United States Department of Energy

Nuclear Criticality Safety Program

Five-Year Execution Plan for the Mission and Vision

FY2017 through FY2021

National Nuclear Security Administration

October 2016

Department of Energy Nuclear Criticality Safety Program Five-Year Execution Plan for Fiscal Years 2017 through 2021, dated October 2016.

Approved:

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Manager
Nuclear Criticality Safety Program

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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
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[1]	Collaborative International Evaluated Library Organization
COG[2]	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^3	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[4]	R-matrix nuclear data evaluation computer code
SCALE[5]	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]CIELO is a supercomputing platform that supports Los Alamos, Sandia, and Lawrence Livermore. This petascale (more than one quadrillion floating point operations per second) supercomputer helps NNSA ensure the safety, security, and effectiveness of the nuclear stockpile while maintaining the moratorium on testing.

[2]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.

[3]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.

[4]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.

[5]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. Jerry McKamy (NA511) is the NCSP Manager. He 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 FY17 work tasks will help address a number of NCSP Mission and Vision Goals, and additional goals will be addressed in FY18-FY21. 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 dosimetery laboratory has been completed 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.

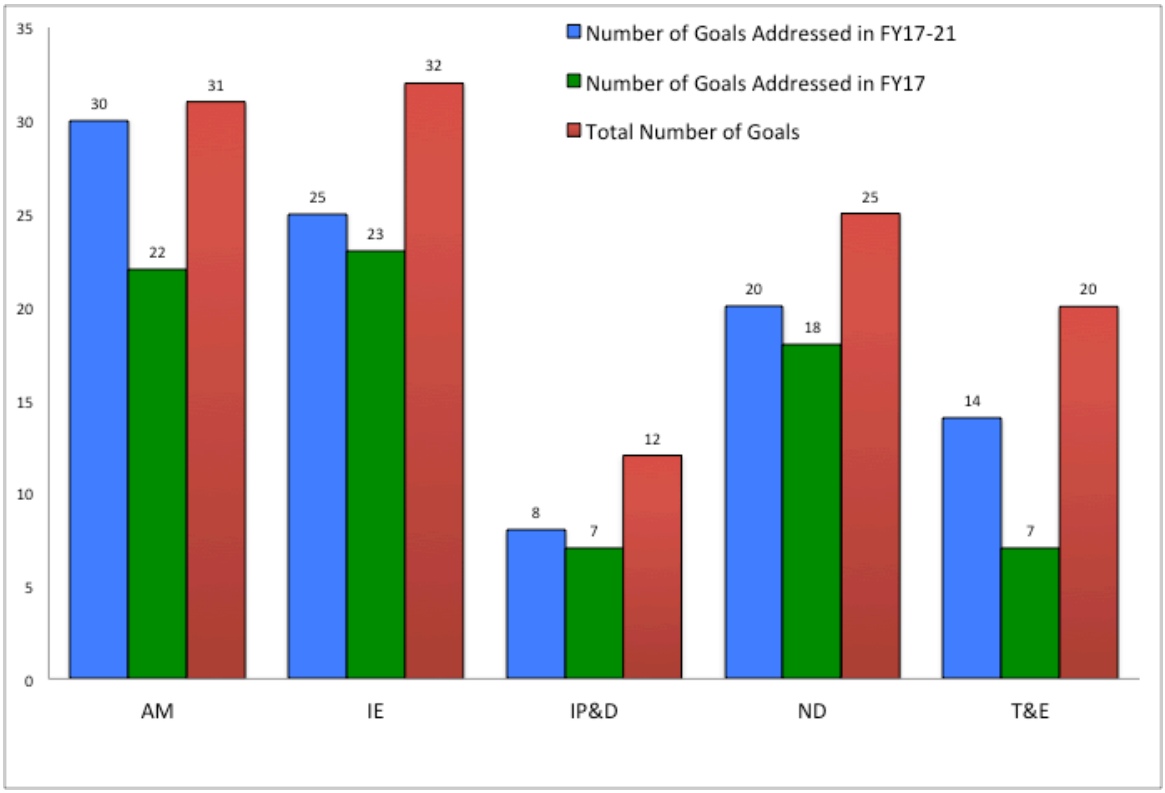


Figure 1.1 Number of NCSP Mission and Vision Program Element Goals Addressed by the NCSP Five-Year Plan

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 30 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, FY17 work tasks will address 22 of the 31 AM goals. Examples of goals not addressed in FY17 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 planning to make a minimal investment toward the development and deployment of time-dependent multi-physics analysis capabilities to support excursion analyses; development 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 **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. FY17 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 FY17. 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 **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 25 of 32 IE goals to assess, design, perform, and document integral experiments. FY17 work tasks will address 23 of 32 IE goals. Examples of goals not addressed in FY17 but are addressed in the out years include: develop the infrastructure to support dynamic experiments; design and execute a neptunium critical experiment capability; design and build a small sample "rabbit" transfer system. Although a smaller set of goals is addressed in FY17, 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. Task proposals have been submitted for these goals, and these proposals will be considered pending increased NCSP IE budget targets.

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. FY17 work tasks will address 18 of 25 ND goals. Examples of goals not addressed in FY17 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 14 of 20 T&E goals during the next five years and 7 of 20 T&E goals in FY17. The tasks primarily support the development and maintenance of the classroom and "hands-on" training courses at SNL and NNSS. FY17 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 FY17 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. As a result, there is a technical gap within the T&E program element, and some goals cannot be accomplished within the current five-year T&E budget targets. Examples of goals not addressed include: develop a mobile CAT 1 criticality hands-on critical or near critical demonstration capability; 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 and 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. 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
- Information Preservation and Dissemination
- Integral Experiments
- 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)

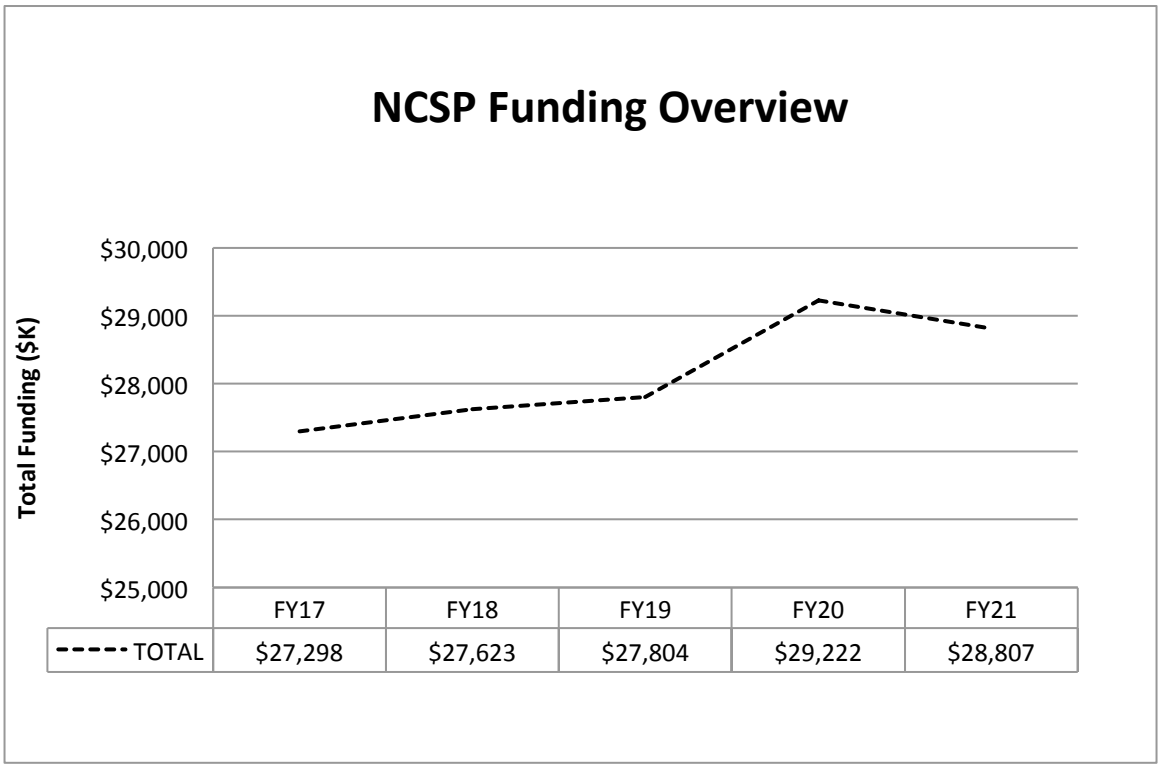
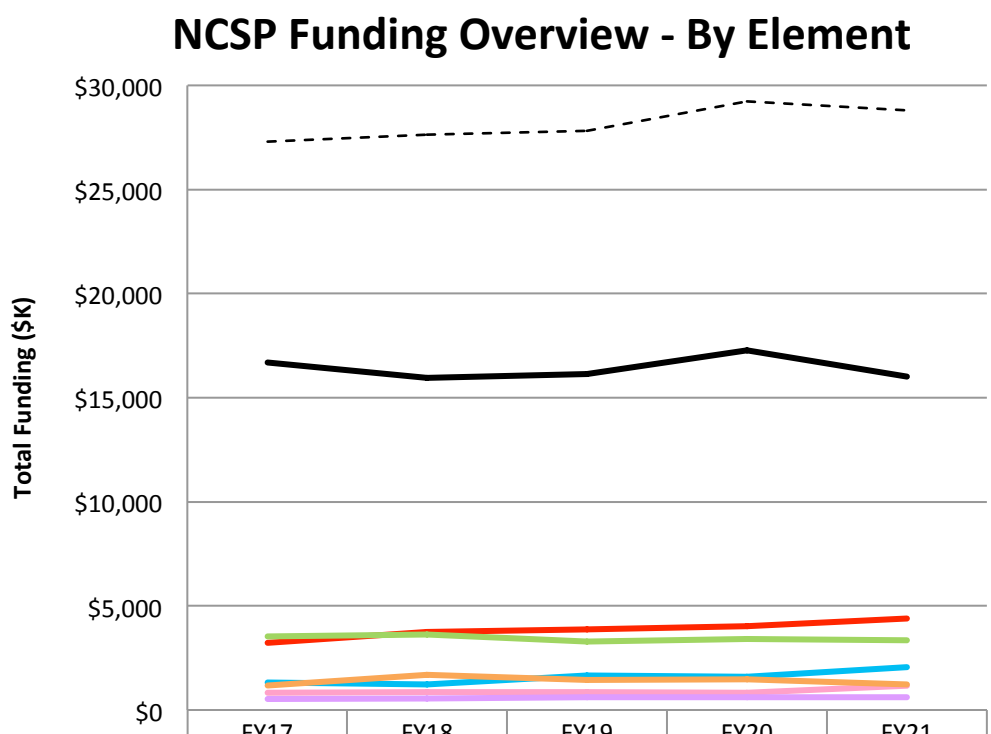
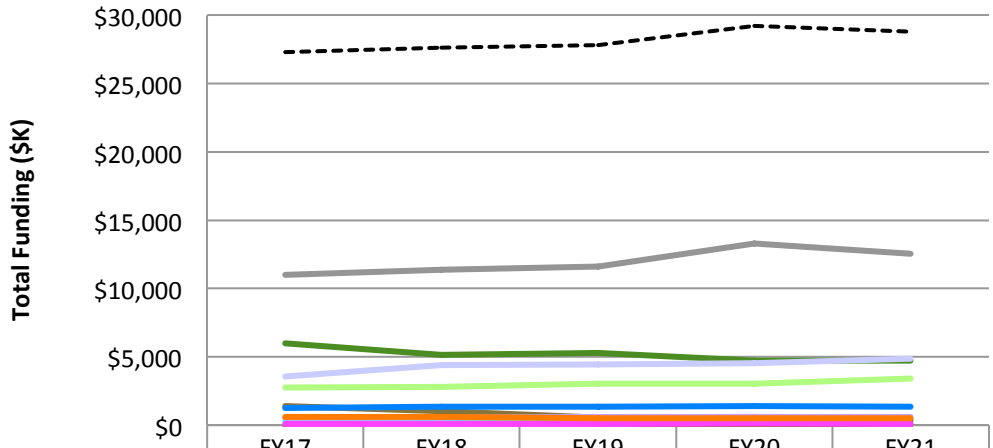


Table 2.2 NCSP Funding Overview – By Element



	FY17	FY18	FY19	FY20	FY21
AM	$3,213	$3,735	$3,860	$4,030	$4,385
IE	$16,702	$15,949	$16,124	$17,285	$16,002
IP&D	$821	$850	$850	$840	$1,180
ND	$3,538	$3,639	$3,280	$3,402	$3,355
T&E	$1,320	$1,220	$1,660	$1,605	$2,065
TS	$1,176	$1,680	$1,430	$1,460	$1,220
CSSG	$528	$550	$600	$600	$600
TOTAL	$27,298	$27,623	$27,804	$29,222	$28,807

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



	FY17	FY18	FY19	FY20	FY21
BNL	$216	$275	$325	$410	$427
LANL	$10,991	$11,395	$11,612	$13,307	$12,525
LLNL	$2,733	$2,790	$3,012	$3,055	$3,394
NNSS	$5,976	$5,150	$5,300	$4,700	$4,700
ORNL	$3,559	$4,394	$4,435	$4,555	$4,850
RPI	$1,392	$1,000	$530	$540	$340
SNL	$1,255	$1,334	$1,365	$1,375	$1,341
SRS	$0	$50	$50	$40	$30
Y12	$72	$75	$75	$130	$80
CSSG	$528	$550	$600	$600	$600
NCSP	$576	$610	$500	$510	$520
TOTAL	$27,298	$27,623	$27,804	$29,222	$28,807

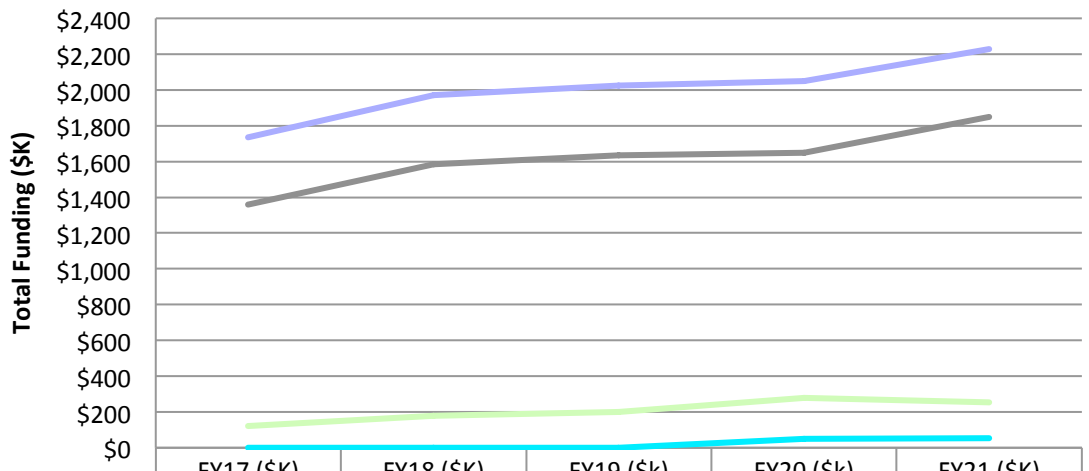
Finally, the goal of the NCSP is to provide "transparent responsiveness" for the DOE and Stakeholders. Therefore, this Plan and all accomplishments achieved under the auspices of the NCSP are posted in a timely manner on the NCSP website at: http://ncsp.llnl.gov/.

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 (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
BNL	$0	$0	$0	$50	$52
LANL	$1,358	$1,585	$1,635	$1,650	$1,850
LLNL	$120	$180	$200	$280	$253
ORNL	$1,735	$1,970	$2,025	$2,050	$2,230

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

- BNL will be funded in FY20/FY21 to work with LLNL and universities to incorporate Thermal Scattering and Self-Shielding in GND/FUDGE.
- LANL's funding will increase in out years to address MCNP support and modernization needs. Additional budget increases provided in out years are to offset anticipated decreased MCNP support from other parts of NNSA.
- 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.
- ORNL's funding will increase in out years are to support SCALE maintenance and modernization and to ensure that SCALE is available to support NCS analyses using modern computing platforms. Beginning in FY18, two new tasks will be initiated to perform inter-comparison studies of S/U analysis tools as well as participation in a multi-laboratory benchmark inter-comparison study for NCS analysis tools.

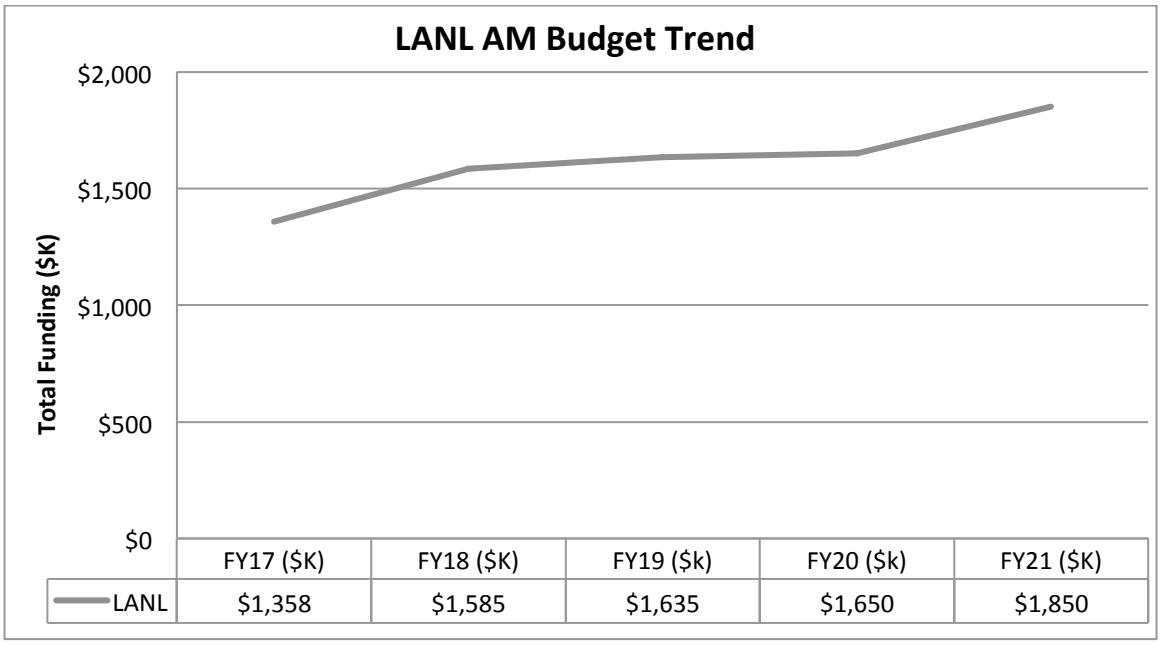
2.1.2 Approved Tasks

2.1.2.1 Los Alamos National Laboratory (LANL)

LANL AM1 ($1094K) [IRSN Area of Collaboration (See Appendix E**)]**
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® 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.

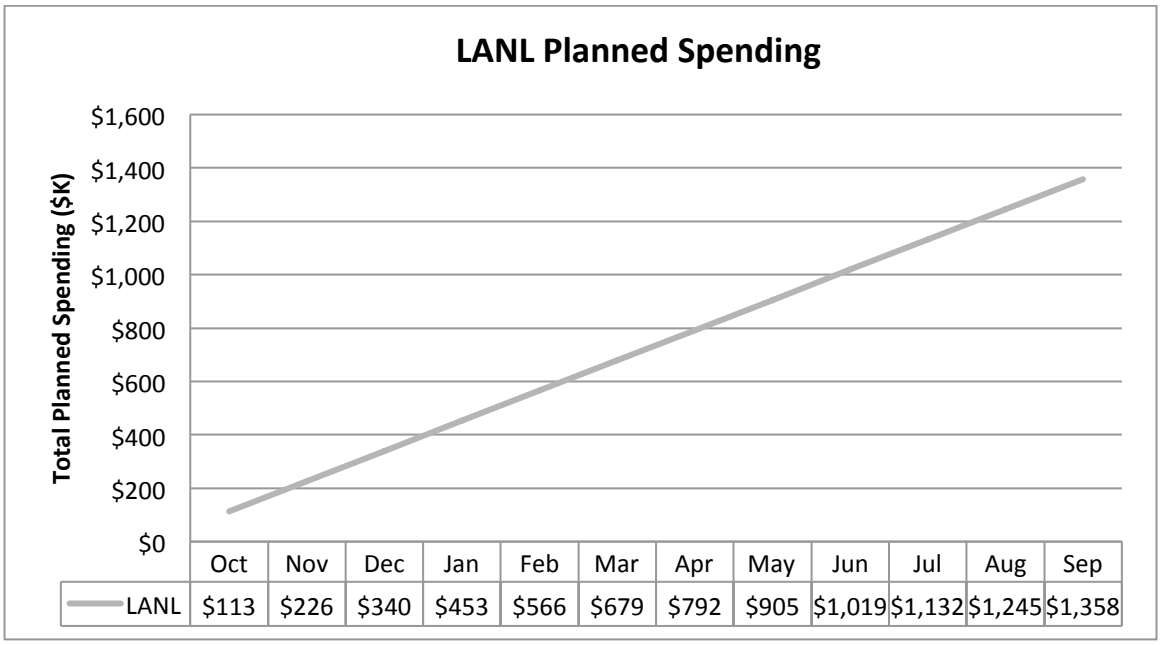
LANL AM2 ($264K) [IRSN Area of Collaboration (See Appendix E**)]**
This is a continuing task to support development and maintenance of the NJOY nuclear data processing code system, implement capabilities as needed to process new general purpose nuclear data files in the continuously evolving ENDF-6 format, 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.

