United States Department of Energy

Nuclear Criticality Safety Program

Five-Year Execution Plan for the Mission and Vision

FY2019 through FY2023

October 2018

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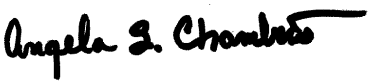
Department of Energy Nuclear Criticality Safety Program Five-Year Execution Plan for Fiscal Years 2019 through 2023, dated September 2019.

Approved:



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ACRONYMS AND DEFINITIONS

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

GODIVA	Unreflected Fast-Burst Assembly
IAEA	International Atomic Energy Agency
ICSBEP	International Criticality Safety Benchmark Evaluation Project
IE	Integral Experiments
IER	Integral Experiment Request
IP&D	Information Preservation and Dissemination
IRMM	Institute for Reference Materials and Measurements
IRSN	Institut De Radioprotection et De Sûreté Nucléaire
KENO[2]	Monte Carlo Criticality Computer Code
KRUSTY	Kilopower Reactor Using Stirling TechnologY
LA	Los Alamos (report)
LANL	Los Alamos National Laboratory
LINAC	Linear Accelerator
LLNL	Lawrence Livermore National Laboratory
MCNP®[3]	Monte Carlo N Particle Computer Code
MSTS	Mission Support and Test Services
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
NNL	Naval Nuclear Laboratory
NNSA	National Nuclear Security Administration
NNSS	Nevada Nuclear Security Site
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]COG was originally developed to solve deep penetration problems in support of underground nuclear testing. Variance reduction techniques are very important to these problems and hence the name COG was chosen as in "to cog the dice" or cheat by weighting.

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

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[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. Angela Chambers (NA-511) is the NCSP Manager. She is supported by the Criticality Safety Support Group (CSSG) and the Nuclear Data Advisory Group (NDAG), regarding technical matters, and by the Criticality Safety Coordinating Team (CSCT), consisting of Federal Criticality Safety Practitioners at the sites regarding DOE field criticality safety issues. Charters for the CSCT, CSSG, and the NDAG can be found on the NCSP website at: (http://ncsp.llnl.gov/). The NCSP Planning Calendar can also be found on the NCSP website at: (http://ncsp.llnl.gov/).

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

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

The NCSP Mission and Vision provides specific goals for each program element. Each task in the current Five-Year Plan aligns with a specific NCSP Mission and Vision goal. The number of goals addressed by the current Five-Year Plan is provided in Figure 1.1. As shown in Figure 1.1, the FY19 work tasks will help address a number of NCSP Mission and Vision Goals, and additional goals will be addressed in FY19-FY23. Overall, the NCSP is on track to accomplish a significant number of Mission and Vision goals during the next five years. Also, the installation of the measurements laboratory at NNSS has been completed. These IE goals are completed and no further work is

required. The subsequent discussion provides a summary of the projected task accomplishments and technical gaps for each program element.

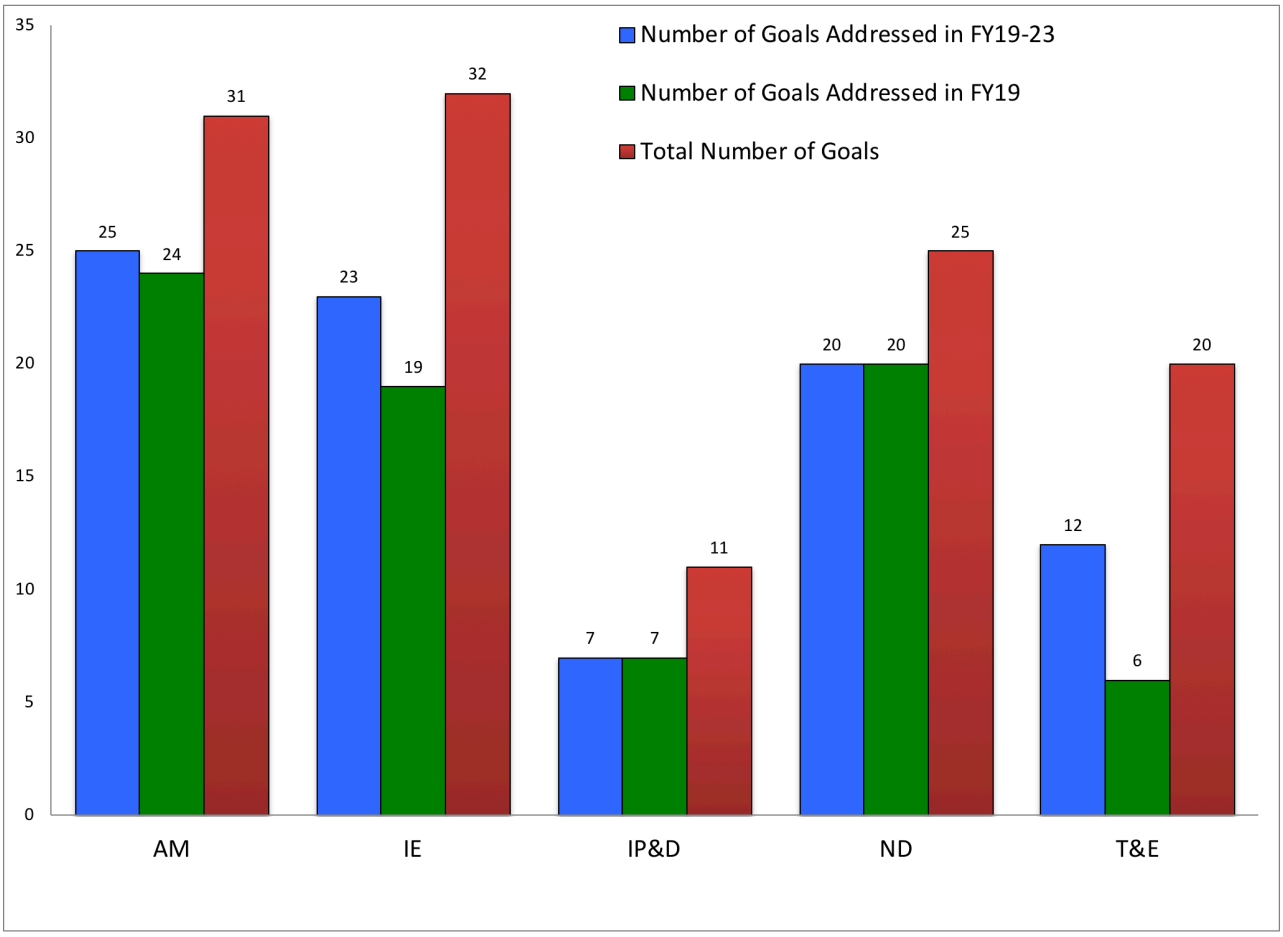


Figure 1.1 Number of NCSP Mission and Vision Program Element Goals Addressed by the NCSP Five-Year Plan

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 25 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, FY19 work tasks will address 24 of the 31 AM goals. Examples of goals not addressed in FY19 but are addressed in the out years include: thermal neutron scattering and self-shielding in GND/FUDGE; development of an adaptive-in-temperature method for fast on-the-fly sampling of thermal neutron scattering data in MCNP6. With regard to the overall AM technical gap over the next 5 years, the NCSP is continuing to make a modest investment toward the development and deployment of time-dependent multi-physics analysis capabilities to support excursion analyses; develop and maintenance of time-dependent geometry modeling capabilities; however, additional budget allocation would be needed to achieve these target AM goals during the next five years. Currently, the NCSP is not able to invest in coupling of modern NCS radiation transport software with CAD/CAE packages. Task proposals have been submitted for all of these goals, and these proposals will be considered pending increased NCSP AM budget targets.

The **Integral Experiments** program element maintains a fundamental capability for the DOE NCSP to be able to perform critical, subcritical, and fundamental physics measurements, to address specific-site needs on a prioritized basis, and this program element also supports maintaining a fundamental nuclear materials handling capability, which enables hands-on NCS training programs and various other programs for the DOE NCSP and other Government Agencies. The Five-Year Plan tasks specifically support 23 of 32 IE goals to assess, design, perform, and document integral experiments. FY19 work tasks will address 19 of 32 IE goals. Examples of goals not addressed in FY19 but are addressed in the out years include: design a neptunium critical experiment capability; design a Jezebel-like critical assembly; design and build a small sample "rabbit" transfer system. Although a smaller set of goals is addressed in FY19, a significant number of IE goals are addressed during the next five years. However, there are some IE goals that cannot be addressed within the current five-year budget targets. Examples of goals not addressed include: expansion of the radiochemistry laboratory capabilities at NNSS; standup "hot"/"cold" machine shops at NCERC; design and deploy low scatter capabilities at NCERC; acquisition of Np metal at NCERC; and the construction of new critical assemblies (solution reactor and Np burst reactor). Task proposals have been submitted for these goals, and these proposals will be considered pending increased NCSP IE budget targets.

The **Information Preservation & Dissemination** program element preserves primary documentation supporting criticality safety [e.g., benchmark critical experiments from the International Criticality Safety Benchmark Evaluation Project (ICSBEP)] and makes this information available for the benefit of the technical community including international partners (e.g., IRSN, AWE, CEA and OECD) through the NCSP website (http://ncsp.llnl.gov). The Five-Year Plan tasks specifically support 7 of 12 IP&D goals for preserving and disseminating technical, programmatic, and operational information important for nuclear criticality safety. FY19 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 FY19. Overall, there are some IP&D goals that cannot be addressed based on current budget targets. Examples of goals not addressed include: maintaining and publishing (as an electronic newsletter) a U.S./international database of near misses, operational issues and lessons learned (historical/future); implementing a process to rapidly disseminate information (e.g., operational upsets, emergency response) to criticality safety professionals ("Crit spam").

The **Nuclear Data** program element includes the measurement, evaluation, testing, and publication of neutron cross-section data for nuclides of high importance to nuclear criticality safety analyses. The Five-Year Plan tasks specifically support 20 of 25 ND goals to improve and disseminate measured and evaluated differential cross-section and covariance data needed by the AM element to support NCS analyses. FY19 work tasks will also address 20 of 25 ND goals. Examples of goals not addressed in FY19 but are addressed in the out years include: identify and prioritize differential measurements beyond the next five years; identify and prioritize differential evaluations beyond the next five years. Overall, a large number of goals are addressed within the current ND budget targets; however, technical gaps do exist, and some ND goals cannot be addressed. Examples of goals not addressed include: develop and utilize sensitivity/uncertainty (S/U) analysis capabilities to prioritize NCSP nuclear data needs and quantify target accuracies needed for differential measurement and evaluation tasks; develop new analysis tools to fully utilize new experimental capabilities such as the time project chamber (TPC), Chi-nu, and correlated data. Task proposals have been submitted for these goals, and these proposals will be considered pending increased NCSP ND budget targets.

The **Training and Education** program element identifies, develops, and facilitates training needs and educational resources (including hands-on training with fissionable material systems) in areas where no suitable alternative exists. The primary purpose of the T&E element is to maintain and enhance the technical abilities and knowledge of those who impact or are impacted directly by the practice of criticality safety. The Five-Year Plan tasks specifically support 12 of 20 T&E goals during the next five years and 6 of 20 T&E goals in FY19. The tasks primarily support the development and maintenance of the classroom and "hands-on" training courses at the Nevada Field Office, SNL and NNSS. A new course for Criticality Safety Officers will be developed to be piloted in FY20. FY19 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 FY19 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. Examples of goals not addressed include: develop an integrated compendium of training and education resources that is coordinated for consistency across US agencies and institutions and accessible to the criticality safety community; develop an integrated compendium of training and education resources that is coordinated with international partners to foster consistency on material and maximize use of unique resources; establish a sustainable program (internship, rotational assignments, etc.) to facilitate collaborative training and education opportunities (national and international); establish a multi-lab team to develop recommendations on a qualification program approach, complete with criteria, benefits, and required resources to ensure adequate implementation of the ANSI/ANS-8.26 standard, develop an NCSET module for the use of the NCS slide rule to support emergency response, and develop a mobile CAT 1 criticality hands-on critical or near critical demonstration capability. These goals will be considered pending increased NCSP T&E budget targets.

Although some technical gaps exist in each program element, execution of the NCSP Five-Year Plan will accomplish a significant number of Mission and Vision goals during the next five years. As a result, the NCSP will be able to accomplish the overall mission to provide sustainable expert leadership, direction, and technical infrastructure needed to support safe, efficient fissionable material operations within the DOE. A new Mission and Vision document is currently in development that will provide a new baseline for all NCSP technical program elements starting in FY19.

2.0 Technical Program Elements

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

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

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

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

Table 2.1 NCSP Funding Overview
(NNSA Budget Baseline Requests)

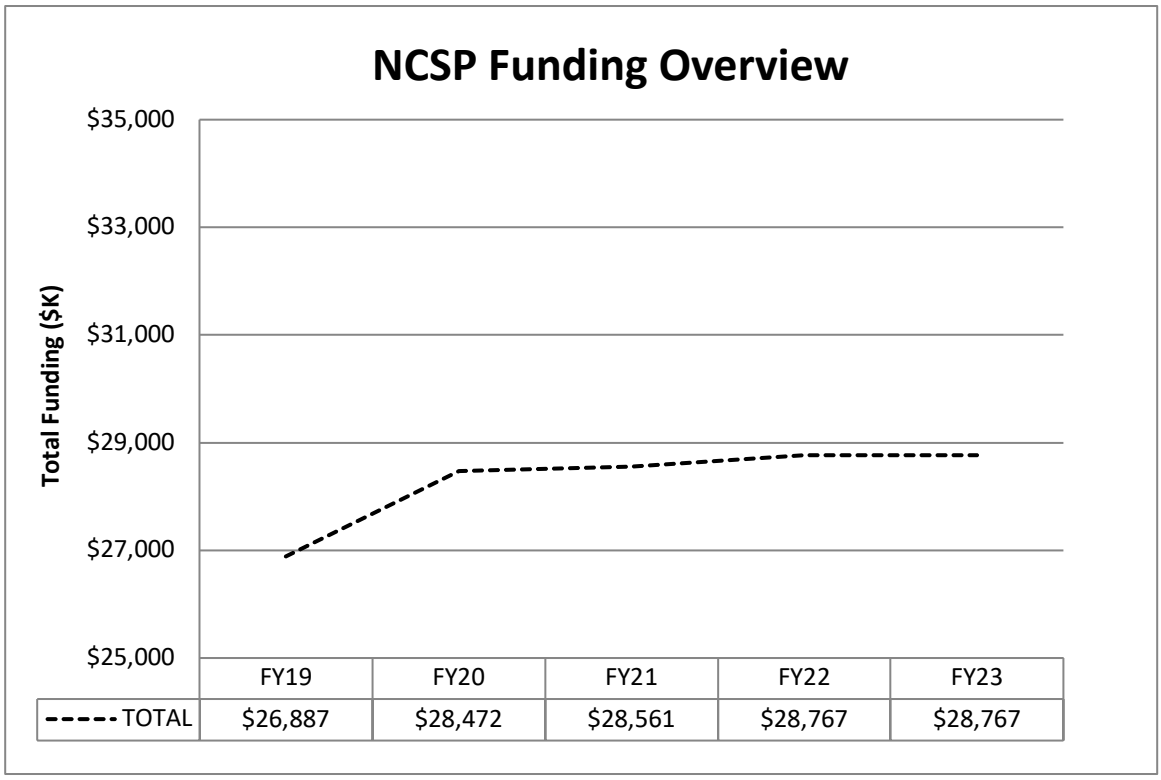
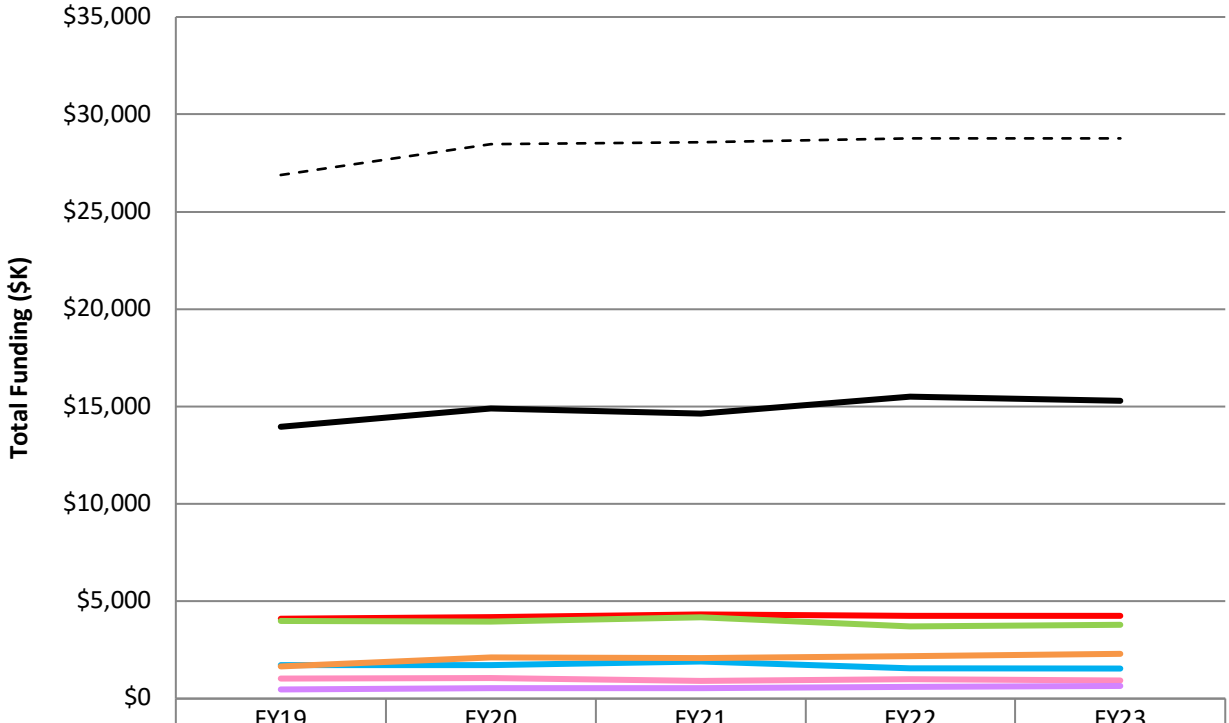
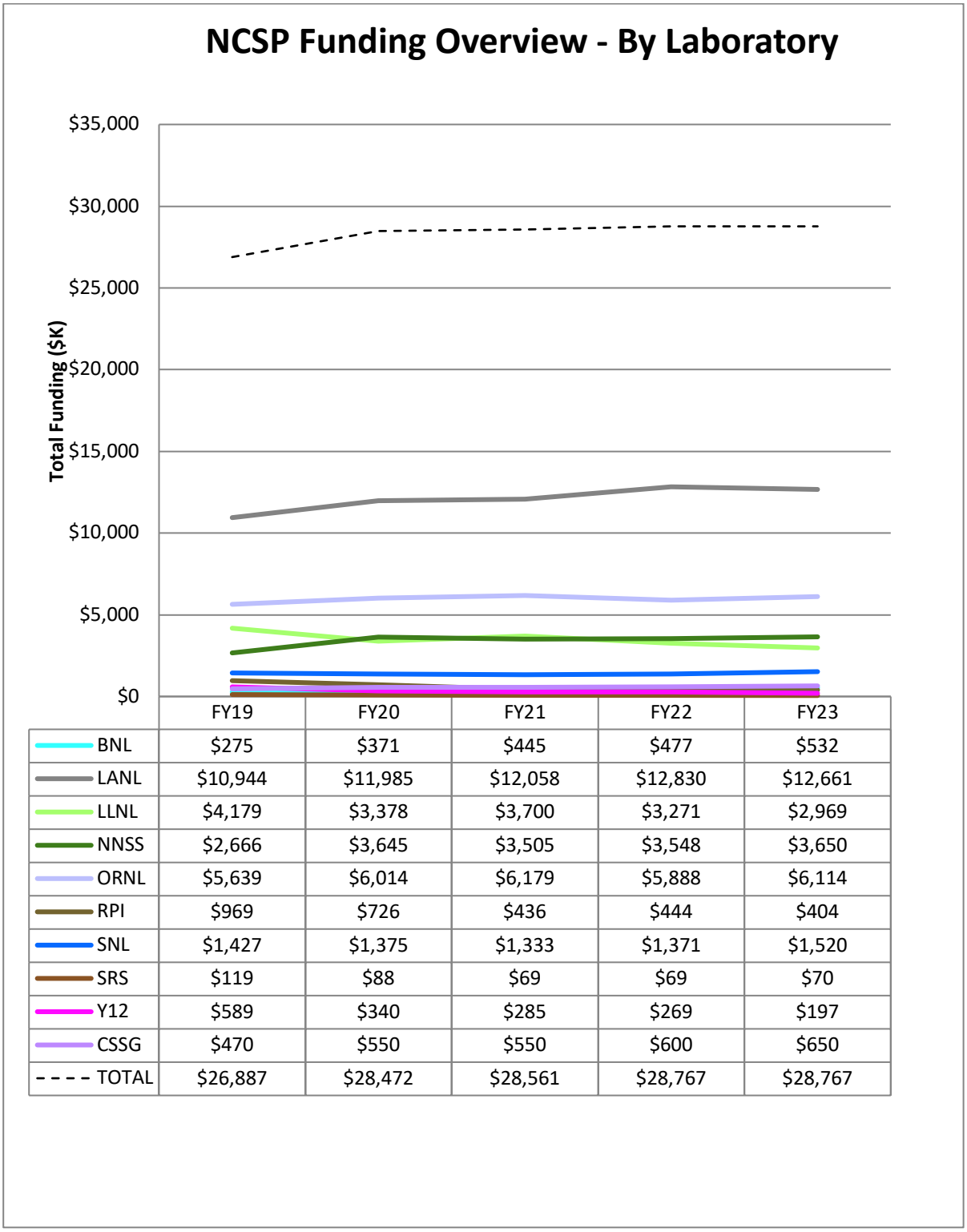


Table 2.2 NCSP Funding Overview – By Element



	FY19	FY20	FY21	FY22	FY23
AM	$4,102	$4,174	$4,322	$4,257	$4,258
IE	$13,958	$14,912	$14,626	$15,505	$15,303
IP&D	$1,017	$1,056	$909	$981	$938
ND	$3,971	$3,954	$4,175	$3,707	$3,775
T&E	$1,716	$1,722	$1,905	$1,545	$1,544
TS	$1,653	$2,104	$2,074	$2,172	$2,299
CSSG	$470	$550	$550	$600	$650
TOTAL	$26,887	$28,472	$28,561	$28,767	$28,767

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



	FY19	FY20	FY21	FY22	FY23
BNL	$275	$371	$445	$477	$532
LANL	$10,944	$11,985	$12,058	$12,830	$12,661
LLNL	$4,179	$3,378	$3,700	$3,271	$2,969
NNSS	$2,666	$3,645	$3,505	$3,548	$3,650
ORNL	$5,639	$6,014	$6,179	$5,888	$6,114
RPI	$969	$726	$436	$444	$404
SNL	$1,427	$1,375	$1,333	$1,371	$1,520
SRS	$119	$88	$69	$69	$70
Y12	$589	$340	$285	$269	$197
CSSG	$470	$550	$550	$600	$650
TOTAL	$26,887	$28,472	$28,561	$28,767	$28,767

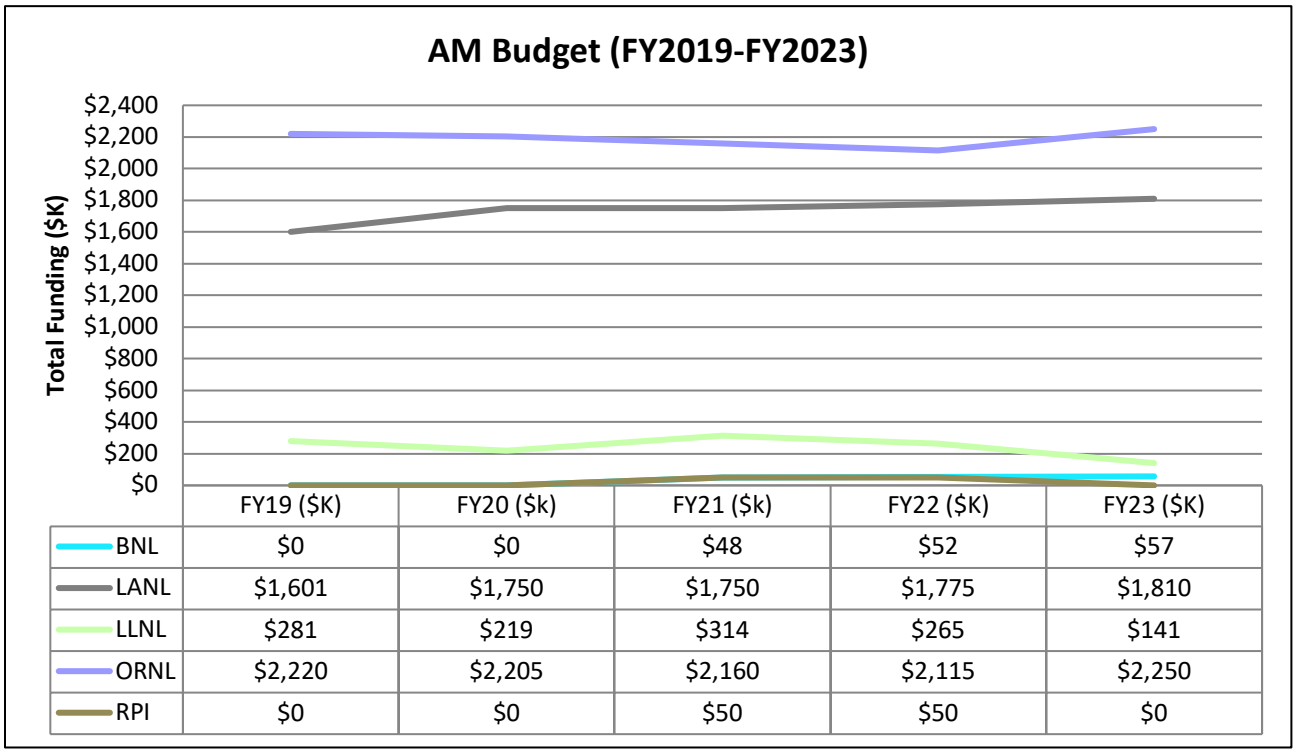
Finally, the goal of the NCSP is to provide "transparent responsiveness" for the DOE and Stakeholders. Therefore, this Plan and all accomplishments achieved under the auspices of the NCSP are posted in a timely manner on the NCSP website at: http://ncsp.llnl.gov/.

