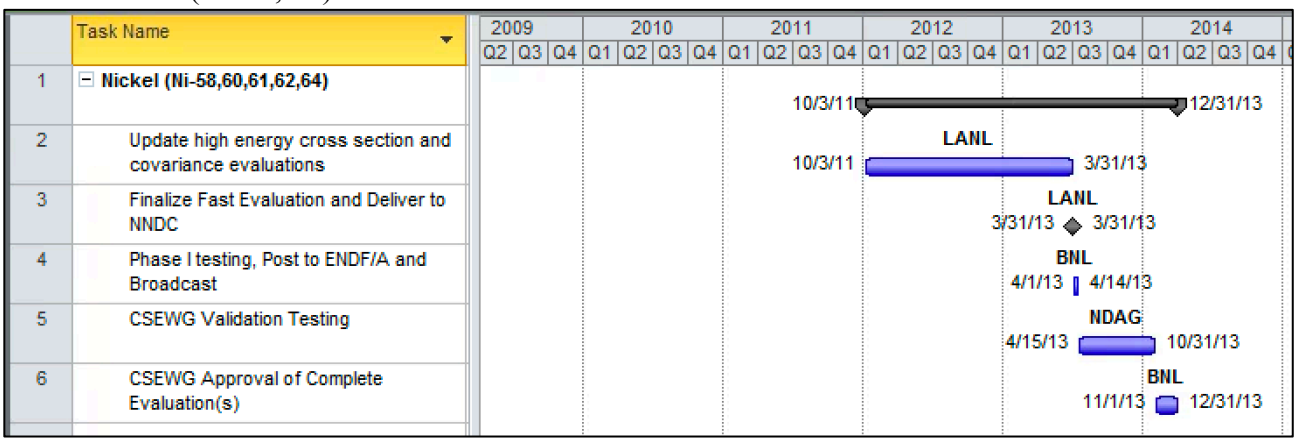
B-1.3 Cobalt (Co-59)



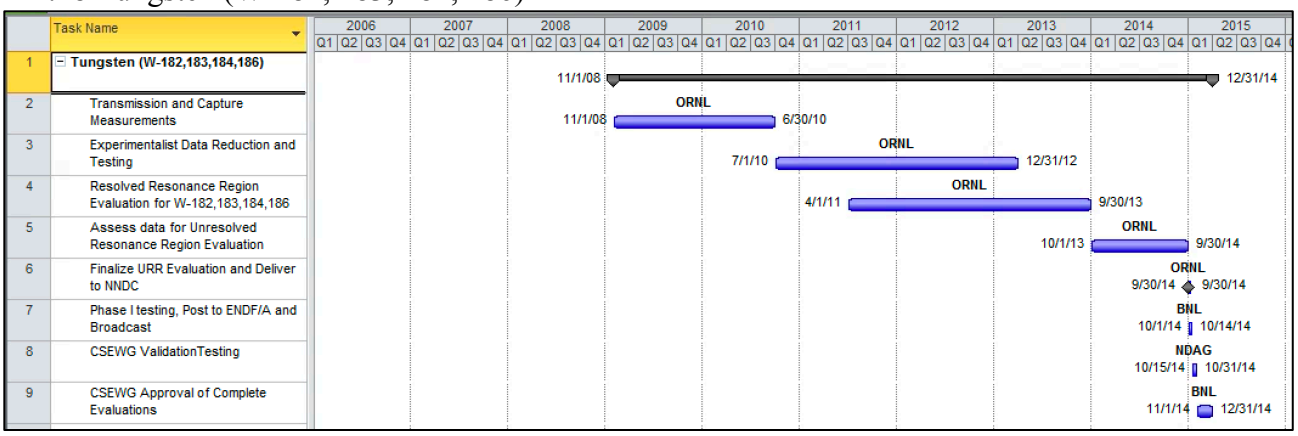
B-1.16 Copper (Cu-63, 65)



B-1.17 Nickel (Ni-58, 60)



B-1.18 Tungsten (W-182, 183, 184, 186)



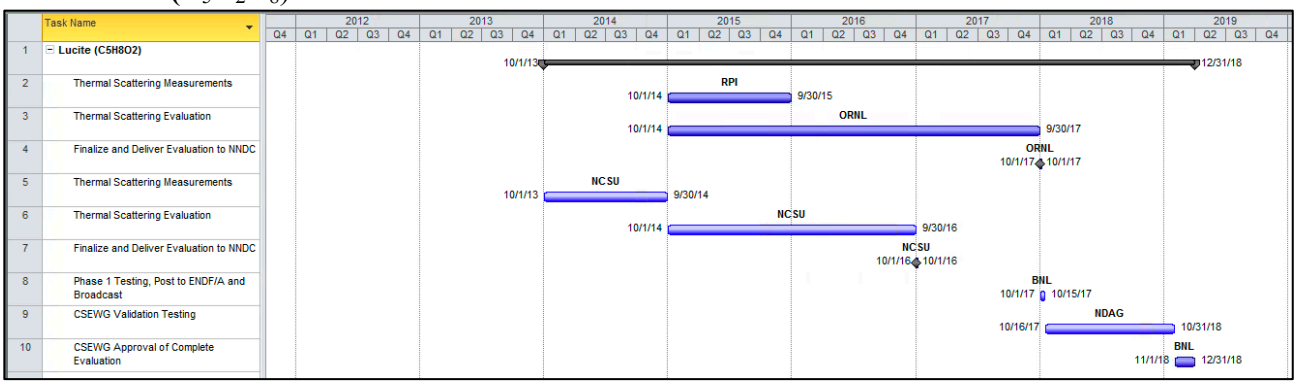
B-2 Differential Measurements and Evaluations – Compounds
(The following list provides the specific GANTT chart to refer to for each element work schedule)