Table 2.1-2 LANL AM Budget Trend (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
LANL	$1,358	$1,585	$1,635	$1,650	$1,850

Table 2.1-3 LANL AM Planned Spending (FY2017)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LANL	$113	$226	$340	$453	$566	$679	$792	$905	$1,019	$1,132	$1,245	$1,358

LANL AM Milestones:

Occurs all 4 Quarters

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

Quarter 1

- Provide training course on theory and practice of Monte Carlo criticality calculations with MCNP6 ® (AM1: Q1).

Quarter 2

- Support NCSP interests in RSICC release of MCNP6.2 ® including Whisper (AM1: Q2).
- Issue an MCNP® V&V report (AM1: Q2).

Quarter 3

- Implement resonance reconstruction in NJOY21 (AM2: Q3).

Quarter 4

- Expand the set of ICSBEP benchmarks for MCNP6 ® and Whisper (AM1: Q4).
- Update MCNP® ACE data libraries as needed in preparation for ENDF/B-VIII (AM1: Q4).
- Implement V&V data checking in ACEtk (AM2: Q2).
- Complete Python driver for NJOY21 processing (AM2: Q2).

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

Beginning in FY2018, increased budget is provided to address MCNP support and modernization needs. Additional budget increases provided in out years to offset anticipated decreased MCNP support from other parts of NNSA.

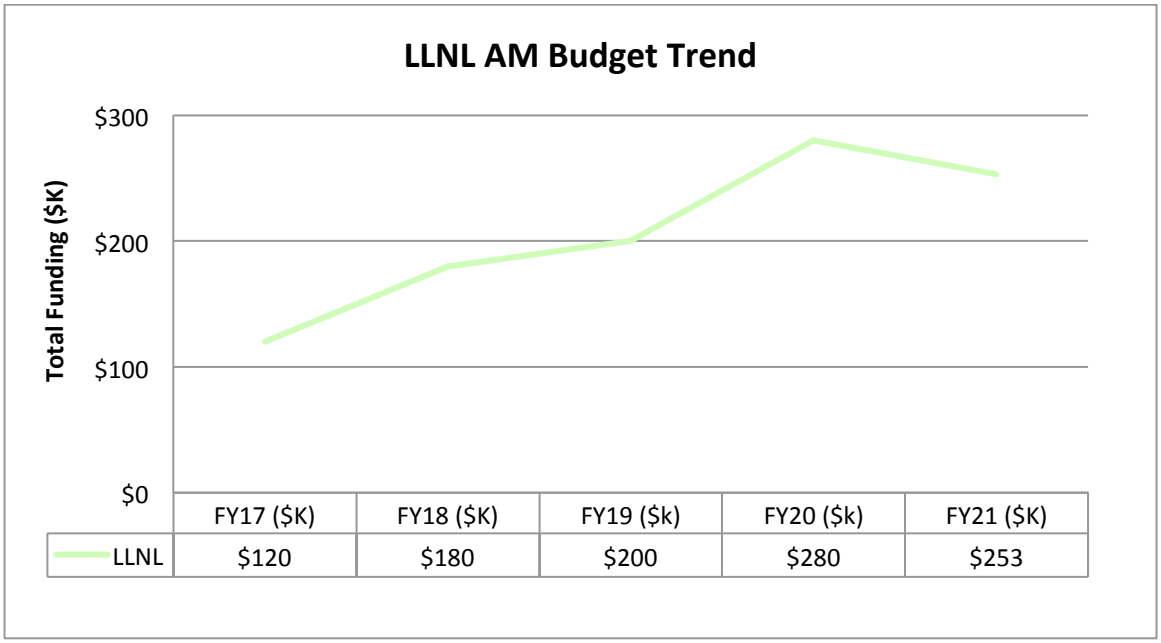
2.1.2.2 Lawrence Livermore National Laboratory (LLNL)

LLNL AM1 ($96K) [IRSN Area of Collaboration (See Appendix E**)]**
This task is an ongoing approved task to provide 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, CSEWG and NDAG.

LLNL AM2 ($0K) [AWE and IRSN Area of Collaboration (See Appendix E and F**)]**
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. Although $0K NCSP funding is allocated for this task, the task is authorized and work will be performed through international collaboration efforts. The task will support work to simulate the response of GODIVA, CALIBAN or APRF to a fast reactivity insertion of various magnitudes and to simulate the GODIVA and APRF accidents including quantification of mechanical damage to support structures and surface oxidation and to add delayed neutron and photon emission physics.

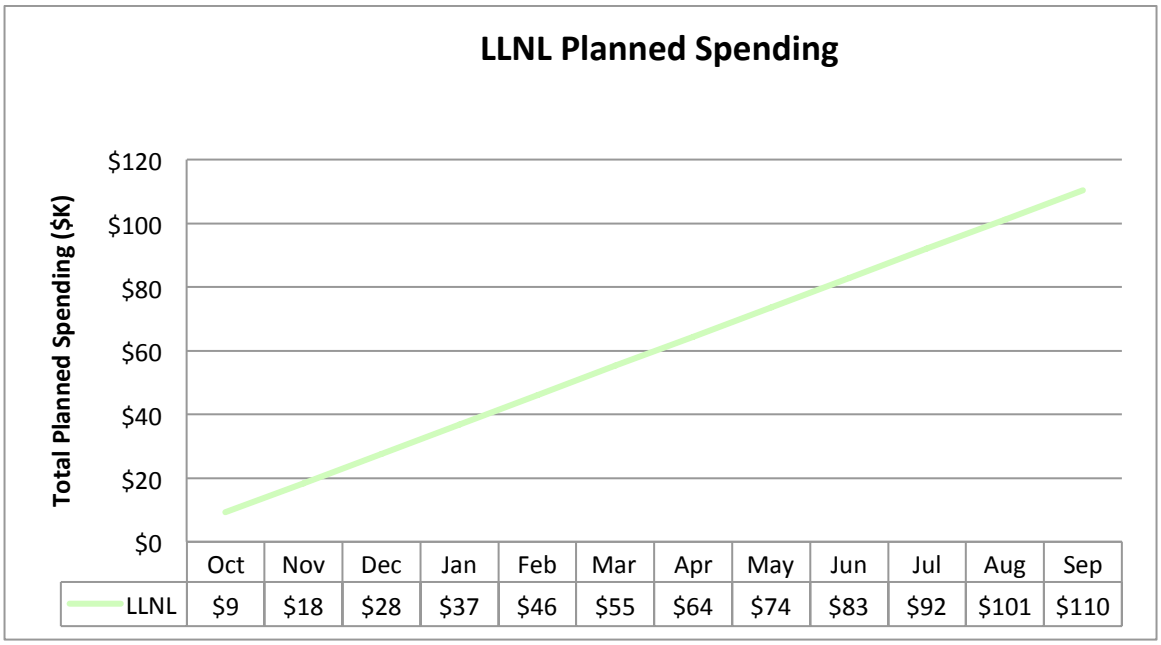
LLNL AM3 ($24K) [AWE and IRSN Area of Collaboration (See Appendix E and F**)]**
This is an ongoing task to support work to generate a criticality SlideRule for plutonium systems.

Table 2.1-4 LLNL AM Budget Trend (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
LLNL	$120	$180	$200	$280	$253

Table 2.1-5 LLNL AM Planned Spending (FY2017)*



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LLNL	$9	$18	$28	$37	$46	$55	$64	$74	$83	$92	$101	$110

* 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 (AM1: All Qtrs).

Quarter 4

- Complete annual IRSN-LLNL-ORNL status report on the SlideRule development and provide report to NCSP Manager (AM3: Q4).

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

An increase is provided in FY18 and extending into 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.

The COG code system is used almost exclusively by NNSA, unlike the widely used code systems SCALE and MCNP.

2.1.2.3 Oak Ridge National Laboratory (ORNL)

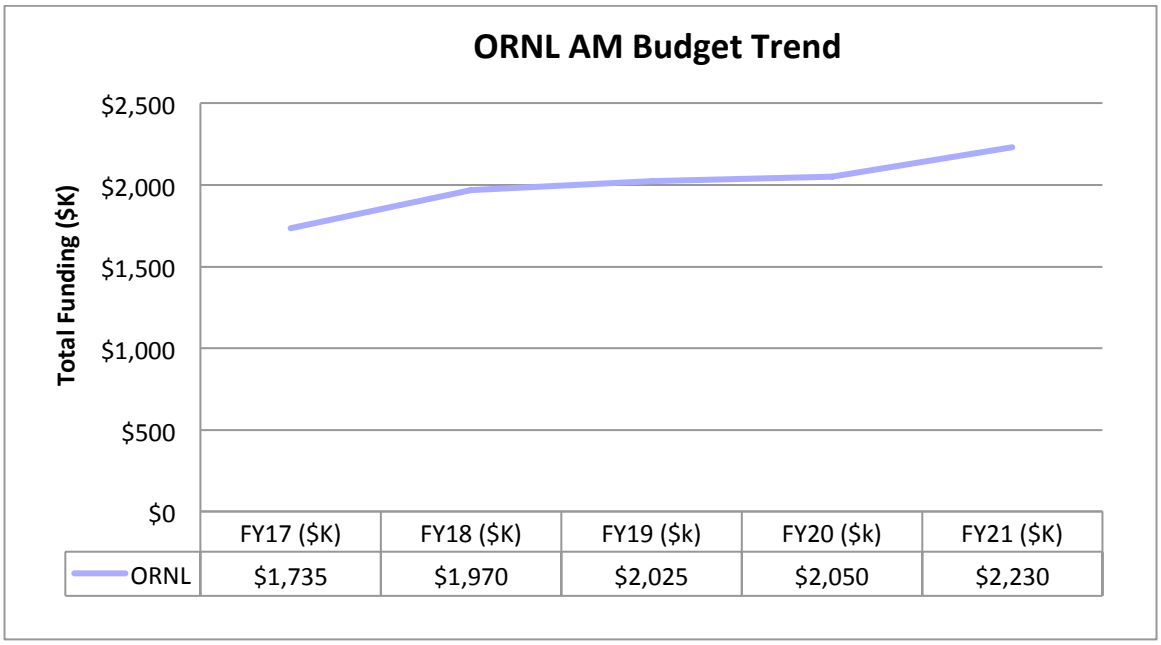
ORNL AM1 ($353K)
RSICC ongoing approved task to collect, update, package, and distribute software and associated nuclear data libraries to the criticality safety community (i.e., SCALE, MCNP, VIM, and COG and nuclear data processing (i.e., NJOY, AMPX and SAMMY). Also, test and disseminate processed nuclear data associated with the software.

ORNL AM2 ($1094K) [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 ($264K) [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.

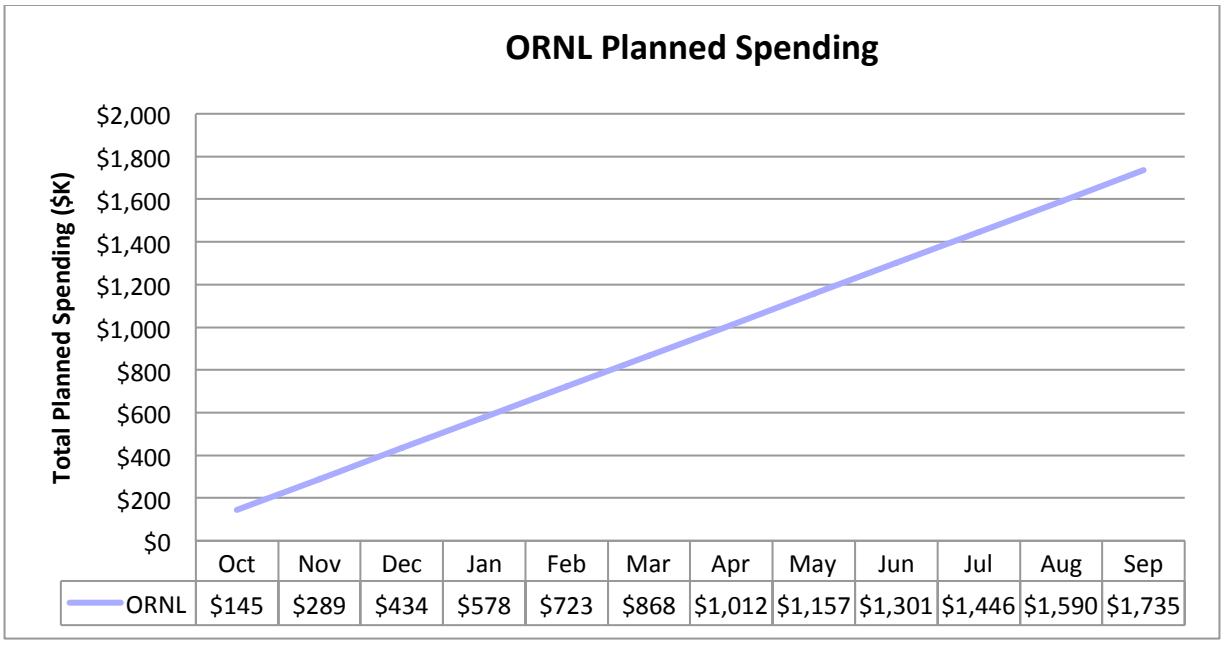
ORNL AM6 ($24K) [AWE and IRSN Area of Collaboration (See Appendix E and F**)]**
This is an ongoing task to collaborate with IRSN and LLNL to modernize the existing SlideRule accident response tool. ORNL developed the initial SlideRule, and under this task, IRSN will update the SlideRule using modern 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.

Table 2.1-6 ORNL AM Budget Trend (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
ORNL	$1,735	$1,970	$2,025	$2,050	$2,230

Table 2.1-7 ORNL AM Planned Spending (FY2017)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
ORNL	$145	$289	$434	$578	$723	$868	$1,012	$1,157	$1,301	$1,446	$1,590	$1,735

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: All Qtrs).

Quarter 2

- Issue an annual SCALE maintenance report to the NCSP Manager (AM2: Q2).
- Document AMPX modernization and technical support for SCALE CE, multigroup, and covariance libraries and report status annually to the NCSP Manager (AM3: Q2).

Quarter 4

- Publish annual newsletter to users to communicate software updates, user notices, generic technical advice, and training course announcements (AM2: Q4).
- Complete annual IRSN-LLNL-ORNL status report on the SlideRule development and provide report to NCSP Manager (AM6:Q4).

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

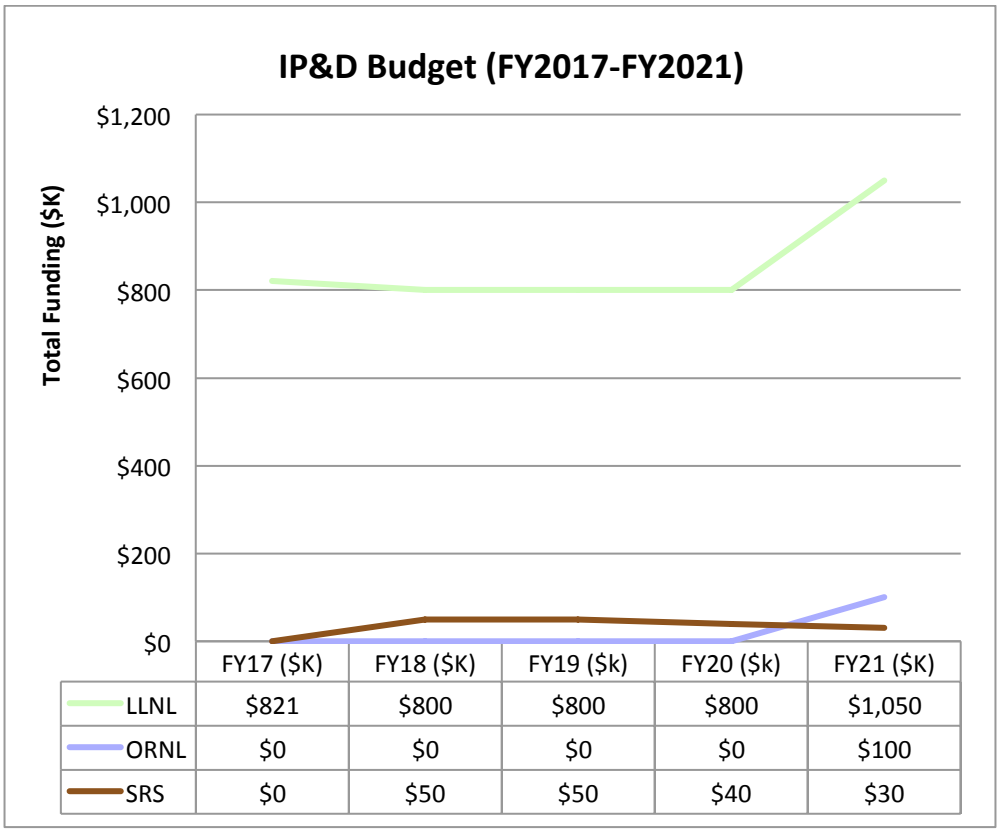
Increases in out years to support SCALE maintenance and modernization and to ensure that SCALE is available to support NCS analyses using modern computing platforms. Beginning in FY18, two new tasks will be initiated to perform inter-comparison studies of S/U analysis tools as well as participation in a multi-laboratory benchmark inter-comparison study for NCS analysis tools.

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 (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
LLNL	$821	$800	$800	$800	$1,050
ORNL	$0	$0	$0	$0	$100
SRS	$0	$50	$50	$40	$30

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

- LLNL's funding will increase in out year for additional ICSBEP capabilities, tasks, and milestones.
- 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 out years to continue ARH-600 support and maintenance, transitioning from Hanford.

2.2.2 Approved Tasks

2.2.2.1 Lawrence Livermore National Laboratory (LLNL)

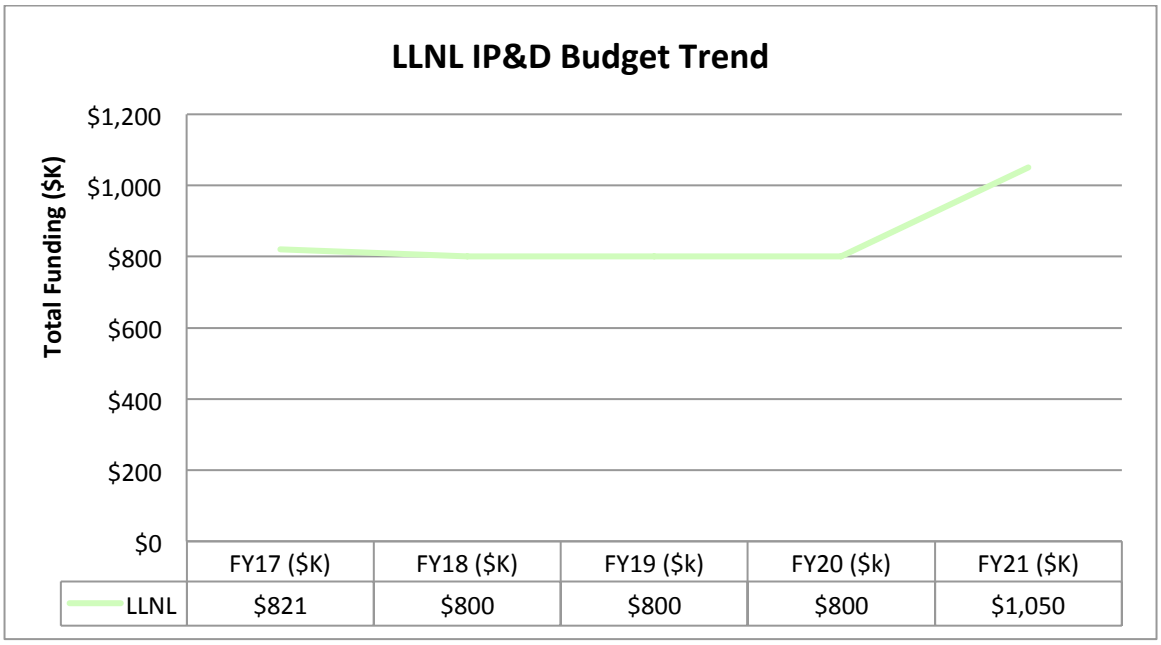
LLNL IP&D1 ($221) [AWE and IRSN Area of Collaboration (See Appendix E and F)**]**
This is an ongoing approved task that provides independent and Technical Review Group (TRG) reviews for all newly completed NCSP funded experiments. Priority historical experiments will be evaluated and reviewed (internal, 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 ($600K)
This is an ongoing approved task for operation, maintenance and modernization of both unclassified and classified NCSP websites. The NCSP websites are the central focal point for access to criticality safety information collected under the NCSP, and are the gateway to a comprehensive set of hyperlinks to other sites containing criticality safety information resources. This task also provides operations and maintenance for information technology supporting the NCERC (e.g., "Red" network).