2.1 Analytical Methods (AM)

2.1.1 Program Element Description

The Analytical Methods program element provides development and maintenance of state-of-the-art analytical capabilities for the processing of nuclear data from the Evaluated Nuclear Data File (ENDF) and the radiation transport analysis needed to support Nuclear Criticality Safety (NCS) evaluations for subcriticality and shielding. An essential aspect of the AM capabilities is the human expertise required to develop the analytical software, provide software configuration control, and train and assist the user community. A table precedes each task description and provides information about the Task Name, Task Title, Task Budget, and collaborators. The list of collaborators may include IRSN or AWE. These international collaborators have provided a list of tasks of interest to each organization (see Appendix E for IRSN and Appendix F for AWE).

Table 2.1-1 AM Budget (FY2019-FY2023)



	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)	FY23 ($K)
BNL	$0	$0	$48	$52	$57
LANL	$1,601	$1,750	$1,750	$1,775	$1,810
LLNL	$281	$219	$314	$265	$141
ORNL	$2,220	$2,205	$2,160	$2,115	$2,250
RPI	$0	$0	$50	$50	$0

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

- BNL will be funded in FY21-FY23 to work with LLNL and universities to incorporate Thermal Scattering and Self-Shielding in GND/FUDGE.
- LANL's funding will not significantly increase in the out years, although there are some very modest increases in LANL-AM1 and LANL-AM2 funding in FY22 and FY23.
- LLNL's funding will decrease after a small peak in FY21 due to the completion of LLNL-AM5 and LLNL-AM7 tasks.
- After a slight decline in funding in FY19 ORNL's funding will increase in out years to support additional scope in ORNL-AM2 and ORNL-AM3.

2.1.2 Approved Tasks

2.1.2.1 Los Alamos National Laboratory (LANL)

Task Name	Task Title
LANL AM1	MCNP Maintenance and Support, Uncertainty Analysis Development, and Modernization
Budget	**Collaborators**
$1,200K	IRSN (IRSN-AM15)

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

Task Name	Task Title
LANL AM2	NJOY Development and Maintenance, Uncertainty Analysis Development, and Modernization
Budget	**Collaborators**
$270K	IRSN (IRSN-AM7)

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.

Task Name	Task Title
LANL AM4	Sensitivity/Uncertainty Comparison Study with a Focus on Upper Subcritical Limits
Budget	**Collaborators**
$46K	IRSN (IRSN-AM14), ORNL (ORNL-AM9)

Sensitivity-Uncertainty Comparison Study with a Focus on Upper Subcritical Limits. LANL, ORNL, and IRSN will compare results from the various methods on a small set of benchmark problems. Collaboration with ORNL and IRSN. Results will be documented in a report.

Task Name	Task Title
LANL AM5	Proposed Benchmark Intercomparison Study
Budget	**Collaborators**
$50K	IRSN (IRSN-AM13), ORNL (ORNL-AM10), LLNL (LLNL-AM5)

Inter-laboratory Benchmark Comparison Study. The proposal is for IRSN to lead a new comparison based on the MORET code with the latest JEFF-3.2 data and ENDF/B-VIII.0 data, when available, using their existing comprehensive selection of 2,714 benchmarks and collate their results together with those from LLNL (COG), LANL (MCNP) and ORNL (SCALE).

Task Name	Task Title
LANL-AM6	Technical Data for the Pitzer Formulation of Solution Compositions to Include Uranium/Plutonium Solutions with Selected Admixed Absorbers
Budget	**Collaborators**
$35K	ORNL (ORNL-AM16), LLNL (LLNL-AM7), IRSN (IRSN-AM17)

This is a new task to support development of Pitzer formulations for uranium and plutonium solutions for inclusion into the SCALE system and MCNP material input processor. ORNL is the lead on this task.

Table 2.1-2 LANL AM Budget Trend (FY2019-FY2023)

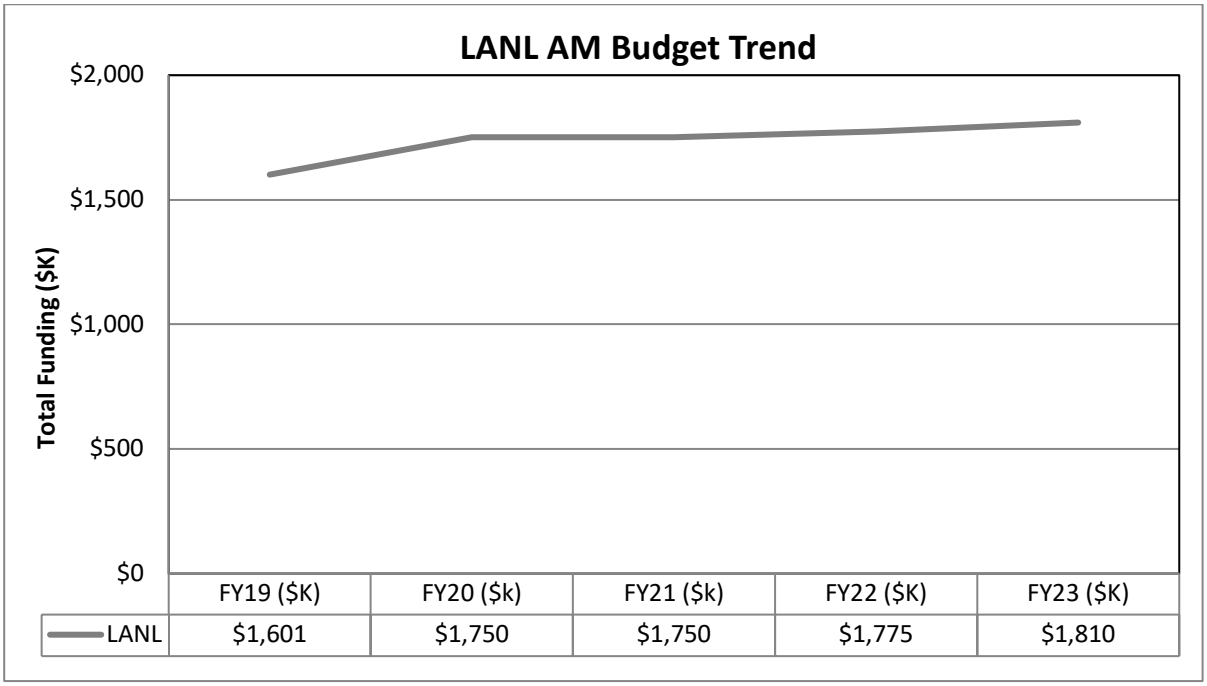
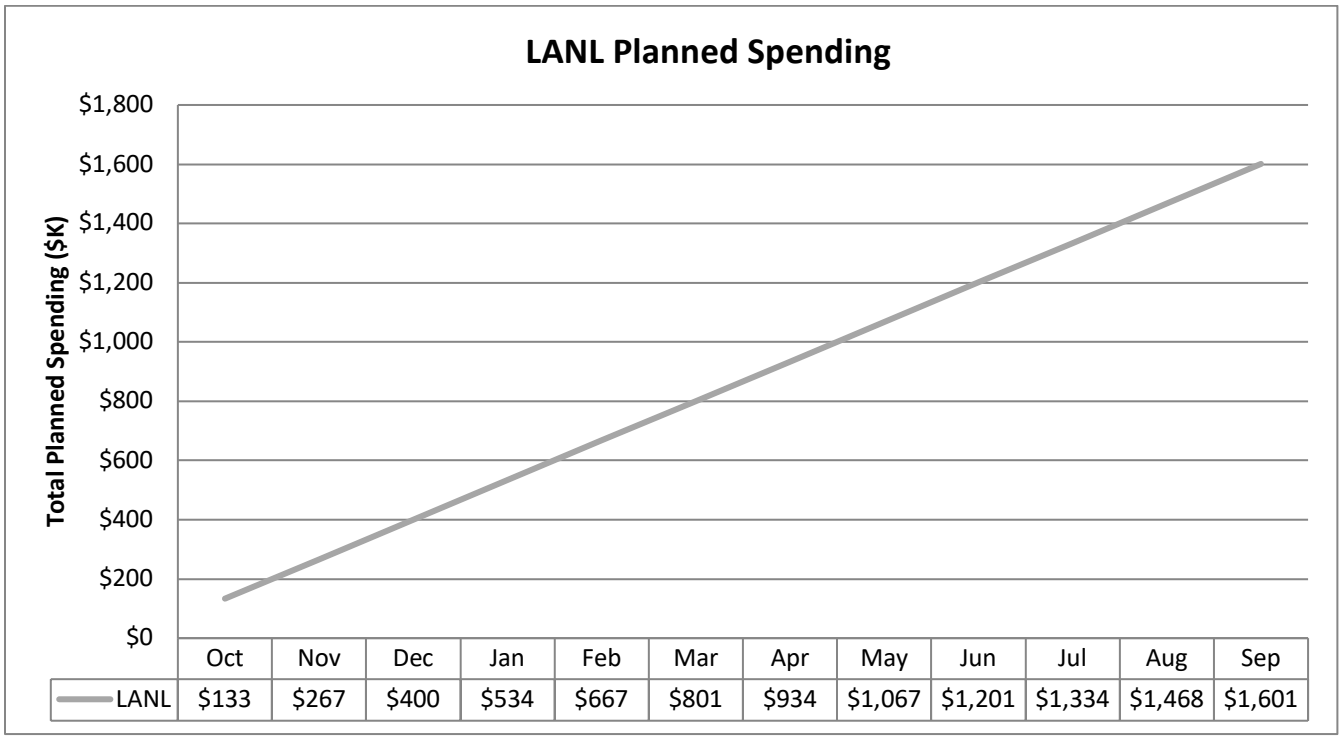


Table 2.1-3 LANL AM Planned Spending (FY2019)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LANL	$133	$267	$400	$534	$667	$801	$934	$1,067	$1,201	$1,334	$1,468	$1,601

LANL AM Milestones:

Occurs all 4 Quarters

- Support MCNP6 users (AM1)
- Support NJOY users (AM2)
- Provide status reports on LANL participation in US and International analytical methods collaborations (AM1, AM2, AM4, AM5, and AM6)

Quarter 1

- Provide reports on summer intern work accomplished (AM1)

Quarter 2

- Issue an MCNP V&V report, including ENDF/B-VIII.0 (AM1)
- Provide MCNP6 Criticality training course (AM1)
- Provide status of R&D and modernization efforts at the NCSP Technical Program Review (AM1)
- Implement the Doppler broadening capabilities into the NJOY21 framework (AM2)

Quarter 3

- Release initial version of MCNP6 with automatic convergence testing & under-sampling diagnostics to several NCSP early-adopters for testing, issue report (AM1)

Quarter 4

- Implement ACER fast neutron capabilities into the NJOY21 framework (AM2)
- Issue report on the Sensitivity-Uncertainty Comparison Study (AM4)
- Issue report on the ICSBEP Benchmark Comparison Study (AM5)
- Document and release beta versions of ENDF/B-VIII.1 evaluations in ACE format on LANL website (AM1)

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

Beginning in FY22, there is a modest increase in funding to enhance MCNP6 to enable more rigorous NCS experiment simulations.

2.1.2.2 Lawrence Livermore National Laboratory (LLNL)

Task Name	Task Title
LLNL-AM2	Multi-Physics Methods for Simulation of Criticality Excursions
Budget	**Collaborators**
$137K	IRSN (IRSN-AM16)

This is an ongoing approved task to support and build upon existing LLNL state-of-the-art 3-D analytical and multi-physics methods including participation in international collaboration efforts (e.g., CSEWG, IAEA, OECD).

Task Name	Task Title
LLNL-AM3	Slide Rule Application
Budget	**Collaborators**
$31K	IRSN (IRSN-AM5), (AWE-AM1), ORNL (ORNL-AM6)

This is an ongoing task to support work to generate and update a criticality slide rule, including for plutonium systems. IRSN is the lead on this task.

Task Name	Task Title
LLNL-AM5	Proposed Benchmark Intercomparison Study
Budget	**Collaborators**
$50K	IRSN (IRSN-AM13), ORNL (ORNL-AM10), LANL (LANL-AM5)

Inter-laboratory Benchmark Comparison Study. The proposal is for IRSN to lead a new comparison based on the MORET code with the latest JEFF-3.2 data and ENDF/B-VIII.0 data, when available, using their existing comprehensive selection of 2,714 benchmarks and collate their results together with those from LLNL (COG), LANL (MCNP) and ORNL (SCALE).

Task Name	Task Title
LLNL-AM6	Proposed 1-D Multipoint Analytical Benchmark Comparison
Budget	**Collaborators**
$23K	ORNL (ORNL-AM11), University of Arizona

This is a continuing task to support development of a new one-dimensional multi-energy-point analytic benchmark and perform intercomparison studies of NCSP analytical methods using analytical benchmarks. ORNL will collaborate with LLNL on this task. *Carry-over funds from FY18 will be used for this task as well.*

Task Name	Task Title
LLNL-AM7	Technical Data for the Pitzer Formulation of Solution Compositions to Include Uranium/Plutonium Solutions with Selected Admixed Absorbers
Budget	**Collaborators**
$40K	ORNL (ORNL-AM16), LANL (LANL-AM6)

This is a new task to support development of Pitzer formulations for uranium and plutonium solutions for inclusion into the SCALE system and MCNP material input processor. ORNL is the lead on this task.

Table 2.1-4 LLNL AM Budget Trend (FY2019-FY2023)

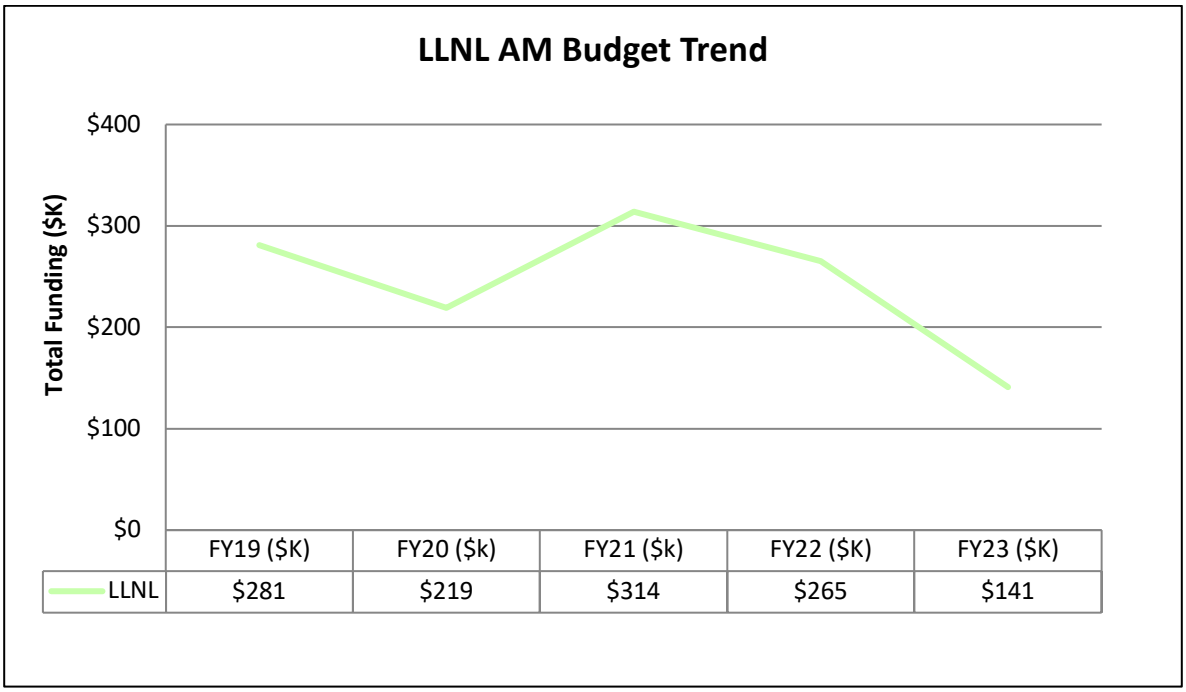
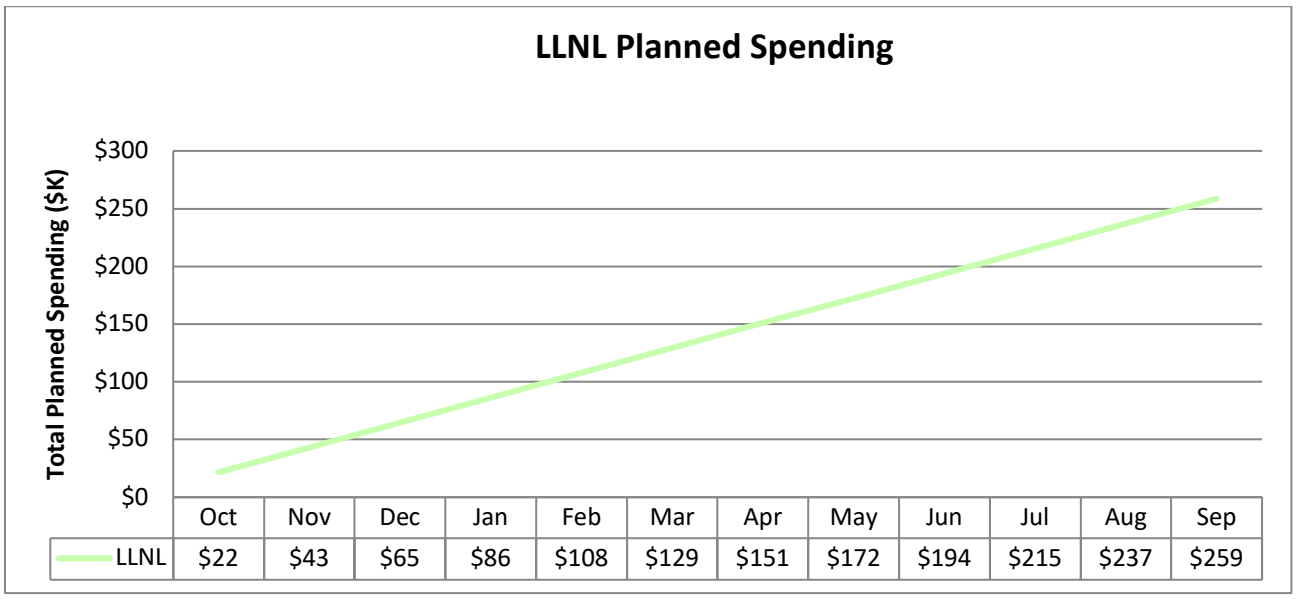


Table 2.1-5 LLNL AM Planned Spending (FY2019)*



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

LLNL AM Milestones:

Occurs all 4 Quarters

- Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, AM5, AM6, AM7).

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

LLNL's funding will increase in FY19 to collaborate with BNL incorporating Thermal Scattering and Self-Shielding in GND/FUDGE (LLNL-AM4) starting in FY21.

2.1.2.3 Oak Ridge National Laboratory (ORNL)

Task Name	Task Title
ORNL-AM1	Radiation Safety Information Computational Center (RSICC)
Budget	**Collaborators**
$325K	None

RSICC ongoing approved task to collect, update, package, and distribute software and associated nuclear data libraries (i.e., SCALE, MCNP, VIM, and COG and nuclear data processing (i.e., NJOY, AMPX and SAMMY) to the NCS community. The NCS community includes: DOE and NNSA M&O NCS staff, e.g., LANL, LLNL, SNL, SRNS, etc., DOE-EM M&O NCS staff, e.g., PGDP, PORTS, SRNL, etc. This does not include NRC-regulated NCS staff, M&O subcontractors, and independent consultants. University students in Nuclear Engineering programs performing NCS analysis is also included. Also, test and disseminate processed nuclear data associated with the software.

Task Name	Task Title
ORNL-AM2	SCALE/KENO/TSUNAMI Maintenance and Support/Cross-Section and Generation/Modernization
Budget	**Collaborators**
$1,200K	IRSN (IRSN-AM1, IRSN-AM3)

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.

Task Name	Task Title
ORNL-AM3	AMPX Maintenance and Modernization
Budget	**Collaborators**
$270K	IRSN (IRSN-AM9)

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.

Task Name	Task Title
ORNL-AM6	Slide Rule Application
Budget	**Collaborators**
$31K	IRSN (IRSN-AM5), AWE (AWE-AM1), LLNL (LLNL-AM3)

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

Task Name	Task Title
ORNL-AM9	Sensitivity/Uncertainty Comparison Study with a Focus on Upper Subcritical Limits
Budget	**Collaborators**
$46K	IRSN (IRSN-AM14), LANL (LANL-AM4)

This is a new task to examine various methods that have been developed recently to assist the Criticality Safety Analyst (CSA) determine a safe Upper Subcritical Limit (USL) for an application of interest. IRSN has developed the MACSENS tool which relies on Monte Carlo results from the MORET code. ORNL has developed the TSUNAMI package, which relies on Monte Carlo results from KENO (among various transport options), and LANL has developed the Whisper package which relies on Monte Carlo results from MCNP6.® The three Laboratories will compare results from the various methods on a small set of benchmark problems to be chosen. Differences in results will be understood, and one or more of the methods may be improved as a result. The results for these benchmark problems, such as sensitivity profiles and individual components of the USL, will be compared. The NCSP AM Working Group will provide a forum for presenting and discussing results to ensure timely completion of the milestones. One of the three Labs will be responsible for consolidating and comparing calculated results and for preparing a summary report.