B-2.3 Paraffinic Oil
B-2.4 Hydrofluoric Acid (HF)
B-2.5 Hydraulic Fluid (Silicone Oil)
B-2.6 Paraffin (C_nH_{2n+2})

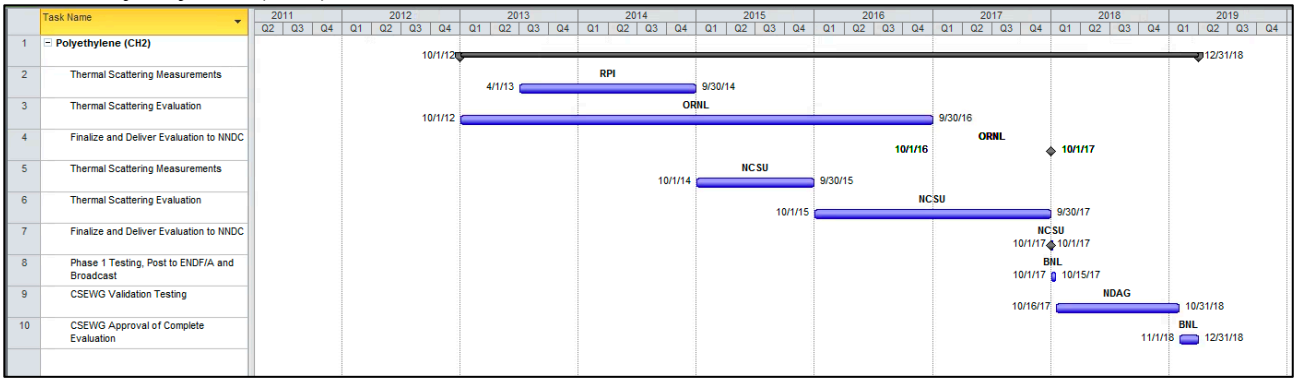
<u>Completed Work</u>

B-2.1 Lucite ($C_5O_2H_8$)
B-2.2 Polyethylene (CH_2)
B-2.7 Beryllium (metal)
B-2.8 Beryllium Oxide (BeO)
B-2.9 Crystal Graphite
B-2.10 Reactor Graphite
B-2.11 Silicon Carbide (SiC)
B-2.12 Silicon Dioxide (SiO_2)
B-2.12 Uranium Dioxide (UO_2)
B-2.13 Uranium Nitride (UN)
B-2.14 Hexagonal Ice (H_2O) – evaluated by NNL
B-2.15 Yttrium Hydride (YH_2) – evaluated by NNL

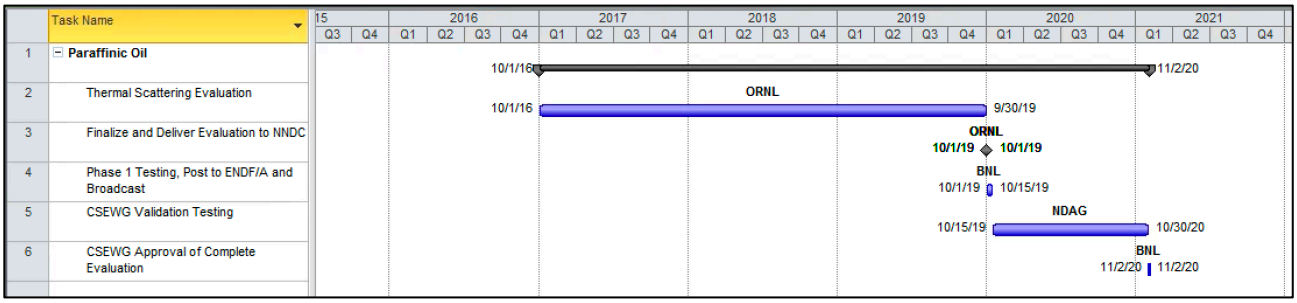
B-2.1 Lucite ($C_5O_2H_8$)



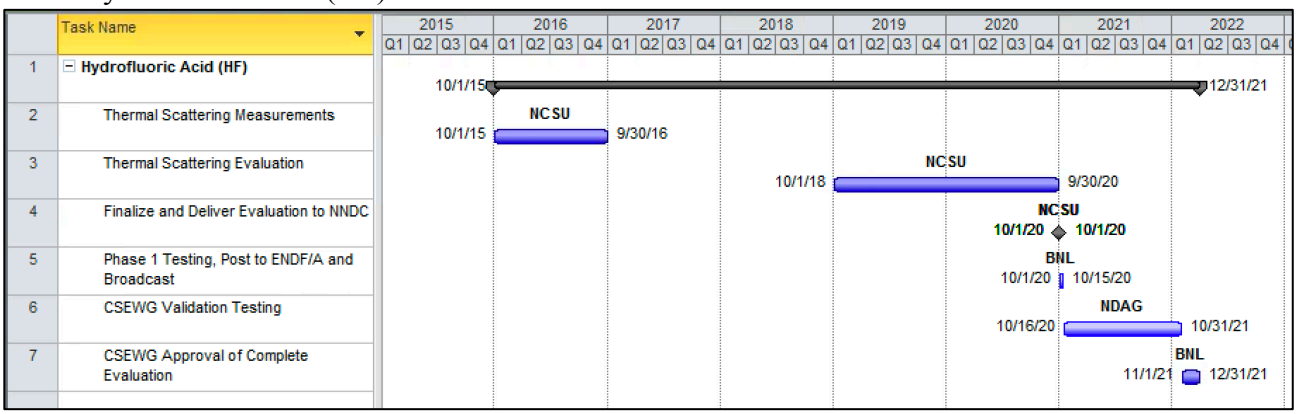
B-2.2 Polyethylene (CH_2)