LLNL IP&D3 ($0K)

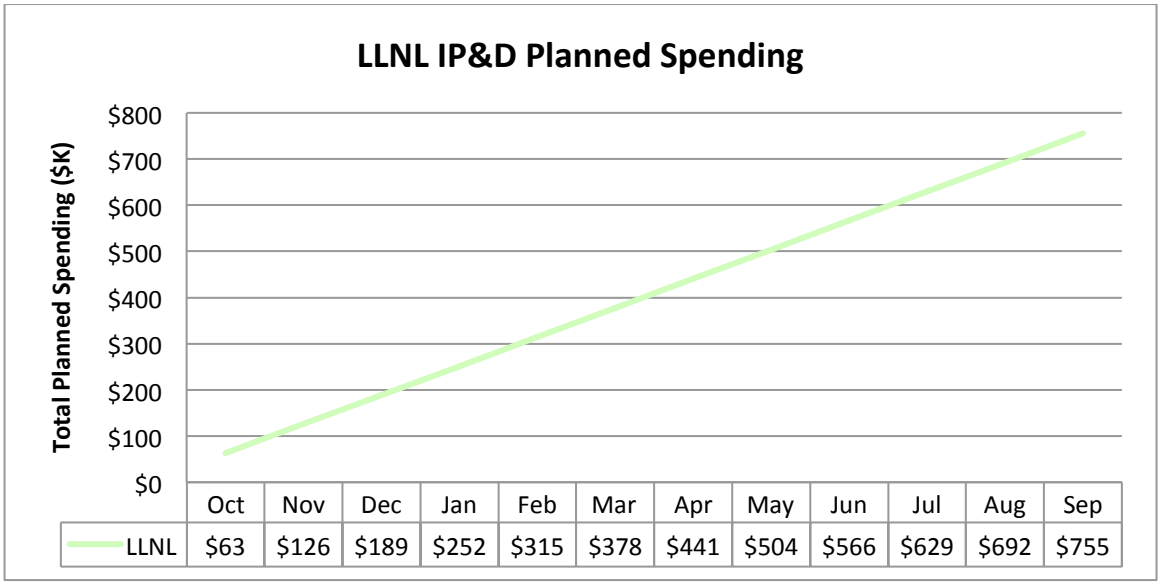
This is a carryover task to create a searchable database of all NCSP funded work and will be completed with the funding that was allocated in FY16. NCSP Management team will develop the database structure and work with LLNL to transition current website archive data to new database.

Table 2.2-2 LLNL IP&D Budget Trend (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
LLNL	$821	$800	$800	$800	$1,050

Table 2.2-3 LLNL IP&D Planned Spending (FY2017)*



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LLNL	$63	$126	$189	$252	$315	$378	$441	$504	$566	$629	$692	$755

* 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 and provide status in quarterly reports (IPD1: All Qtrs).
- 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 (IPD1: All Qtrs).
- Maintain, operate and modernize both unclassified and classified NCSP websites, databases, and "Red" network and provide user assistance as required and provide status in quarterly reports (IPD2: All Qtrs).

Quarter 2

- Transition current website archive data to new searchable database for LLNL-IPD3 from FY16 (IPD3: Q2).

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

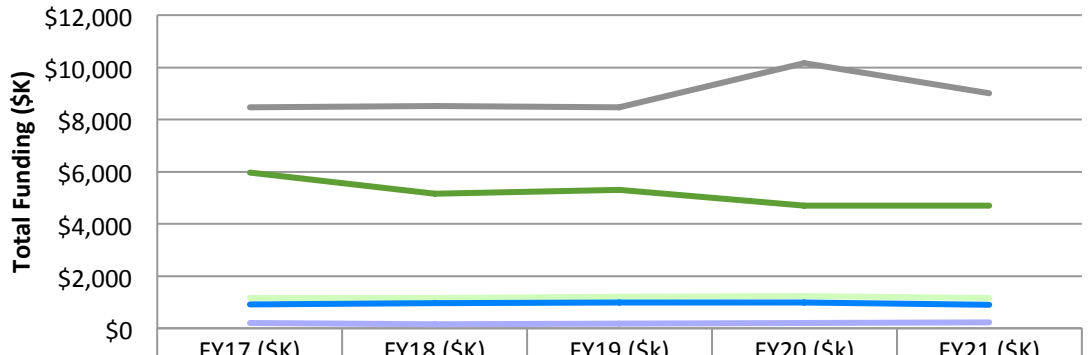
FY19 and out-year increases in funding for additional ICSBEP capabilities, tasks, and milestones.

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 (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
LANL	$8,471	$8,525	$8,462	$10,160	$9,010
LLNL	$1,154	$1,155	$1,207	$1,230	$1,171
NNSS	$5,976	$5,150	$5,300	$4,700	$4,700
ORNL	$192	$150	$175	$215	$220
SNL	$909	$969	$980	$980	$901

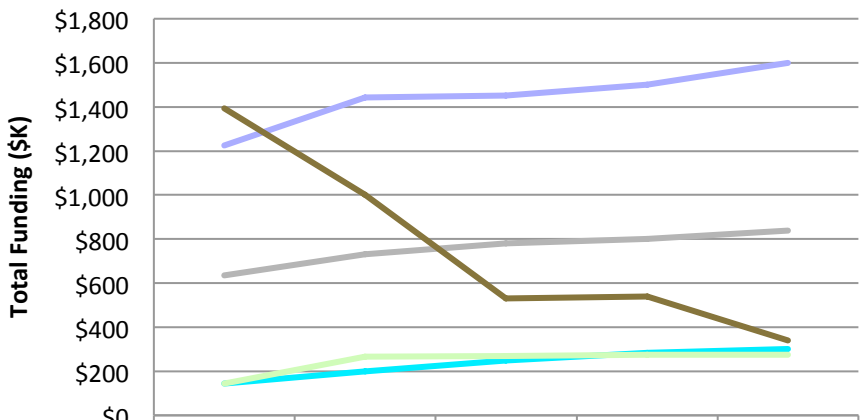
All Integral Experiment tasks and milestones are published as a standalone document. Contact the NSCP Program Manager, Dr. Jerry McKamy, if you have a 'Need-to-Know.'

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 FY2017 through FY2021 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 (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
BNL	$144	$200	$250	$285	$300
LANL	$634	$730	$780	$802	$840
LLNL	$144	$265	$270	$275	$275
ORNL	$1,224	$1,444	$1,450	$1,500	$1,600
RPI	$1,392	$1,000	$530	$540	$340

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 increase in out years to support the Delayed Fission Gamma Multiplicity and Spectra tasks and testing of the revised U-233 resonance-region cross-section evaluation by IRSN.
- 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.
- 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 ($144K)

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 (FY2017-FY2021)

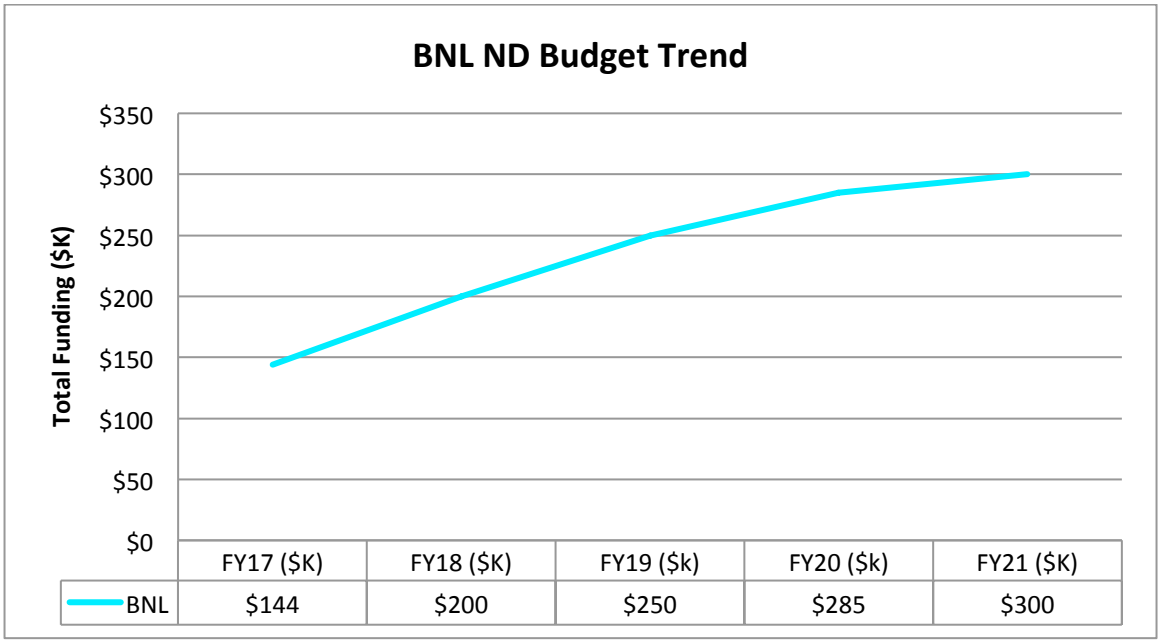
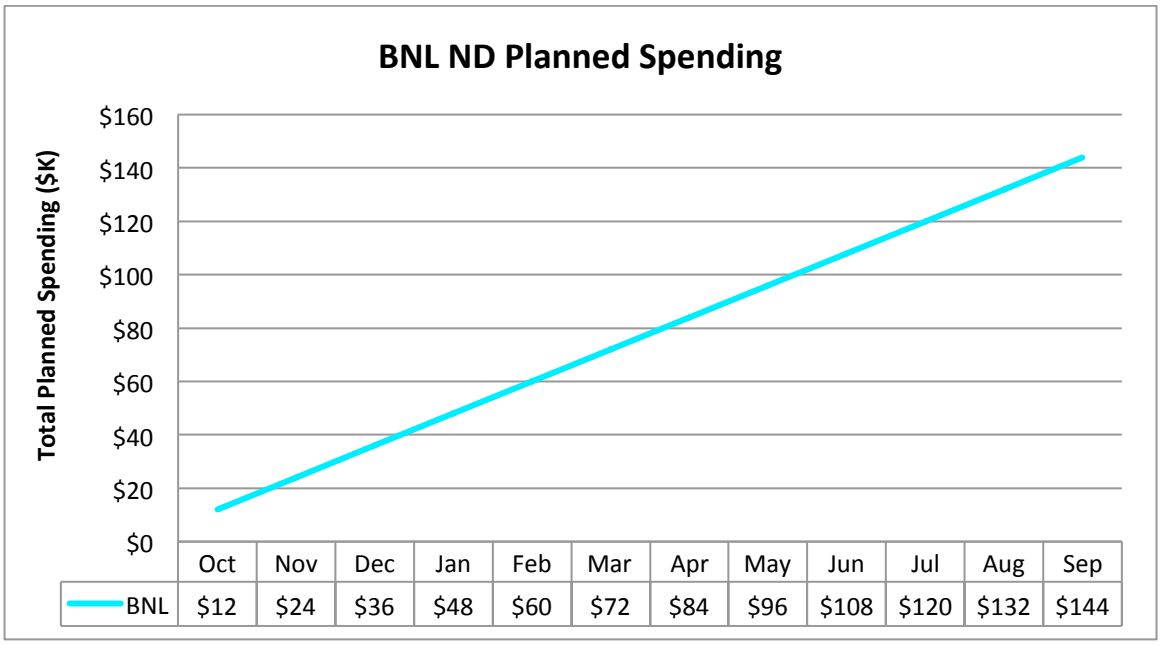


Table 2.4-3 BNL ND Planned Spending (FY2017)



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: All Qtrs).

Quarter 3

- If mandated by CSEWG, release new ENDF library (ND1: Q3).

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

Steady funding in FY17 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 ($605K) [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.

LANL ND2 ($29K)
This is an ongoing approved task for LANL to provide support for the NDAG Chairmanship, participation in relevant Working Groups, and coordination of the NCSP ND element work program with current and future DOE needs.

Table 2.4-4 LANL ND Budget Trend (FY2017-FY2021)

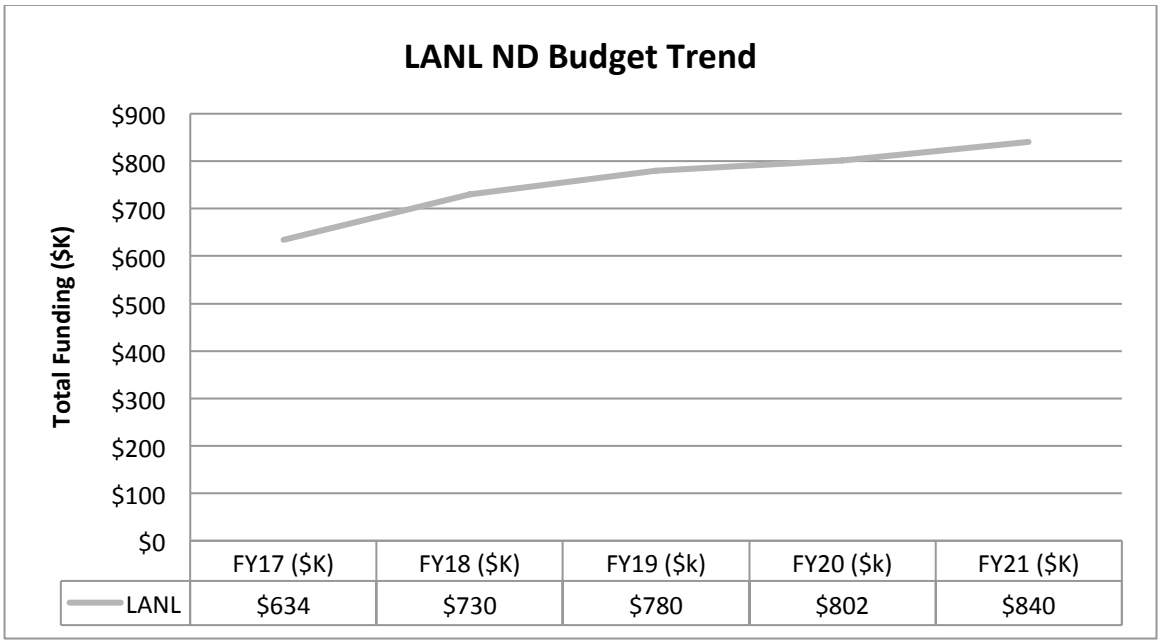
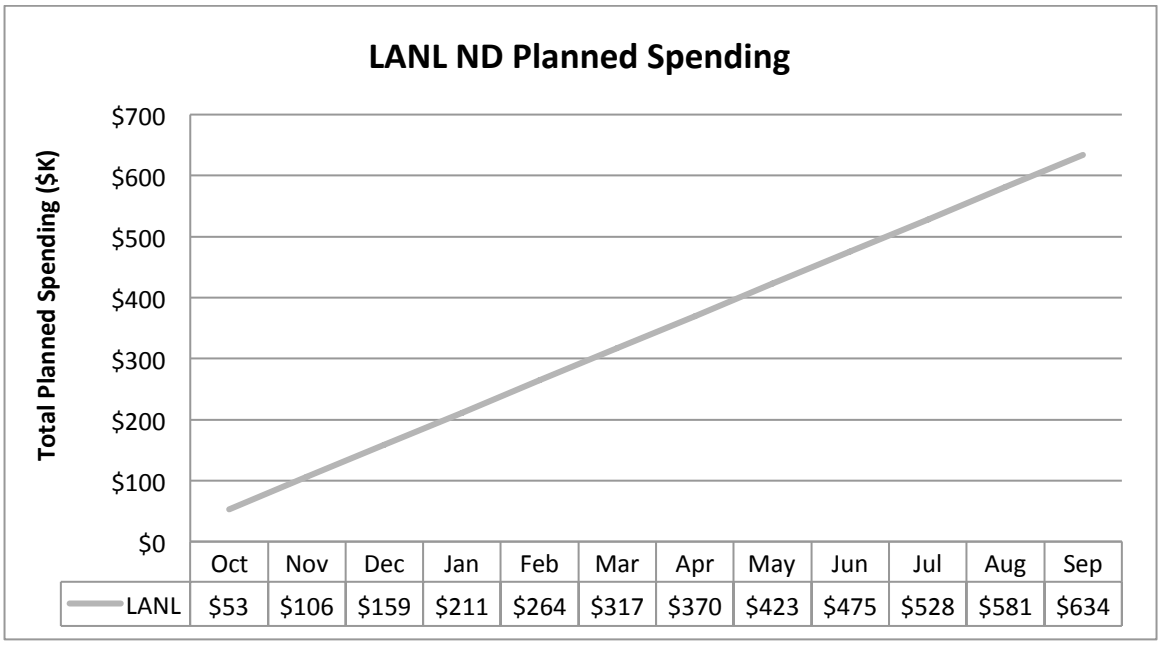


Table 2.4-5 LANL ND Planned Spending (FY2017)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LANL	$53	$106	$159	$211	$264	$317	$370	$423	$475	$528	$581	$634

LANL ND Milestones:

Occurs all 4 Quarters

- Provide status reports on LANL participation in US and International Nuclear Data collaborations (ND1, ND2: All Qtrs).
- Review IER requests (ND2: All Qtrs).

Quarter 1

- Conduct annual NDAG meeting (ND2: Q1).
- Conduct CSEWG Data Validation Committee session (ND1: Q1).
- Report data testing results with beta versions of CIELO and ENDF/B-VIII.0 cross sections (ND1: Q1).

Quarter 3

- Conduct CSEWG Data Validation Committee session (ND1: Q3).
- Report data testing results with beta versions of CIELO and ENDF/B-VIII.0 cross sections (ND1: Q3).
- Review NDAG deliberations with DOE/NCSP during the Annual Technical Review (ND2: Q3).

Quarter 4

- Coordinate the annual update to the NCSP nuclear data work schedule in the Five Year Plan (ND2: Q4).
- Deliver nuclear data evaluations as indicated in Appendix B of this document (ND1: Q4).

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 ($0K) [IRSN Area of Collaboration (See Appendix E**)]**

This is an ongoing approved task to work with IRSN to develop 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 COMET. This is a task that has a dual benefit and links the ND and IE program elements. Funding for this task is included in LLNL IE1. As the IE experimental work is performed, IRSN and LLNL will be able to provide time-dependent emission data for delayed gammas. The task is identified under ND to show the linkage with the IE element.

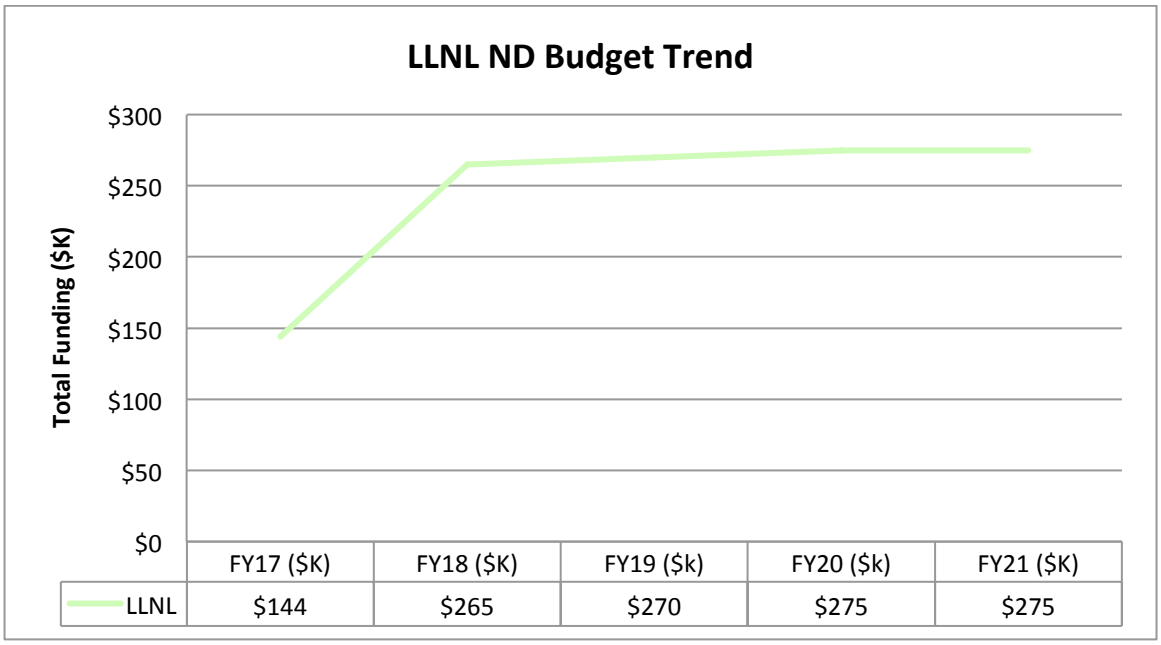
LLNL ND2 ($72K)

This is an ongoing approved task in collaboration with NCSU and Bettis to refine and complete basic atomistic models for executing molecular dynamics simulations for polyethylene (CH2). 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 COG 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. Additionally, work will begin for calculating the scattering law, $S(\alpha,\beta)$, and the thermal neutron scattering cross sections for other materials as indicated in Appendix B. $75K matching funding will be provided by the NR Program (Bettis).