Task Name	Task Title
ORNL-AM10	Proposed Benchmark Intercomparison Study
Budget	**Collaborators**
$50K	IRSN (IRSN-AM13), LLNL (LLNL-AM5), LANL (LANL-AM5)

Inter-laboratory Benchmark Comparison Study. The proposal is for IRSN to lead a new comparison based on the MORET code with the latest JEFF-3.2 data and ENDF/B-VIII.0 data, when available, using their existing comprehensive selection of 2,714 benchmarks and collate their results together with those from LLNL (COG), LANL (MCNP) and ORNL (SCALE).

Task Name	Task Title
ORNL-AM11	Proposed 1-D Multipoint Analytical Benchmark Intercomparison
Budget	**Collaborators**
$0K – FY18 Carryover – $24K	LLNL (LLNL-AM6), University of Arizona

This task involves the completion of a comparison of several computational features of both NCSP Monte Carlo and U. of Arizona deterministic codes in the diffusion approximation. Since the analytical solution accommodates upwards of 500 energy points, a meaningful criticality comparison of codes and libraries becomes possible including resonance treatments. With a full heterogeneous solution, we can also study 1D assemblies as to their composition and including control rods and various fuel designs. With an overall comparison to a true analytical solution as a baseline, one can document biases, if any, in Monte Carlo codes. The University of Arizona will establish the 1-D analytical benchmarks, ORNL will provide COG Monte Carlo results (ORNL-AM6), and ORNL will provide SCALE Monte Carlo results for this task. The work progress on this task will be monitored by the NCSP Analytical Methods Working Group. *Carry-over funds from FY18 will be used for this task.*

Task Name	Task Title
ORNL-AM13	Nuclear Data and Cross Section Testing Using ENDF/B-VIII.0
Budget	**Collaborators**
$89K	University of Florida

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

Task Name	Task Title
ORNL-AM14	Development and Addition of Continuous-Energy Sensitivity Data Files to SCALE's VALID Library
Budget	**Collaborators**
$34K	University of Tennessee

Provide a rigorous technical basis for selecting critical experiment benchmarks for use in validating computer codes.

Task Name	Task Title
ORNL-AM15	The Effects of Temperature on the Propagation of Nuclear Data Uncertainty in Nuclear Criticality Safety Calculations
Budget	**Collaborators**
$100K	Massachusetts Institute of Technology

This is a new task to develop an analytic methodology and implement it in a module of the AMPX nuclear data processing code to allow the nuclear data covariance to accurately reflect the degree of knowledge of the cross section at different temperatures. This new capability will allow for investigating and demonstrating the effects of temperature on the propagation of nuclear data uncertainty in nuclear criticality safety applications.

Task Name	Task Title
ORNL-AM16	Technical Data for the Pitzer Formulation of Solution Compositions to Include Uranium/Plutonium Solutions with Selected Admixed Absorbers
Budget	**Collaborators**
$75K	LLNL (LLNL-AM7), LANL (LANL-AM6)

This is a new task to develop the safety basis from existing material density data and/or perform additional chemistry experiments, as needed. Reduce the data to fit the Pitzer formulations for the uranium (Near-Term Objective) and plutonium (Long-Term Objective) solutions. This formulation capability will be incorporated into the SCALE System and it can be incorporated into the MCNP material input processor. ORNL is the lead on this task.

Table 2.1-6 ORNL AM Budget Trend (FY2019-FY2023)

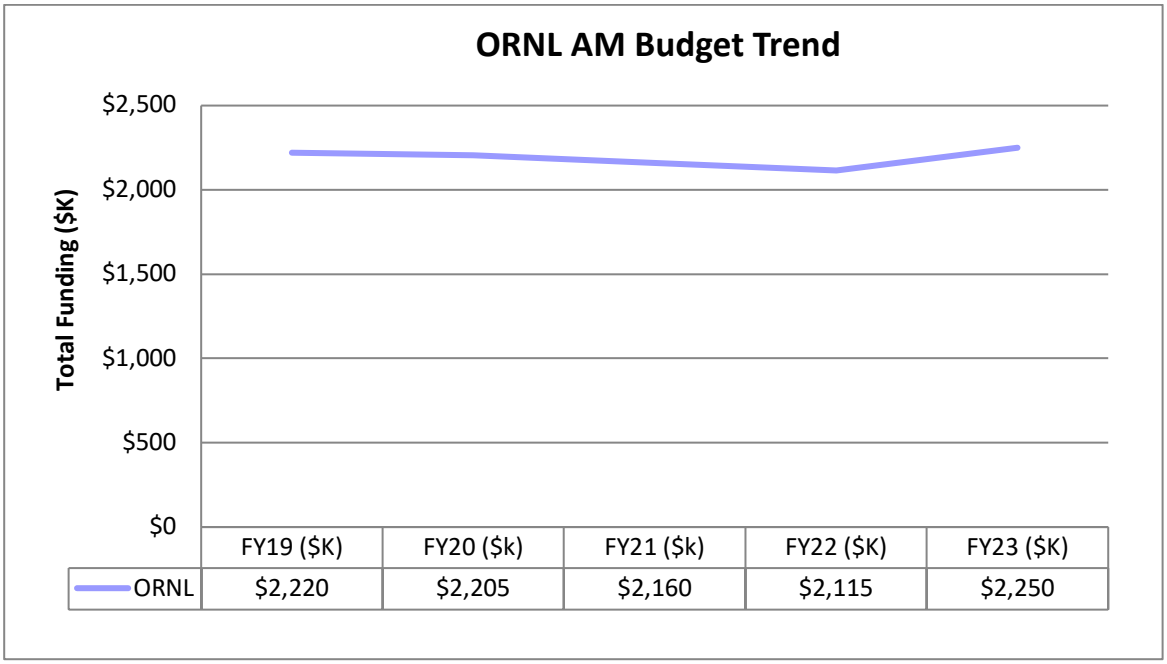
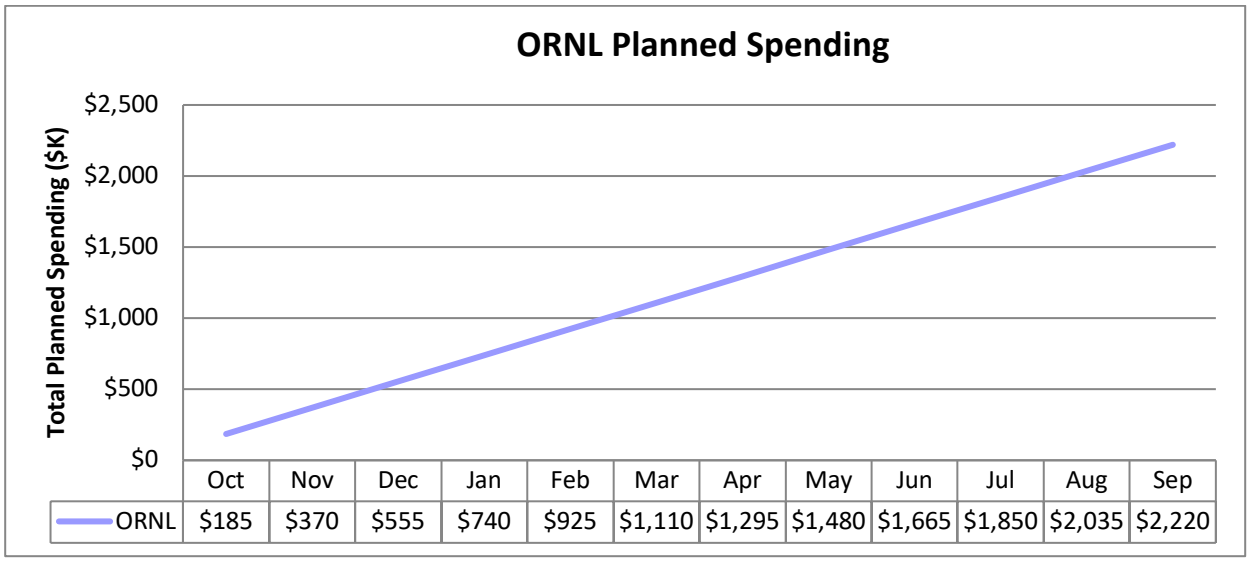


Table 2.1-7 ORNL AM Planned Spending (FY2019)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
ORNL	$185	$370	$555	$740	$925	$1,110	$1,295	$1,480	$1,665	$1,850	$2,035	$2,220

ORNL AM Milestones:

Occurs all 4 Quarters

- Continue distribution of available and newly packaged software to the NCS community requesters (at no direct cost to them) and provide distribution totals quarterly. (AM1)
- Provide status reports on ORNL participation in US and International Analytical Methods collaborations and provide brief trip summary report to NCSP Manager on items of NCSP interest. (AM2, AM3)
- Provide status on ORNL AM activities in NCSP Quarterly Progress Reports. (AM1, AM2, AM3, AM6, AM9, AM10, AM11, AM13, AM14, AM15, AM16)

Quarter 2

- Issue an annual SCALE maintenance report to the NCSP Manager. (AM2)

Quarter 4

- Publish annual newsletter to users to communicate software updates, user notices, generic technical advice, and training course announcements. (AM2)
- Document AMPX modernization and technical support for SCALE CE, multigroup, and covariance libraries and report status annually to the NCSP Manager. (AM3)

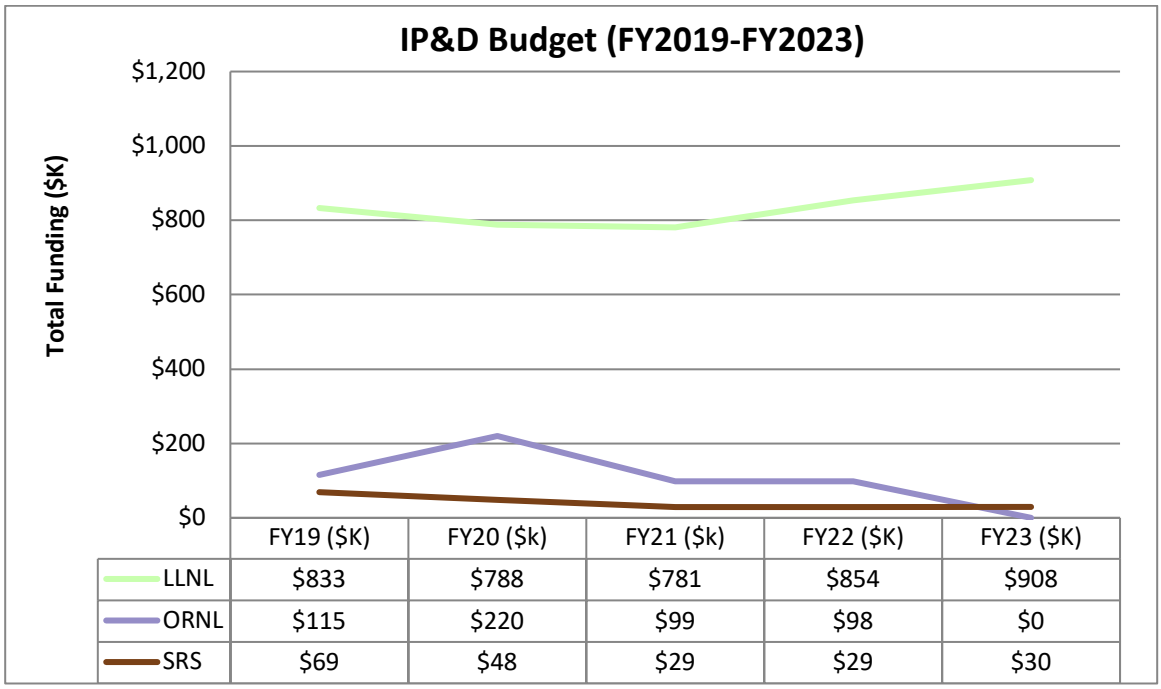
EOC – for out-year peaks and dips in budget plots:
ORNL's funding will decrease slightly over the period FY19-22 but will increase in FY23 due to a slight increase in SCALE maintenance funding in FY23.

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 (FY2019-FY2023)



	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)	FY23 ($K)
LLNL	$833	$788	$781	$854	$908
ORNL	$115	$220	$99	$98	$0
SRS	$69	$48	$29	$29	$30

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

- LLNL's funding will increase in out years for additional ICSBEP capabilities, tasks, and milestones in addition to upgrading the NCSP website with a "search" capability. The NCSP classified website and NCSP Integral Experiment Database has been discontinued.
- 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 continue in FY19 to continue support and maintenance for the CritView software that includes ARH-600 data, and funding for this task will decrease in the out years due to the transition from development to maintenance of the CritView software (it is expected that bugs and improvements will decline FY19-FY23.

2.2.2 Approved Tasks

2.2.2.1 Lawrence Livermore National Laboratory (LLNL)

Task Name	Task Title
LLNL IPD1	Conduct ICSBEP for Benchmarks listed in Appendix C of the 5-Year Plan and publish annual revision to the Handbook
Budget	**Collaborators**
$275K	IRSN (IRSN-IPD1), AWE (AWE-IPD1)

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

Task Name	Task Title
LLNL IPD2	Maintain the NCSP Website and Systems
Budget	**Collaborators**
$458K	None

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

Task Name	Task Title
LLNL IPD4	Benchmark Evaluation of Hot Box, LLNL Historical Critical Configurations at High Temperature
Budget	**Collaborators**
$100K	None

This is a new approved task for evaluation of the LLNL “Hot Box” for inclusion in the ICSBEP Handbook.

Table 2.2-2 LLNL IPD Budget Trend (FY2019-FY2023)

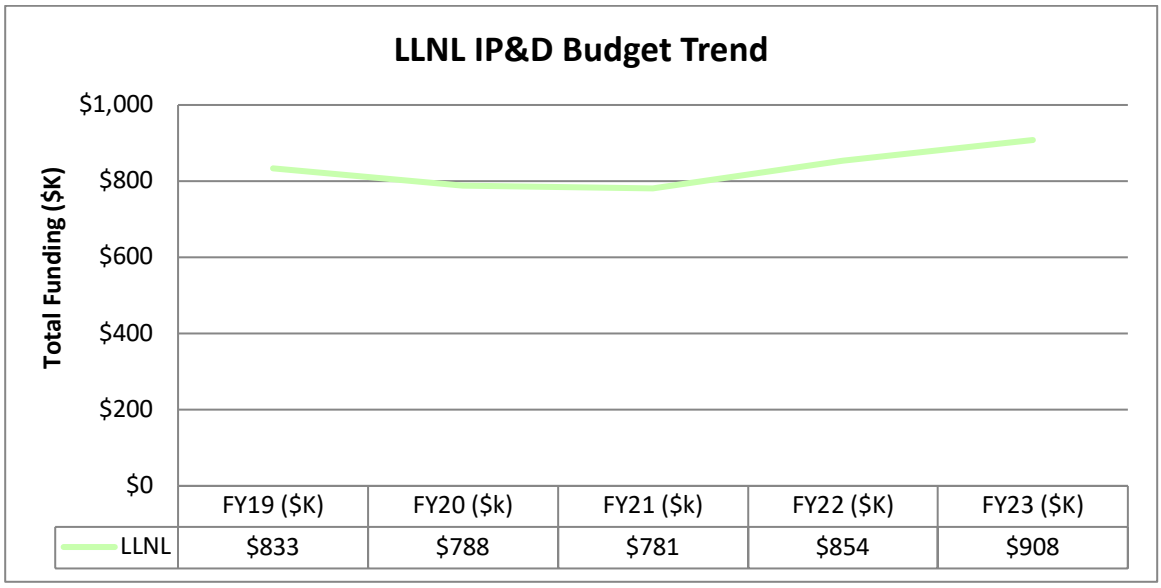
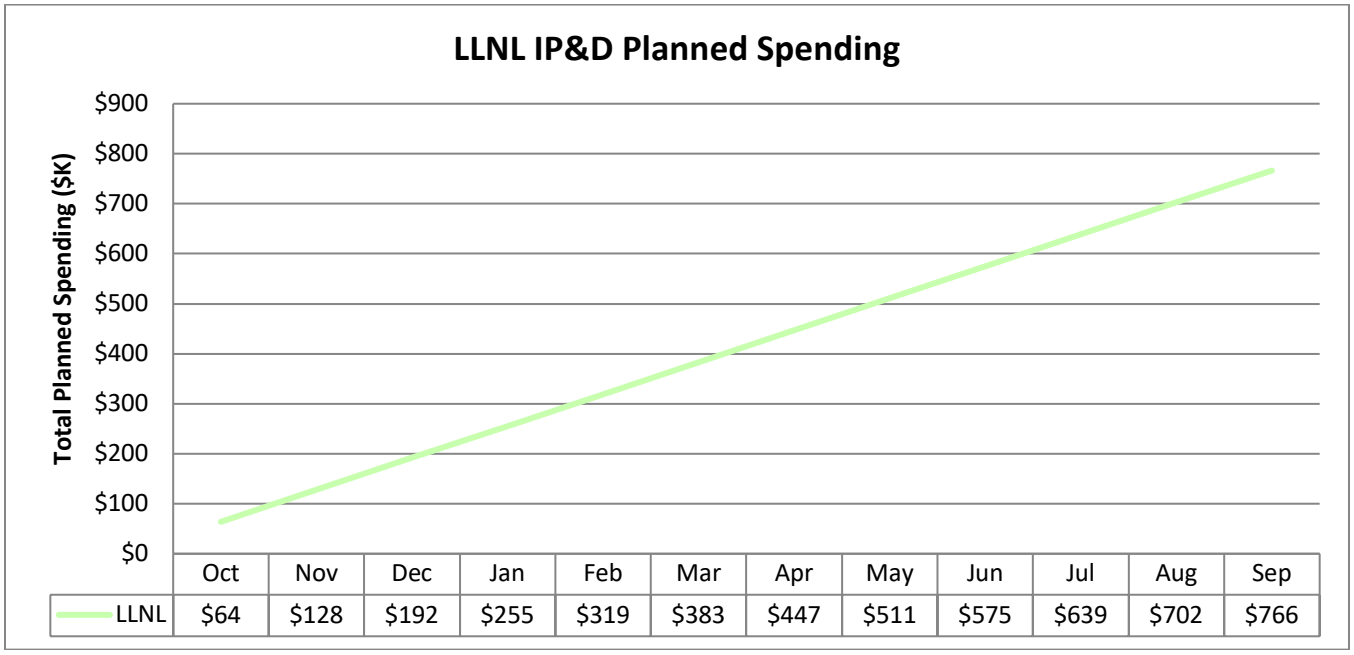


Table 2.2-3 LLNL IP&D Planned Spending (FY2019)*



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

LLNL IPD 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. (IPD1)
- Provide status reports on LLNL participation in US and International IPD collaborations (including ICSBEP) and provide brief summary report to NCSP Manager on items of NCSP interest. (IPD1)
- Maintain, operate and modernize he NCSP website, databases, and provide user assistance as required. (IPD2)
- Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. (IPD4)

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

LLNL's funding will increase in out years for additional ICSBEP capabilities, tasks, and milestones. The NCSP classified website and the NCSP Integral Experiment database was discontinued starting in FY19.

2.2.2.2 Oak Ridge National Laboratory (ORNL)

Task Name	Task Title
ORNL IPD5	Oak Ridge Health Physics Research Reactor CAAS Benchmark Evaluation
Budget	**Collaborators**
$100K	None

Generate a CAAS benchmark for the ICSBEP using measurement data from the Oak Ridge Health Physics Research Reactor (HPRR). The first subtask involves a search of the ORNL archives to determine if the information needed to create an ICSBEP CAAS benchmark based on the HPRR is available. All the relevant information will be documented in a fashion like CED-3b of the CEdT process. At the end of the first year, the data collected during the first subtask will be evaluated, and if it is deemed possible to create a new CAAS benchmark then the second subtask will begin in FY20.

Task Name	Task Title
ORNL IPD6	Preservation and Dissemination of Unpublished Critical Experiments by Mihalczo
Budget	**Collaborators**
$15K	None

Assist Dr. John Mihalczo, ORNL Ret., to identify documentation of ~25 critical experiments and ~10 subcritical experiments he performed during his career at ORNL. The results of this task will be used report to the NCSP Manager those experiments that may be of benefit to the NCS community. Those experiments of value to the NCS community will be described in a subsequent proposal. These experiments have been documented internally by Mihalczo and his colleagues, but the details of these experiments have not been published openly beyond a short abstract for different conferences.

Table 2.2-4 ORNL IP&D Budget Trend (FY2019-FY2023)

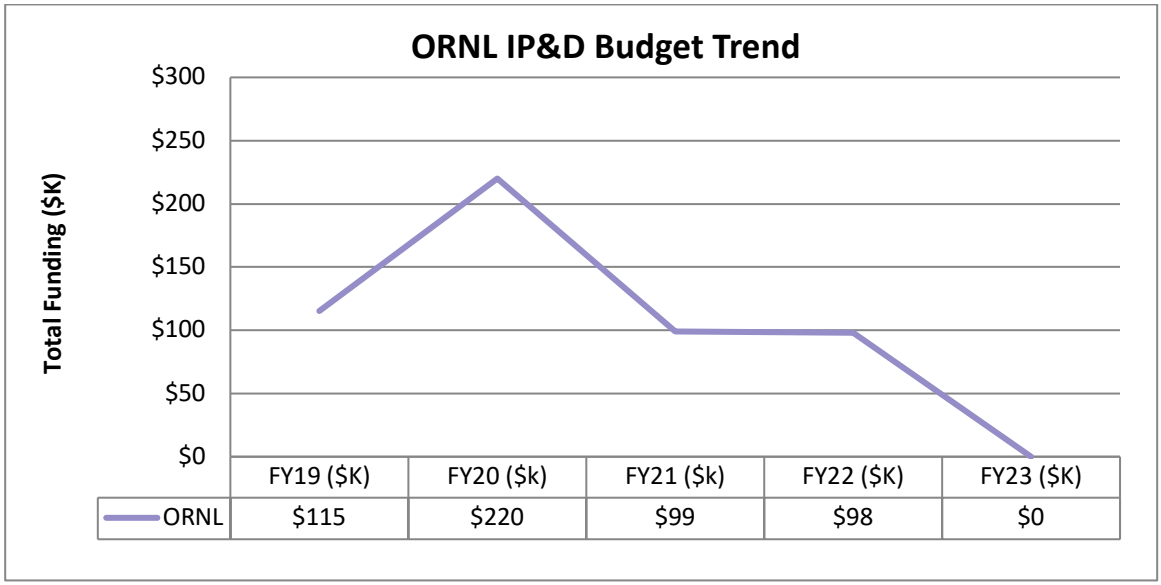
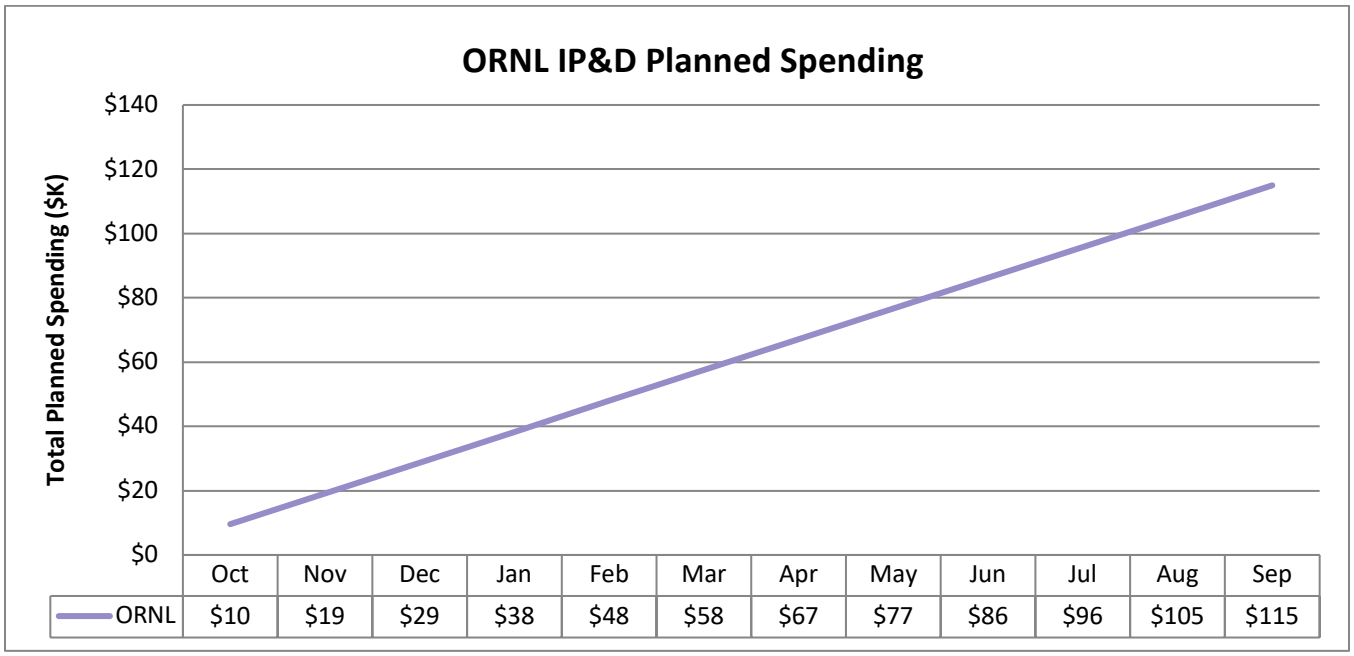


Table 2.2-5 ORNL IP&D Planned Spending (FY2019)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
ORNL	$10	$19	$29	$38	$48	$58	$67	$77	$86	$96	$105	$115

ORNL IPD MILESTONES:

Quarter 2

- Complete documentation of data needed for an ICSBEP benchmark based on the ORNL HPRR (IPD5)

Quarter 3

- Perform initial evaluation of HPRR data and determine if this task should continue (IPD5)

Quarter 4

- Perform some initial benchmark simulations to evaluate the quality of the data collect in IPD5 and the ability to simulate the measured data (IPD5)
- Report on progress made with the review of 25 critical experiments and their potential applicability and quality for generating ICSBEP evaluations in an FY20 NCSP proposal (IPD6)

EOC – for out-year peaks and dips in budget plots:
Funding for ORNL benchmark work in IPD5 and IPD6 peak in FY20 then funding declines as a result of task completion.