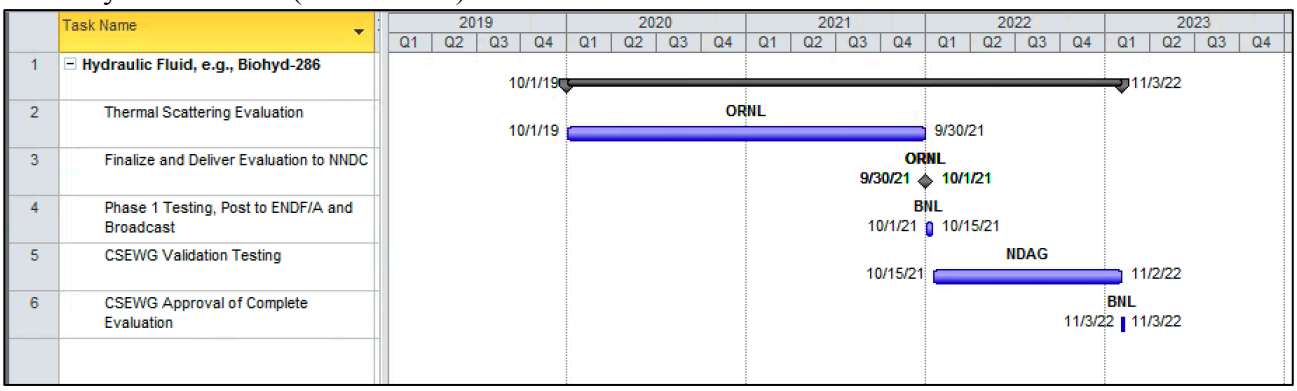
B-2.3 Paraffinic Oil



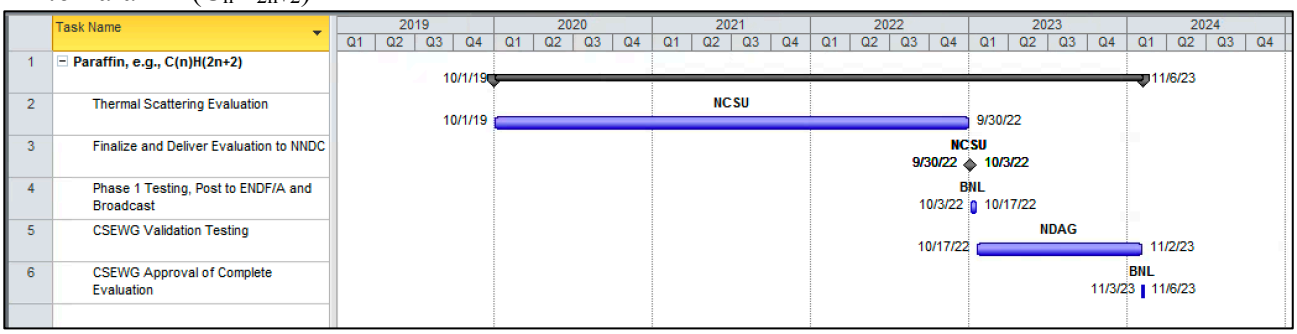
B-2.4 Hydrofluoric Acid (HF)



B-2.5 Hydraulic Fluid (Silicone Oil)



B-2.6 Paraffin (C_nH_{2n+2})



Appendix C

Fiscal Year 2018 Projected Foreign Travel

Destination	Date	Labs	Count	Costs ($)	One Sentence Description	Task	Milestone	Justification
Trieste, Italy	Oct-17	LLNL	1	10,000	ICTP-IAEA Workshop (Percher)	LLNL-ND2 LLNL-ND3 LLNL-ND5 LLNL-TS5	Provide brief trip summary report to NCSP Manager (Q3).	Practical two-week workshop to develop competency in the evaluation of nuclear reaction data for applications assisting in LLNL succession planning supporting AM, IE and ND.
Bariloche, Argentina	Mar-8	LLNL	1	5,000	IYNC2018 (Percher)	LLNL-TS5	Provide brief trip summary report to NCSP Manager (Q3).	Practical conference devoted to young professionals and women focusing on knowledge transfer in relevant areas of nuclear science and technology at the only other laboratory providing thermal scattering law data.
Cancun, Mexico	Apr-18	LLNL	2	10,000	PHYSOR2018 (Heinrichs, Verbeke)	LLNL-IE all	Provide brief trip summary report to NCSP Manager (Q3).	Preeminent conference devoted to reactor physics
OECD/NEA Paris, France	May-18	LLNL	2	10,000	WPEC Meeting (Sleaford, Lent)	LLNL-ND4 LLNL-ND6 LLNL-TS5	Provide brief trip summary report to NCSP Manager (Q3).	Technical meeting of international experts on nuclear data including SG38 (GND) and SG42 (Thermal scattering law)
OECD/NEA Paris, France	Jun-18	LLNL	2	10,000	Participate in WPNCS annual meeting (Heinrichs, Percher)	LLNL-IPD1 LLNL-TS5	Provide brief trip summary report to NCSP Manager (Q4).	Participate in WPNCS governance and expert group meetings on MC methods and excursion analyses.
Vienna, Austria	Dec-2018	LLNL	2	10,000	IAEA Technical Meetings (Cullen, Lent)	LLNL-ND5	Provide brief trip summary report to NCSP Manager (Q3).	Technical meeting of international experts on nuclear data processing.
Paris, France	TBD	LLNL	2	10,000	Coordinate International Collaboration Efforts with IRSN (Heinrichs, Percher	LLNL-IE all	Provide brief trip summary report to NCSP Manager (Q4).	Coordinate joint IRSN-LLNL work as described in Appendix E of the Five Year Execution Plan.
Aldermaston, United Kindgom	TBD	LLNL	2	10,000	JOWOG29/30 Meetings (Heinrichs, Hickman, McAvoy)	LLNL-IE all LLNL-TS5	Provide brief trip summary report to NCSP Manager (Q4).	Coordinate joint AWE-LLNL work per 5YP.
OECD/NEA Paris, France	May-18	NDAG Chair	1	5,000	Participate in WPEC annual meeting (Zerkle)	NCSP-TS9	Provide brief trip summary report to NCSP Manager (Q3).	As NDAG Chair, participate in WPEC.
OECD/NEA Paris, France	May-18	RPI	2	10,000	Participate in WPEC annual meeting (Liu, Danon)	RPI-ND1 RPI-ND/2	Provide brief trip summary report to NCSP Manager (Q3).	As US Measurements Chair, participate in WPEC and SG-40 annual meeting to present NCSP/RPI nuclear data measurement work. Participate in SG-42 (thermal scattering meeting) to present NCSP/RPI thermal scattering measurements and analysis.