LLNL ND3 ($72K)

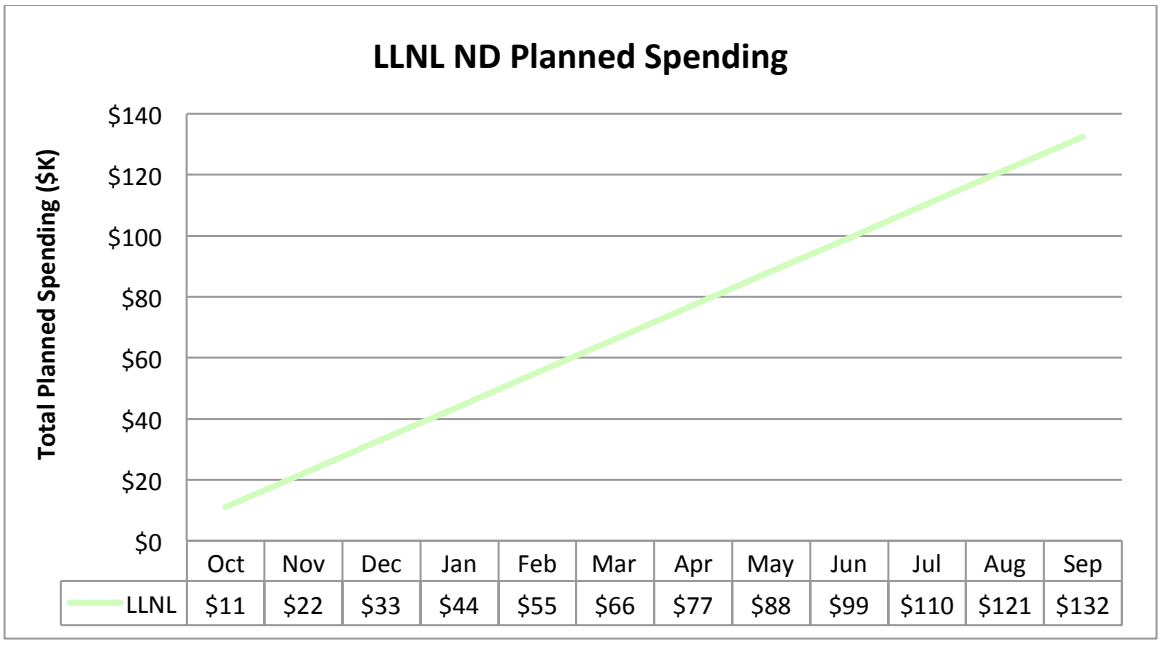
This is an ongoing approved task in collaboration with NCSU and Bettis to develop a "next generation" computational platform for calculating thermal neutron scattering cross sections and to assist in interpreting and processing related measured data. This tool will be based on rigorous physics and will 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. $100K matching funding will be provided by the NR Program (Bettis).

Table 2.4-6 LLNL ND Budget Trend (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
LLNL	$144	$265	$270	$275	$275

Table 2.4-7 LLNL ND Planned Spending (FY2017)*



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LLNL	$11	$22	$33	$44	$55	$66	$77	$88	$99	$110	$121	$132

* 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/NCSU nuclear data activities to NCSP Manager (ND2, ND3: All Qtrs).

Quarter 4

- Deliver thermal neutron scattering data evaluations as indicated in Appendix B of the 5-Year Plan (ND2: Q4).

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

Increase in funding in FY18 to support the Delayed Fission Gamma Multiplicity and Spectra tasks and testing of the revised U-233 resonance-region cross-section evaluation by IRSN.

2.4.2.4 Oak Ridge National Laboratory (ORNL)

ORNL ND1 ($816K) [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 ND4 ($24K)
Ongoing task to develop nuclear data evaluation capabilities to analyze thermal neutron scattering measurements to produce new cross-section evaluations for thermal moderators. This task is being performed in collaboration with RPI who is tasked to perform double differential thermal scattering measurements.

ORNL ND6 ($384K)
This is a new 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.

Table 2.4-8 ORNL ND Budget Trend (FY2017-FY2021)

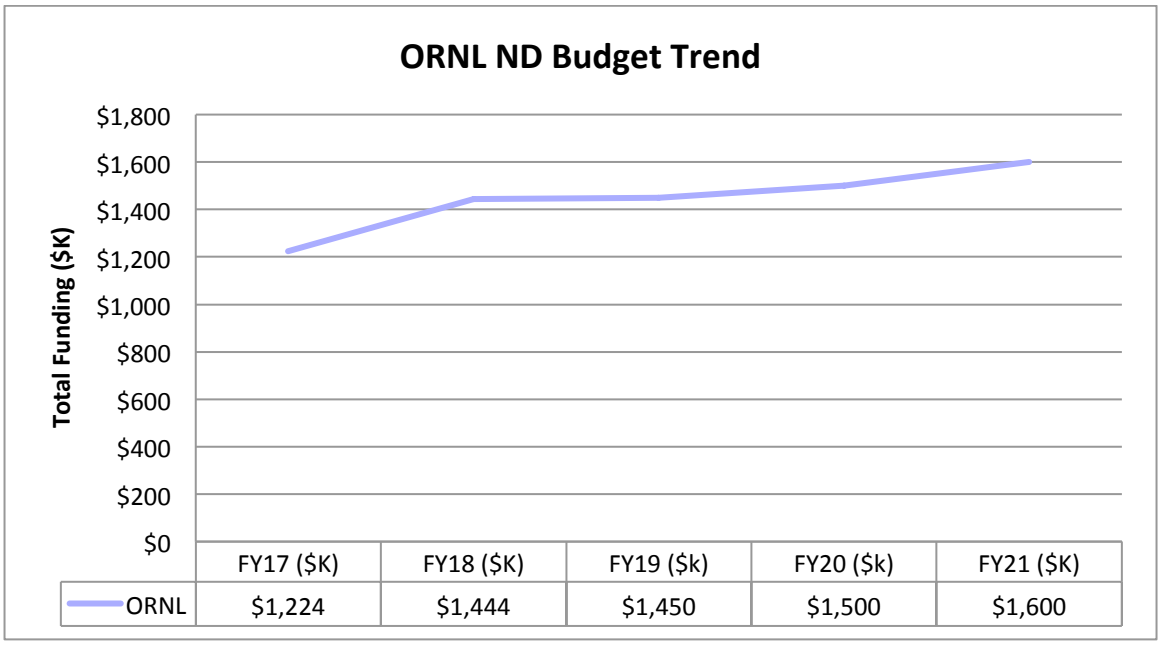
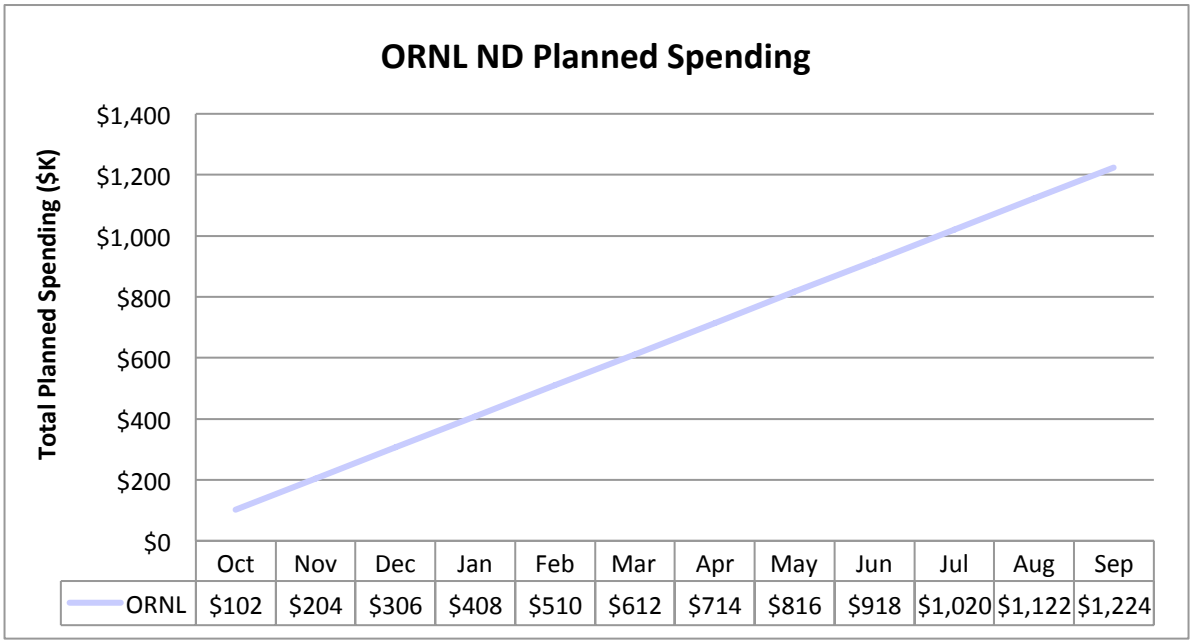


Table 2.4-9 ORNL ND Planned Spending (FY2017)



ORNL ND Milestones:

Occurs all 4 Quarters

- Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND4: All Qtrs).
- 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: All Qtrs).
- Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B (ND1: All Qtrs).

Quarter 3

- Complete nuclear data work plan for ^{233}U and provide plan to NCSP Manager (ND1: Q3).

Quarter 4

- Develop prototypic methodology to analyze measured thermal neutron scattering data for supporting the development of a thermal cross-section evaluation capability (ND4: Q4).
- Document SAMMY modernization progress and report status annually to the NCSP Manager (ND6: Q4).

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

Increases in out years for support of nuclear data measurement and evaluation work, including procurement of enriched isotopes samples needed for cross-section measurements. In addition, budget increase is provided to support the SAMMY modernization effort.

2.4.2.5 Renssalaer Polytechnic Institute (RPI)

RPI ND1 ($317K)
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 ($115K)
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 ($960K)
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 (FY2017-FY2021)

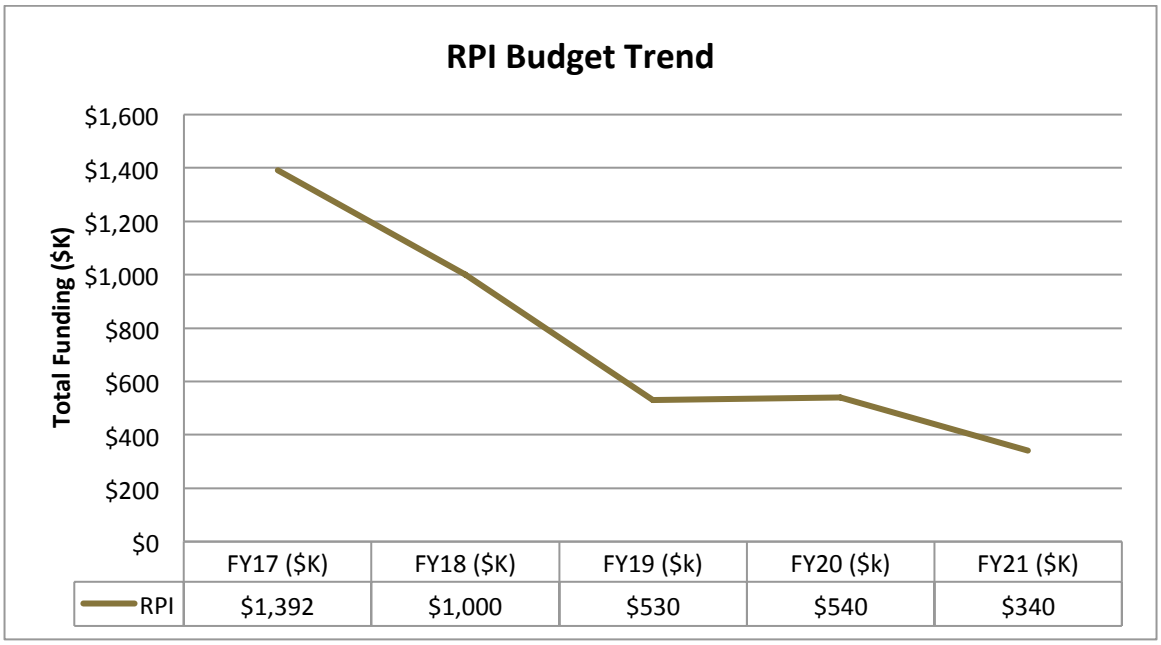
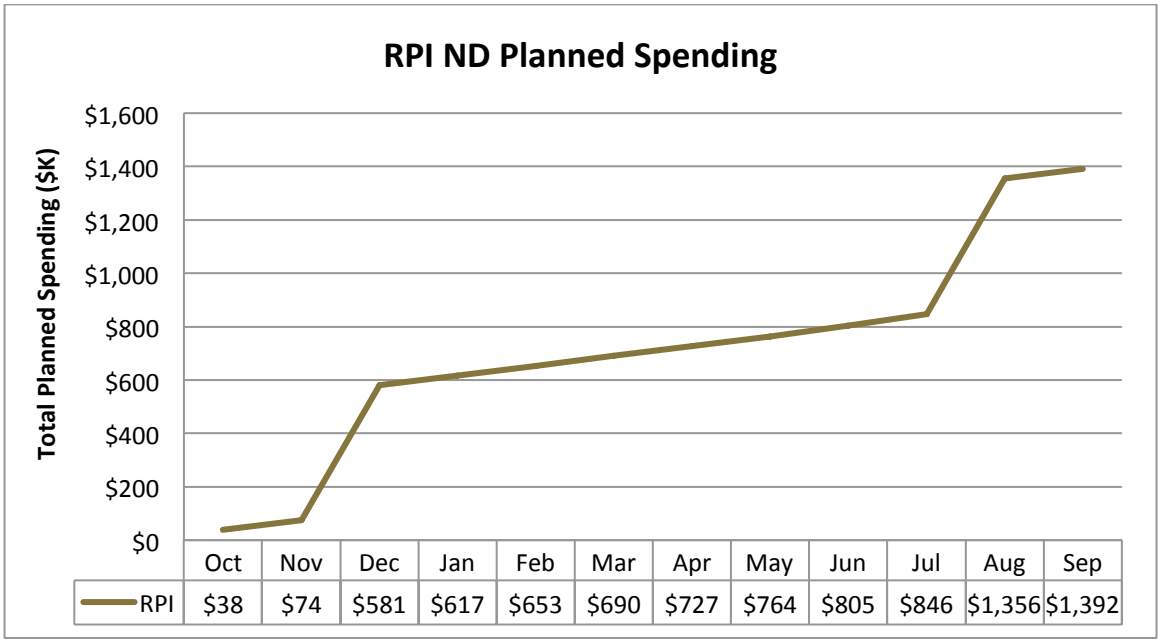


Table 2.4-11 RPI ND Planned Spending (FY2017)



RPI ND Milestones:

Occurs all 4 Quarters

- Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND2, ND3: All Qtrs).
- 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: All Qtrs).

Quarter 1

- Continue modulator purchase in coordination with NR (ND3: Q1).
- Complete factory acceptance test for all Klystrons (ND3: Q1)
- Initiate accelerator section order with data from SLAC and coordination with NR (ND3: Q1).

Quarter 3

- Complete transmission measurement with ORNL sample per the nuclear data schedule in Appendix B (ND1: Q3).
- Complete capture measurement per the nuclear data schedule in Appendix B (ND1: Q3).
- Perform thermal scattering measurements per the nuclear data schedule in Appendix B (ND2: Q3).

Quarter 4

- Complete data analysis for transmission and capture measurements and provide data to ORNL as needed to support the evaluation effort per the nuclear data schedule in Appendix B (ND1: Q4).
- Complete thermal scattering measurement and data analysis and provide data to ORNL as needed to support the evaluation effort per the nuclear data schedule in Appendix B (ND2: Q4).

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

High funding level tapering off in FY17-20 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.

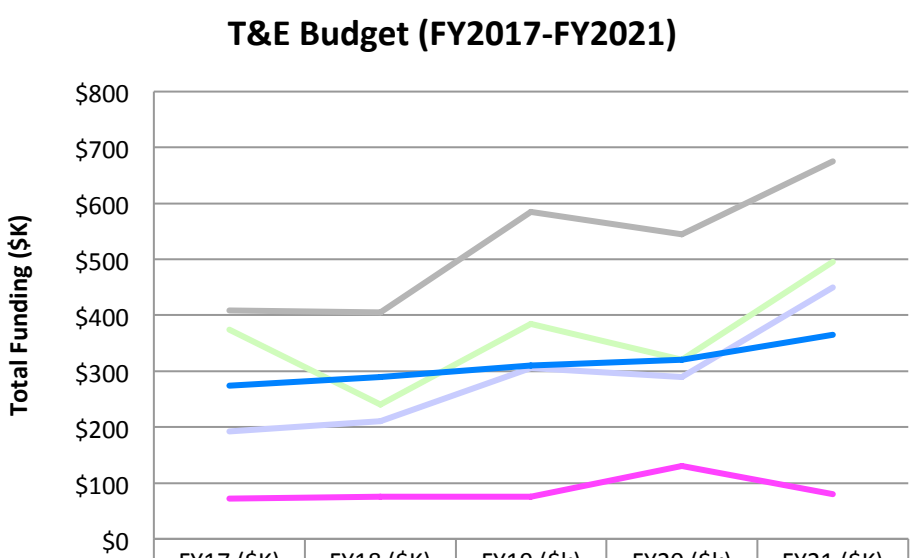
2.5 Training and Education (T&E)

2.5.1 Program Element Description

The Training and Education 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 T&E 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 T&E 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 T&E Budget (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
LANL	$408	$405	$585	$545	$675
LLNL	$374	$240	$385	$320	$495
ORNL	$192	$210	$305	$290	$450
SNL	$274	$290	$310	$320	$365
Y12	$72	$75	$75	$130	$80

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 Traning 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)

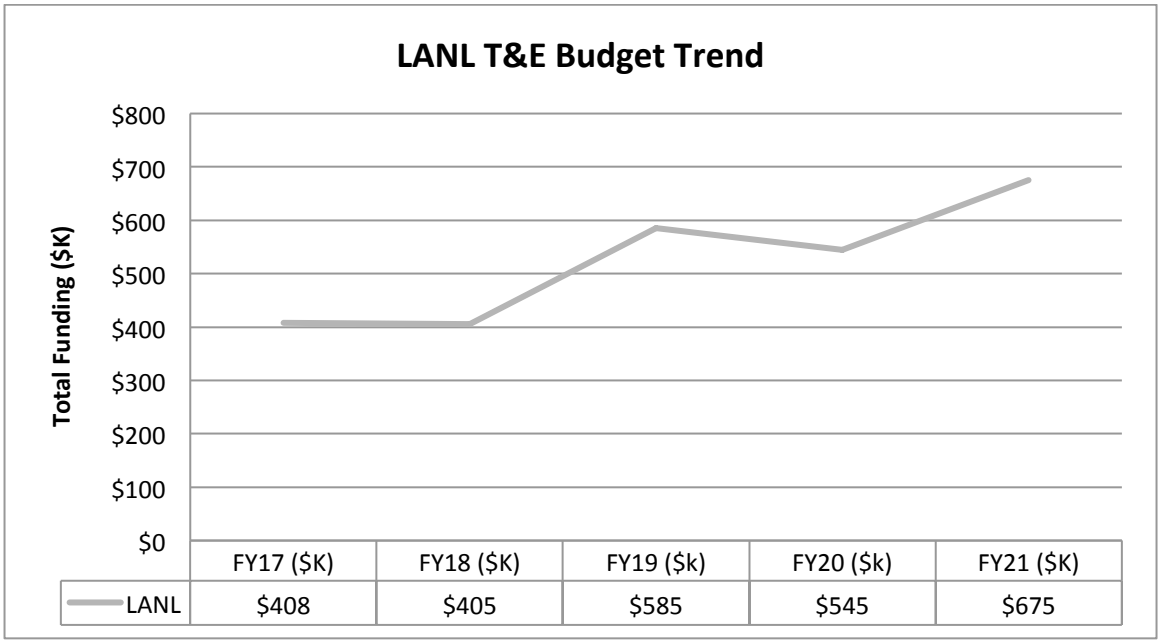
LANL T&E1 ($360K)

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.

LANL T&E3 ($48K)

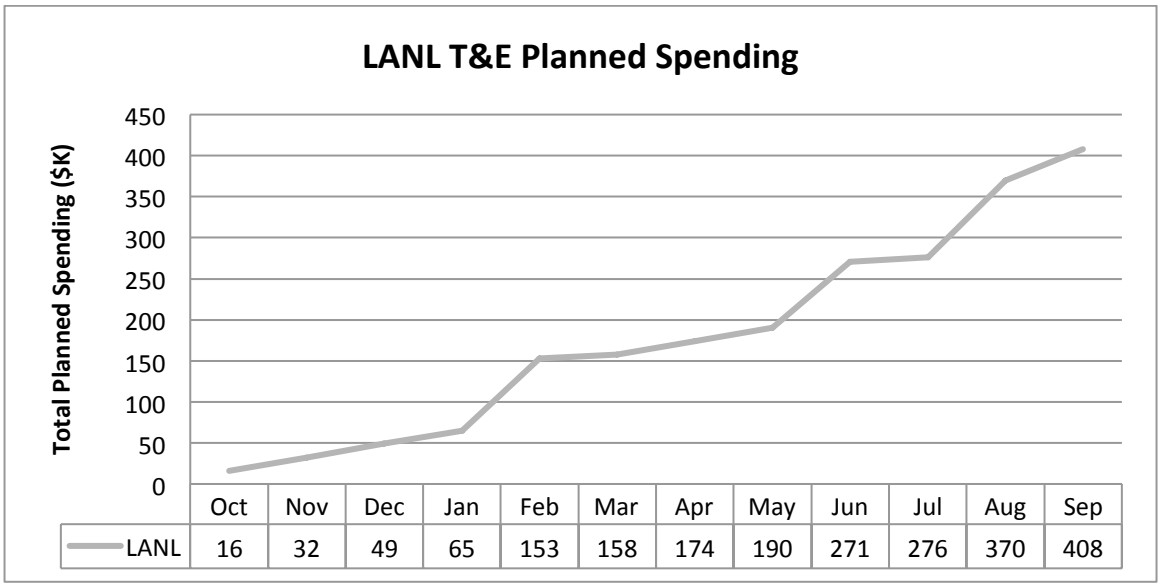
This is a new LANL task in collaboration with ORNL to facilitate the increased usage of modern sensitivity/uncertainty (S/U) tools and practices in DOE-site validation efforts. The objective of this task is to provide a 1-day onsite introductory validation training class to multiple DOE sites that are 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 T&E Budget Trend (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
LANL	$408	$405	$585	$545	$675

Table 2.5-3 LANL T&E Planned Spending (FY2017)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LANL	16	32	49	65	153	158	174	190	271	276	370	408

LANL T&E 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 (TE1: All Qtrs).
- In collaboration with ORNL, provide introductory 1-day S/U workshop training to one or more DOE sites (TE3:Q4).