2.2.2.3 Savannah River Site (SRS)

Task Name	Task Title
SRS IPD1	ARH-600 Reissue
Budget	**Collaborators**
$69K	None

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

Table 2.2-6 SRS IP&D Budget Trend (FY2019-FY2023)

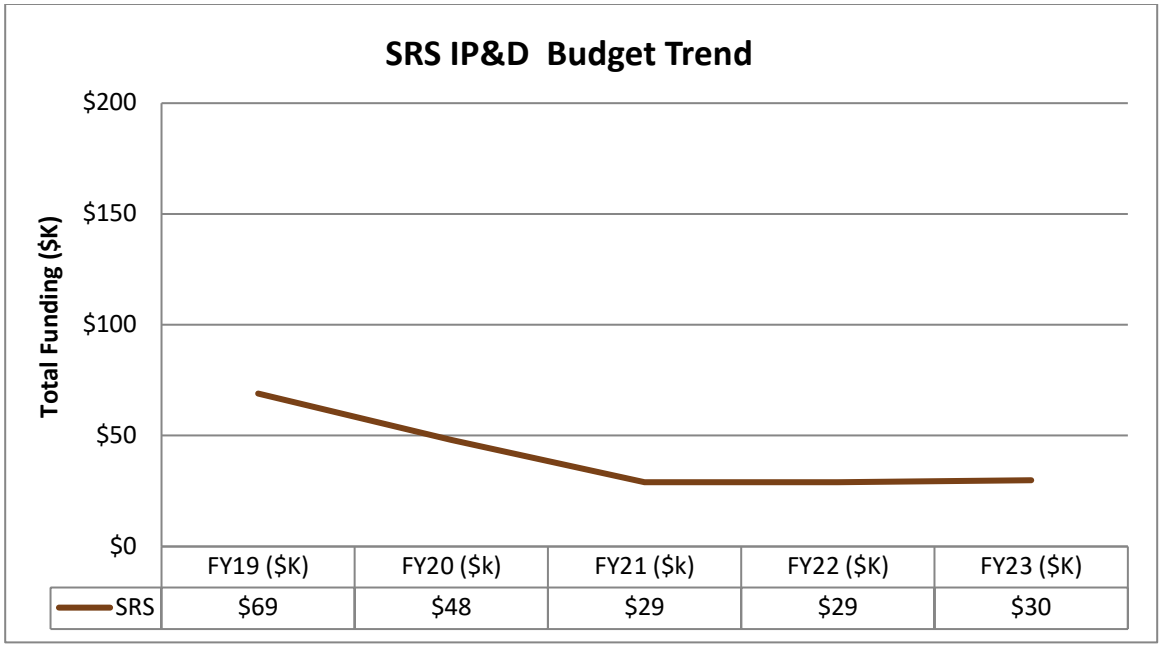
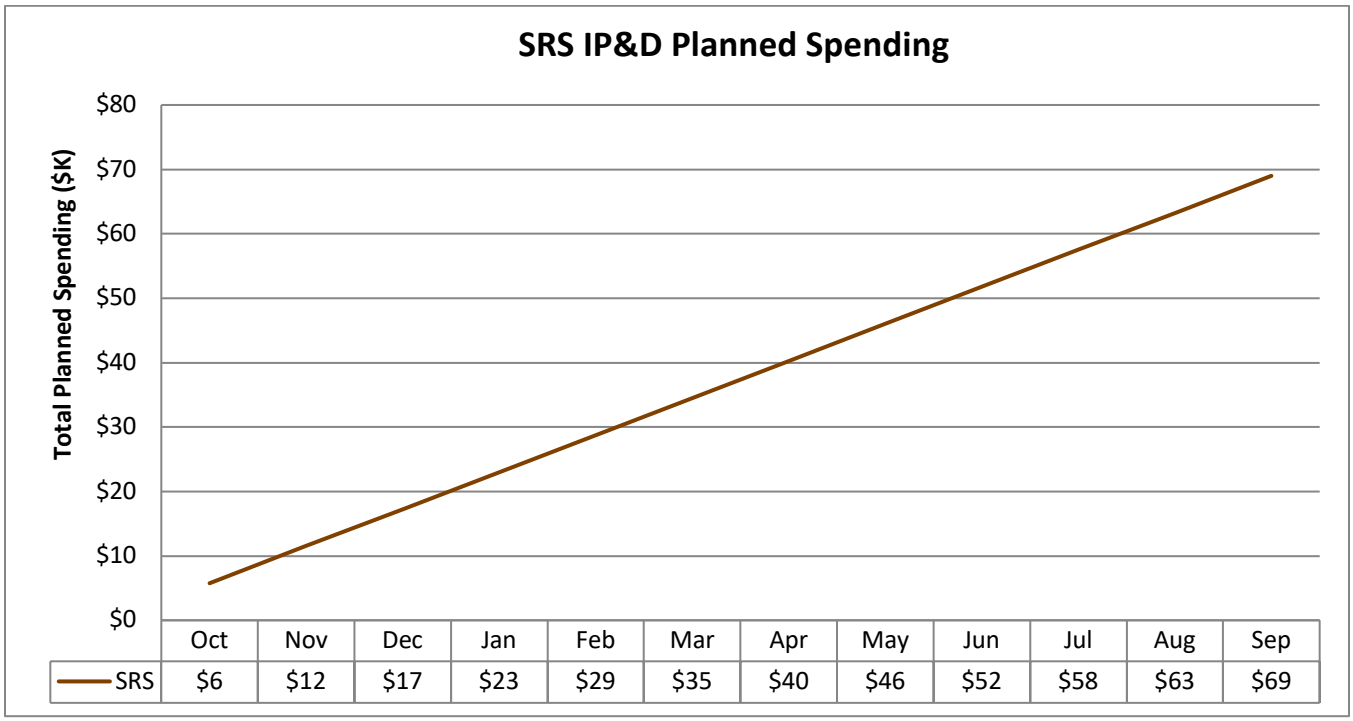


Table 2.2-7 SRS IP&D Planned Spending (FY2019)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SRS	$6	$12	$17	$23	$29	$35	$40	$46	$52	$58	$63	$69

SRS IP&D Milestones

Occurs all 4 Quarters
- Provide status reports on SRS progress. (IPD1)

Quarter 2
- Develop QA documents for current version to meet current SRS/DOE requirements. (IPD1)

Quarter 4
- Issue Preliminary (updated) CritView version for internal testing. (IPD1)
- Issue Preliminary User Guide to support internal testing. (IPD1)

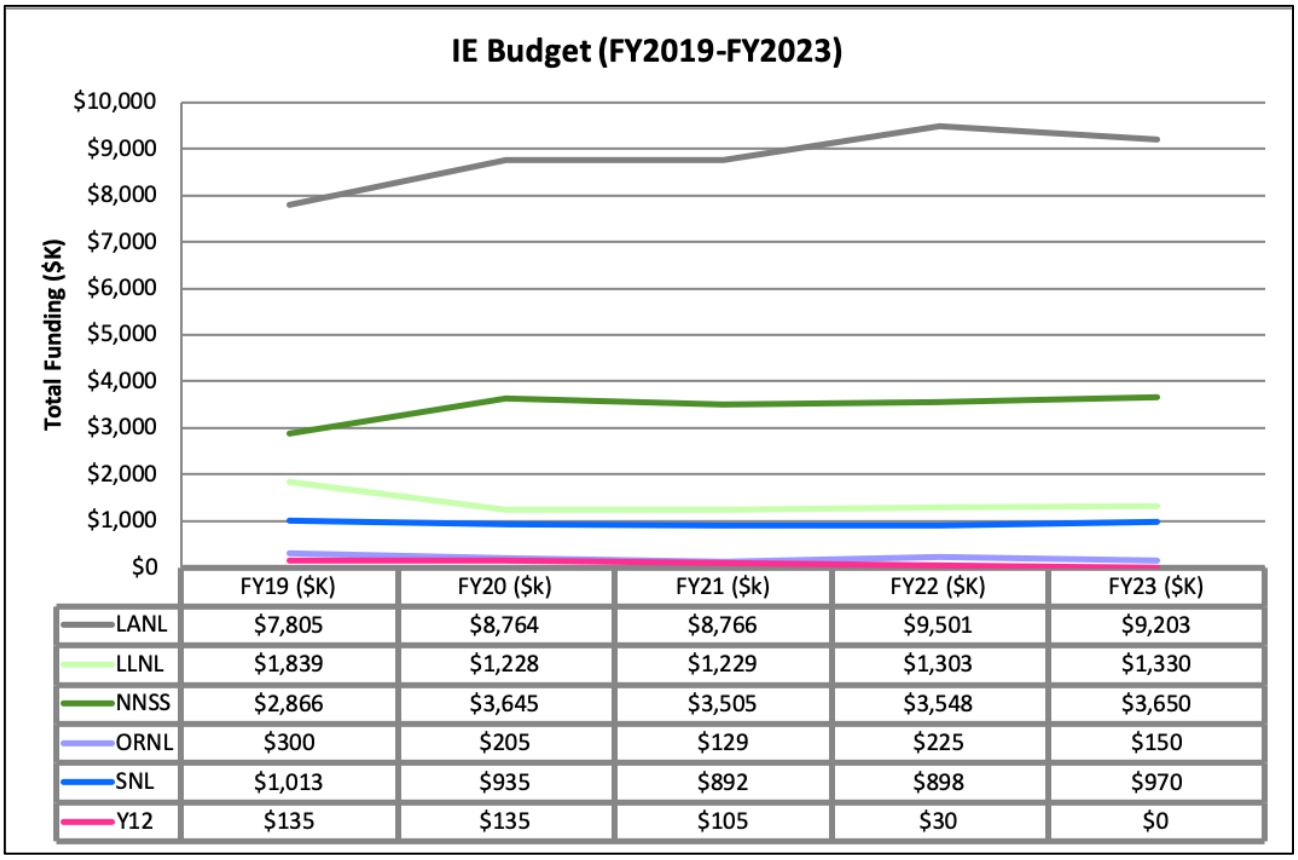
EOC – for out-year peaks and dips in budget plots:
SRS funding will continue in FY19 for the support and maintenance for the CritView software that includes ARH-600 data, and funding for this task will decrease in the out years due to the transition from development to maintenance of the CritView software (it is expected that bugs and improvements will decline FY19-FY23).

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 material 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 (FY2019-FY2023)



	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)	FY23 ($K)
LANL	$7,805	$8,764	$8,766	$9,501	$9,203
LLNL	$1,839	$1,228	$1,229	$1,303	$1,330
NNSS	$2,866	$3,645	$3,505	$3,548	$3,650
ORNL	$300	$205	$129	$225	$150
SNL	$1,013	$935	$892	$898	$970
Y12	$135	$135	$105	$30	$0

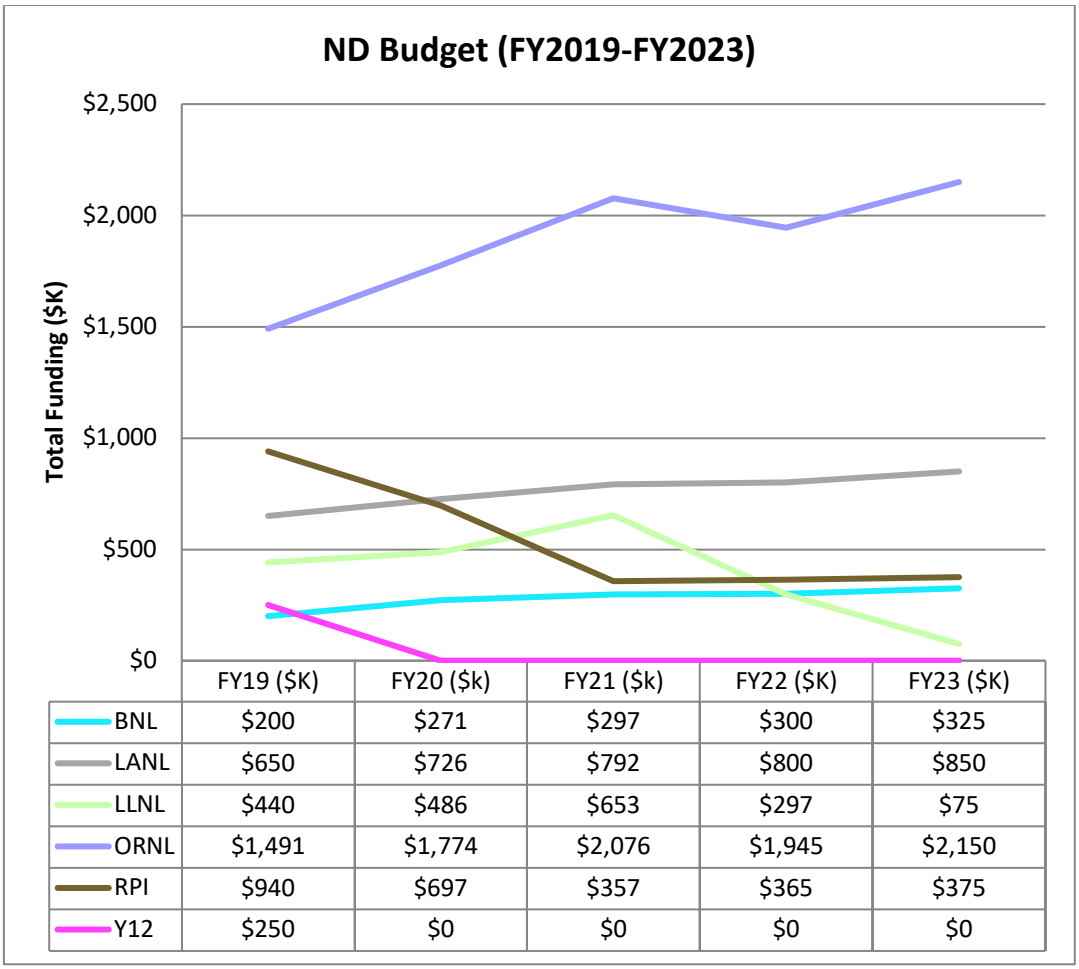
All Integral Experiment tasks and milestones are published as a standalone document. Contact the NCSP Program Manager, Dr. Angela Chambers, if you have a 'Need-to-Know.'

2.4 Nuclear Data (ND)

2.4.1 Program Element Description

The Nuclear Data program element includes the measurement, evaluation, testing, and publication of neutron cross-section data for nuclides of high importance to NCS analyses. The NCSP continues to improve coordination of ND activities by fostering a strong collaborative effort among all of the national and international resources in this highly technical area. The objective is to solve the highest priority ND problems relevant to criticality safety in a timely manner. This program element is essential for the NCSP because it provides the nuclear cross-section data required by the AM program element. Refer to Appendix B for the FY2019 through FY2023 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 (FY2019-FY2023)



	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)	FY23 ($K)
BNL	$200	$271	$297	$300	$325
LANL	$650	$726	$792	$800	$850
LLNL	$440	$486	$653	$297	$75
ORNL	$1,491	$1,774	$2,076	$1,945	$2,150
RPI	$940	$697	$357	$365	$375
Y12	$250	$0	$0	$0	$0

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

- BNL's funding will increase in out years to perform additional work on ADVANCE and to increase succession planning efforts in the outyears.
- LANL's funding will modestly increase in the out years to ramp up nuclear data evaluation and testing.

- LLNL's funding will decrease in FY22 due to the completion of the several tasks: development and implementation of an advanced and rigorous computational platform for thermal neutron scattering analysis, delayed fission gamma multiplicity and spectra, and the evaluation of neutron radiative capture gamma production in cadmium.
- ORNL's funding will increase in out years to support nuclear data measurement and evaluation work, including procurement of enriched isotopes samples needed for cross-section measurements. In addition, a modest funding increase in FY20/21 is due to a new task for thermal neutron scattering measurements for improvement of criticality calculations and propagation of scattering kernel uncertainties and the evaluation of thermal and resolved resonance ranges of UO_2 and PuO_2.
- 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.
- Y-12 funding in FY19 is for the fabrication of a new DU/molybdenum neutron production target to support NCSP measurements at IRMM/GELINA for neutron cross-section measurements.

2.4.2 Approved Tasks

2.4.2.1 Brookhaven National Laboratory (BNL)

Task Name	Task Title
BNL ND1	National Nuclear Data Center (NNDC) Support to the NCSP
Budget	**Collaborators**
$200K	None

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 (FY2019-FY2023)

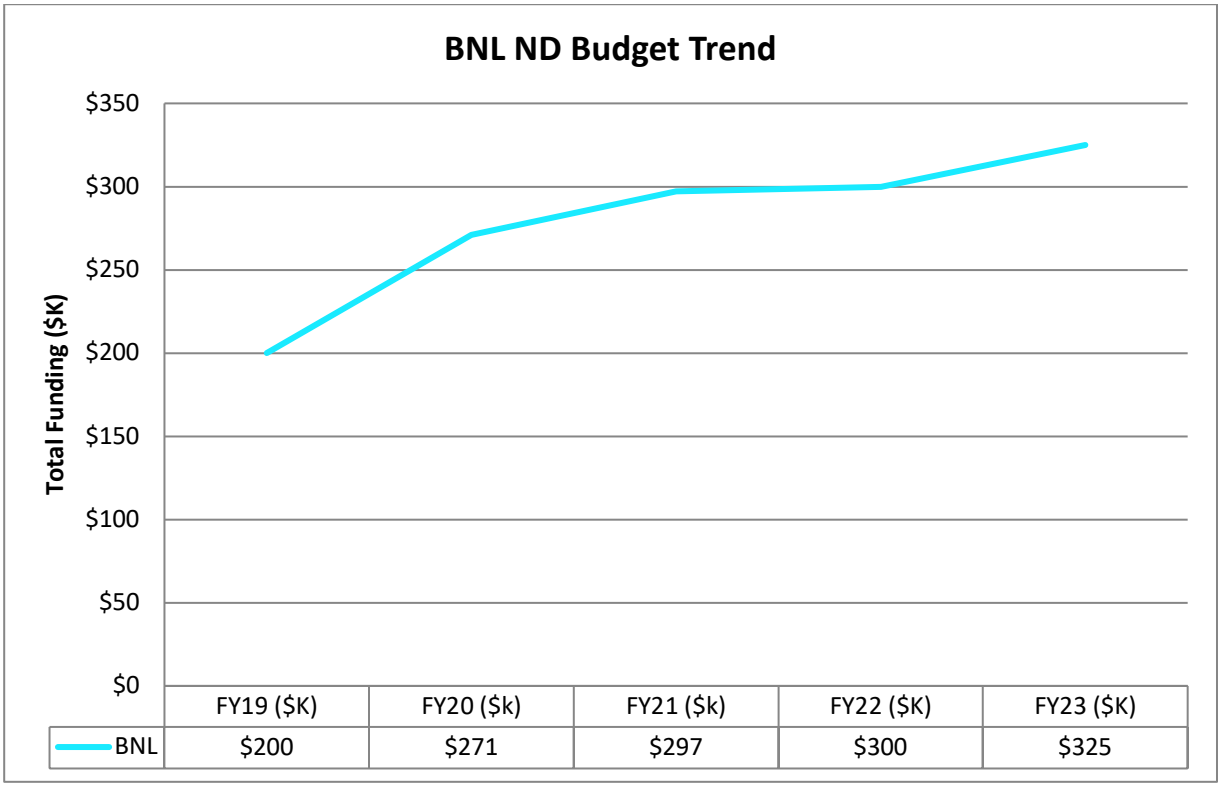
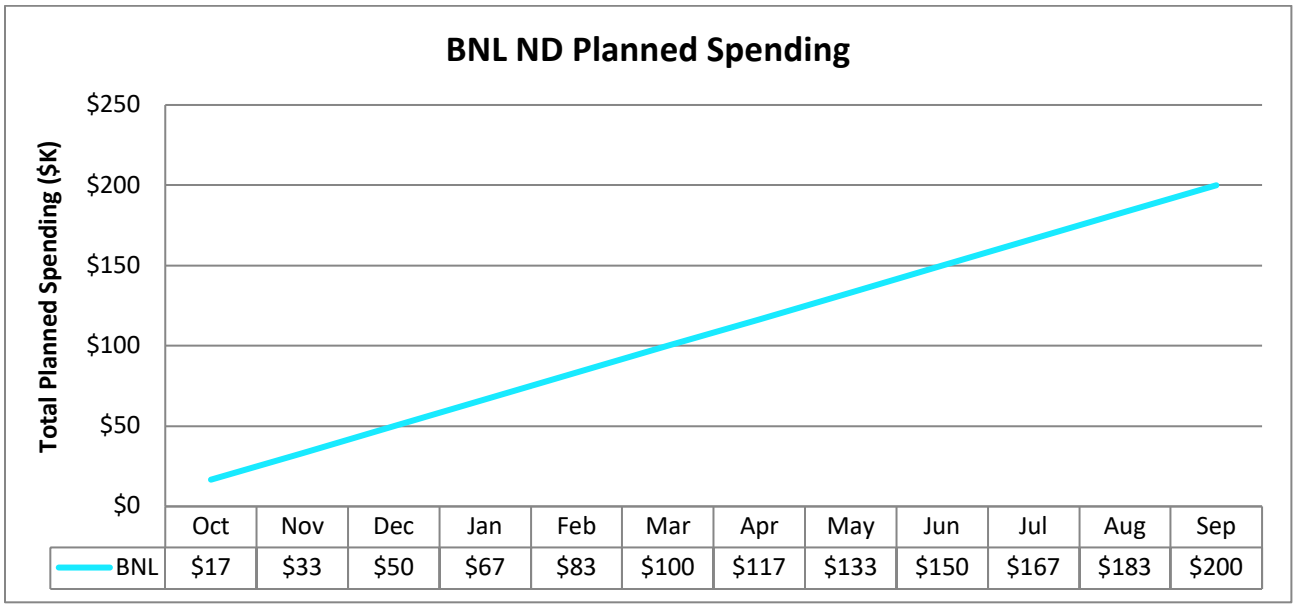


Table 2.4-3 BNL ND Planned Spending (FY2019)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BNL	$17	$33	$50	$67	$83	$100	$117	$133	$150	$167	$183	$200

BNL ND Milestones:

Occurs all 4 Quarters

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

Quarter 3

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

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

Steady funding in throughout FY19-23 due to a continuation of milestones for ENDF testing with ADVANCE. Increase in funding in out-years for additional work on ADVANCE's testing capabilities as defined in the NCSP Mission and Vision document.