Destination	Date	Labs	Count	Costs ($)	One Sentence Description	Task	Milestone	Justification
Cancun, Mexico	Apr-18	LANL	1	5,000	PHYSOR2018 (Mckenzie)	LANL-IE all	Provide brief trip summary report to NCSP Manager (Q3).	Preeminent conference devoted to reactor physics
OECD/NEA Paris, France	May-18	LANL	2	10,000	Attend annual WPEC meeting and associated Sub-Group meetings (Conlin, Haeck)	LANL-AM2	Provide brief trip summary report to NCSP Manager (Q3).	Contributor to multiple sub-groups. Conlin co-leads SG43.
OECD/NEA Paris, France	May-18	LANL	2	10,000	Attend annual WPEC meeting and associated Sub-Group meetings (Kawano, Talou)	LANL-ND1	Provide brief trip summary report to NCSP Manager (Q3).	CSEWG representation to WPEC. Contributor to multiple sub-groups.
OECD/NEA Paris, France	Jun-18	LANL	2	12,000	OECD Expert Group Meetings for NCSP, collaboration with IRSN on NCS (Brown, Rising, Alwin)	LANL-AM1	Provide brief trip summary report to NCSP Manager (Q3).	Participation provides state-of-art information for improving MCNP®, Whisper, and other computational methods that are necessary and heavily used in NCSP work. In addition this allows for direct collaboration with IRSN.
IRMM Mol, Belgium	Jan-18 Apr-18 Jun-16 Sep-18	ORNL	1	60,000	Perform resonance region nuclear data measurements using GELINA facility at IRMM in accordance with Appendix B of the Five Year Plan (Guber)	ORNL-ND1	Provide brief trip summary report to NCSP Manager (Q4).	Continues cross-section measurements to support the production of new cross-section evaluations per the schedule in Appendix B of the Five Year Plan.
Beijing, China, London, UK, or Vienna, Austria.	May-18	ORNL	1	5,000	Participate in ISO standards meeting on nuclear criticality safety (Bowen)	NCSP-TS1	Provide brief trip summary report to NCSP Manager (Q4).	Participate in ISO standards meeting (ISO TC85/SC5/WG8) on nuclear criticality safety to ensure NCSP interests are represented in the development of international standards for nuclear criticality safety. Travel to perform nuclear data measurements and evaluations.
IRSN Paris, France	Nov-17 May-18 Sep-18	ORNL	1	45,000	Perform nuclear data evaluation and testing work with IRSN (Sobes)	ORNL-ND1	Provide brief trip summary report to NCSP Manager (Q4).	Continues cross-section evaluation work to complete nuclear data evaluations per the schedule in Appendix B of the Five Year Plan.
OECD/NEA Paris, France	May-18	ORNL	2	10,000	Participate in WPEC annual meeting, coordinate international nuclear data collaborations for the NCSP, and present NCSP/ORNL nuclear data evaluation work (Pigni, Sobes)	ORNL-ND1	Provide brief trip summary report to NCSP Manager (Q3).	Exchange of information with international nuclear data community to improve NCSP nuclear data evaluations and cultivate new collaborations to support future NCSP nuclear data work tasks.

Destination	Date	Labs	Count	Costs ($)	One Sentence Description	Task	Milestone	Justification
Vienna, Austria	May-18	ORNL	1	5,000	Participate in IAEA working group meeting to improve nuclear data evaluations to support new evaluations of interest to the NCSP (Pigni).	ORNL-ND1	Provide brief trip summary report to NCSP Manager (Q3).	Exchange of information with international nuclear data community to support the development of nuclear data evaluations in Appendix B of the Five Year Plan.
OECD/NEA Paris, France	Jun-18	ORNL	2	10,000	Continue U.S. leadership in OECD/NEA Working Party on Nuclear Criticality Safety (WPNCS) as chair of expert group on Uncertainty Analysis for Criticality Safety Assessment (Rearden) and benchmark lead in expert group on Advanced Monte Carlo Techniques (Bowen, Rearden).	ORNL-AM2	Provide brief trip summary report to NCSP Manager (Q3).	At this workshop new methods of nuclear data covariance generation will be exchanged and the best methods would be implemented within the SAMMY modernization project for the benefit of NCSP.
Aix en Provence, France	Oct-17	ORNL	2	8,000	4th International Workshop on Nuclear Data Covariances (Arbanas, Sobes)	ORNL-ND6	Provide brief trip summary report to NCSP Manager (Q3).	At this workshop new methods of nuclear data covariance generation will be exchanged and the best methods would be implemented within the SAMMY modernization project for the benefit of NCSP.
Paris, France	Nov-17	ORNL	1	5,000	WPEC Fall 2017 Meeting (TBD)	ORNL-ND1	Provide brief trip summary report to NCSP Manager (Q3).	Present the evaluation work for ENDF/B-VIII.0 supported by the NCSP and possible collaboration with other institutions, especially for the WPEC subgroup for the CIELO collaboration. Exchange of information with international NCS community to improve NCSP nuclear data work and cultivate new collaborations to support future NCSP nuclear data tasks.