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)

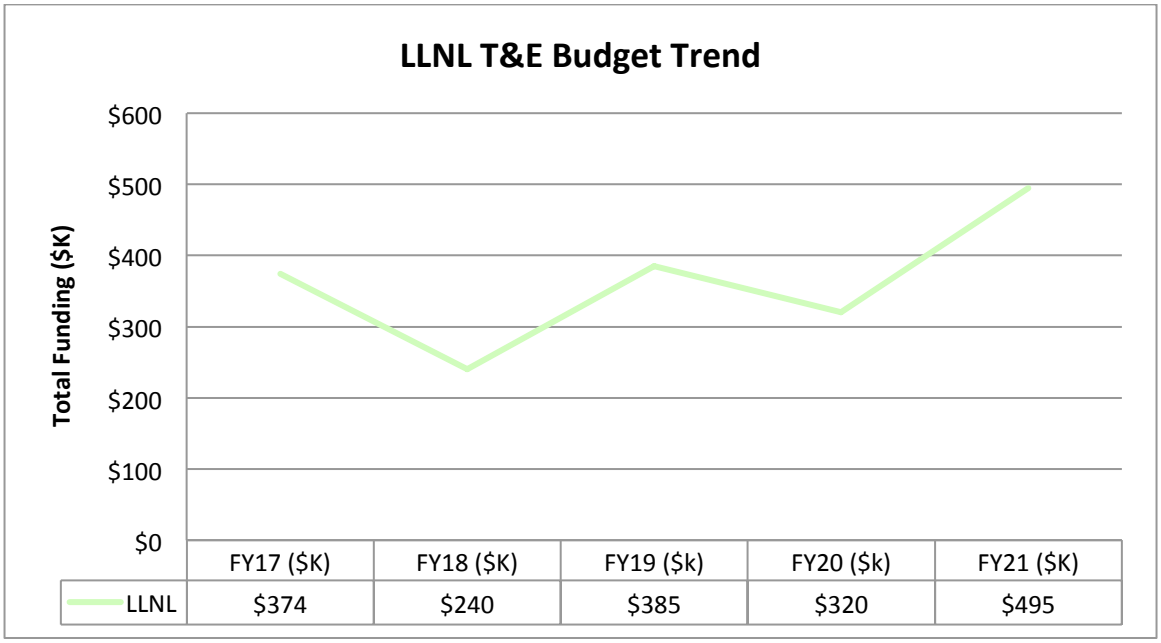
LLNL T&E1 ($230K)

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, NCERC and SNL.

LLNL T&E3 ($144K)

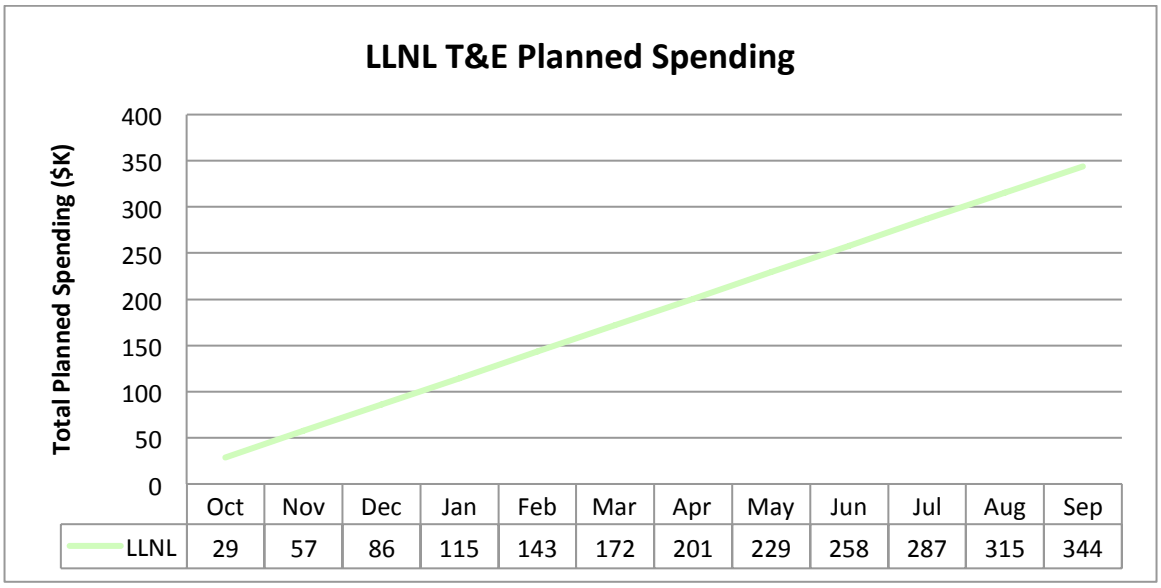
This is a new approved task to provide increased LLNL support for FY2017 classroom instruction at the Nevada Site Facility and participation in T&E transition activities.

Table 2.5-4 LLNL T&E Budget Trend (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
LLNL	$374	$240	$385	$320	$495

Table 2.5-5 LLNL T&E Planned Spending (FY2017)*



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LLNL	29	57	86	115	143	172	201	229	258	287	315	344

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

LLNL T&E 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: All Qtrs).
- Provide increased LLNL support for FY2017 classroom instruction at the Nevada Site Facility and participation in T&E transition activities in accordance with the schedule approved by the NCSP Manager (TE2: All Qtrs).

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

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)

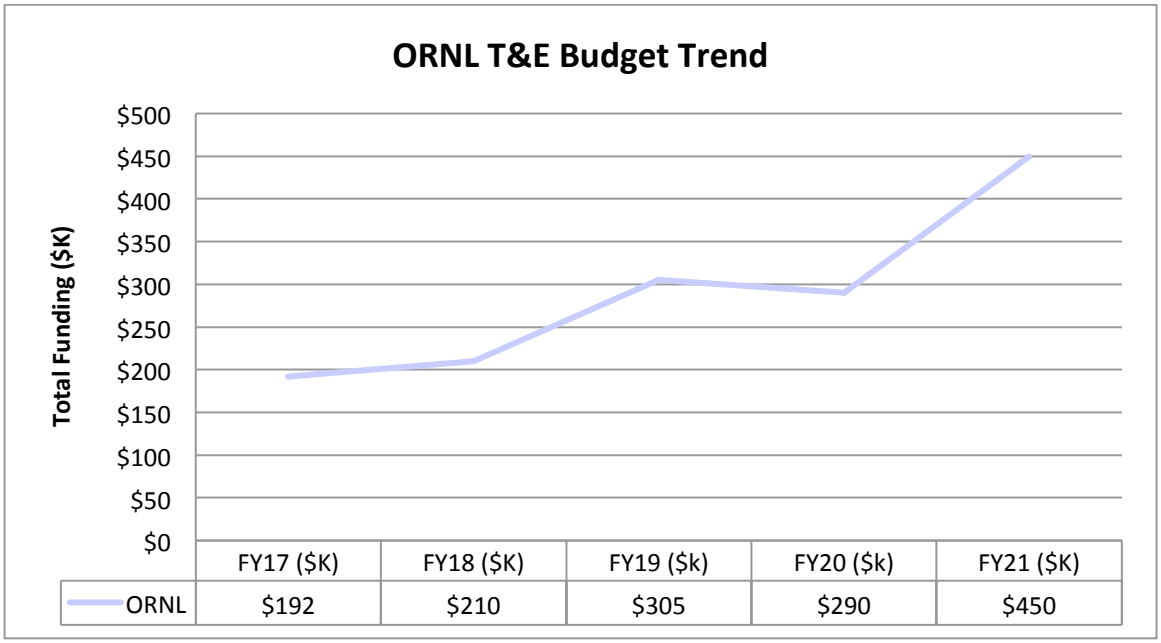
ORNL T&E1 ($144K)

Ongoing ORNL task to manage the collaborative multi-laboratory development, designing, and scheduling of the multi-faceted and phased NCSP training program and oversee the execution of the program. The task also includes support for an ORNL nondestructive assay (NDA) expert to providing training on NDA measurement capabilities as part of the NCSP training courses. In addition, the task also provides support for a senior NCS engineer to provide classroom instruction for the NCSP training course.

ORNL T&E5 ($48K)

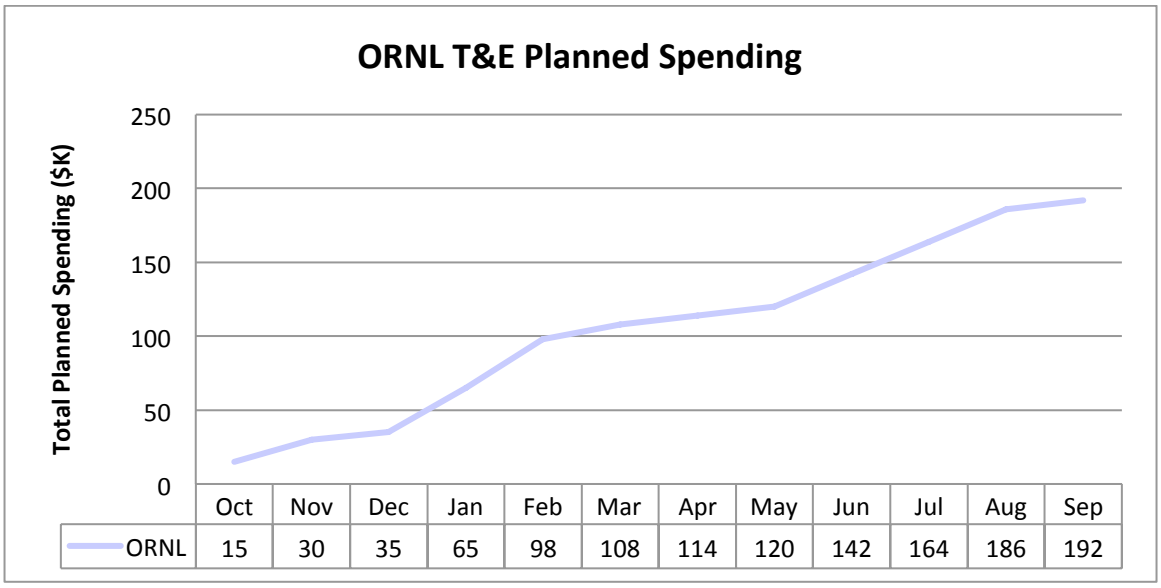
This is a new ORNL task in collaboration with LANL to facilitate the increased usage of modern sensitivity/uncertainty (S/U) tools and practices in DOE-site validation efforts. The objective of this task is to provide a 1-day onsite introductory validation training class to multiple DOE sites that are 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 2.5-6 ORNL T&E Budget Trend (FY2017-FY2021)



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
ORNL	$192	$210	$305	$290	$450

Table 2.5-7 ORNL T&E Planned Spending (FY2017)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
ORNL	15	30	35	65	98	108	114	120	142	164	186	192

ORNL T&E Milestones:

Occurs all 4 Quarters

- Provide status reports in NCSP Quarterly Progress Reports on implementation of the NCS training program (TE1: All Qtrs).
- Provide status reports in NCSP Quarterly Progress Reports on improvements/modifications to baseline NCS course training materials based on self-evaluation and feedback from reviewers, observers, trainers, and the NCSP manager (TE1: All Qtrs).

Quarter 4

- In collaboration with LANL, provide introductory 1-day S/U workshop training to one or more DOE sites (TE5:Q4).

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 T&E1 ($274K)

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 training class.

Table 2.5-8 SNL T&E Budget Trend (FY2017-FY2021)

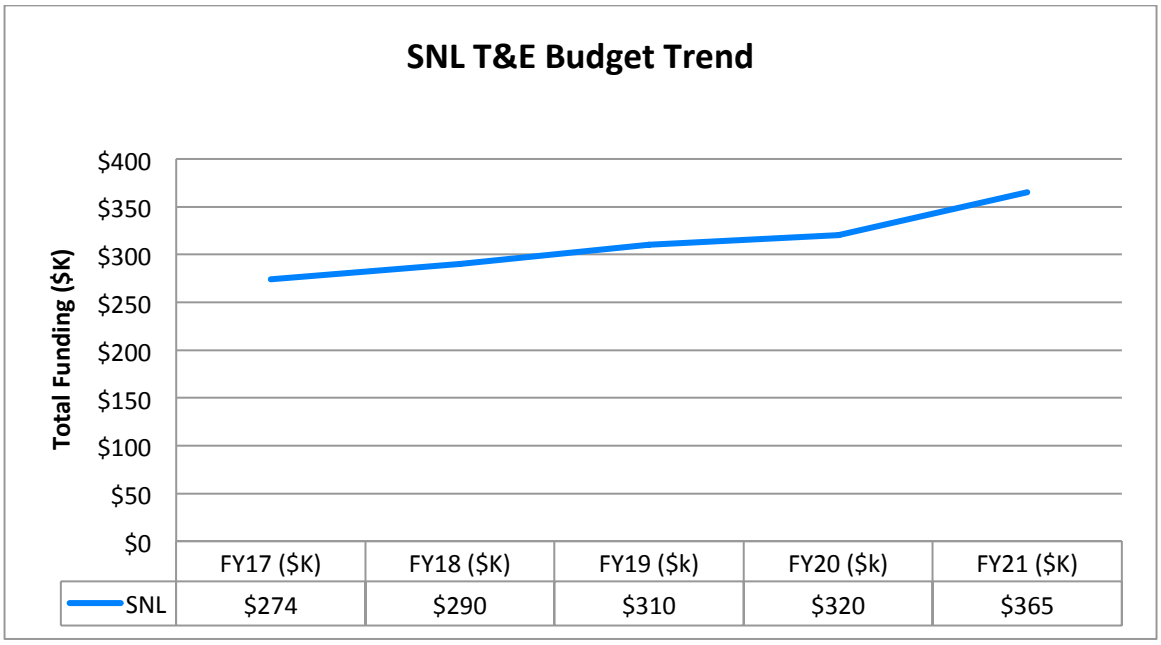
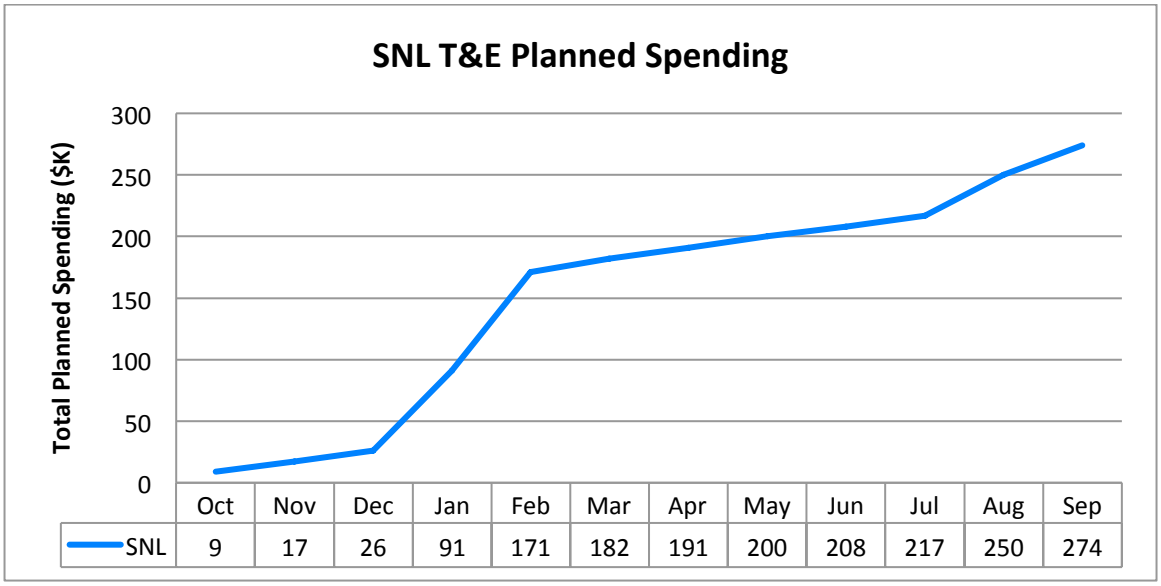


Table 2.5-9 SNL T&E Planned Spending (FY2017)



SNL T&E Milestones:

All Quarters

- Conduct hands-on training classes at Sandia and provide Human Factors and Equipment Reliability module support to the training classes in accordance with the approved schedule (TE1: All Qtrs).

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 Y12

Y12 T&E1 ($72K)

This is a newly integrated, approved task for Y12 to assist in conducting the current criticality safety training classes at NFO and NCERC.

Table 2.5-10 Y12 T&E Budget Trend (FY2017-FY2021)

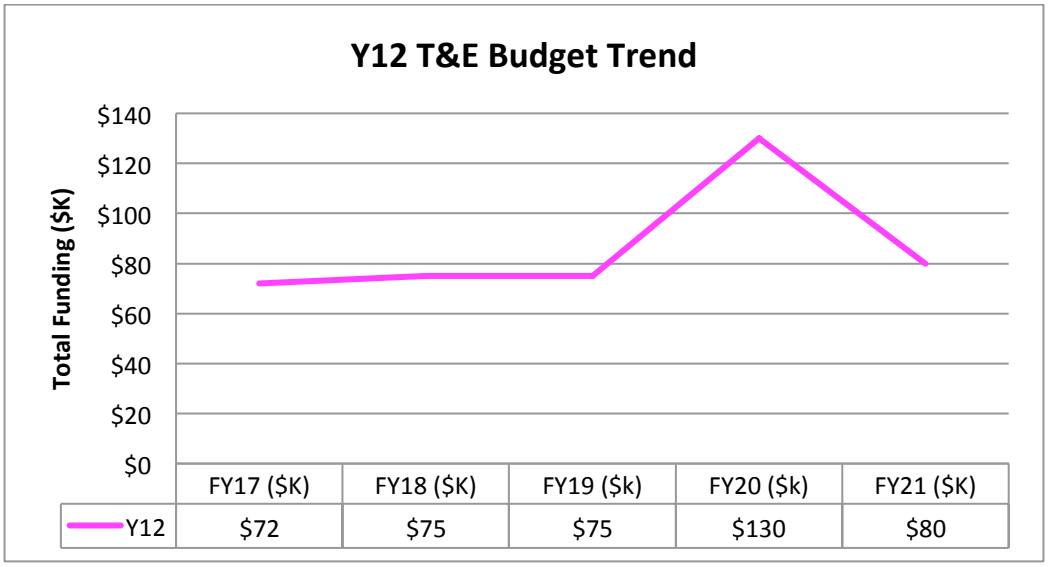
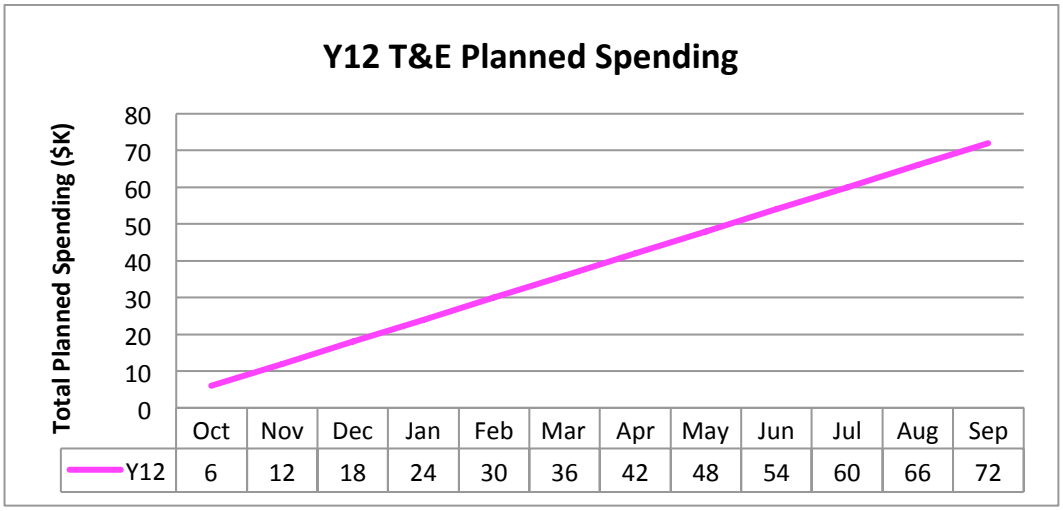


Table 2.5-11 Y12 T&E Planned Spending (FY2017)



Y12 T&E Milestones:

All Quarters

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

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)

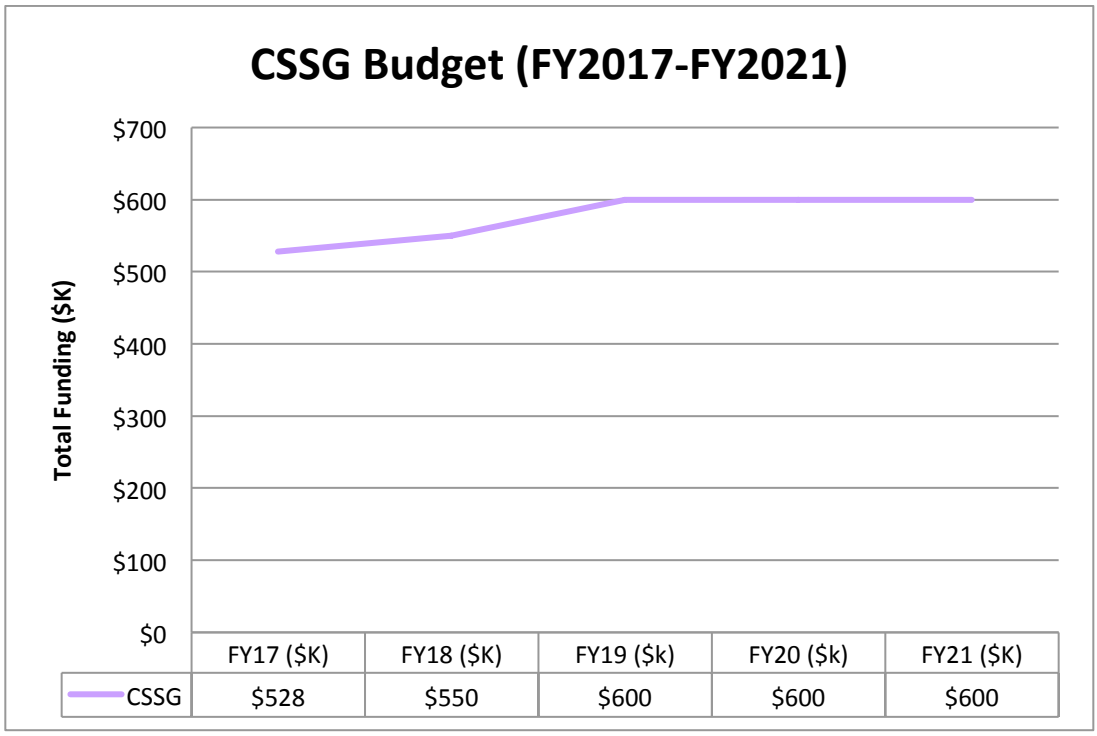
The CSSG is comprised of recognized criticality safety experts from DOE offices and contractor organizations. The primary function of the CSSG is to provide operational and technical expertise to the DOE through the NCSP Manager. The CSSG also provides the NCSP Manager with technical reviews of orders, 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 additional members in order to support new member transition and overlap). Only contractor members are funded. There is currently one DOE-EM member, who does not get funded. The CSSG receives modest support for its contractor members (nine CSSG contractor members' $50K/member + $25K for the CSSG Chair + $25K for the CSSG Deputy Chair).