2.4.2.2 Los Alamos National Laboratory (LANL)

Task Name	Task Title
LANL ND1	Nuclear Data Evaluation and Testing
Budget	**Collaborators**
$650K	IRSN (IRSN-ND2)

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

Table 2.4-4 LANL ND Budget Trend (FY2019-FY2023)

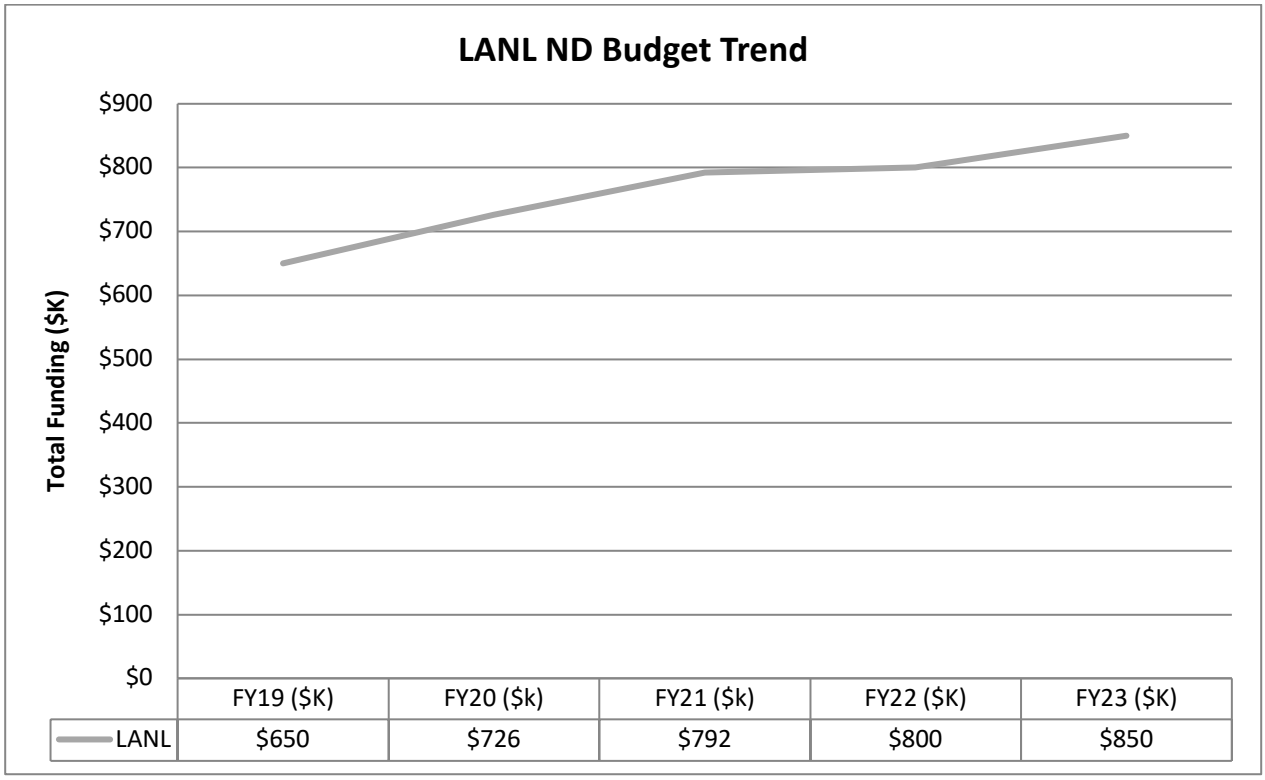
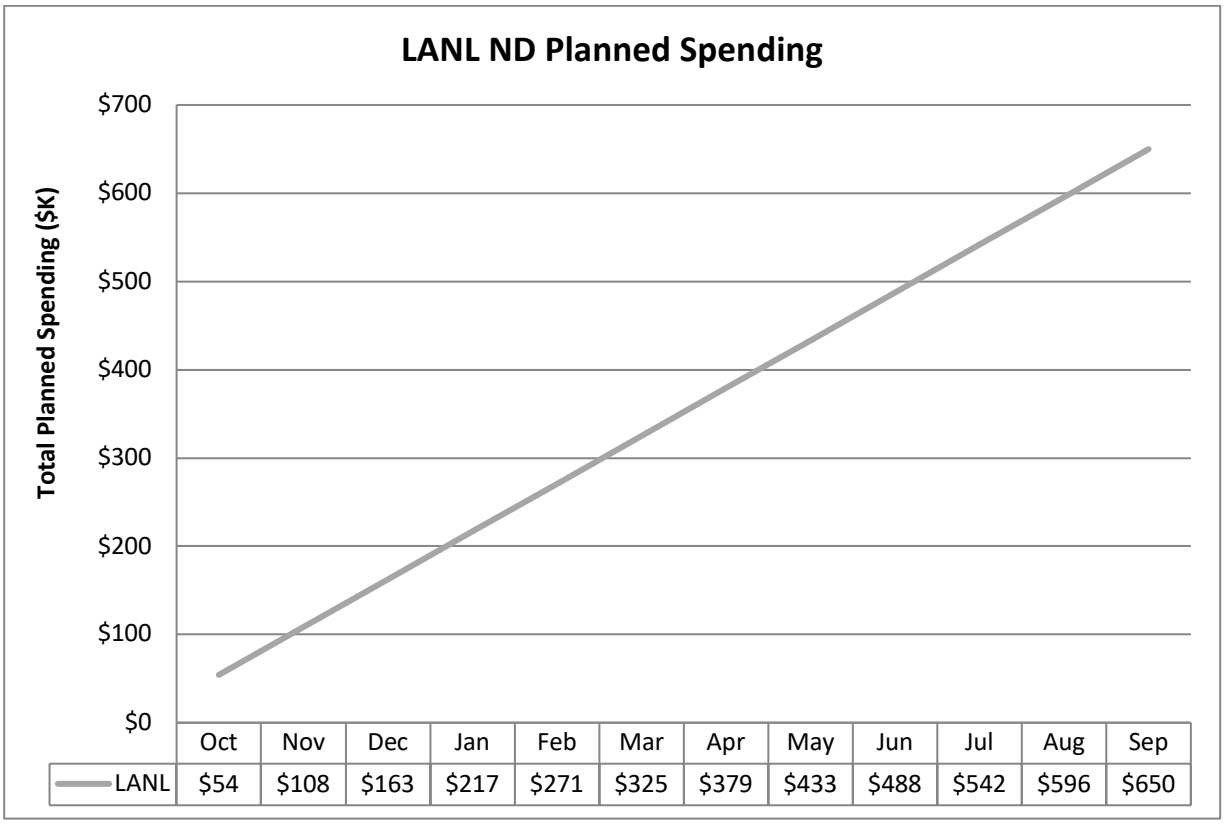


Table 2.4-5 LANL ND Planned Spending (FY2019)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LANL	$54	$108	$163	$217	$271	$325	$379	$433	$488	$542	$596	$650

LANL ND Milestones:

Occurs all 4 Quarters

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

Quarter 1

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

Quarter 4

- Report on development of machine learning tools, in particular decision trees, for criticality-safety applications and sensitivity to nuclear data. (ND1)
- Deliver nuclear data evaluations as indicated in Appendix B of this document. (ND1)

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

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

2.4.2.3 Lawrence Livermore National Laboratory (LLNL)

Task Name	Task Title
LLNL ND1	Subtask 1 – Delayed Fission Gamma Multiplicity and Spectra
Budget	**Collaborators**
$37K	IRSN (IRSN-ND1)

This is an ongoing approved task (subtask 1 of 2) to work with IRSN to develop, test, and document a first principles analytic method to determine the equilibrium and time-dependent emission of delayed gammas based on event-by-event modeling of the fission process and subsequent fission product decay. This subtask supports continued data testing as new experimental data becomes available from foil activation measurements and dosimetry testing using GODIVA, FLATTOP, and other assemblies.

Task Name	Task Title
LLNL ND1	Subtask 2 – Delayed Fission Gamma Multiplicity and Spectra
Budget	**Collaborators**
$50K	IRSN (IRSN-ND1)

This is an ongoing approved task (subtask 2 of 2) to work with IRSN to develop, test, and document a first principles analytic method to determine the equilibrium and time-dependent emission of delayed gammas based on event-by-event modeling of the fission process and subsequent fission product decay. This subtask involves issuing a report to document the technical basis of the method and data testing results.

Task Name	Task Title
LLNL ND2	Generation and Benchmarking of Thermal Neutron Scattering Cross Sections in Support of Advanced Nuclear Reactor Concepts
Budget	**Collaborators**
$69K	North Carolina State University and Naval Nuclear Laboratory

This is an ongoing approved task in collaboration with NCSU and NNL to refine and complete basic atomistic models for executing molecular dynamics simulations for the moderator materials specified in Appendix B. A potential function describing the atomistic interactions will be chosen and parameterized to reproduce its observed characteristics. Subsequently, the excitation spectrum (i.e., vibrations, rotations, etc.) will be calculated. This information will be used to develop LEAPR-THERMR modules in NJOY to calculate the scattering law, S(α,β), 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(α,β) libraries in both ENDF File 7 and ACE ("A Compact ENDF" file) formats will be tested in NCSP analytic methods using relevant criticality safety benchmarks selected from the ICSBEP Handbook. Finally, the S(α,β) libraries in ENDF File 7 will be provided to the National Nuclear Data Center at Brookhaven National Laboratory. The NR Program (NNL) will provide $75K in matching funding.

Task Name	Task Title
LLNL ND3	Development and Implementation of an Advanced and Rigorous Computational Platform for Thermal Neutron Scattering Analysis
Budget	**Collaborators**
$100K	North Carolina State University and Naval Nuclear Laboratory

This is an ongoing approved task in collaboration with NCSU and NNL to develop and refine a "next generation" computational platform for calculating thermal neutron scattering cross sections and to assist in interpreting and processing related measured data. This tool will be based on rigorous physics and will abandon all simplifications such as the incoherent, cubic and Gaussian approximations that are implemented in current computer codes. In addition, it will include the option to accept as input phonon frequency spectra (as in the current practice), full dispersion relations (as needed to address strong coherent scattering materials such as carbon and beryllium), velocity autocorrelation functions (as the starting point for describing liquids and non-crystalline materials), and/or the van Hove correlation function (i.e., $G(\mathbf{r},t)$) for exact calculations of the full $S(\alpha,\beta)$ of a given material including the self and distinct components. Furthermore, advanced, physics-based $S(\alpha,\beta)$ interpolation free analysis methods will be investigated. For completeness, the code will include a generalized capability for calculating the coherent elastic scattering cross section for crystalline materials that addresses any material and structure as specified by the user. Finally, method specific formulations for estimating covariance information for the data will be explored and included. The NR Program (NNL) will provide $100K in matching funding.

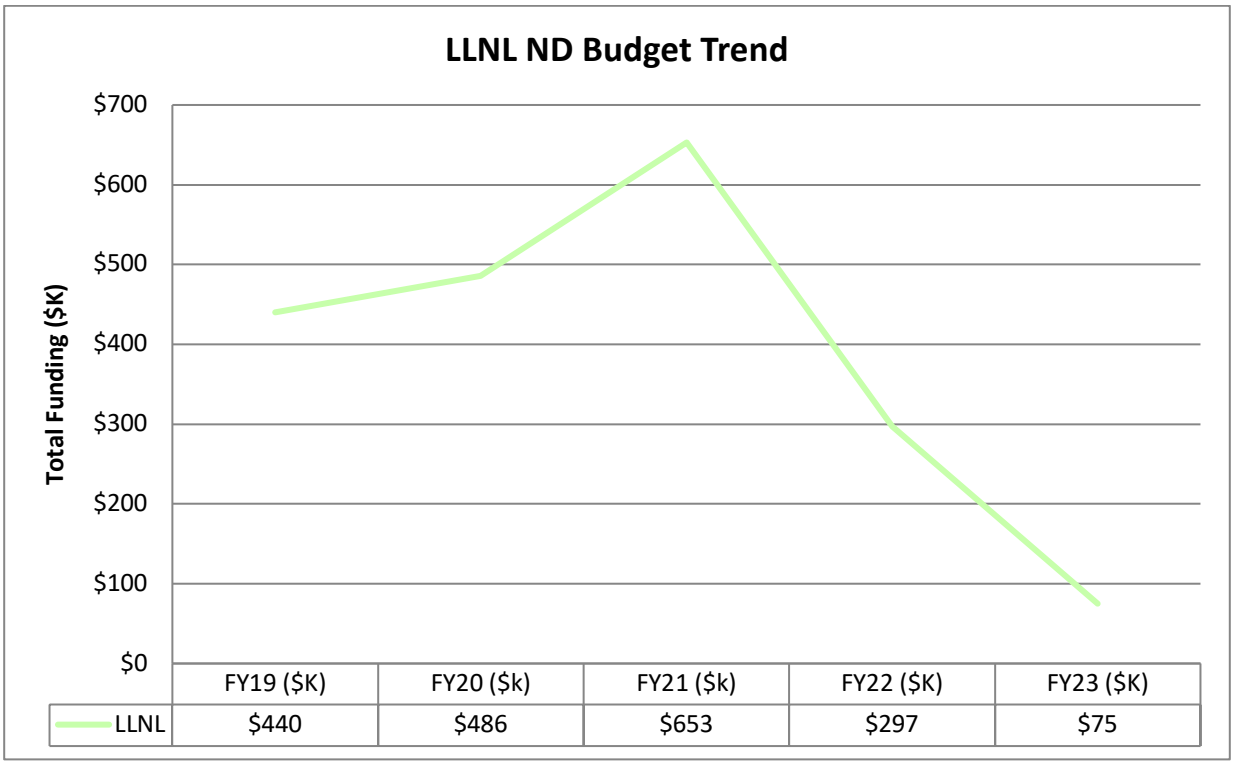
Task Name	Task Title
LLNL ND5	Development and Implementation of a Modern Doppler Broadening Approach Including Atomic Binding Effects
Budget	**Collaborators**
$92K	North Carolina State University and Naval Nuclear Laboratory

This is an ongoing approved task in collaboration with NCSU and NNL to formulate, develop and implement a modern Doppler broadening of nuclear cross sections that abandons the free gas approximation and accounts for atomic binding effects. The NR Program (NNL) will provide $75K in matching funding.

Task Name	Task Title
LLNL ND6	Evaluate Neutron Radiative Capture Gamma Production in Cadmium
Budget	**Collaborators**
$92K	None

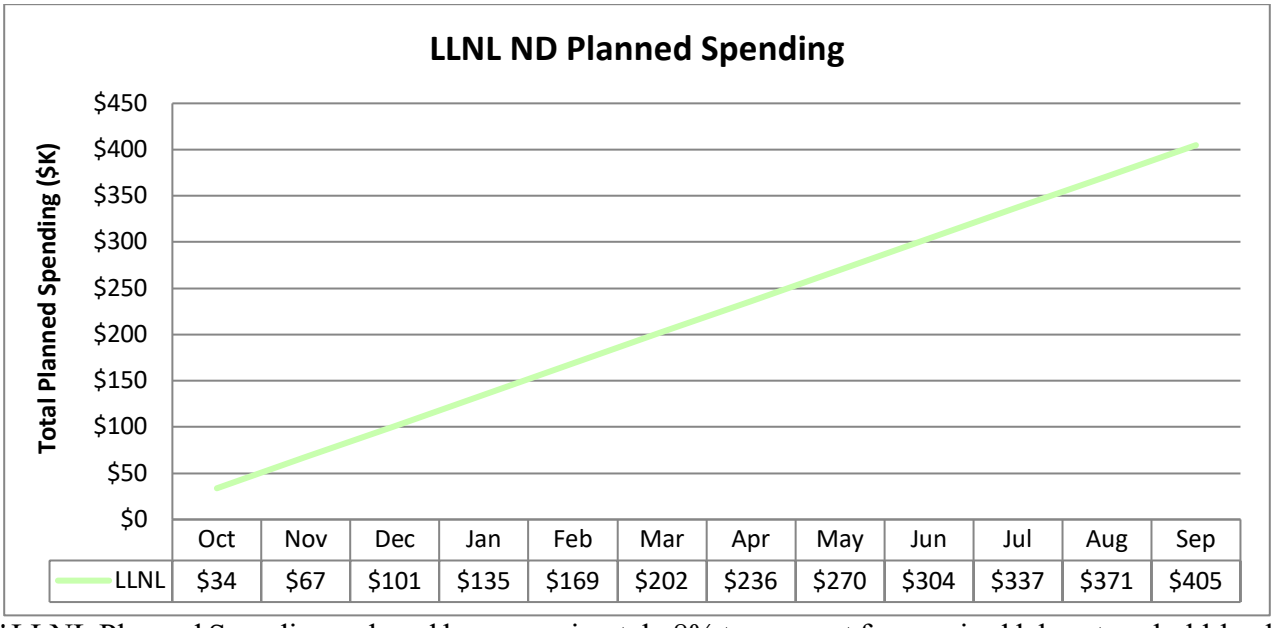
This is an ongoing approved task to evaluate available neutron radiative capture gamma production data for cadmium and revise the ENDF/B-VIII.0 evaluation to include the evaluated best values. This task also includes testing the revised evaluations for cadmium using the ICSBEP evaluation ALARM-TRAN-CH2-SHIELD-001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

Table 2.4-6 LLNL ND Budget Trend (FY2019-FY2023)



	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)	FY23 ($K)
LLNL	$440	$486	$653	$297	$75

Table 2.4-7 LLNL ND Planned Spending (FY2019)*



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
LLNL	$34	$67	$101	$135	$169	$202	$236	$270	$304	$337	$371	$405

*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 (ND1 {subtask 1 and 2}, ND2, ND3, ND5, ND6).

Quarter 4

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

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

LLNL's funding will increase until FY21 due to the completion of the development and implementation of an advanced and rigorous computational platform for thermal neutron scattering analysis. LLNL work over the planning period also includes stable funding for the generation and testing of thermal scattering law data in collaboration with NCSU, delayed fission gamma multiplicity and spectra tasks and testing of the revised ^{233}U resonance-region cross-section evaluation by IRSN. LLNL funding will decrease in the outyears due to the completion of LLNL-ND7 ('Alpha-N' benchmark measurements), ND8 (Fission TPC measurement of the U-233/U-235 (n,f) cross section ratio), and ND9 (Li-6 doped liquid scintillator array for fission correlations) tasks.

2.4.2.4 Oak Ridge National Laboratory (ORNL)

Task Name	Task Title
ORNL ND1	Nuclear Data Measurement and Evaluation
Budget	**Collaborators**
$900K	IRSN (IRSN-ND1), JRC-Geel

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.

Task Name	Task Title
ORNL ND3	Isotopic Sample Leases to Support ND1 ND Measurements
Budget	**Collaborators**
$40K	JRC-Geel, RPI

This "task" is to separate out funding for natural and stable, isotopically enriched samples, for nuclear data measurements aligned with the priorities and schedule provided in Appendix B. The task also supports activation analysis to demonstrate the likely lease options to negotiate with DOE/SC-NP (DOE Office of Science- Nuclear Physics).

Task Name	Task Title
ORNL ND6	SAMMY Nuclear Data Evaluation Code Modernization
Budget	**Collaborators**
$350K	JRC-Geel, RPI

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

Task Name	Task Title
ORNL ND7	Nuclear Data Evaluation and Testing for Nuclear Criticality Safety Applications
Budget	**Collaborators**
$68K	Georgia Institute of Technology

This is an ongoing task to collaborate with the Georgia Institute of Technology to identify benchmark experiments and develop SCALE and MCNP models to evaluate and test nuclear data evaluations recently completed by the US Nuclear Criticality Safety Program (NCSP). In addition, the project

task will be designed for a student to work under the guidance of an ORNL nuclear data and criticality safety expert. Upon completion of the project, the proposed project will provide feedback on the performance of the new nuclear data evaluations and help identify whether further data improvements are needed.

Task Name	Task Title
ORNL ND10	Monte Carlo Evaluation of Differential and Integral Data
Budget	**Collaborators**
$133K	None

This is new work to build on ORNL's recent applications of Monte Carlo method to some of the VALID library IBEs (350), and to the Monte Carlo evaluation of thermal neutron scattering data on light water, while applying most recent advances in Bayesian Monte Carlo methods. The Monte Carlo evaluation of R-matrix resonance parameters would be leveraged by the ORNL's nuclear data evaluation code SAMMY that is being modernized in the NCSP ORNL-ND6 task. The proposed framework would complement the S/U tools in SCALE by computing response sensitivities, it would quantify the magnitude of presently neglected non-linear effects, and when used for simultaneous evaluation of differential and integral data it would obviate the need for conventional data adjustment. After this methodology is developed, it will be demonstrated on a small scale and results provided to the NCSP manager. Ultimately, if the results are successful, this task will be scaled up to the level of the proposal (FY19, proposal 35) and be used to prioritize nuclear data measurements.

Table 2.4-8 ORNL ND Budget Trend (FY2019-FY2023)

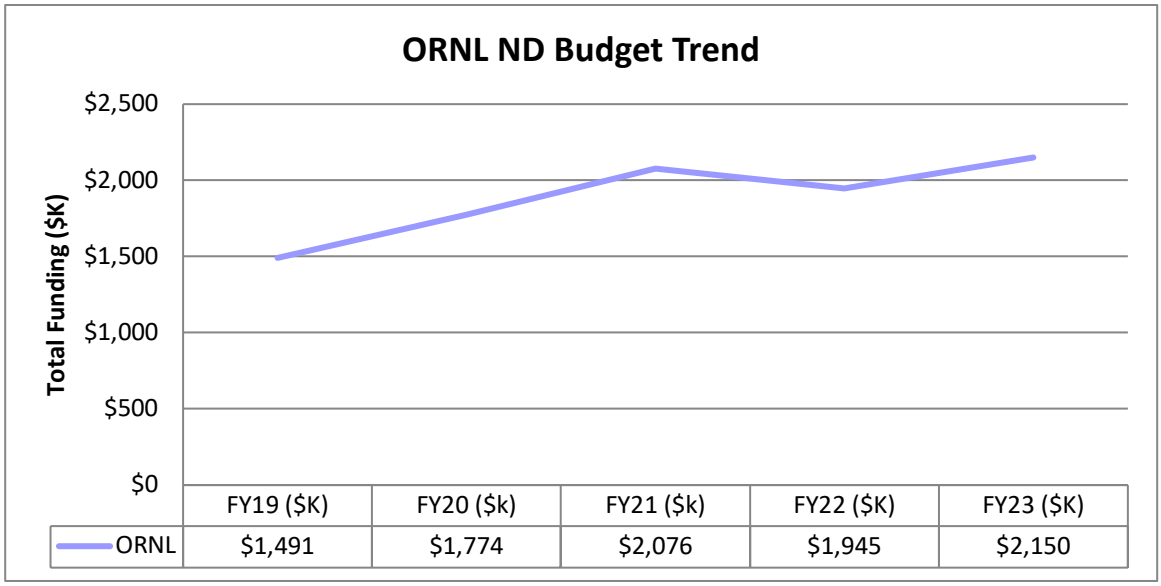
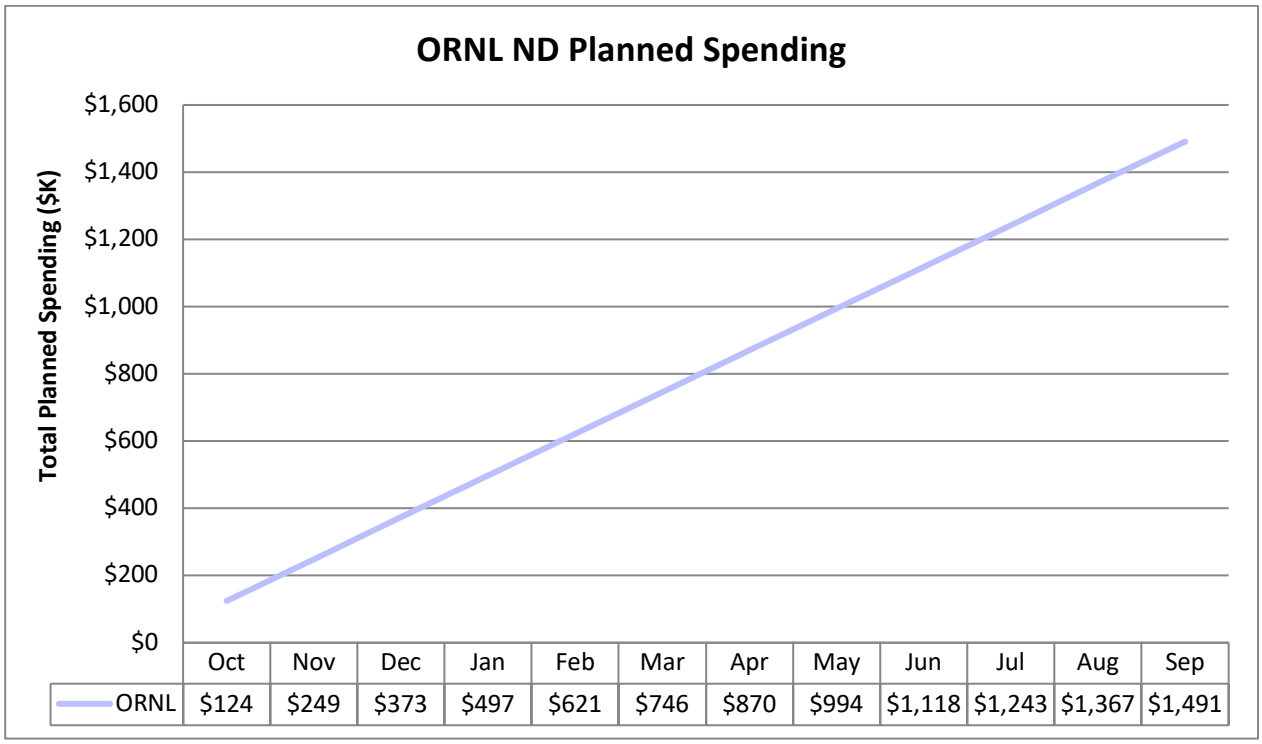


Table 2.4-9 ORNL ND Planned Spending (FY2019)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
ORNL	$124	$249	$373	$497	$621	$746	$870	$994	$1,118	$1,243	$1,367	$1,491

ORNL ND Milestones:

Occurs all 4 Quarters

- Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND3, ND6, ND7, ND10).
- Provide status reports on ORNL participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND1).
- Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B (ND1).