NOTE: The above projected foreign travel meetings have been confirmed as technical working group meetings and not as conferences.

Appendix D

Baseline Budget Needs for Execution Year FY2018

Baseline budget need for the FY2018 Nuclear Criticality Safety Program (NCSP) is $27,623k with 95% of funding supporting NCSP FTE's, equating to approximately 52 national laboratory or facility contractor employees, who provide programmatic needs as outlined in the NCSP *The Mission and Vision of the United States Department of Energy Nuclear Criticality Safety Program for the Fiscal Years 2014-2023.* All tasks are approved based on their contribution to the achievement of the five- and ten-year goals as outlined in the Mission and Vision document.

NCSP includes the following five technical program elements plus support infrastructure, with each having the major deliverables for FY2018:

- Analytical Methods
  - Criticality Safety Computer Codes SCALE and MCNP support. Maintain Radiation Safety Information Computational Center who distributes all software. Also, development of updated Criticality SlideRule capability. ~7 FTEs supported. International collaborations: SCALE, NJOY, MCNP, AMPX work with AWE and IRSN.
- Information Preservation and Dissemination
  - NCSP website upgrade and maintenance. ~11 new ICSBEP evaluations and publications (OECD collaboration). Provide experimental uncertainty correlations.
- Integral Experiments
  - Execution of ~17 critical/subcritical experiment and 10 critical/subcritical experiment evaluations published (NCERC and SNL). Permanent party staff supported. Control System upgrades needed. International collaborations: TEX experiments with IRSN and AWE, NDA experiments with IRSN/CEA, CAAS experiment design with AWE, IRSN, Japan, SNL experiment design and execution with IRSN.
  - Continue deliverables in WFO agreements with NASA. NASA Space Technology Mission Directorate (STMD) has a firm program deliverable to complete KRUSTY in early 2018 in collaboration with the NCSP. The KRUSTY core is of enduring interest for future experiments supporting NNSA mission and thus we are sharing costs.
  - Additional funding requirement to fund both Laboratory logistics costs and NNSS safety basis work.
- Nuclear Data
  - Nuclear data evaluations and measurements of ~19 elements and ~4 compounds. RPI refurbishment (NR collaboration). Produce new scattering law data (NCSU and RPI collaboration). Modernization of SAMMY resonance analysis software. ~7 FTEs supported. International collaborations: Data testing and evaluations with AWE and IRSN. Measurements with IRMM.
- Training and Education
  - Two 2-week courses at NNSS/NCERC/Sandia.
  - One 1-week managers course at Sandia.
  - One 1-week managers course at NCERC
  - Resolution of CSSG comments (CSSG Tasking 2016-01) for 2-week Hands-on course at NNSS/NCERC/Sandia.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~3 FTEs supported.

Over target budget need for FY2018 NCSP is $1.4M that would support 6 additional high priority tasks to address key Mission and Vision goals not addressed within the current budget target:

- Support, as necessary, NCERC criticality assembly/support equipment upgrades. ($750K)
- Provide an excursion analysis capability (LLNL) ($100K)
- Expand radiochemistry laboratory capabilities at NNSS ($100K)
- Standup "hot"/"cold" machine shops at NCERC ($100K)
- Reduce NCERC integral experiment backlog ($250K)
- Sensitivity/Uncertainty Analysis to support Nuclear Data element ($100K)

Baseline Budget Needs for Execution Year FY2019

Baseline budget need for the FY2019 Nuclear Criticality Safety Program (NCSP) is $27,294k with 95% of funding supporting NCSP FTE's, equating to approximately 52 national laboratory or facility contractor employees, who provide programmatic needs as outlined in the NCSP *The Mission and Vision of the United States Department of Energy Nuclear Criticality Safety Program for the Fiscal Years 2014-2023.* All tasks are approved based on their contribution to the achievement of the five- and ten-year goals as outlined in the Mission and Vision document.

NCSP includes the following five technical program elements plus support infrastructure, with each having the major deliverables for FY2019:

- Analytical Methods
  - Criticality Safety Computer Codes SCALE and MCNP support. Maintain Radiation Safety Information Computational Center who distributes all software. Development of NCS excursion analysis capability, including an updated Criticality SlideRule capability. ~7 FTEs supported. International collaborations: SCALE, NJOY, MCNP, AMPX work with AWE and IRSN.
- Information Preservation and Dissemination
  - NCSP website upgrade and maintenance. ~9 new ICSBEP evaluations and publications (OECD collaboration). Provide experimental uncertainty correlations.
- Integral Experiments
  - Execution of ~18 critical/subcritical experiment and 9 critical/subcritical experiment evaluations published (NCERC and SNL). Permanent party staff supported. Initiate design efforts for neptunium and Jezebel critical experiments. DSA changes and facility modifications for pneumatic rabbit system and NAD lab construction. International collaborations: TEX experiments with IRSN and AWE, CAAS experiment design with AWE, IRSN, Japan, SNL experiment design and execution with IRSN.
- Nuclear Data
  - Nuclear data evaluations and measurements of ~16 elements and ~4 compounds. RPI refurbishment (NR collaboration). Produce new scattering law data (NCSU and RPI collaboration). Modernization of SAMMY resonance analysis software. ~7 FTEs supported. International collaborations: Data testing and evaluations with AWE and IRSN. Measurements with IRMM.
- Training and Education
  - Two 2-week courses at NNSS/NCERC/Sandia.
  - One 1-week managers course at Sandia.
  - One 1-week managers course at NCERC.
  - Development of a Criticality Safety Officer/Fissile Material Handler Course for piloting in FY20.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~2.5 FTEs supported.
- Over target budget need for FY2019 NCSP is $0.88M that would support 5 additional high priority tasks to address key Mission and Vision goals not addressed within the current budget target:
  - Develop and deploy mobile critical/near critical hands-on demonstration capability ($180K)
  - Reduce NCERC integral experiment backlog and new Np experiment ($200K)
  - Non-Destructive Assay Technical Support Group ($300K)
  - Expand radiochemistry laboratory capabilities at NNSS ($100K)
  - Computer code NCS analysis capability modernization ($100K)