NCSP TS1 ($528K)

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

Table 3.1 CSSG Budget Trend (FY2017-FY2021)*



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 ($576K) - ORNL

This is an ongoing approved task for ORNL to support the DOE NCSP Management in the program management and execution of the NCSP. ORNL is the Lead Laboratory for the NCSP infrastructure being responsible for the annual updates for the 5-year plan and the annual activities of the NCSP in supporting the NNSA PPBE cycle at the direction and supervision of the NCSP manager.

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 ($120K) - 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 ($120K) - 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 ($72K) - 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.

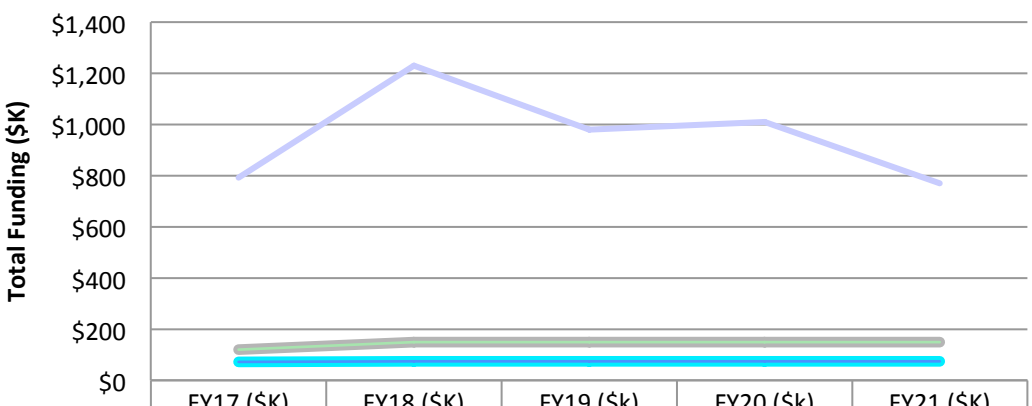
NCSP TS7 ($120K) - ORNL

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 evaluation capabilities that currently exist at ORNL. The work associated with this task is to address key nuclear data evaluator succession planning needs for the NCSP. As part of this task, a post-doctoral staff member will work with an ORNL nuclear data evaluation specialist to complete NCSP nuclear data evaluation work tasks thereby training the next generation of nuclear data experts to perform neutron resonance analyses for the NCSP.

NCSP TS8 ($96K) - ORNL

This is a new task to develop a program management tool that will improve the overall efficiency of managing the NCSP. 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. As a longer-term objective, an additional out year task will be to develop a NCSP management tool to streamline management and tracking of NCSP IE tasks and machine schedule availability at NCERC. Also, the NCSP program management tools will be developed to interface with the NNSA G2 system. The G2 system is developed and maintained by the ORNL Nonproliferation Systems Group (NSG) at ORNL. As a result, the ORNL/NSG will utilize previously-developed program management tools, where possible, to expedite the development and implementation of the program management tools needed to support the management and execution of the NCSP.

Table 4.1 NCSP Technical Support (FY2017-FY2021) - by Laboratory



	FY17 ($K)	FY18 ($K)	FY19 ($k)	FY20 ($k)	FY21 ($K)
BNL	$72	$75	$75	$75	$75
LANL	$120	$150	$150	$150	$150
LLNL	$120	$150	$150	$150	$150
ORNL	792	1230	980	1010	770
SNL	$72	$75	$75	$75	$75

NCSP TS Milestones:

Occurs all 4 Quarters

- Manage C_EdT process and coordinate execution of planned IERs each FY (TS2: All Qtrs).
- 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: All Qtrs).

Quarter 4

- Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY (TS2: Q4).
- Publish final Five-Year Plan (TS2: Q4).
- Provide NCSP Manager annual report of succession planning efforts (TS3, TS4, TS5, TS6, and TS7: Q4).
- Develop initial prototype of NCSP Program Management Tool (TS8:Q4).

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 FY2017
Provided to the NA-50 Budget Office in October 2016

Argonne National Laboratory (ANL): $50K

Task: Criticality Safety Support Group

Reflects funds for participation in the Criticality Safety Support Group (CSSG), as it provides technical support to the Nuclear Criticality Safety Program (NCSP) Manager regarding planning and execution of the NCSP.

ANL POC: Jim Morman (630-252-6076), jamorman@anl.gov
DOE POC: Jerry McKamy, NNSA (301-903-7980)

Brookhaven National Laboratory (BNL): $216K

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) FY17 Five-Year Plan dated October 2016, or as directed by the NCSP Manager.

BNL POC: David Brown (631-344-2814), dbrown@bnl.gov
DOE POC: Jerry McKamy, NNSA (301-903-7980)

Los Alamos National Laboratory (LANL): $11,116K

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) FY17 Five-Year Plan dated October 2016, 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: Jerry McKamy, NNSA (301-903-7980)

Lawrence Livermore National Laboratory (LLNL): $2,783K

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) FY17 Five-Year Plan dated October 2016, 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: Jerry McKamy, NNSA (301-903-7980)

Nevada National Security Site - NSTec (NNSS): $5,976K

Task: Integral Experiments

Reflects funds to continue support for integral experiments, as delineated in the Nuclear Criticality Safety Program (NCSP) FY17 Five-Year Plan dated October 2016, or as directed by the NCSP Manager.

NNSS POC: Jeff Lewis (702-524-0647), lewisjm@nv.doe.gov
DOE POC: Jerry McKamy, NNSA (301-903-7980)

Oak Ridge National Laboratory (ORNL): $4,285K

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) FY17 Five-Year Plan dated October 2016, 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).

Within available funds continue work on the new, modern NDA measurement system (SNAPSHOT) that ORNL has been working to complete for field deployment, support the TSG, perform NDA experiments, and perform NDA program management tasks as directed by the NNSA NDA Program Manager.

ORNL POC: Mike Dunn (865-574-5260), dunnme@ornl.gov
DOE POC: Jerry McKamy, NNSA (301-903-7980)

Renssalaer Polytechnic Institute (RPI): $1,392K

Task: Nuclear Data

Reflects funds to conduct differential measurements as delineated in the Nuclear Criticality Safety Execution (NCSP) FY17 Five-Year Plan dated October 2016 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: Jerry McKamy, NNSA (301-903-7980)

Sandia National Laboratories (SNL): $1,255K

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) FY17 Five-Year Plan dated October 2016, or as directed by the NCSP Manager.

SNL POC: Gary Harms (505-845-3244), gaharms@sandia.gov
DOE POC: Jerry McKamy, NNSA (301-903-7980)

Savannah River Site (SRS): $75K

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

Reflects funds to continue support as the CSSG Chair during FY17, 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: Jerry McKamy, NNSA (301-903-7980)

Y-12 National Security Complex (Y-12): $122K

Tasks: Training and Education and the Criticality Safety Support Group

Reflects funds to support the training and education program, as delineated in the Nuclear Criticality Safety Program (NCSP) FY17 Five-Year Plan dated October 2016, 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: Jerry McKamy, NNSA (301-903-7980)

Appendix B
Nuclear Data

Priority Needs */ Additional Needs	Thermal scattering (BeO, HF, D_2O, SiO_2, CH_2, C_2F_4, $C_5O_2H_8$, Oil, etc.), ^{239}Pu, 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(14), SiO_2 (14), D_2O (15), $C_5O_2H_8$ (15), SiO_2, ^{55}Mn (12), ^{180,128,183,184,186}W (14)

	Materials	Pre FY2015	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	Post-FY2021
Measurements	Calcium (Ca)									
	Cerium (Ce)									
	Iron (Fe)									
	Tantalum (Ta)									
	Vanadium (V)									
	Zirconium (Zr)									
	Polyethylene (CH_2)	H_2O / CH_2								
	Lucite ($C_5O_2H_8$)									

	Materials	Pre FY2015	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	Post-FY2021
Complete Evaluations	Calcium (Ca)									
	Cerium (Ce)									
	Cobalt (Co)									
	Copper (Cu)									
	Dysprosium (Dy)									
	Gadolinium (Gd)									
	Iron (Fe)									
	Lead (Pb)									
	Nickel (Ni)									
	Oxygen (O)									
	Rhodium (Rh)									
	Plutonium-239									
	Tantalum (Ta)									
	Uranium-235									
	Uranium-238									
	Vanadium (V)									
	Zirconium (Zr)									
	Hydrofluoric Acid (HF)									
	Lucite ($C_5O_2H_8$)									
	Polyethylene (CH_2)									
	Oil (Texaco #522)									
	Hydraulic Fluid (Biohyd-286)									
	Reactor Graphite									
	Paraffin (C_nH_{2n+2})									
	Beryllium (metal)									
	Beryllium Oxide (BeO)									
	Uranium Oxide (UO_2)									
	Triuranium Octoxide (U_3O_8)									
	Uranium Silicide (U_3Si_2)									

Priority Needs */ Additional Needs			Thermal scattering (BeO, HF, D_2O, SiO_2, CH_2, C_2F_4, $C_5O_2H_8$, Oil, etc.), ^{239}Pu, 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(14), SiO_2 (14), D_2O (15), $C_5O_2H_8$ (15), SiO_2, ^{55}Mn (12), ^{180,128,183,184,186}W (14)							
	Materials	**Pre FY2015**	**FY2015**	**FY2016**	**FY2017**	**FY2018**	**FY2019**	**FY2020**	**FY2021**	**Post-FY2021**
	Uranium Carbide (UC)									
	Plutonium Oxide (PuO_2)									
	Uranium Hydride (UH_3)									
	Plutonium Hydride (PuH_{2+x})									
		ORNL		**RPI**		**LANL**		**LLNL/NCSU**		**IRSN**

- **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.**

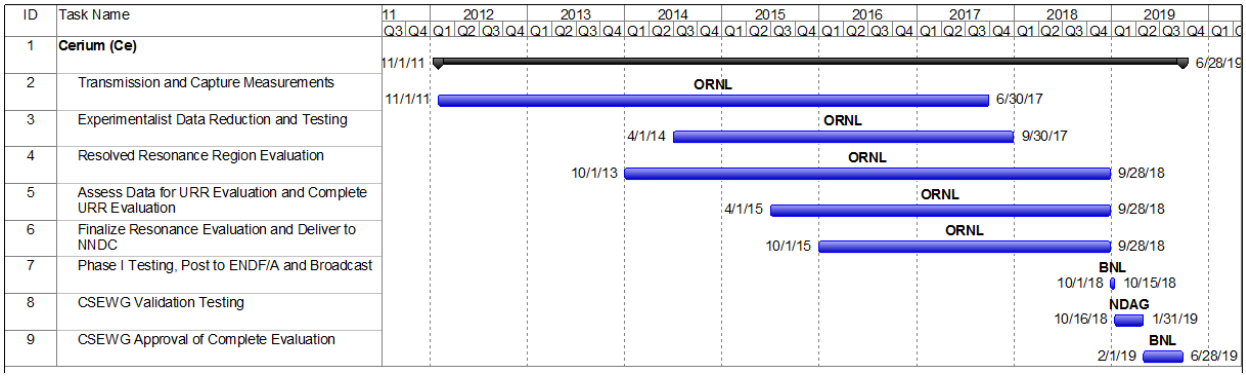
B-1 Differential Measurements and Evaluations – Elements
(The following list provides the specific GANTT chart to refer to for each element work schedule)

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 Strontium (Sr)
B-1.12 Tantalum (Ta)
B-1.13 Uranium (U-235)
B-1.14 Uranium (U-238)
B-1.15 Vanadium (V-51)
B-1.16 Zirconium (Zr-90, 91, 92, 94, 96)
B-1.17 Copper (Cu-63, 65)

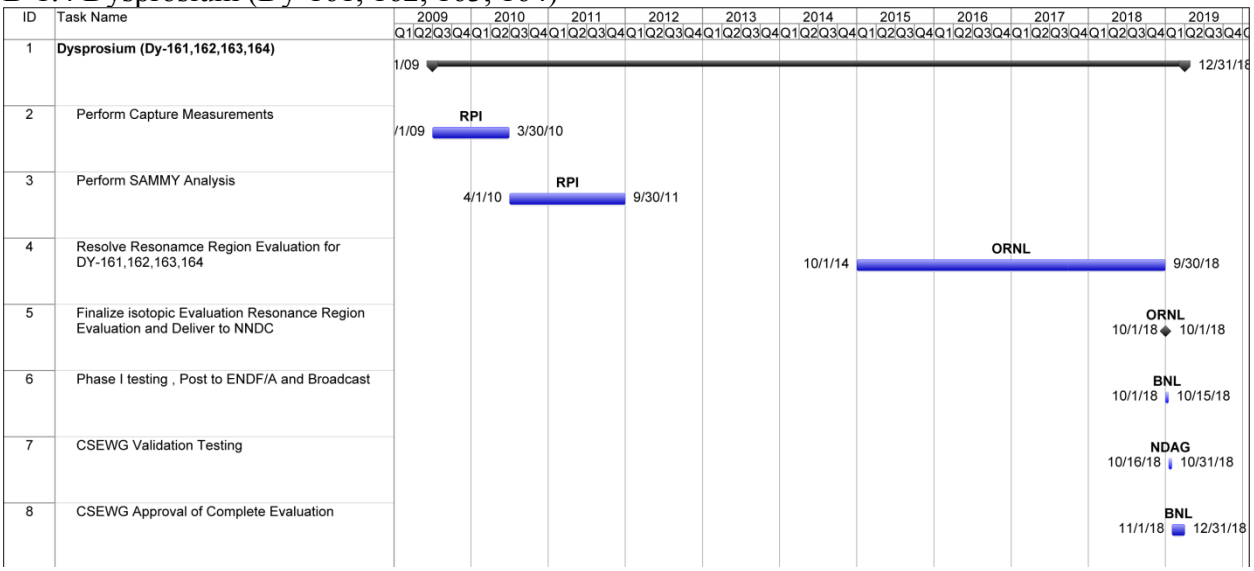
Completed Work

B-1.1 Calcium (Ca)
B-1.3 Cobalt (Co-59)
B-1.18 Nickel (Ni-58, 60)
B-1.19 Tungsten (W-182, 183, 184, 186)

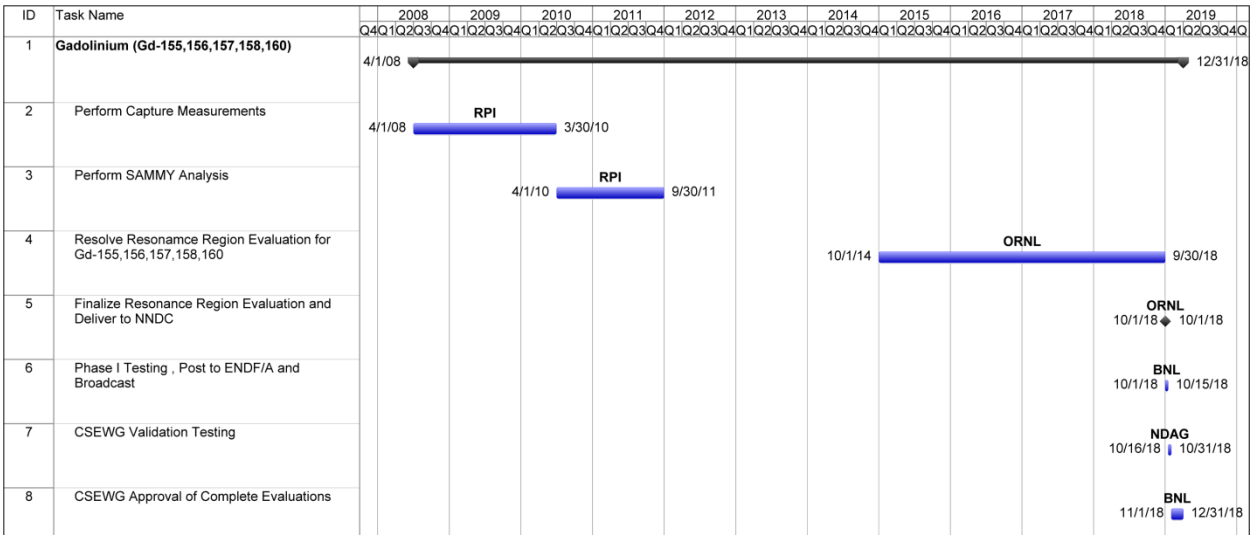
B-1.2 Cerium (Ce)



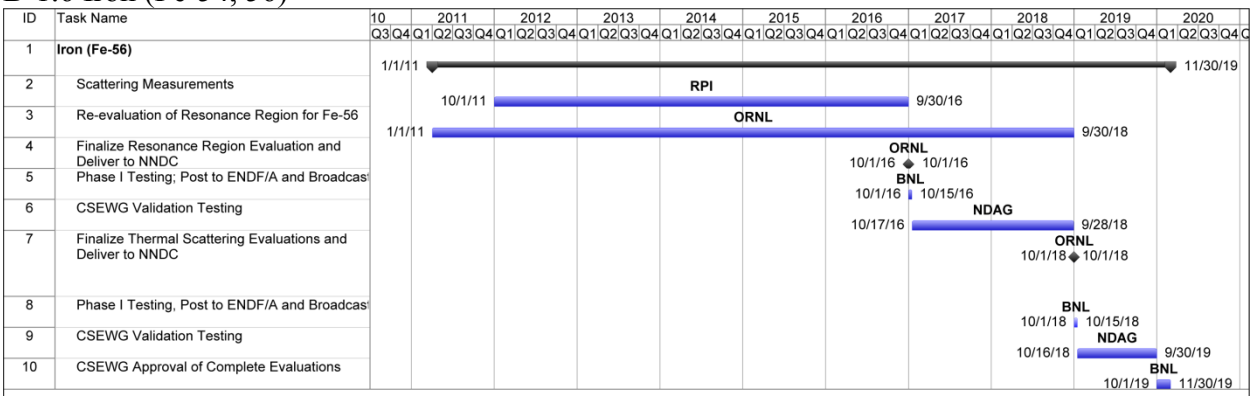
B-1.4 Dysprosium (Dy-161, 162, 163, 164)