Quarter 4

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

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

ORNL's funding will modestly increase in the out years to support nuclear data measurements and evaluation work, including support to the SAMMY modernization effort. Two tasks begin in FY20 and FY21 for thermal neutron total cross section measurements for improvement of NCS calculations (ORNL-ND4) and the evaluation of (ORNL-ND9) thermal and resolved resonance ranges of UO_2 and PuO_2.

2.4.2.5 Renssalaer Polytechnic Institute (RPI)

Task Name	Task Title
RPI ND1	Resonance Region Nuclear Data Measurement Capability at RPI
Budget	**Collaborators**
$340K	None

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. Aligns with LANL-ND1 and ORNL-ND1 (evaluation).

Task Name	Task Title
RPI ND2	Thermal Neutron Scattering Measurement for Improvement of Criticality Calculations and Propagation of Scattering Kernel Uncertainties
Budget	**Collaborators**
$200K	None

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. Aligns with ORNL-ND4.

Task Name	Task Title
RPI ND3	RPI/ORNL: LINAC 2020 Nuclear Data Capabilities Maintenance Plan
Budget	**Collaborators**
$400K	Naval Nuclear Laboratory

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. Additional funds were allocated from NNSS-IE1 carry over in late FY19 to allow for additional budget to cover costs associated with LINAC equipment cost overruns.

Table 2.4-10 RPI ND Budget Trend (FY2019-FY2023)

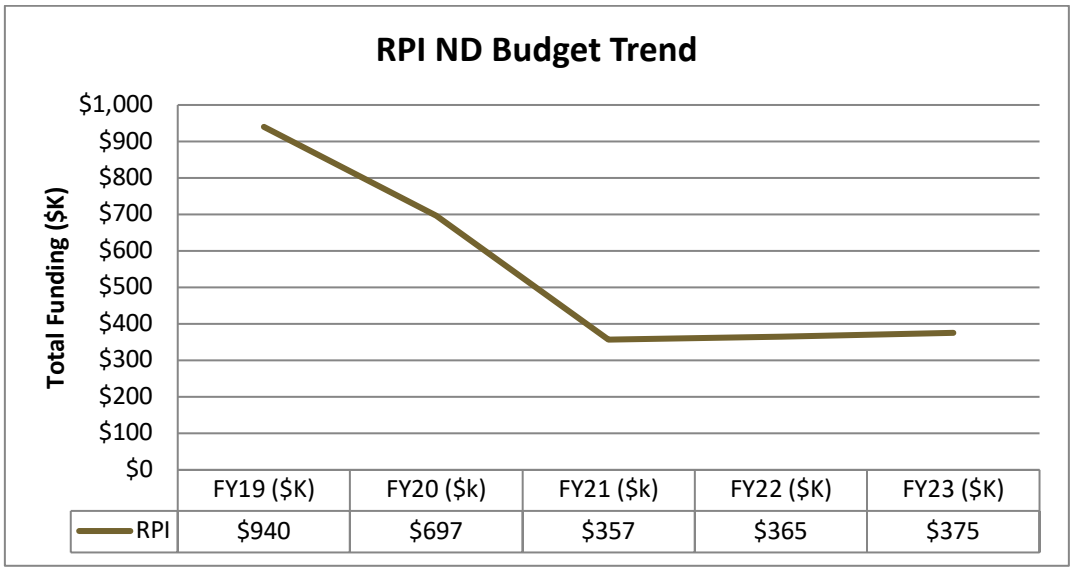
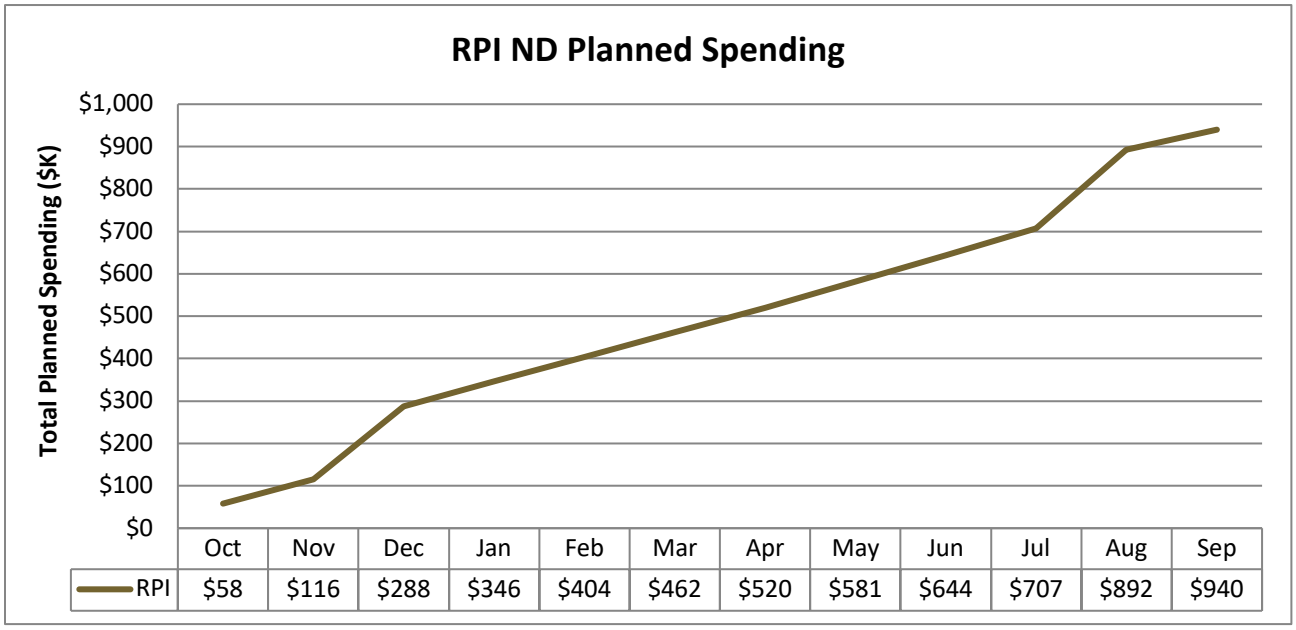


Table 2.4-11 RPI ND Planned Spending (FY2019)



RPI ND Milestones:

Occurs all 4 Quarters

- Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND2, ND3)
- Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND1, ND2)

Quarter 1

- Complete analysis of measurement from FY-18 (ND1)
- Factory acceptance tests of RF Modulators 2 and 3 (ND3)

Quarter 2

- Complete cold moderator preliminary design phase (ND2)
- Delivery of RF Modulator 1 and Klystron 1 (ND3)
- Factory acceptance tests of RF Modulators 4 and 5 (ND3)

Quarter 3

- Complete transmission measurement per the nuclear data schedule in Appendix B (ND1).
- Complete capture measurement per the nuclear data schedule in Appendix B (ND1)
- Factory Acceptance test for Tapered Phase Velocity and Speed of Light #1 Accelerator Sections (ND3)

Quarter 4

- Complete data analysis for transmission and capture measurements and provide the data to ORNL as needed to support the evaluation effort per the nuclear data schedule in Appendix B (ND1)
- Complete cold moderator design (ND2)
- Delivery and of TPV and SOL1 Accelerator Sections (ND3)

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

High funding level tapering off in FY19-23 supports the RPI LINAC 2020 Nuclear Data Capabilities Maintenance Plan co-funded by Naval Reactors for an initial investment period of approximately 3 years with a decrease of funding at the end of that investment period.

2.4.2.6 Y-12 National Security Complex

Task Name	Task Title
Y12 ND1	Y-12 Fabrication of New Uranium Target for IRMM/GELINA for Cross-section Measurements
Budget	**Collaborators**
250K	IRMM

This task involves the fabrication of a new depleted uranium/molybdenum target for IRMM/GELINA for cross section measurements. As part of the IRMM collaboration, this task will ensure continued availability of the accelerator for NCSP nuclear data measurements.

Table 2.4-12 Y-12 ND Budget Trend (FY2019-FY2023)

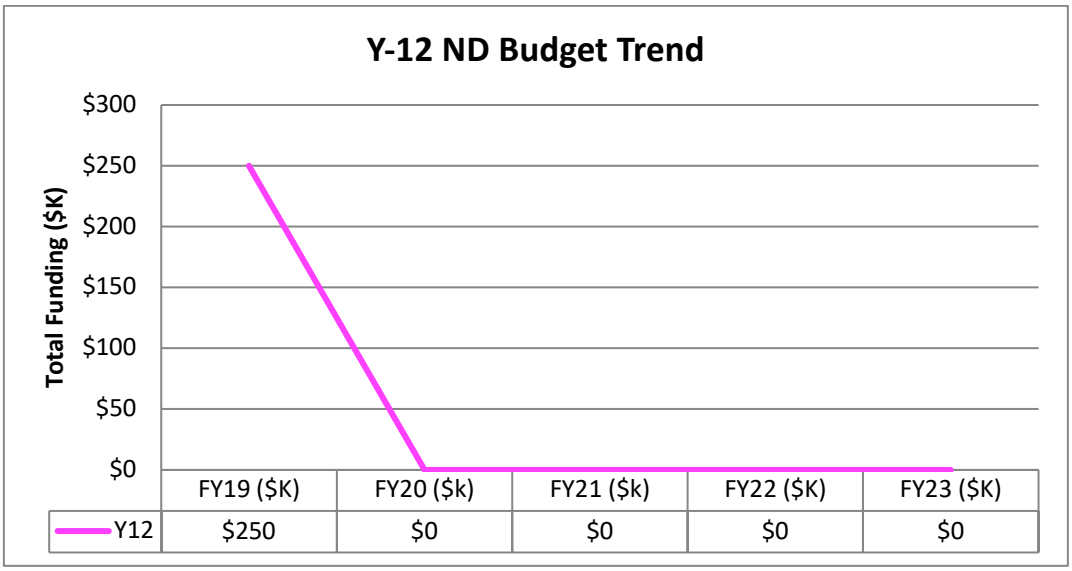
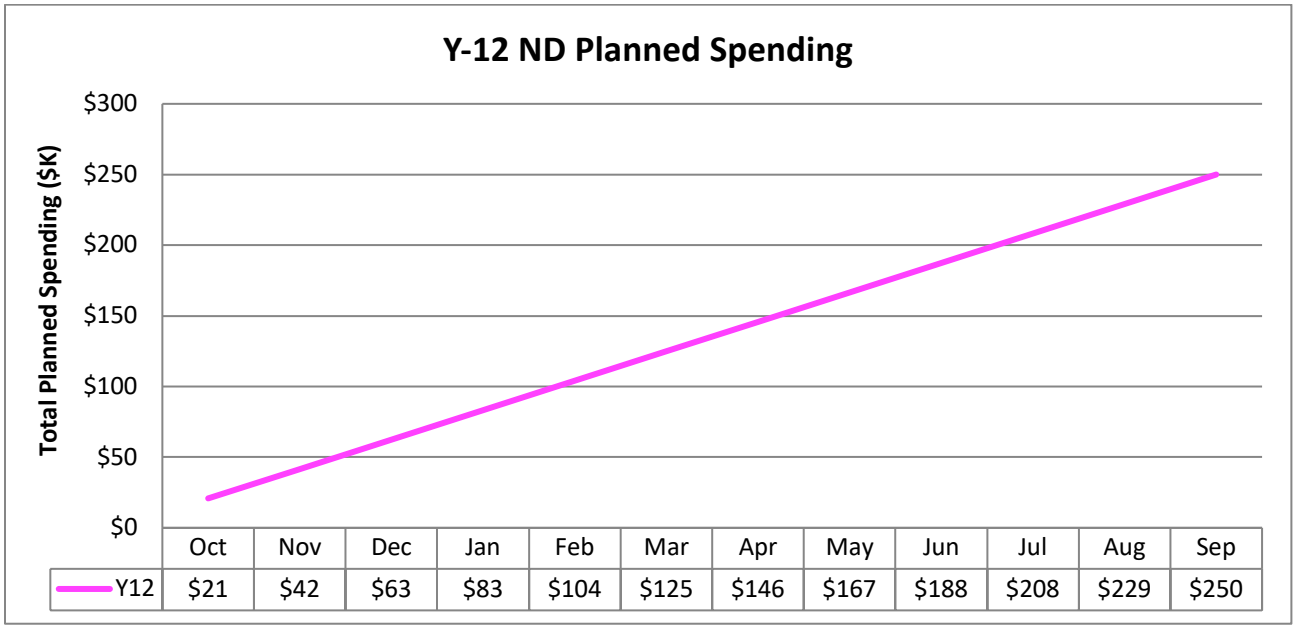


Table 2.4-13 Y-12 ND Planned Spending (FY2019)



Y-12 ND Milestones

Occurs all 4 Quarters

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

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

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

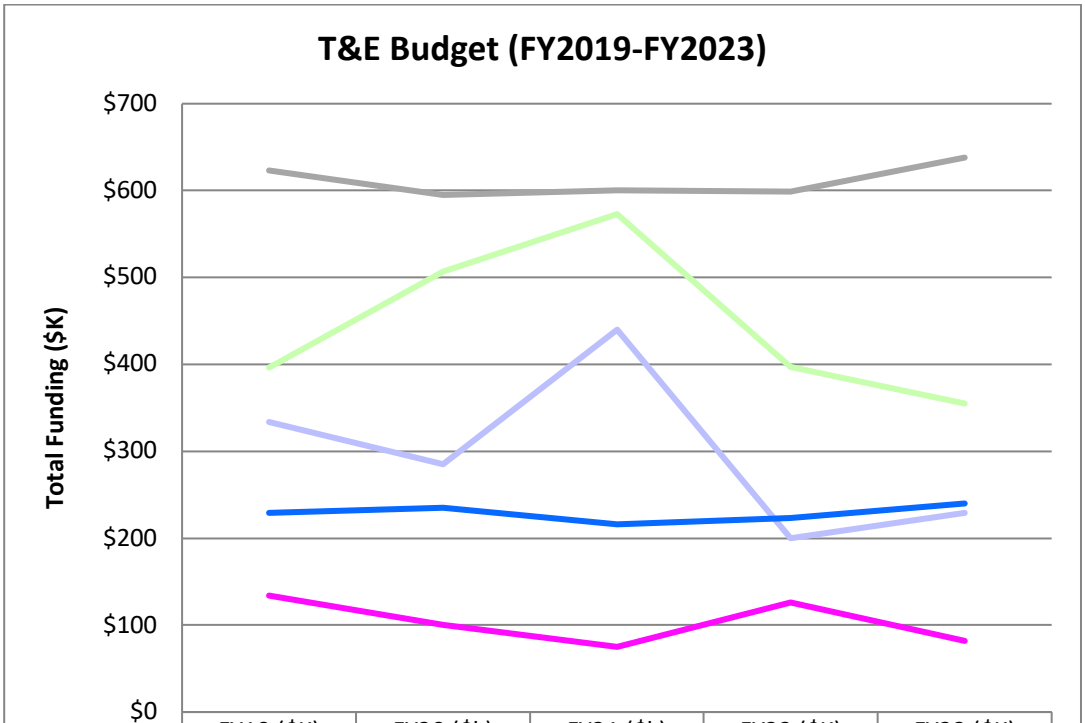
2.5 Training and Education (TE)

2.5.1 Program Element Description

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

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

Table 2.5-1 TE Budget (FY2019-FY2023)



	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)	FY23 ($K)
LANL	$623	$595	$600	$599	$638
LLNL	$396	$507	$573	$397	$355
ORNL	$334	$285	$440	$200	$229
SNL	$229	$235	$216	$223	$240
Y12	$134	$100	$75	$126	$82

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 in addition to several modestly funded tasks to develop training aides and tutorials for NCS students (LANL-TE2 and -TE5).
- 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. Funding decreases after FY21.
- 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. Funding decreases in FY21 after various NCSet modules and tutorials to support NCS training and education are completed (ORNL-TE6, -TE7, and -TE8).
- SNL's funding is modestly increased in out years (FY22-23) to help mitigate the increased cost for conducting Hands-on Training courses.
- Y12's funding will slightly increase in FY21, in order to develop criticality safety tutorials to incorporate NCS into design.

2.5.2 Approved Tasks

2.5.2.1 Los Alamos National Laboratory (LANL)

Task Name	Task Title
LANL TE3	Conduct Hands-On Criticality Safety Training Course at NCERC
Budget	**Collaborators**
$376K	None

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.

Task Name	Task Title
LANL TE4	On-Site Introductory Training for the NCS Practitioner on Modern Approaches to Validation using Sensitivity and Uncertainty Analysis Tools
Budget	**Collaborators**
$30K	None

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

Task Name	Task Title
LANL TE6	Development of University Pipeline for Criticality Safety Professionals
Budget	**Collaborators**
$92K	None

Development of a University Pipeline for Criticality Safety Professionals.

Task Name	Task Title
LANL TE7	Design and Develop a New NCSP T&E Course Criticality Safety Officers at DOE/NNSA Nuclear Facilities
Budget	**Collaborators**
$25K	ORNL (ORNL TE9), SNL (SNL TE2), LANL (LANL TE7)

At the direction of ORNL, assist as a team member in the design and development of a new NCSP TE Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities. This task will use a CSSG tasking response as a roadmap for course development.

Task Name	Task Title
LANL TE8	Reactivity Simulation Aids
Budget	**Collaborators**
$100K	None

Further develop existing and new reactivity simulation aids that can be used to support the NCSP mission, along with the Training and Education (TE) simulation aid goals for the DOE Complex.

Table 2.5-2 LANL TE Budget Trend (FY2019-FY2023)

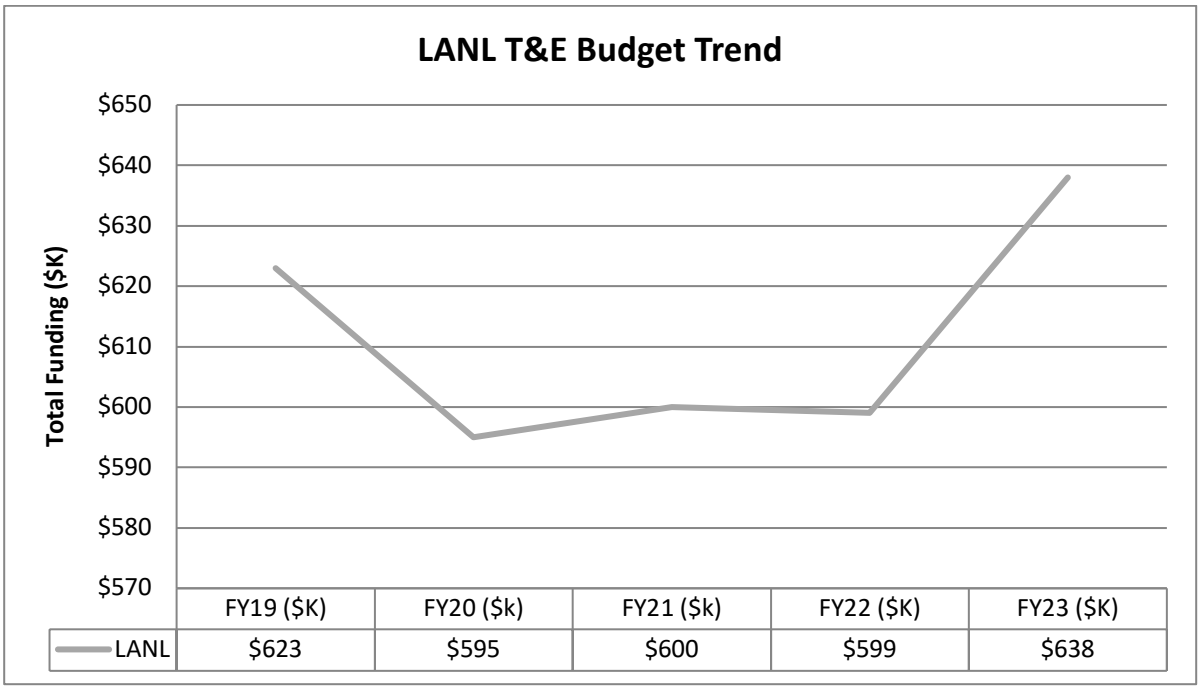
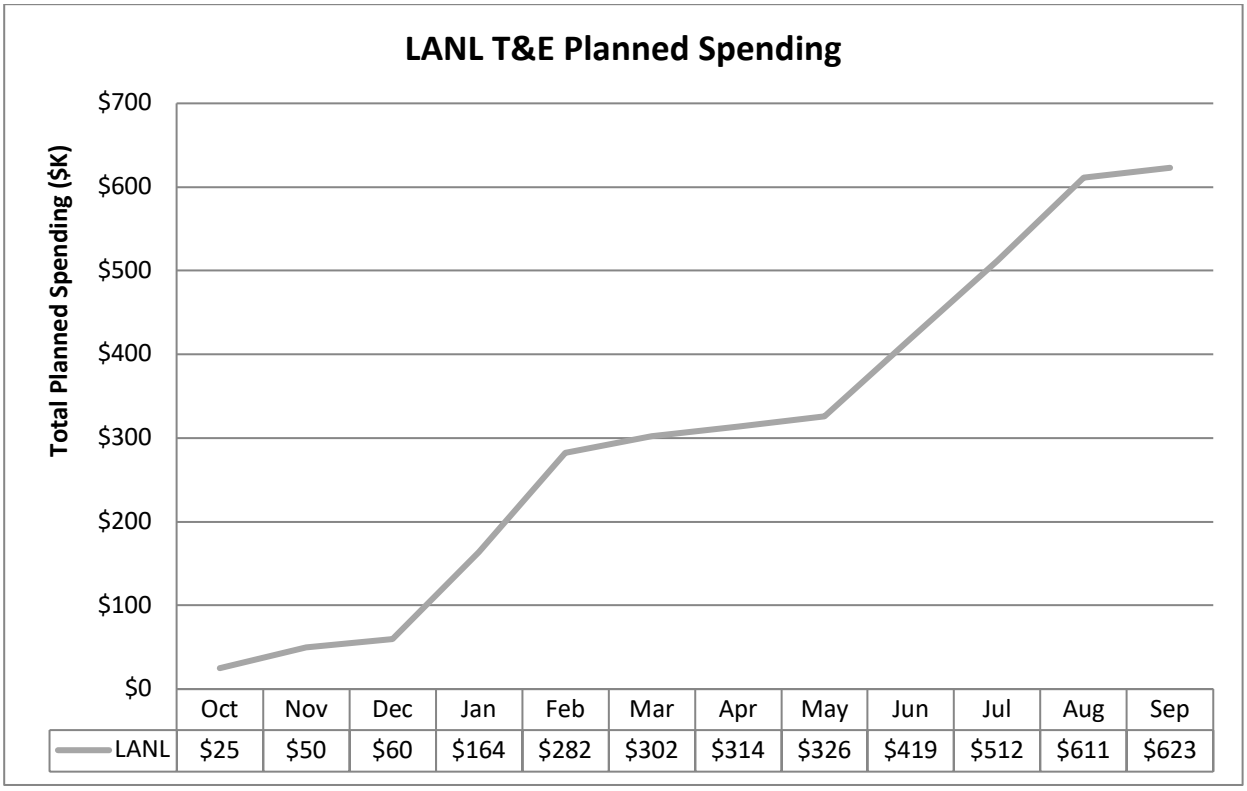


Table 2.5-3 LANL TE Planned Spending (FY2019)



LANL TE Milestones:

Occurs all 4 Quarters

- Provide status reports on all training activities to the NCSP Manager. (TE3, TE6, TE7, TE8)
- Provide training in accordance with the approved schedule. (TE3)

Quarter 4

- In collaboration with ORNL, provide introductory 1-day S/U workshop training to one or more DOE sites in FY19. (TE4)
- Provide end of year progress report. (TE6, TE7, TE8)

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

The funding decrease in FY20 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 the deployment of 1-week hands-on criticality safety course for criticality safety officers and fissile material handlers and tutorials for NCS students.