Baseline Budget Needs for Execution Year FY2020

Baseline budget need for the FY2020 Nuclear Criticality Safety Program (NCSP) is $28,472k with 95% of funding supporting NCSP FTE's, equating to approximately 53 national laboratory or facility contractor employees, who provide programmatic needs as outlined in the NCSP *The Mission and Vision of the United States Department of Energy Nuclear Criticality Safety Program for the Fiscal Years 2014-2023.* All tasks are approved based on their contribution to the achievement of the five- and ten-year goals as outlined in the Mission and Vision document.

NCSP includes the following five technical program elements plus support infrastructure, with each having the major deliverables for FY2020:

- Analytical Methods
  - Criticality Safety Computer Codes SCALE and MCNP support. Maintain Radiation Safety Information Computational Center who distributes all software. Development of NCS excursion analysis capability, including an updated Criticality SlideRule capability. ~8 FTEs supported. International collaborations: SCALE, NJOY, MCNP, AMPX work with AWE and IRSN.
- Information Preservation and Dissemination
  - NCSP website upgrade and maintenance. ~9 new ICSBEP evaluations and publications (OECD collaboration). Provide experimental uncertainty correlations.
- Integral Experiments
  - Execution of ~18 critical/subcritical experiment and 9 critical/subcritical experiment evaluations published (NCERC and SNL). Permanent party staff supported. Continue efforts to design and execute neptunium and Jezebel critical experiments. DSA changes and facility modifications for pneumatic rabbit system and NAD lab construction. International collaborations: TEX experiments with IRSN and AWE, CAAS experiment design with AWE, IRSN, Japan, SNL experiment design and execution with IRSN.
- Nuclear Data
  - Nuclear data evaluations and measurements of ~7 elements and ~3 compounds. RPI refurbishment (NR collaboration). Produce new scattering law data (NCSU and RPI collaboration). Modernization of SAMMY resonance analysis software ~6 FTEs supported. International collaborations: Data testing and evaluations with AWE and IRSN. Measurements with IRMM.
- Training and Education
  - Two 2-week courses at NNSS/NCERC/Sandia.
  - One 1-week managers course at Sandia.
  - One 1-week managers course at NCERC.
  - One "special" week-long course similar to a Sandia or NCERC hands-on class for AWE.
  - Criticality Safety Officer/Fissile Material Handler NCS training pilot course.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~2.5 FTEs supported.

Appendix E

International Collaboration with the Institut De Radioprotection et De Sûreté Nucléaire (IRSN)

IRSN has an active and growing program of collaboration with the NCSP that aims to underpin and enhance IRSN's nuclear criticality safety. IRSN will provide its expertise and capabilities to support the NCSP's mission and vision so that the collaboration is mutually beneficial to both organizations.

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2018 IRSN contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
Analytical Methods						
IRSN-AM1	Validation and qualification methods	ORNL-AM2	Covariance matrices establishment of the selection of Integral Experiments	I. DUHAMEL	B. REARDEN	ORNL
IRSN-AM3	Monte Carlo & sensitivity calculations	ORNL-AM2	Technical exchanges on sources convergence issues, sensitivity coefficients calculations and kinetics parameters calculations	A. JINAPHANH B. COCHET	B. REARDEN	ORNL
IRSN-AM5	Update of the slide rule	ORNL-AM6 LLNL-AM3 AWE-AM1	Subtask 2 of IRSN proposal Update of the "slide rule" for the rapid response estimation of a criticality accident (using COG, MCNP, MAVRIC, ATTILA…)	M. DULUC	D. BOWEN D. HEINRICHS C. WILSON	ORNL LLNL AWE

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2018 IRSN contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
IRSN-AM7	ACE QA testing and implementation	LANL-AM2	Implementation of the defined QA tests in ACEtk and integration in GAIA	L. LEAL	J. CONLIN	LANL
IRSN-AM8	Analytical methods Expert Group	NCSP-TS2	IRSN participation to NCSP analytical methods expert group and IRSN participation to TPR meeting	S. EVO	D. HEINRICHS D. BOWEN	NCSP
IRSN-AM9	Cross sections processing validation	ORNL-AM3	Development of an interface between GAIA and AMPX and test interface capabilities	R. ICHOU	D. BOWEN	ORNL
IRSN-AM11	Optimization computation methods	LLNL-AM1	Analysis of PROMETHEE use, training and assistance Development of specific capabilities for COG plugin	Y. RICHET	D. HEINRICHS	LLNL
IRSN-AM13	Benchmark intercomparison study	LLNL-AM5 ORNL-AM10 LANL-AM5	Definition of common set of developed benchmark models Calculations for Pu and HEU systems	I. DUHAMEL	D. HEINRICHS B. REARDEN F. BROWN	LLNL ORNL LANL
IRSN-AM14	Sensitivity/Uncertainty comparison study with a focus on Upper Subcritical Limits	ORNL-AM9 LANL-AM4	Definition of two test cases Calculations and intercomparison technical report	I. DUHAMEL	B. REARDEN F. BROWN	ORNL LANL