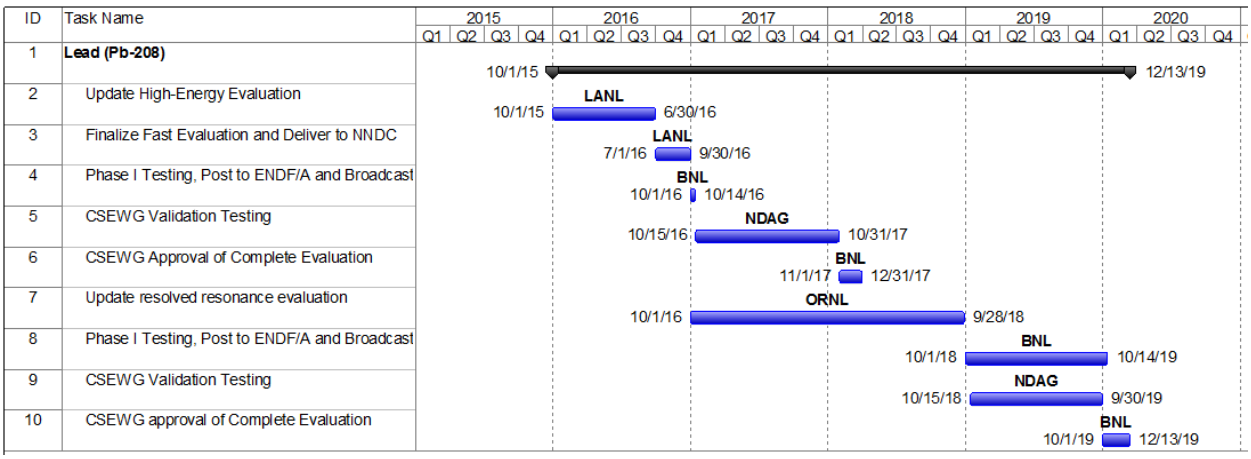
B-1.5 Gadolinium (Gd-155, 156, 157, 158, 160)



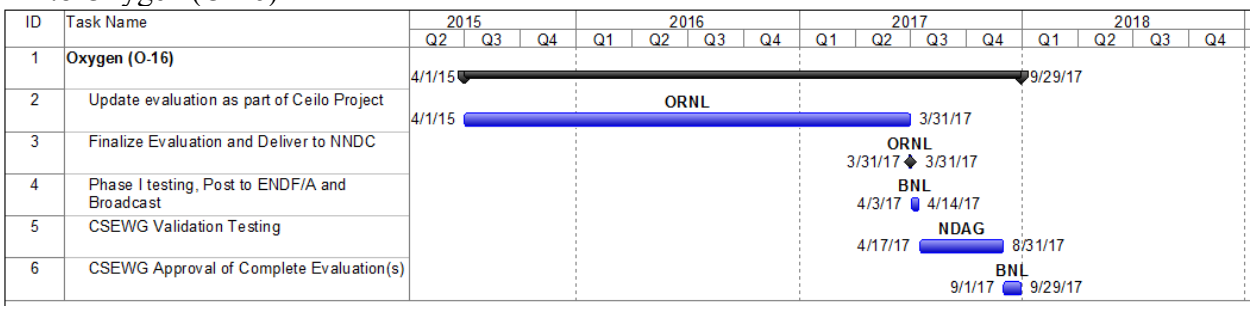
B-1.6 Iron (Fe-54, 56)



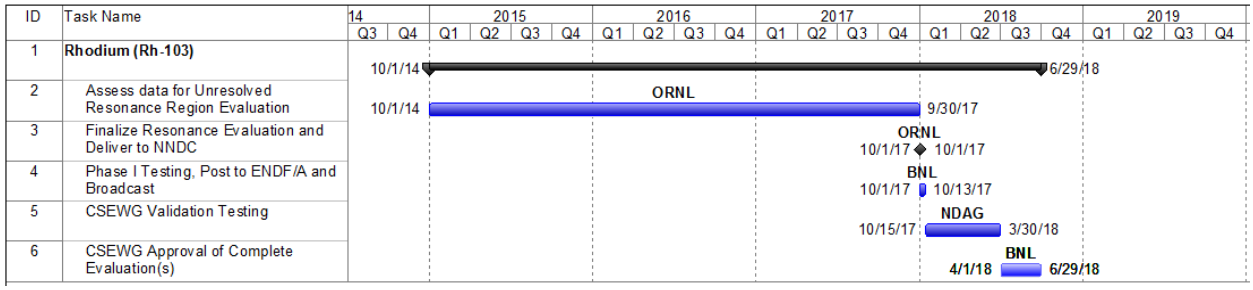
B-1.7 Lead (Pb-208)



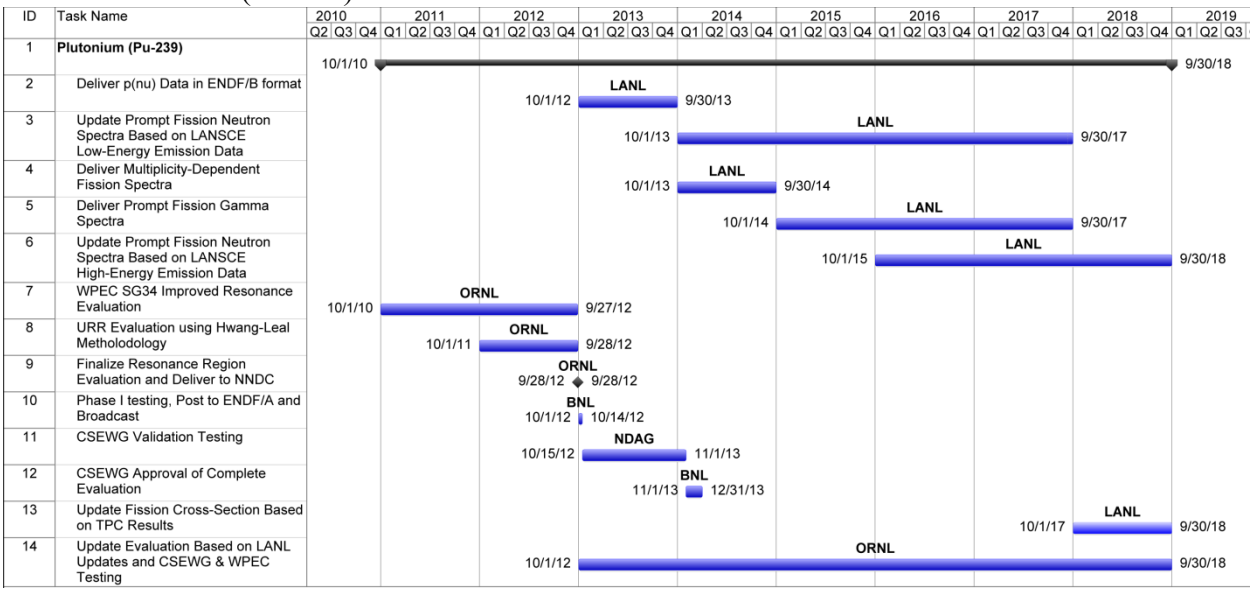
B-1.8 Oxygen (O-16)



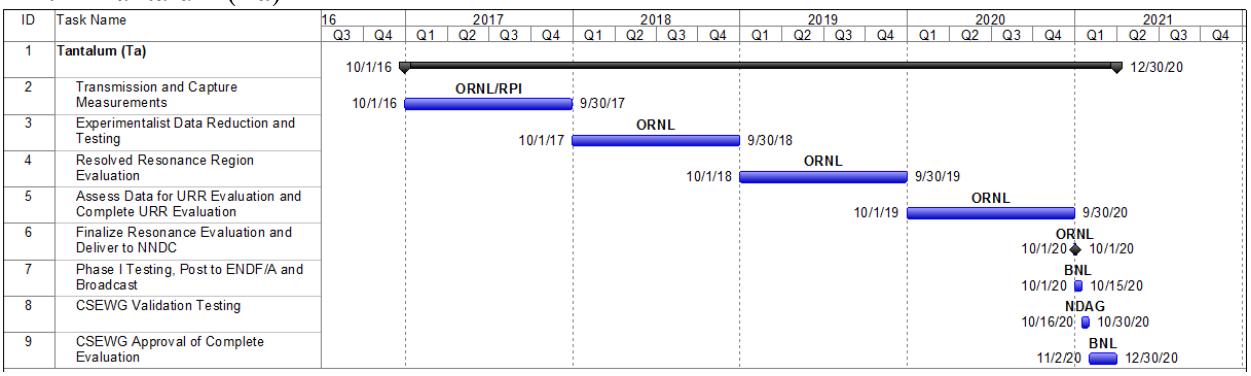
B-1.9 Rhodium (Rh-103)



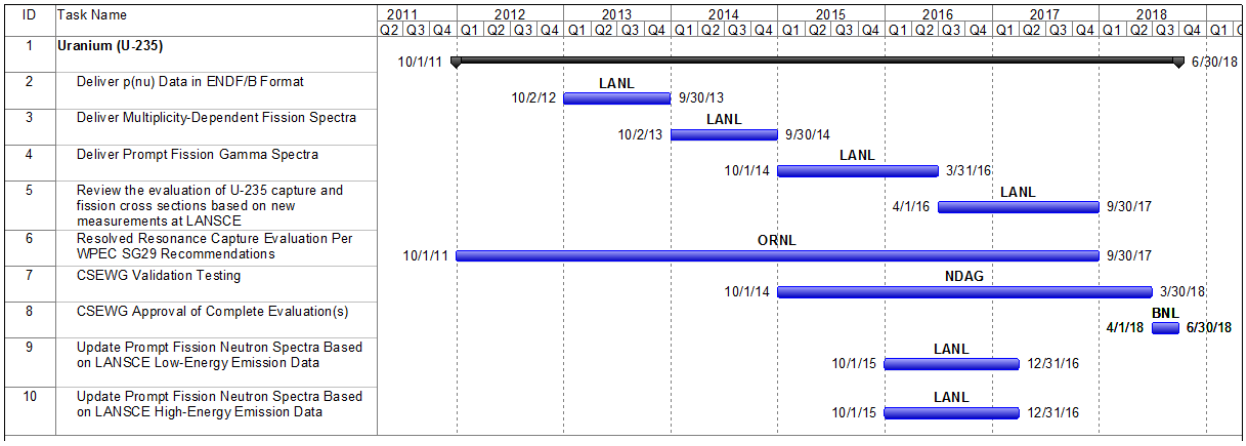
B-1.10 Plutonium (Pu-239)



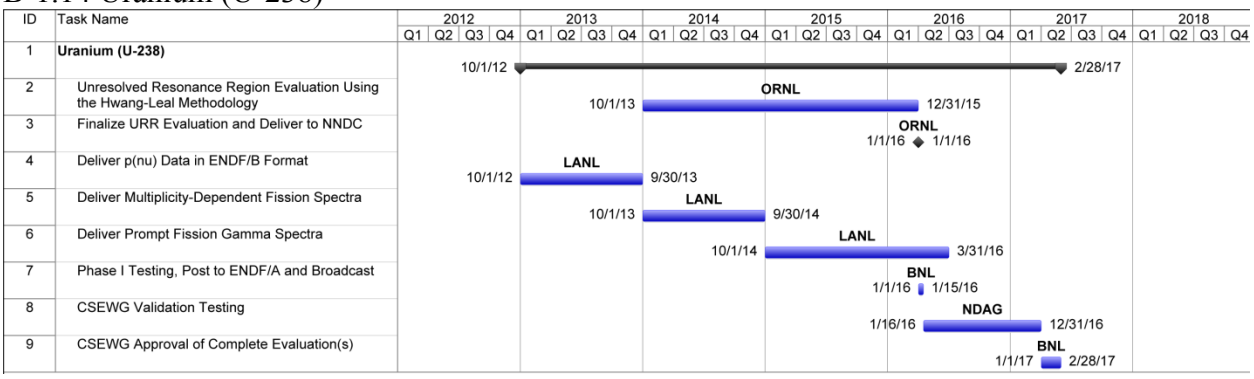
B-1.12 Tantalum (Ta)



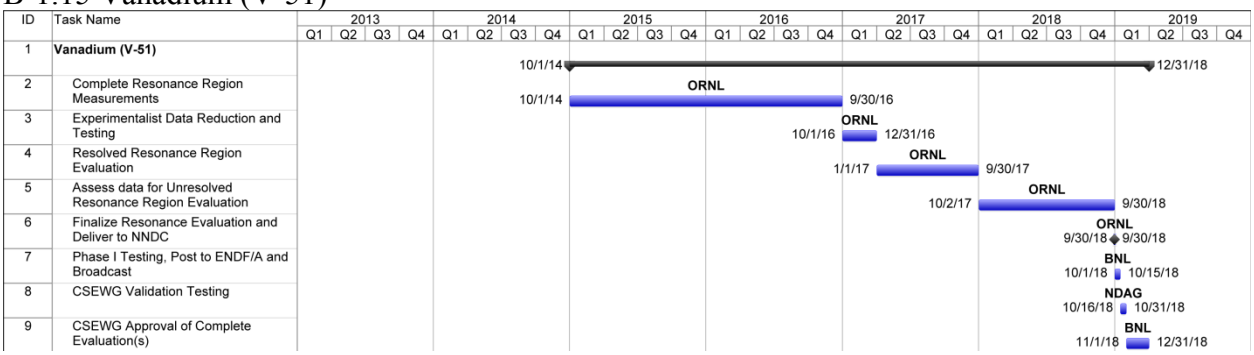
B-1.13 Uranium (U-235)



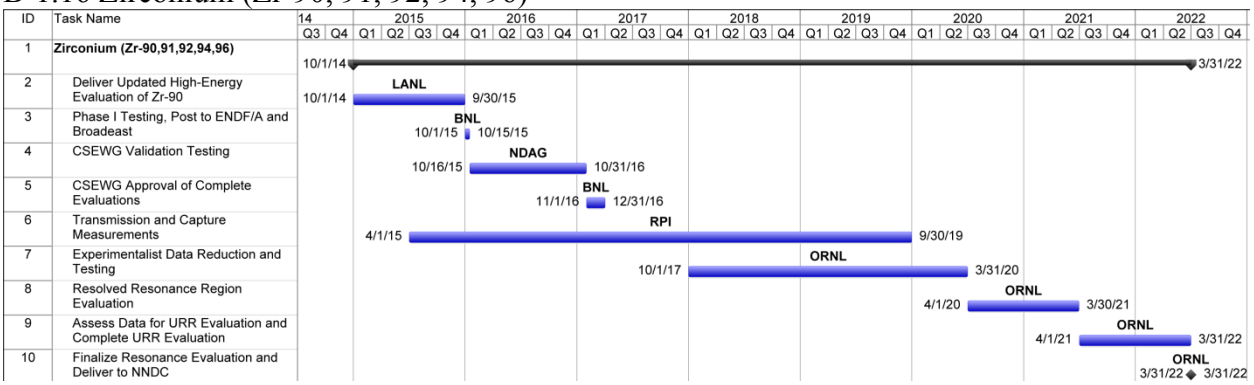
B-1.14 Uranium (U-238)



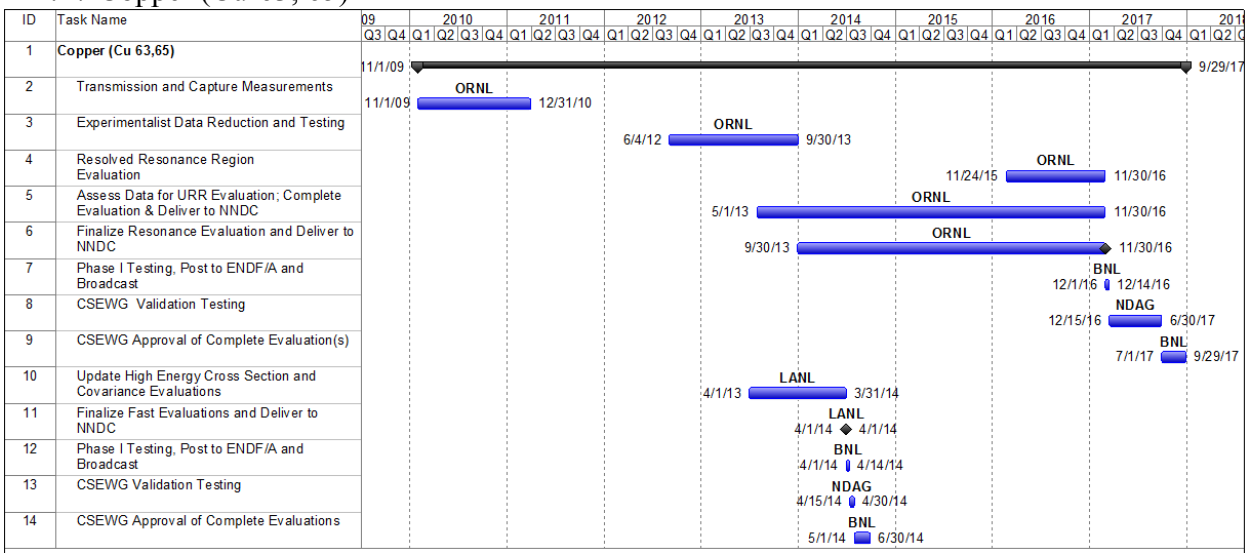
B-1.15 Vanadium (V-51)



B-1.16 Zirconium (Zr-90, 91, 92, 94, 96)



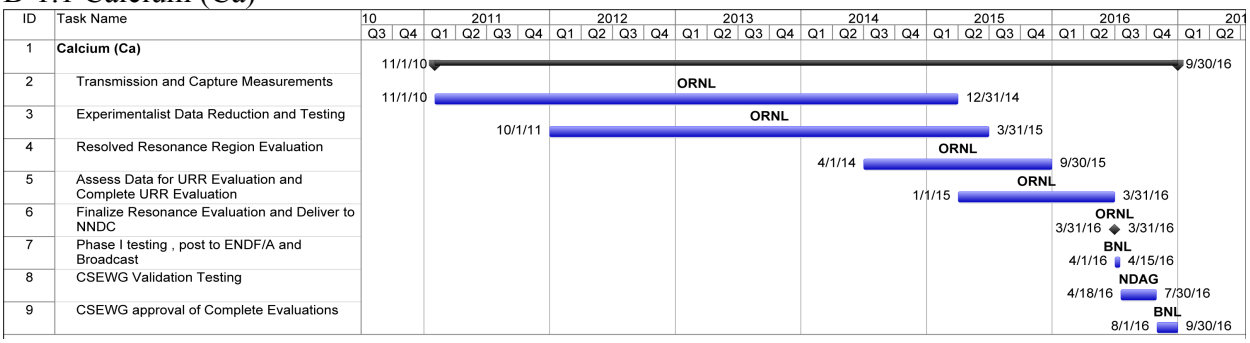
B-1.17 Copper (Cu-63, 65)



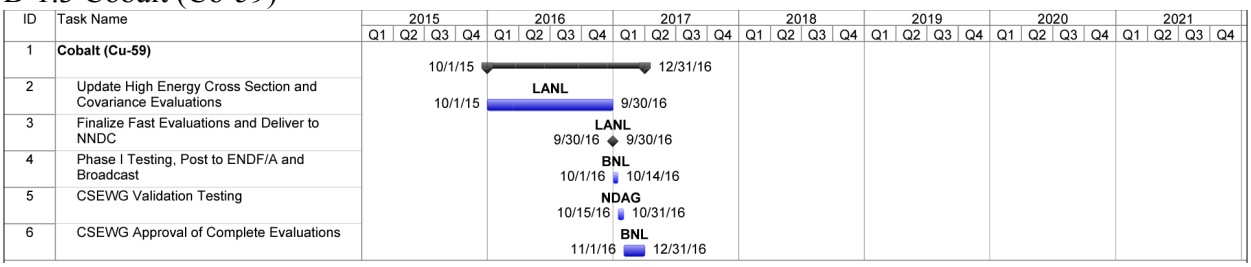
Completed Differential Measurements and Evaluations – Elements

(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.)