2.5.2.2 Lawrence Livermore National Laboratory (LLNL)

Task Name	Task Title
LLNL TE1	Conduct Hands-on Training at the DAF (TACS)
Budget	**Collaborators**
$238K	None

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

Task Name	Task Title
LLNL TE3	Classroom Criticality Safety Training
Budget	**Collaborators**
$69K	None

This is an ongoing approved task to provide LLNL support for FY2019 classroom instruction at the Nevada Site Facility and participation in T&E development activities.

Task Name	Task Title
LLNL TE8	Incorporate Superior Reflectors into TACS "Hands On" Training
Budget	**Collaborators**
$64K	None

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

Task Name	Task Title
LLNL TE9	Design and Develop a New NCSP T&E Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities
Budget	**Collaborators**
$25K	None

At the direction of ORNL, assist as a team member in the design and development of a new NCSP TE Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities. This task will use a CSSG tasking response as a roadmap for course development.

Table 2.5-4 LLNL TE Budget Trend (FY2019-FY2023)

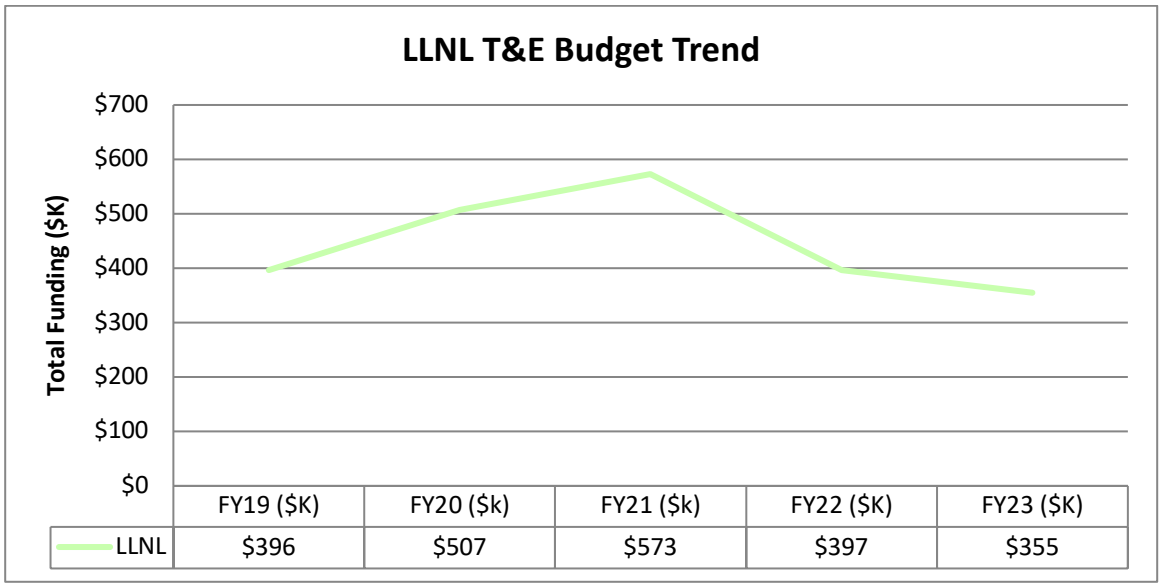
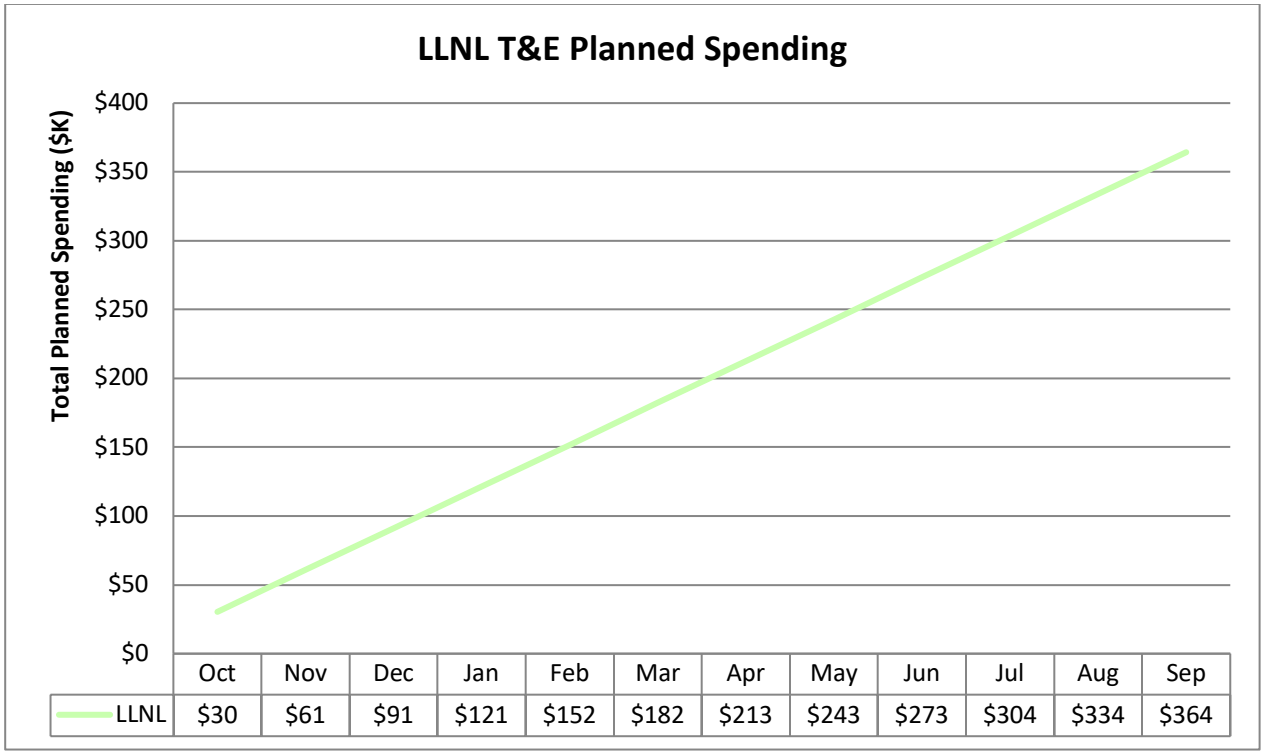


Table 2.5-5 LLNL TE Planned Spending (FY2019)*



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

LLNL TE Milestones:

Occurs all 4 Quarters

- Update, maintain and support the registration process and provide classroom and "hands on" TACS training in accordance with the schedule approved by the NCSP Manager (TE1, TE3).
- Conduct subcritical measurements using beryllium shells and finalize training materials addressing the concept of superior reflection. (TE8)
- Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)

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

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

2.5.2.3 Oak Ridge National Laboratory (ORNL)

Task Name	Task Title
ORNL TE1	Manage and Provide Instruction for the DOE Nuclear Criticality Safety Training & Education Program
Budget	**Collaborators**
$179K	IRSN (IRSN TE1), AWE (AWE TE1)

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

Task Name	Task Title
ORNL TE5	On-Site Introductory Training for the NCS Practitioner on Modern Approaches to Validation using Sensitivity and Uncertainty Analysis Tools
Budget	**Collaborators**
$30K	None

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

Task Name	Task Title
ORNL TE9	Design and Develop a New NCSP T&E Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities
Budget	**Collaborators**
$25K	LLNL (LLNL TE9), SNL (SNL TE2), LANL (LANL TE7)

At the direction of ORNL, assist as a team member in the design and development of a new NCSP TE Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities. This task will use a CSSG tasking response as a roadmap for course development.

Task Name	Task Title
ORNL TE10	Design of a Subcritical Assembly at ORNL for use with the CSO/FMH Courses
Budget	**Collaborators**
$100K	Y12 (Y12 TE3)

This task involves the feasibility for the design and installation of a subcritical assembly for use in the NCSP CSO training course being developed by the NCSP starting in FY2019. If feasible, this task will involve the development of a new proposal for FY20 for a detailed design and installation of a subcritical assembly at ORNL using existing resources at Y-12.

Table 2.5-6 ORNL TE Budget Trend (FY2019-FY2023)

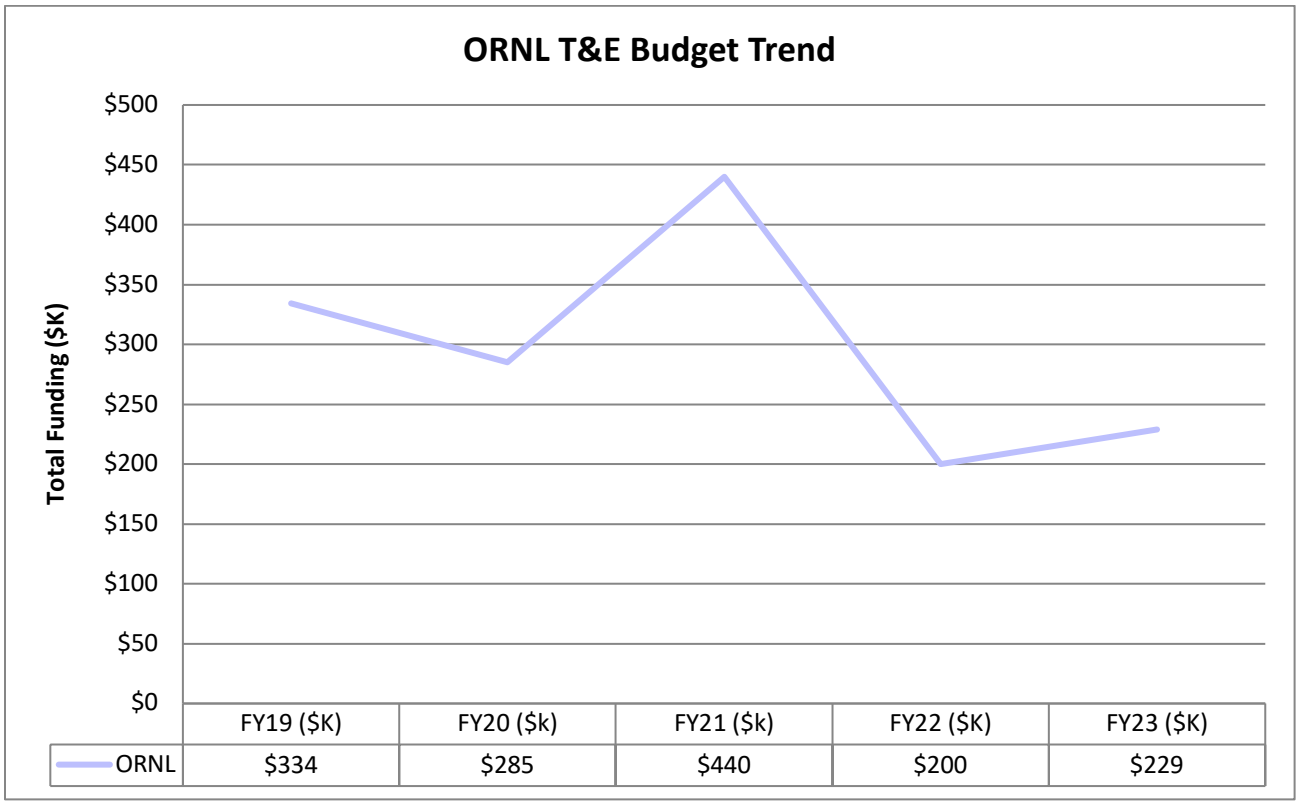
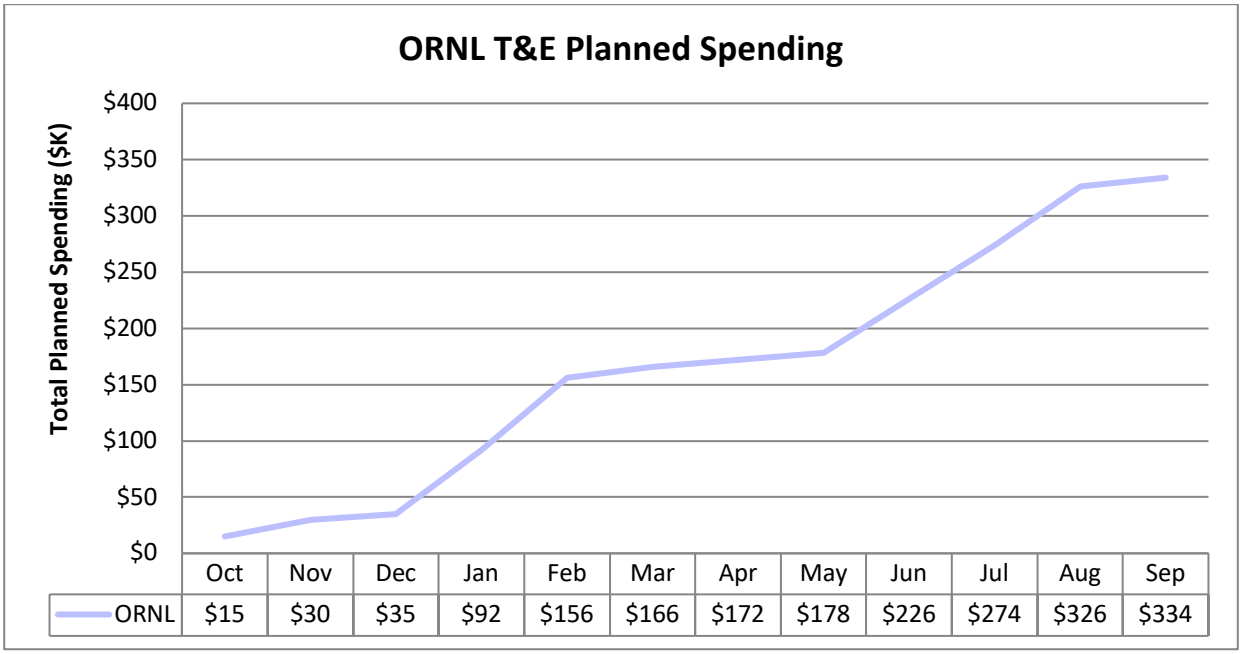


Table 2.5-7 ORNL TE Planned Spending (FY2019)



ORNL TE Milestones:

Occurs all 4 Quarters

- Provide a status report in NCSP Quarterly Progress Reports on implementation of the NCS training program and resolution of CSSG comments from CSSG tasking 2016-01. (TE1)
- Provide status reports in NCSP Quarterly Progress Reports on improvements/modifications to baseline NCS course training materials based on CSSG assessment report 2016-01, self-evaluation, and feedback from reviewers, observers, trainers, and the NCSP manager. (TE1)
- Provide a status report in NCSP Quarterly Progress Reports on the progress of 1-day onsite introductory validation training conducted at one or more DOE sites. (TE5)
- Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)

Quarter 4

- Develop a feasibility report to the NCSP manager for the design and installation of a subcritical assembly at ORNL using existing resources at Y-12. If the concept is feasible, submit a proposal for consideration for FY20. (TE10)

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

ORNL funding continues 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)

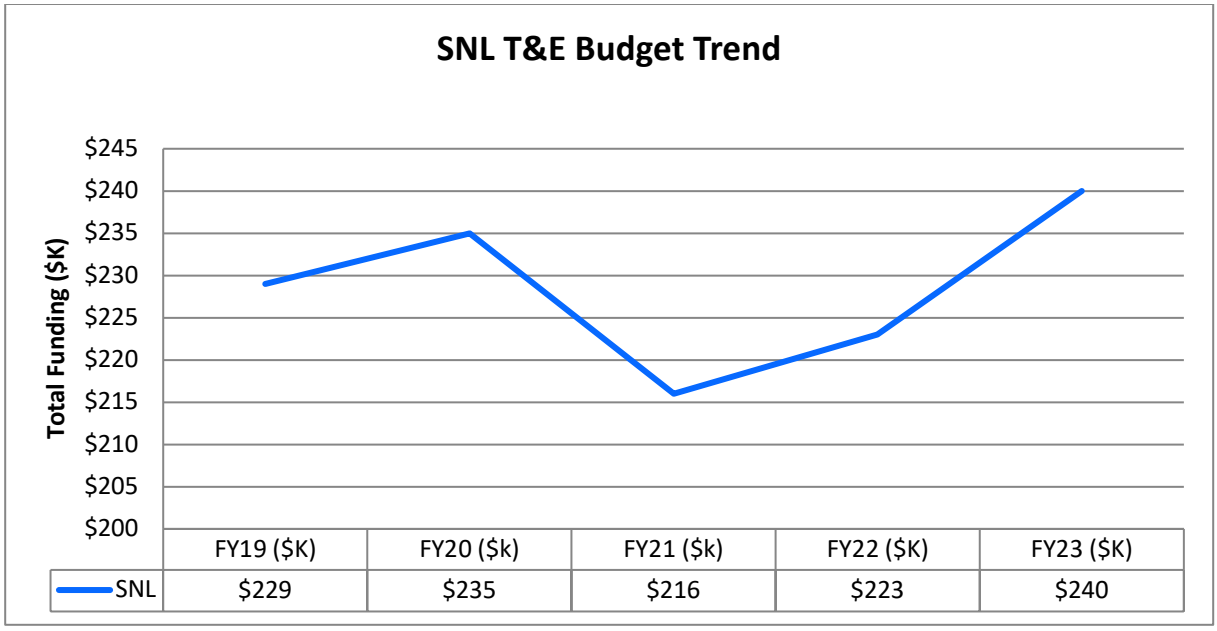
Task Name	Task Title
SNL TE1	Prepare for and Conduct Hands-on Criticality Safety Training at SNL
Budget	**Collaborators**
$204K	IRSN (IRSN TE1), AWE (AWE TE1)

This is an ongoing approved task to conduct hands-on 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.

Task Name	Task Title
SNL TE2	Design and Develop a New NCSP T&E Course Criticality Safety Officers at DOE/NNSA Nuclear Facilities
Budget	**Collaborators**
$25K	ORNL (ORNL TE9), LLNL (LLNL TE9), LANL (LANL TE7)

At the direction of ORNL, assist as a team member in the design and development of a new NCSP TE Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities. This task will use a CSSG tasking response as a roadmap for course development.

Table 2.5-8 SNL TE Budget Trend (FY2019-FY2023)



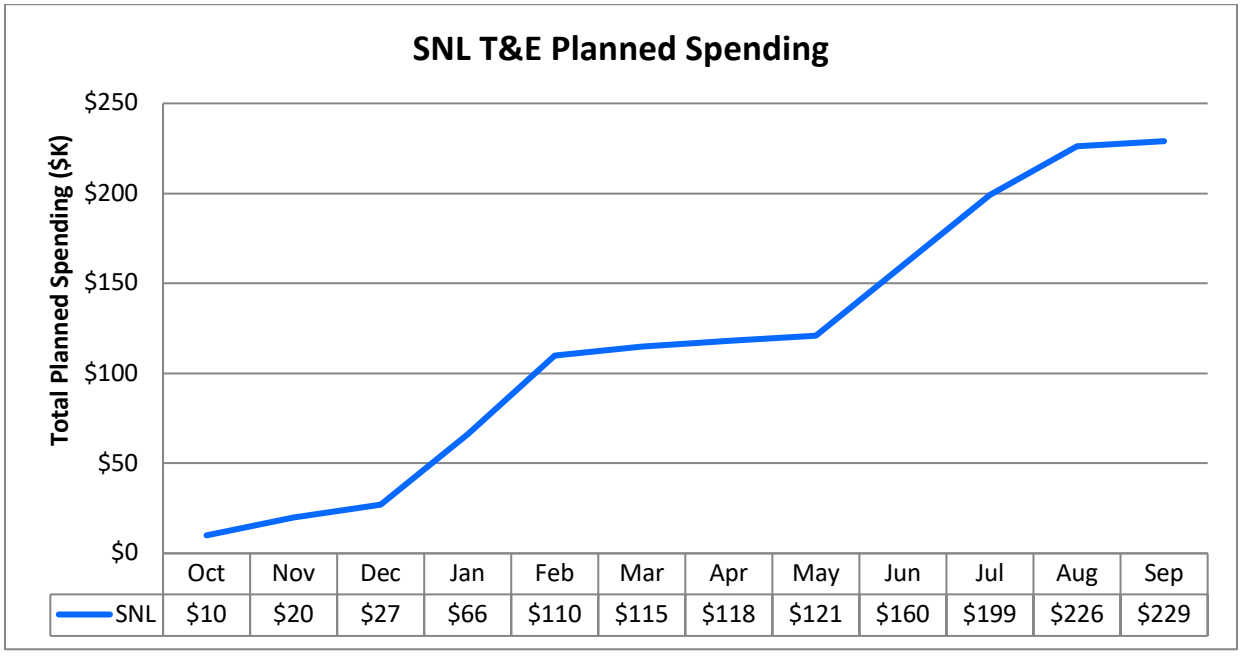


Table 2.5-9 SNL T&E Planned Spending (FY2019)

SNL T&E Milestones:

All Quarters

- Conduct hands-on training classes at Sandia and provide Human Factors and Equipment Reliability module support to the LANL training classes in accordance with the approved schedule. (TE1)
- Work with LLNL, ORNL, LANL to develop and deploy a 1-week hands-on NCSP T&E course for fissile material handlers and criticality safety officer. (TE2)

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

The SNL budget trend show modest increases in out-years to help mitigate increased cost of doing business to support the hands-on courses. In FY19-20, SNL will support the development of the CSO course. The course will be piloted in FY20.