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2018 IRSN contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
Integral Experiments						
IRSN-IE1 **IER 184**	TEX - Ta experiment	LLNL-IE1	Sensitivity/uncertainty calculations Contribution to the evaluation of the first experiments	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE3 **IER 209**	New 7uPCX experiment	SNL-IE1	Contribution to ICSBEP reevaluation	N. LECLAIRE	G. HARMS	SNL
IRSN-IE5 **IER 206**	New BUCCX experiment	SNL-IE1	Contribution to ICSBEP reevaluation	N. LECLAIRE	G. HARMS	SNL
IRSN-IE6 **IER 306**	Rh foils experiment	SNL-IE1	IRSN proposal: preliminary evaluation of experimental uncertainties prior to the experiments CED-2 report	N. LECLAIRE	G. HARMS	SNL
IRSN-IE7 **IER 305**	Mo foils and rods experiment	SNL-IE1	IRSN proposal: CED-3a report Mo foils supplying	N. LECLAIRE	G. HARMS	SNL
IRSN-IE8 **IER 285**	Ti experiment	SNL-IE1	Analysis of the experiments Comparison with MIRTE program	N. LECLAIRE	G. HARMS	SNL
IRSN-IE11 **IER 297**	TEX - Hf experiment	LLNL-IE1	Contribution to Jemina plates characterization	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE12 **IER 147**	Reference values of GODIVA radiation field	LLNL-IE1	Contribution to final CED report	M. DULUC F. TROMPIER	D. HEINRICHS	LLNL
IRSN-IE13 **IER 148**	International intercomparison exercise using GODIVA	LLNL-IE1 AWE-IE1		M. DULUC F. TROMPIER	D. HEINRICHS C. WILSON	LLNL AWE

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2018 IRSN contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
IRSN-IE14 **IER 252**	Reference values of FLATTOP radiation field	LLNL-IE1 AWE-IE2	Contribution to the analysis of the experiments with IRSN materials. Contribution to the final technical report	M. DULUC F. TROMPIER	D. HEINRICHS C. WILSON	LLNL AWE
IRSN-IE15 **IER 253**	International intercomparison exercise using FLATTOP	LLNL-IE1 AWE-IE3	Participation in the design, contribution to the experiments with IRSN materials	M. DULUC F. TROMPIER	D. HEINRICHS C. WILSON	LLNL AWE
IRSN-IE16 **IER 422**	SCRaP integral experiment	LANL-IE3		W. MONANGE	J. HUTCHINSON	LANL
IRSN-IE19	Solution reactor	-	Strong IRSN interest for participation in the design, specification… of a solution reactor	M. DULUC	-	-
IRSN-IE21 **IER 407**	ISSA ICSBEP benchmark	LLNL-IE12	Analysis of the experiments, participation in the final technical report	W. MONANGE	D. HEINRICHS	LLNL

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2018 IRSN contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
IRSN-IE25 **IER 296**	TEX - MOX experiment	LLNL-IE1	IRSN leads this proposal CED-2 report with LLNL support Characterization of moderator and reflector plates IRSN contribution to the moderator and reflector plates funding.	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE26 **IER 295**	TEX - Iron experiment	LLNL-IE1	IRSN contribution to the design of TEX-Iron Contribution to CED 2 report and review	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE27 **IER 175**	GODIVA CAAS benchmark	ORNL-IE4	Participation in the design. Provide IRSN materials for irradiation, analysis of results	M. DULUC	T. MILLER	ORNL
IRSN-IE28	Cf-252 CAAS benchmark	LLNL-IE1	Participation in the design. Provide IRSN materials for irradiation, analysis of results	M. DULUC F. TROMPIER	D. HEINRICHS	LLNL
IRSN-IE29	Correction factor for dosimetry linked to the orientation of the victim	LLNL-IE1 AWE-IE7	Participation in the design. Provide IRSN materials for irradiation, analysis of results	M. DULUC F. TROMPIER	D. HEINRICHS C. WILSON	LLNL AWE
IRSN-IE30	Full dosimetry exercise around GODIVA/FLATTOP reactors	LLNL-IE1	IRSN proposal for beginning in 2018 with participation in the design. Provide IRSN materials for irradiation, analysis of results	M. DULUC F. TROMPIER	D. HEINRICHS	LLNL

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2018 IRSN contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
IRSN-IE33	Sodium activation experiment around GODIVA/FLATTOP	LLNL-IE1	IRSN proposal for beginning in 2019 with participation in the design. Provide IRSN materials for irradiation, analysis of results	M. DULUC F. TROMPIER	D. HEINRICHS	LLNL
IRSN-IE34	HEU critical and Subcritical measurements	LANL-IE23	Participation in the definition and the design of the experiment	W. MONANGE	J. HUTCHINSON	LANL
IRSN-IE35 **IER 434**	Godiva benchmark for time dependant code validation	LANL-IE3	IRSN proposal for beginning in 2018 with participation in the preliminary design and CED-1 report.	M. DULUC	J. GODA	LANL
IRSN-IE36	ICSBEP Shielding benchmarks for shipping containers	LLNL-IE13 AWE	Participation in the preliminary design and CED-1 report	M. DULUC	D. HEINRICHS C. WILSON	LLNL AWE
IRSN-IE37	Critical and subcritical measurements with a Zero-Power research reactor	LANL-IE21	Analysis of the experiments, participation in the final technical report	E. DUMONTEIL	J. HUTCHINSON	LANL
IRSN-IE38	Experiments in SPRF/CX for Chlorine validation DOE's DE-FOA-0001515	SNL-IE1 ORNL-IE?? University of Tennessee -IE???	Participation in Chlorine experiment preliminary design and feedback on Chlorine exp. performed at Valduc in 2013. Review of CED 1 report.	I. DUHAMEL	G. HARMS V. SOBES I. MALDONADO	SNL ORNL University of Tennessee