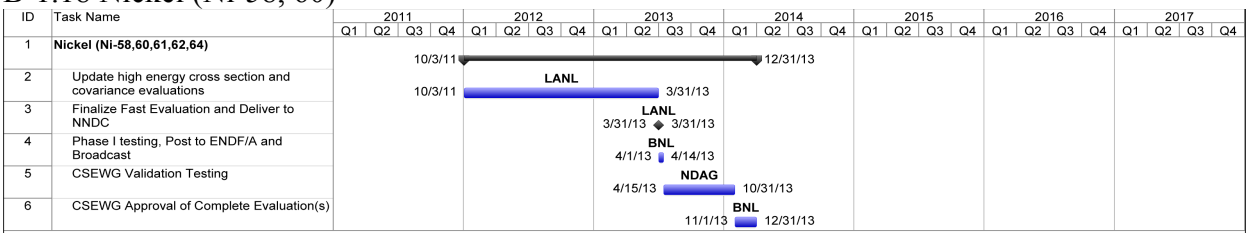
B-1.1 Calcium (Ca)



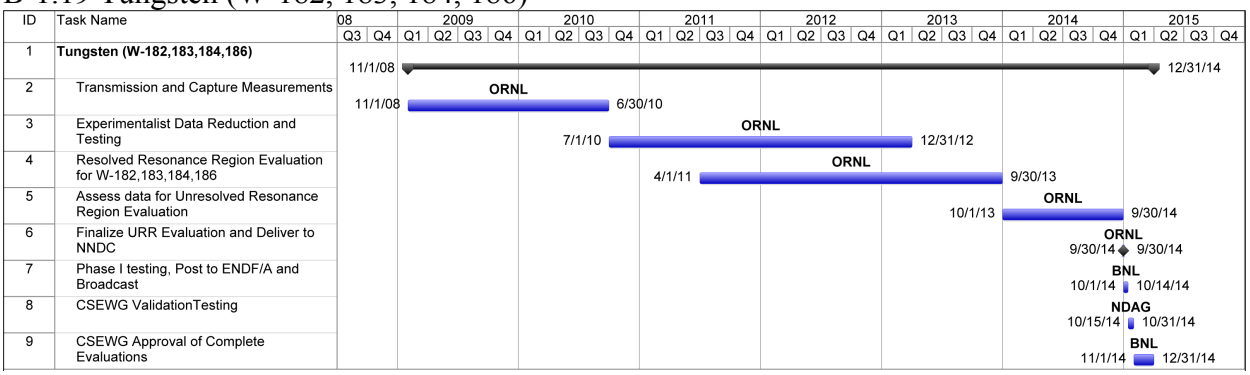
B-1.3 Cobalt (Co-59)



B-1.18 Nickel (Ni-58, 60)



B-1.19 Tungsten (W-182, 183, 184, 186)



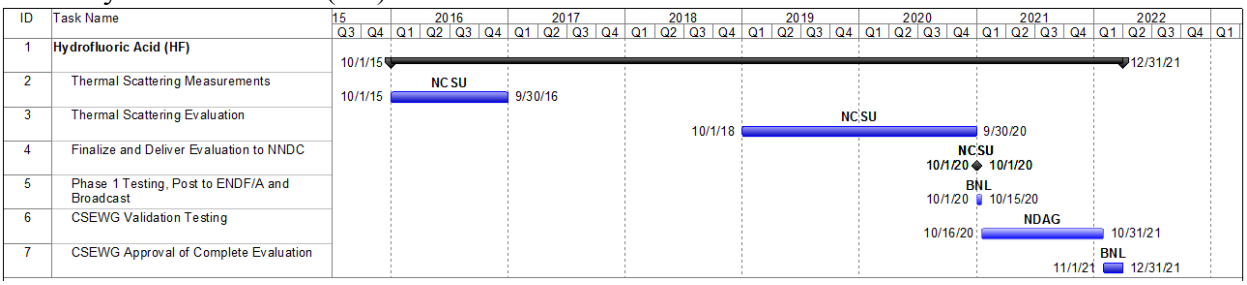
B-2 Differential Measurements and Evaluations – Compounds
(The following list provides the specific GANTT chart to refer to for each element work schedule)

B-2.1 Hydrofluoric Acid (HF)
B-2.2 Lucite ($C_5O_2H_8$)
B-2.3 Polyethylene (CH_2)
B-2.4 Oil (Texaco #522)
B-2.5 Hydraulic Fluid (e.g., Biohyd-286)

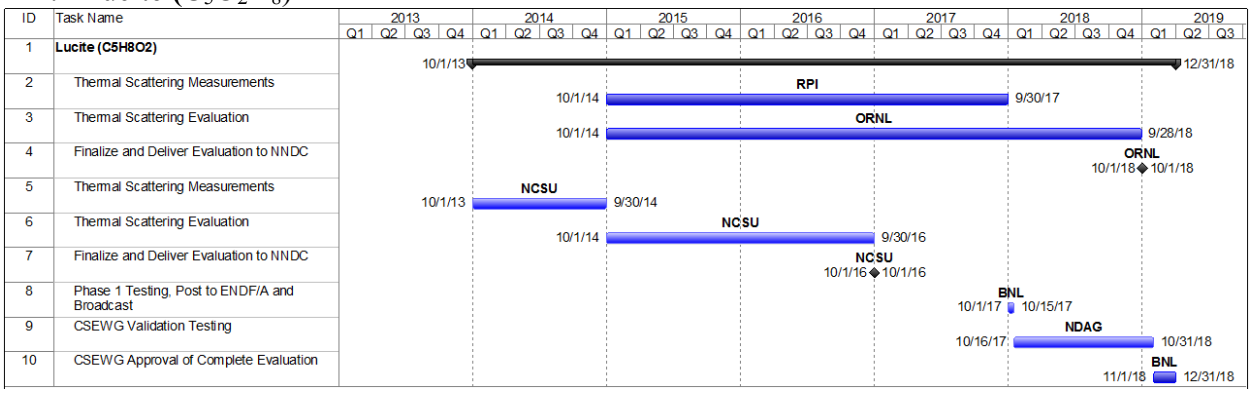
<u>Completed Work</u>

B-2.15 Deuterium Oxide (Heavy water, D_2O)
B-2.16 Silicon Carbide (SiC)
B-2.17 Silicon Dioxide (SiO_2)

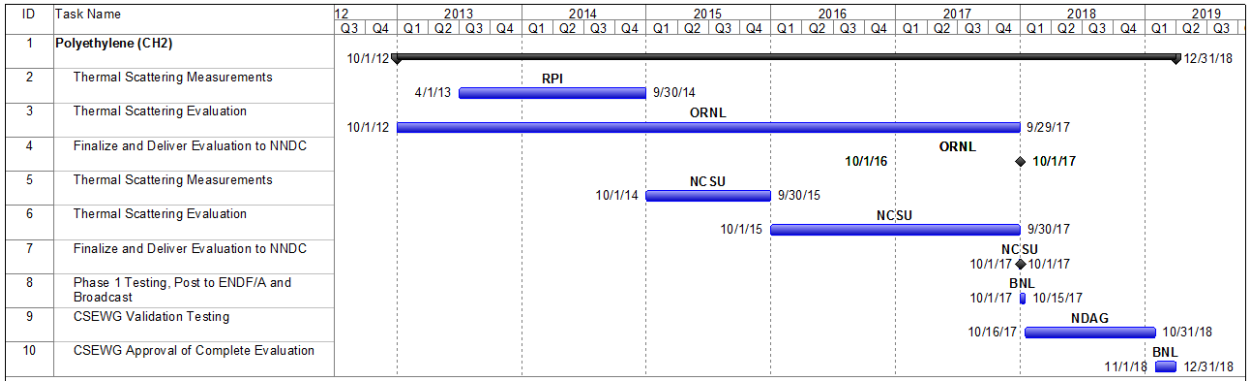
B-2.1 Hydrofluoric Acid (HF)



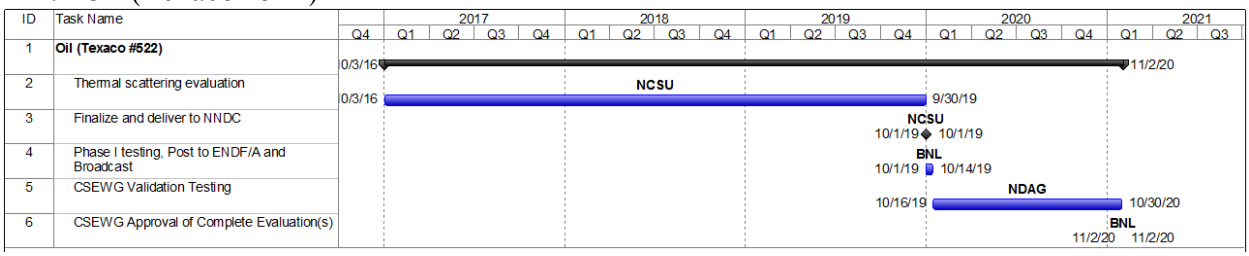
B-2.2 Lucite ($C_5O_2H_8$)



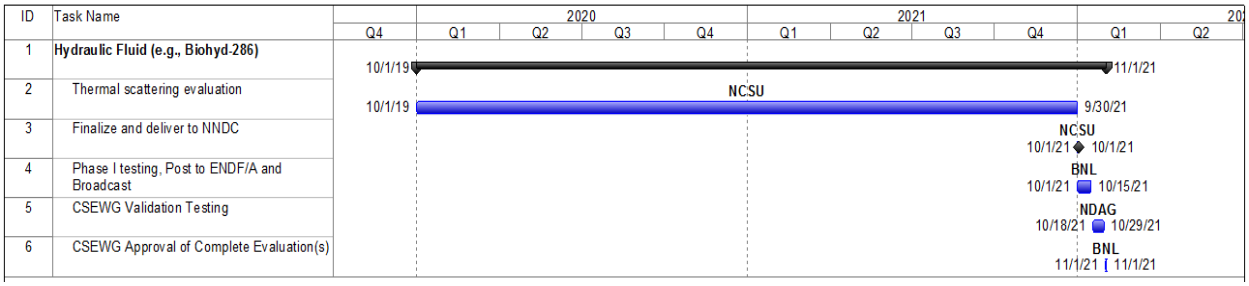
B-2.3 Polyethylene (CH_2)



B-2.4 Oil (Texaco #522)



B-2.5 Hydraulic Fluid (e.g., Biohyd-286)



Appendix C

Fiscal Year 2017 Projected Foreign Travel

Destination	Date	Labs	Count	Costs ($)	One Sentence Description	Task	Milestone	Justification
OECD/NEA Paris, France	TBD	LANL LLNL SNL	8	40,000	Present/publish NCSP ICSBEP evaluations at annual ICSBEP Technical Meeting (Harms, Ames, Hutchinson, Sanchez, Chambers, Heinrichs, Keefer, Watson)	LLNL-IPD1	Provide brief trip summary report to NCSP Manager (Q3).	Present/publish NCSP ICSBEP evaluations at annual ICSBEP Technical Meeting.
AWE Aldermaston, UK	TBD	LLNL	2	10,000	Coordinate International Collaboration Efforts with AWE (Heinrichs, Scorby)	LLNL-IE all	Provide brief trip summary report to NCSP Manager (Q3).	Coordinate joint AWE-LLNL work described in Appendix F of the Five Year Execution Plan.
OECD/NEA Paris, France	Sep-17	LLNL	2	10,000	Participate in WPNCS annual meeting (Scorby, Kim)	LLNL-AM1	Provide brief trip summary report to NCSP Manager (Q4).	Participate in WPNCS governance and expert group meetings on MC methods and excursion analyses.
Paris, France	Sep-17	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.
Poole, UK	May-17	LLNL	2	10,000	ANSWERS Seminar (Lee, Zywiec)	LLNL-AM1	Provide brief trip summary report to NCSP Manager (Q3).	Attend the AMEC 2015 ANSWERS Seminar devoted to radiation shielding, reactor physics and nuclear criticality safety software applications, V&V and R&D.
Paris, France	Oct-17	LLNL	1	5,000	Particpate in ICRS-RPSD (Shielding) Conference (persons Kim)	LLNL-AM3	Provide brief trip summary report to NCSP Manager (Q4).	Handheld Nuclear Criticality Safety Slide Rule application and work with LLNL/IRSN to generate a Criticality Slide Rule for Plutonium Systems
OECD/NEA Paris, France	May-17	RPI	2	10,000	Participate in WPEC annual meeting (Liu, Danon)	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.
Jeju, South Korea	Apr-2017	LANL	4	28,000	Participate in ANS Mathematics and Computation Topical Meeting 2017 (Brown, Rising, Hutchinson, Bahran)	LANL-AM1 LANL-AM3	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.
OECD/NEA Paris, France	Jul-17	LANL	3	21,000	OECD Expert Group Meeting plus IRSN Collaboration (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.

Destination	Date	Labs	Count	Costs ($)	One Sentence Description	Task	Milestone	Justification
OECD/NEA Paris, France	May-17	LANL	2	10,000	Participate in WPEC annual meeting (Kahler, Conlin)	LANL-AM2 LANL-ND1	Provide brief trip summary report to NCSP Manager (Q3).	Contributor to multiple sub-groups. CSEWG representative to WPEC.
IRSN Paris, France	TBD	LANL	2	10,000	Meet with IRSN colleagues to advance technical work of mutual interest (Kahler, Conlin)	LANL-AM2 LANL-ND2	Provide brief trip summary report to NCSP Manager (Q4).	Collaborate on work of joint NCSP-IRSN interest per the existing MOU
IRMM Mol, Belgium	Jan-17 Apr-17 Jun-17 Sep-17	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.
Paris, France	Jun-17	ORNL	1	5,000	Participate in ISO standards meeting on nuclear criticality safety (Bowen)	NCSP-TS7	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.
IRSN Paris, France	Nov-16 May-17 Sep-17	ORNL	2	45,000	Perform nuclear data evaluation and testing work with IRSN (Pigni, 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-17	ORNL	1	5,000	Participate in WPEC annual meeting as Chair of ENDF Formats Committee, coordinate international nuclear data collaborations for the NCSP, and present NCSP/ORNL nuclear data evaluation work (Dunn)	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.
OECD/NEA Paris, France	May-17	ORNL	2	10,000	Participate in WPNCS (Dunn, Rearden)	ORNL-AM2	Provide brief trip summary report to NCSP Manager (Q3).	Exchange of information with international NCS community to improve NCSP analytical methods work and cultivate new collaborations to support future NCSP analytical methods tasks.
Vienna, Austria	May-17	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 (Q4).	Exchange of information with international nuclear data community to support the development of nuclear data evaluations in Appendix B of the Five Year Plan.
Vienna, Austria	Dec-16	ORNL	1	5,000	Participate in R-matrix workshop at IAEA (Arbanas)	ORNL-ND6	Provide brief trip summary report to NCSP Manager (Q2).	Exchange of information with international nuclear data community to support SAMMY modernization for the NCSP.

FYI - 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 FY2017

Baseline budget need for the FY2017 Nuclear Criticality Safety Program (NCSP) is $27,298k 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 FY2017:

- Analytical Methods
  - Criticality Safety Computer Codes SCALE and MCNP support. Maintain Radiation Safety Information Computational Center who distributes all software. Perform sensitivity/uncertainty analysis for CAAS experiments and designs. 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. ~8 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 2017 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 ~20 elements and ~3 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.
  - One "special" week-long course similar to a Sandia or NCERC hands-on class.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~3 FTEs supported.

Over target budget need for FY2017 NCSP is $3.1M that would support 6 additional high priority tasks to address key Mission and Vision goals not addressed within the current budget target:

- Develop and deploy a mobile (CAT III or IV) critical/near critical hands-on demo capability ($100K)
- Expand radiochemistry laboratory capabilities at NNSS ($100K)
- Standup "hot"/"cold" machine shops at NCERC ($100K)
- Design and deploy low scatter capabilities at NCERC ($200K)
- Evaluate the feasibility of re-establishing an experimental pulse die-away capability for testing new thermal neutron scattering laws ($100K)
- Purchase enriched samples for cross section measurements ($2.5M)

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. 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. 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 ~20 elements and ~3 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.
  - One "special" week-long course similar to a Sandia or NCERC hands-on class for AWE.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~3 FTEs supported.

Baseline Budget Needs for Execution Year FY2019

Baseline budget need for the FY2019 Nuclear Criticality Safety Program (NCSP) is $27,804k 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 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. ~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. 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 ~20 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.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~3 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 2017 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 1 and 2 of IRSN proposal Update of the "slide rule" for the rapid response estimation of a criticality accident (using MCNP, MAVRIC…)	M. DULUC	M. DUNN D. HEINRICHS C. WILSON	ORNL LLNL AWE
IRSN-AM7	ACE QA testing and implementation	LANL-AM2	Implementation of the defined QA tests in ACEtk and integration in GAIA	W. HAECK	J. CONLIN	LANL
IRSN-AM8	Analytical methods Expert Group	NCSP-TS2	IRSN participation to NCSP analytical methods expert group	E. LETANG	M. DUNN	NCSP
IRSN-AM9	Cross sections processing validation	ORNL-AM3	Development of an interface between GAIA and AMPX and test interface capabilities	R. ICHOU	M. DUNN	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 M. DUNN F. BROWN	LLNL ORNL LANL

REFERENCE			IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2017 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
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	M. DUNN F. BROWN	ORNL LANL
Integral Experiments						
IRSN-IE1	TEX - Ta experiment	LLNL-IE1	Sensitivity/Uncertainty calculations Contribution to the evaluation and analysis of the first experiments	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE3	New 7uPCX experiment	SNL-IE1	Contribution to ICSBEP evaluation	N. LECLAIRE	G. HARMS	SNL
IRSN-IE5	New BUCCX experiment	SNL-IE1	Contribution to ICSBEP reevaluation	N. LECLAIRE	G. HARMS	SNL
IRSN-IE6	Rh foils experiment	SNL-IE1	IRSN proposal (SNL): preliminary evaluation of experimental uncertainties prior to the experiments CED-2 report	N. LECLAIRE	G. HARMS	SNL
IRSN-IE7	Mo foils and rods experiment	SNL-IE1	IRSN proposal (SNL): evaluation of experimental uncertainties prior to the experiments CED-3a report Mo foils supplying	N. LECLAIRE	G. HARMS	SNL
IRSN-IE8	Ti experiment	SNL-IE1	Analysis of the experiments Comparison with MIRTE program	N. LECLAIRE	G. HARMS	SNL
IRSN-IE11	TEX - Hf experiment	LLNL-IE1	Contribution to Jemima plates characterization	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE12	Reference values of GODIVA radiation field	LLNL-IE1	Participation to additional experiments Contribution to CED reports	M. DULUC F. TROMPIER	D. HEINRICHS	LLNL
IRSN-IE13	International intercomparison exercise using GODIVA	LLNL-IE1 AWE-IE1	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

REFERENCE			IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2017 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
IRSN-IE14	Reference values of FLATTOP radiation field	LLNL-IE1 AWE-IE2	Participation in the design Provide IRSN materials for irradiation, analysis of results	M. DULUC F. TROMPIER	D. HEINRICHS C. WILSON	LLNL AWE
IRSN-IE15	International intercomparison exercise using FLATTOP	LLNL-IE1 AWE-IE3	Participation in the design	M. DULUC F. TROMPIER	D. HEINRICHS C. WILSON	LLNL AWE
IRSN-IE16	SCRaP integral experiment	LANL-IE3	Contribution to the analysis of the experiments Reviewing ICSBEP evaluation	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	ISSA ICSBEP benchmark	LLNL-IE12	Analysis of the experiments, participation in the final technical report	W. MONANGE	D. HEINRICHS	LLNL
IRSN-IE25	TEX - MOX experiment	LLNL-IE1	IRSN leads this proposal CED-2 report with LLNL support Characterization of moderator and reflector plates	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE26	TEX - Iron experiment	LLNL-IE1	Participation in the design	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE27	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
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

REFERENCE			IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2017 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
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	Godiva benchmark for time dependent 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
Information Preservation and Dissemination						
IRSN-IPD1	ICSBEP reviewing	-	IRSN ICSBEP reviewing tasks are reported in the IE tasks for current IERs	-	-	-
IRSN-IPD3	ICSBEP benchmark reviewing	LANL-IE3	IRSN ICSBEP reviewing for FLATTOP reevaluation	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	M. DUNN	ORNL
IRSN-ND2	Nuclear data processing	LANL-ND1	Benchmark testing of ^{235}U and ^{239}Pu cross section library	L. LEAL	S. KAHLER	LANL
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-T&E1 LLNL-T&E1 SNL-T&E1	IRSN attendance to NCSP classes Possible lectures by IRSN	E. LETANG	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 Contribution and POCs		
AWE Reference	Task Description	NCSP Reference	FY2017 AWE Contribution	AWE Technical POC	NCSP Technical POC	DOE Lab
Analytical Methods						
AWE-AM1	Slide rule update	ORNL-AM6, LLNL-AM3, IRSN-AM5	Review methodology, perform calculations, provide input to most appropriate establish fluence-to-dose conversion coefficients	C. Wilson	M. Duluc	ORNL
Integral Experiments						
AWE-IE1	International intercomparison of nuclear accident dosimetry using Godiva-IV	LLNL-IE2, IRSN-IE13	Participate in the production of the final report	C. Wilson	D. Heinrichs	LLNL
AWE-IE2	Flattop radiation field characterisation	LLNL-IE1, IRSN-IE14	Deploy Passive Neutron Spectrometer and undertake detailed analysis of results; Participate in final report	L. Clark	D. Heinrichs	LLNL
AWE-IE3	International intercomparison of nuclear accident dosimetry using Flattop	LLNL-IE1, IRSN-IE15	Participate in experiment design	C. Wilson	D. Heinrichs	LLNL

Reference				AWE Contribution and POCs		
AWE Reference	Task Description	NCSP Reference	FY2017 AWE Contribution	AWE Technical POC	NCSP Technical POC	DOE Lab
AWE-IE4	Godiva-IV radiation field characterisation	LLNL-IE1, IRSN-IE12	Deploy Passive Neutron Spectrometer to make additional measurements; Participate in production of final report.	C. Wilson	D. Heinrichs	LLNL
AWE-IE5	Godiva CAAS benchmark	ORNL-IE4, IRSN-IE27	Review of experiment design	T. Birkett	T. Miller	ORNL
AWE-IE6	Cf-252 CAAS benchmark	LLNL-IE1, IRSN-IE28	Deploy neutron spectrometer and/or analyse measurement data; review report	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 Spectometer	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

Reference				AWE Contribution and POCs		
AWE Reference	**Task Description**	**NCSP Reference**	**FY2017 AWE Contribution**	**AWE Technical POC**	**NCSP Technical POC**	**DOE Lab**
AWE-IE11	Conduct Integral Experiments with Molybdenum-Reflected Pu-metal Assembly	LANL-IE22	Deploy counting systems to provide independent analysis of neutron multiplicity	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	L. Clark	B. Margevicius	LANL
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	D. Heinrichs	LLNL
Information Preservation and Dissemination						
AWE-IP&D1	Conduct benchmark evaluations of legacy IEU integral experiments		Assess feasibility of sponsoring PhD; determine availability of data	C. Wilson		
Training and Education						
AWE-T&E1	Hands-on criticality safety training	LANL-T&E1, LLNL-T&E1, LLNL-T&E3, SNL-T&E1, IRSN-T&E1	AWE personnel to attend training course	R. Jones		