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2018 IRSN contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
Information Preservation and Dissemination						
IRSN-IPD1	ICSBEP reviewing	LLNL-IPD1	IRSN ICSBEP reviewing tasks are reported in the IE tasks	-	-	-
IRSN-IPD3	ICSBEP benchmark reviewing	LLNL-IPD1	IRSN ICSBEP reviewing tasks	I. DUHAMEL	J. FAVORITE	LANL
Nuclear Data						
IRSN-ND1	Contribution to new evaluations	ORNL-ND1	Contribution to new evaluation and validation for ^{54}Fe, ^{103}Rh, ^{55}Mn and Gd isotopes	L. LEAL	D. BOWEN	ORNL
IRSN-ND2	Nuclear data processing	LANL-ND1	Benchmark testing of ^{235}U and ^{239}Pu cross section library	J. CONLIN	J. CONLIN	LANL

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2018 IRSN contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
IRSN-ND3	Nuclear data processing	LLNL-ND4	Resonance evaluation of ^{233}U	L. LEAL	D. HEINRICHS	LLNL
Training and education						
IRSN-T&E1	Hands-on criticality safety training	LANL-TE1 LLNL-TE1 SNL-TE1	IRSN attendance to NCSP classes Possible lectures by IRSN	S. EVO	D. BOWEN	NCSP

Appendix F

International Collaboration with the Atomic Weapons Establishment (AWE)

AWE has an active and growing program of collaboration with the NCSP that aims to underpin and enhance AWE's nuclear criticality safety and associated technologies. AWE will provide its expertise and capabilities to support the NCSP's mission and vision so that the collaboration is mutually beneficial to both organizations.

Reference			AWE Contributions and POCs			
AWE Reference	Task Description	NCSP Reference	FY2018 AWE Contribution	AWE Technical POC	PI	DOE Lab
Analytical Methods						
AWE-AM1	Slide rule update	ORNL-AM6, LLNL-AM3, IRSN-AM5	Perform calculations; attend meetings; review analysis and reports	A. Brown	M. Duluc	ORNL
Integral Experiments						
AWE-IE1	Inaugural International intercomparison of nuclear accident dosimetry using Godiva-IV (2016)	LLNL-IE2, IRSN-IE13	Complete	C. Wilson	D. Hickman	LLNL
AWE-IE2	Flattop radiation field characterisation	LLNL-IE1, IRSN-IE14	Produce final report with reference values	L. Clark	D. Heinrichs	LLNL
AWE-IE3	Inaugural International intercomparison of nuclear accident dosimetry using Flattop (2018)	LLNL-IE1, IRSN-IE15	Co-author experiment design with LLNL; participate in experiment; co-author report	C. Wilson	D. Hickman	LLNL
AWE-IE4	Godiva-IV radiation field characterisation	LLNL-IE1, IRSN-IE12	Complete	C. Wilson	D. Heinrichs	LLNL

Reference			AWE Contributions and POCs			
AWE Reference	Task Description	NCSP Reference	FY2018 AWE Contribution	AWE Technical POC	PI	DOE Lab
AWE-IE5	Godiva-IV CAAS benchmark	ORNL-IE4, IRSN-IE27	Review of experiment design. Provide measurement capability as required.	T. Birkett	T. Miller	ORNL
AWE-IE6	Cf-252 CAAS benchmark	LLNL-IE1, IRSN-IE28	Provide input into final report for ICSBEP	C. Wilson	D. Heinrichs	LLNL
AWE-IE7	Correction factor for dosimetry linked to orientation of the victim	LLNL-IE1, IRSN-IE29	Develop method to unfold directional information from Passive Neutron Spectrometer	C. Wilson	D. Heinrichs	LLNL
AWE-IE8	ICSBEP shielding benchmark for shipping containers	LLNL-IE13, IRSN-IE36	Participate in experiment design	C. Wilson	D. Heinrichs	LLNL
AWE-IE9	Diagnostic development for measurement of correlated leakage radiations	LLNL-IE1	Deploy a range of instruments with fast-timing capabilities to measure spontaneous fission sources; determine suitable techniques to take forward for further development	N. McMillan	D. Heinrichs	LLNL
AWE-IE10	High-resolution neutron spectrometer	LLNL-IE6	Participate in experiment design, measurements and reporting	N. McMillan	D. Heinrichs	LLNL
AWE-IE11	Conduct Integral Experiments with Molybdenum-Reflected Pu-metal Assembly	LANL-IE22	Discuss AWE participation with LANL	N. McMillan	B. Margevicius	LANL
AWE-IE12	Measure fission neutron spectrum shape using threshold activation detectors	IER-153	Provide input into foil selection; use AWE unfolding codes to provide independent analysis. TBC	L. Clark	B. Margevicius	LANL

Reference			AWE Contributions and POCs			
AWE Reference	Task Description	NCSP Reference	FY2018 AWE Contribution	AWE Technical POC	PI	DOE Lab
AWE-IE13	Enhanced methods of criticality accident dosimetry	LLNL-IE1, IRSN-30, IRSN-33	Develop prototypes, participate in design, execution and reporting of dosimetry experiments	C. Wilson	F. Trompier	LLNL
AWE-IE14	2nd International intercomparison of nuclear accident dosimetry using Godiva-IV (2020)	TBC	Produce experiment design; participate in exercise; produce final report	C. Wilson	C. Wilson	LLNL
AWE-IE15	CIDAAS testing using Godiva-IV	TBC	Deploy AWE CIDAAS for test irradiation	C. Wilson	J. Scorby	LLNL
Information Preservation and Dissemination						
AWE-IP&D1	Conduct benchmark evaluations of legacy IEU integral experiments	LLNL-IPD1	Assess feasibility of sponsoring PhD; determine availability of data	C. Wilson	–	–
Training and Education						
AWE-T&E1	Hands-on criticality safety training	LANL-TE1, LLNL-TE1, LLNL-TE3, SNL-TE1, IRSN-TE1	AWE personnel to attend training course	R. Jones	–	–