2.5.2.5 Y-12 National Security Complex

Task Name	Task Title
Y12 TE1	Conduct Hands-On Criticality Safety Training Course (Lecture support week 1 of 2-week hands-on course and course material development)
Budget	**Collaborators**
$69K	ORNL (ORNL TE9), LLNL (LLNL TE9), LANL (LANL TE7)

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

Task Name	Task Title
Y12 TE3	Design of a Subcritical Assembly at ORNL for use with the CSO Courses
Budget	**Collaborators**
$40K	ORNL (ORNL TE10)

Support the task to determine the feasibility of a subcritical assembly for use in the NCSP and CSO training being designed by the NCSP in FY2019.

Task Name	Task Title
Y12 TE4	Design and Develop a New NCSP T&E Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities
Budget	**Collaborators**
$25K	LLNL (LLNL TE9), SNL (SNL TE2), LANL (LANL TE7)

Table 2.5-10 Y12 TE Budget Trend (FY2019-FY2023)

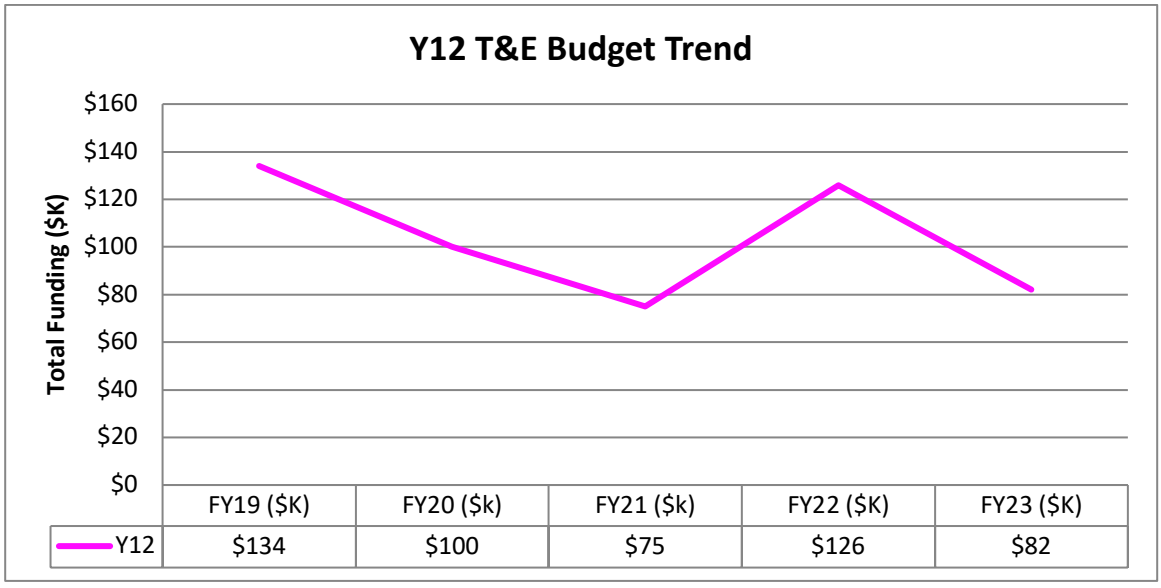
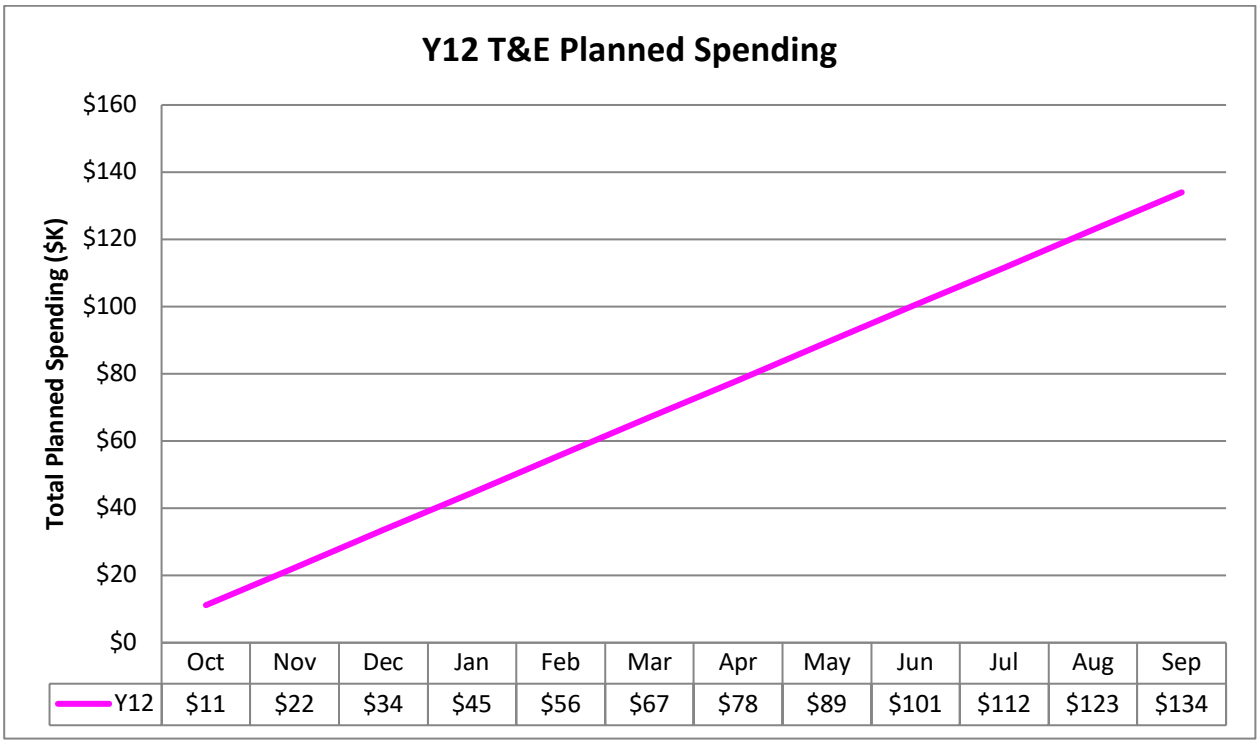


Table 2.5-11 Y12 TE Planned Spending (FY2019)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Y12	$11	$22	$34	$45	$56	$67	$78	$89	$101	$112	$123	$134

Y12 TE Milestones:

All Quarters

- Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1, TE3, TE4)

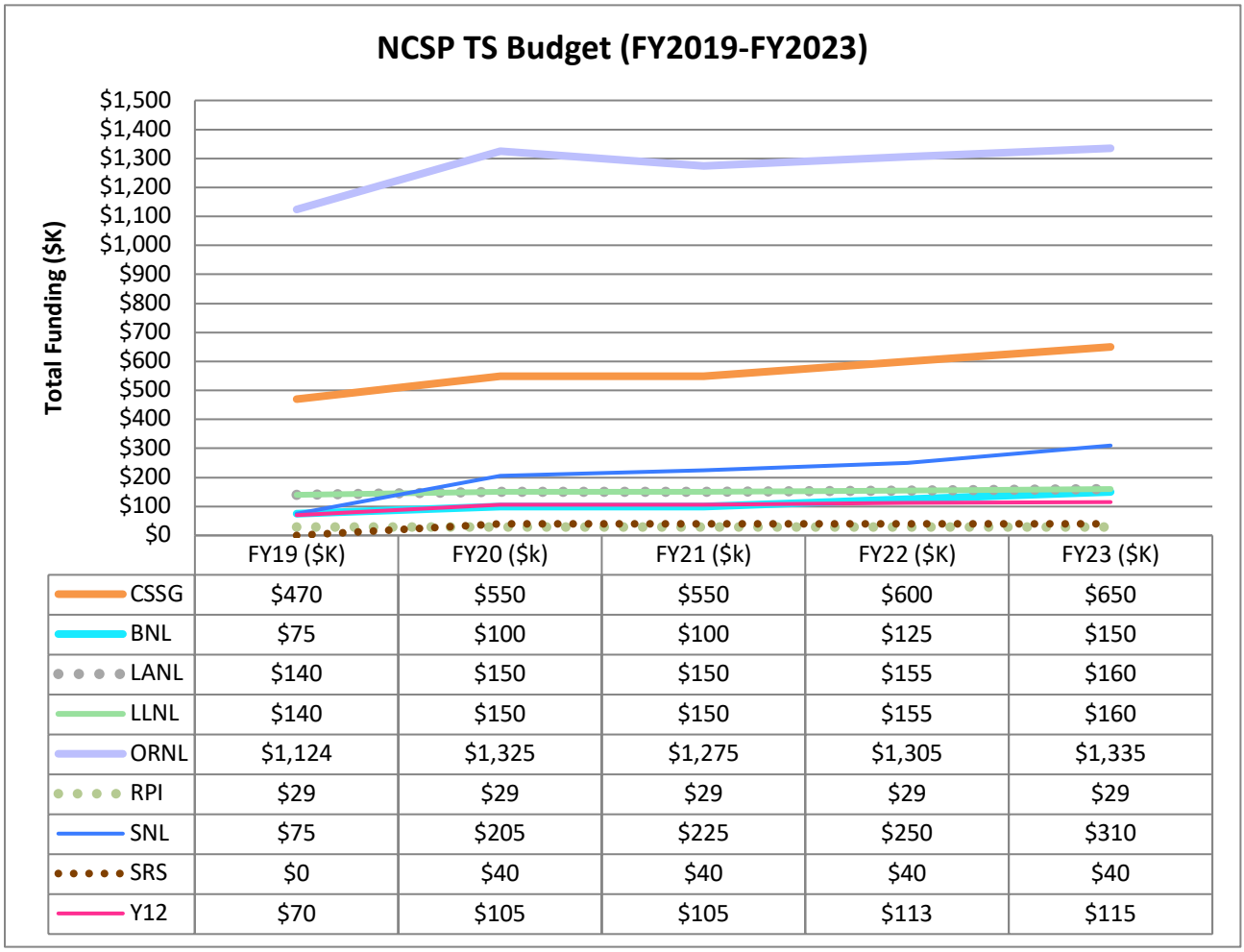
EOC – for out-year peaks and dips in budget plots:

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

3.0 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.

Table 3.1 NCSP Technical Support (FY2019-FY2023) - by Laboratory



	FY19 ($K)	FY20 ($k)	FY21 ($k)	FY22 ($K)	FY23 ($K)
CSSG	$470	$550	$550	$600	$650
BNL	$75	$100	$100	$125	$150
LANL	$140	$150	$150	$155	$160
LLNL	$140	$150	$150	$155	$160
ORNL	$1,124	$1,325	$1,275	$1,305	$1,335
RPI	$29	$29	$29	$29	$29
SNL	$75	$205	$225	$250	$310
SRS	$0	$40	$40	$40	$40
Y12	$70	$105	$105	$113	$115

Task Name	Task Title	
NCSP TS1	CSSG – Support for the Criticality Safety Support Group	
Budget	**Collaborators**	
$470K	None	
Site	**Individual**	**Funds**
NCSP MGR	NCSP Holdback	$80K
ANL	CSSG 1	$0K
DOE-EM	CSSG 2	Not funded by NCSP
LANL	CSSG 3	$60K
	CSSG 4	$65K
CSSG 1	CSSG 5	$50K
ORNL	CSSG 6	$35K
	CSSG 7	$35K
	CSSG 8	$60K
	CSSG 9 (emeritus support)	$5K
	CSSG 10	$30K
SRS	CSSG 11	$50K

The CSSG is comprised of recognized criticality safety experts from DOE offices and contractor organizations. The primary function of the CSSG is to provide operational and technical expertise to the DOE through the NCSP Manager. The CSSG also provides the NCSP Manager with technical reviews of orders, standards, rules, and guides issued by DOE related to criticality safety. In addition, the CSSG responds to requests from the NCSP Manager for information, technical reviews, and evaluations of criticality safety issues throughout the complex. There are normally 10 CSSG members (periodically there could be additional members in order to support new member transition and overlap). Only contractor members of the CSSG are modestly funded. One CSSG member is funded by DOE-EM. This is an ongoing approved task to provide Technical Support as tasked by NCSP Manager through approved CSSG Taskings as documented and provided on the NCSP Website.

Task Name	Task Title
NCSP TS2	ORNL – Support for Lead Lab to Execute the NCSP
Budget	**Collaborators**
$625K	None

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

Task Name	Task Title
NCSP TS3	SNL – Support for Experimentalist Succession Planning
Budget	**Collaborators**
$75K	None

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.

Task Name	Task Title
NCSP TS4	LANL – AM, IE, ND Succession Planning
Budget	**Collaborators**
$140K	None

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.

Task Name	Task Title
NCSP TS5	LLNL – AM, IE, ND Succession Planning
Budget	**Collaborators**
$140K	None

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.

Task Name	Task Title
NCSP TS6	BNL – ND Succession Planning
Budget	**Collaborators**
$75K	None

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.

Task Name	Task Title
NCSP TS7	ORNL – AM, ND Succession Planning
Budget	**Collaborators**
$140K	None

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

Task Name	Task Title
NCSP TS8	ORNL – NCSP Program Management Tools Development
Budget	**Collaborators**
$200K	None

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

Task Name	Task Title
NCSP TS9	NNL – Support for NDAG Chair activities
Budget	**Collaborators**
$29K	None

Provide support for NDAG Chair activities, participate in relevant Working Groups and domestic and international nuclear data meetings as the nuclear data lead for the NCSP, and coordinate NCSP ND element work program with current and future DOE needs. Support the development of the 5-year plan by coordinating and planning nuclear data prioritization meetings and working with the NCSP management team for tracking progress nuclear data tasks over the course of the year. *Funding will be sent to NNL and not RPI for this task.*

Task Name	Task Title
NCSP TS10	Y-12 TPR and Foreign Travel
Budget	**Collaborators**
$35K	None

Support the FY19 Technical Program Review and to fund Y-12 foreign travel as documented in Appendix B.

Task Name	Task Title
NCSP TS11	ORNL – NCSP C_EdT Manager Support
Budget	**Collaborators**
$159K	None

Activities for this task include integral experiment request (IER) tracking, experimental facility metrics, C_EdT duties, Work for Others tracking/approval, keeping the NCSP management team informed about DAF NCSP activities, 5YP IE plan support, working with task MGRs to submit BCR forms, conduct integral experiment (IE) telecons to track IE NCSP work, availability of NCERC and Sandia critical assemblies for NCSP work, and other tasks at the discretion of NCSP manager or execution manager. These funds support C_EdT Manager support from FY19Q1 to mid-Quarter 2 at ORNL. The C_EdT Manager role will transition from ORNL to Sandia for the remainder of the fiscal year.

Task Name	Task Title
NCSP TS15	Y-12 NCSP Support
Budget	**Collaborators**
$35K	None

This task is for subcontractor support to the NCSP, as directed by the NCSP Manager or NCSP Execution Manager.

NCSP TS Milestones:

Occurs all 4 Quarters

- Provide the NCSP manager with a summary of CSSG activities, meetings, and tasks. (TS1)
- Manage C_EdT process and coordinate execution of planned IERs each FY. (TS2)
- Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization effort by the NCSP Management Team. (TS2)
- Provide the NCSP manager with a summary of NDAG chair activities, meetings, and tasks. (TS9)
- Provide the NCSP manager with a summary of NCSP C_EdT Manager tasks as described in the task description. (TS11)
- Provide the NCSP manager with a summary of NCSP subcontractor support (TS15).

Quarter 4

- Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY. (TS2)
- Publish final Five-Year Plan. (TS2)
- Provide NCSP Manager annual report of succession planning efforts. (TS3, TS4, TS5, TS6, and TS7)
- Provide NCSP Manager a status report of progress on the development of a program management tool. (TS8)
- Provide the NCSP manager with a summary report of TPR planning and execution efforts and submit foreign travel reports for trips to ICNC in Q4. (TS10)

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

Increase in FY19 to fund development of NCSP program management tools with corresponding decrease in funding beginning in FY21 after these tools are implemented.

Appendix A
Work Authorization Statements for
Nuclear Criticality Safety Program Funding for Execution Year FY2019
Provided to the NA-50 Budget Office in October 2018

Brookhaven National Laboratory (BNL): $275K

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) FY19 Five-Year Plan dated October 2018, or as directed by the NCSP Manager.

BNL POC: David Brown (631-344-2814), dbrown@bnl.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Los Alamos National Laboratory (LANL): $10,944K

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) FY19 Five-Year Plan dated October 2018, 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: Brian Bluhm (505-667-2440), bkb@lanl.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Lawrence Livermore National Laboratory (LLNL): $3,979K

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) FY19 Five-Year Plan dated October 2018, or as directed by the NCSP Manager; succession planning for equipment support, facility support, and/or radiation transport developers; and for participation in the Criticality Safety Support Group (CSSG), as it provides technical support to the NCSP Manager regarding planning and execution of the NCSP.

LLNL POC: David Heinrichs (925-424-5679), heinrichs1@llnl.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Nevada National Security Site - NSTec (NNSS): $2,866K

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

Reflects funds to continue support for integral experiments, nuclear data, analytical methods tasks as delineated in the Nuclear Criticality Safety Program (NCSP) FY19 Five-Year Plan dated October 2018.

NNSS POC: Jeff Lewis (702-524-0647), lewisjm@nv.doe.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Oak Ridge National Laboratory (ORNL): $5,749K

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) FY19 Five-Year Plan dated October 2018, or as directed by the NCSP Manager; Technical Support for NCSP management; and for succession planning for cross-section processing developers, radiation transport developers, and/or nuclear data evaluators/experimentalists/developers, and for support to the Criticality Safety Support Group (CSSG).

ORNL POC: Douglas G. Bowen (865-576-0315), bowendg@ornl.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Renssalaer Polytechnic Institute (RPI): ($940K) and NDAG Chair at NNL ($29K) – $969K total

Task: Nuclear Data and NDAG Support at NNL

Reflects funds to conduct differential measurements as delineated in the Nuclear Criticality Safety Execution (NCSP) FY19 Five-Year Plan dated October 2018 and continue work, as defined in the RPI LINAC 2020 Nuclear Data Capabilities Maintenance Plan, or as directed by the NCSP Manager. Funds will be sent to the NNL M&O partner, Fluor Marine Propulsion (FMP).

RPI Funds for ND tasks - $940K.
NDAG Chair funds for Mike Zerkle at NNL - $29K.

RPI POC: Yaron Danon (518-276-4008), danony@rpi.edu
NNL POC: Tim Trumble (518-395-5203), timothy.trumbull@unnpp.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Sandia National Laboratories (SNL): $1,317K

Tasks: Integral Experiments and Training and Education

Reflects funds to continue support for integral experiments; training and education; C_EdT Manager Support, and succession planning for experimentalists as, delineated in the Nuclear Criticality Safety Program (NCSP) FY19 Five-Year Plan dated October 2018, or as directed by the NCSP Manager.

SNL POC: Gary Harms (505-845-3244), gaharms@sandia.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Savannah River Site (SRS): $119K

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

Reflects funds to update and maintain ARH-600 as delineated in the Nuclear Criticality Safety Program (NCSP) FY19 Five-Year Plan dated October 2018, or as directed by the NCSP Manager, and to continue support as the CSSG Chair during FY19, as directed by the NCSP Manager and for participation in the CSSG, as it provides technical support to the NCSP Manager regarding planning and execution of the NCSP.

SRS POC: David Erickson (803-557-9445), david.erickson@srs.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Y-12 National Security Complex (Y-12): $589K

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

Reflects funds to support the training and education program, the fabrication of a uranium target needed for nuclear data measurements, the design of integral experiments involving systems with enriched uranium, chlorine, and lithium-6, and the study of a solution reactor design in collaboration with IRSN, as delineated in the Nuclear Criticality Safety Program (NCSP) FY19 Five-Year Plan dated October 2018, or as directed by the NCSP Manager and to support the FY19 Technical Program Review and to fund Y-12 foreign travel as documented in Appendix B. Further, an additional task is funded for general NCSP and CSSG support, as required.

Y-12 POC: Kevin Reynolds (865-241-9067), keven.reynolds@cns.doe.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

NCSP Manager: CSSG Hold Back – $80K

Reflects DOE HQ Hold Back for the CSSG ($80K) that will be held as HQ reserve funds.

DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Appendix B
Nuclear Data Priorities, Basis Statements, and Milestones

Nuclear Data Measurements							
Materials	**Pre-FY2019**	**FY2019**	**FY2020**	**FY2021**	**FY2022**	**FY2023**	**Post-FY2023**
Cerium (^{142}Ce)							
Basis	Neutron transmission and capture of ^{142}Ce in the resonance range. Cerium is an element that is predominately ^{140}Ce (88.450 a/o) and ^{142}Ce (11.114 a/o) and can be found in chemical processing streams because it is commercially used as a catalyst or additive for chemical applications (e.g., glass polishing powder). As a result, cerium appears as an admixed material in process streams. ^{142}Ce is also a stable fission product. The primary interest for cerium cross sections is for poison credit in NCS analyses. The need for improved cerium cross sections has been specifically identified for the Hanford Plutonium Finishing Plant and other similar operations. Isotopically enriched sample required.						
Chlorine (^{35}Cl)							
Basis	Measurement of the ^{35}Cl (n,p) cross section in the resonance range. Chlorine is present in fuel cycle facilities in Pu solutions, electrorefining processes, chloride salts, and as brine/drift in some repository environments. Improved ^{35}Cl (n,p) cross sections needed for poison credit in these in these environments. A need for improved ^{35}Cl cross sections has been specifically identified at LANL and Y-12.						
Lanthanum (^{nat}La)							
Basis	Measurement of neutron transmission and yield of ^{nat}La in the resonance range. Lanthanum is an element that is predominately ^{139}La (99.910 a/o) and a stable fission product. The primary NCS interest is for fission product credit. In the latest edition of the ENDF nuclear data library, the resonance analysis is based on parameters obtain with an experimental set up which is known to have certain problems. Currently, ENDF/B-VIII evaluations for La do not have adequate covariance data based on experimental data. Improved covariance data are needed to support sensitivity/uncertainty analyses for fission product credit applications. Natural samples can be used.						
Molybdenum (^{95}Mo)							
Basis	Measurement of neutron capture in ^{95}Mo in resonance range, URR. Neutron transmission measurements previously completed at RPI. ^{95}Mo is a stable fission product and the primary absorbing nuclide in natural Molybdenum. Molybdenum isotopes are currently encountered in irradiated fuel as fission products or in molybdenum alloys in research reactors and space reactors. The current primary interest in NCS is for fission product credit for transport casks, irradiated fuel storage, and reprocessing plants (UPu-MoZr deposits in French reprocessing plant equipment for example). Needs identified by NR and IRSN for fission product credit and Y-12 for U-Mo applications (lower priority). Isotopically enriched sample required.						

Neptunium (^{237}Np)							
Basis	Measurement of ^{237}Np fission cross section in fast energy range. ^{237}Np is an actinide of interest in nuclear criticality safety for applications at ORNL and other sites. Applications include ^{238}Pu production w/ HFIR at ORNL (low NCSP priority) and fast burst reactor for LANL. Nuclear data improvements will improve critical mass estimates. On the HPRL there is a request for fission cross section in the energy range from 200 keV to 20 MeV. The application list was fast systems, and the required accuracy is 1.5-4%. This requirement comes from the desire to improve the current low accuracy in the covariance matrix (6-8%).						
Tantalum (^{181}Ta)							
Basis	^{181}Ta transmission and capture in resonance range. Natural samples can be used since ^{181}Ta is 99.988 a/o. Tantalum is used at Y-12 for recovering uranium from machine turnings and at LANL for Pu casting operations in PF-4 where it may provide modest moderation and reflection of fissile material. Tantalum is chosen due to its material properties, as it is one of the few materials that can contain molten plutonium metal. Due to this characteristic, tantalum is often used as crucible, distributer, launder, or molds for plutonium casting operations. The wall thickness of these materials varies from a few mm all the way up to a few cm. ^{181}Ta evaluation is one of the oldest in ENDF and long overdue for update. ^{181}Ta transmission and capture measurements with 100m flight station for transmission and 45m for capture. High resolution data resolving resonance structure up to 10 keV and Unresolved self-shielding test using transmission through thick samples. RPI is also trying to resolve issues with resolved resonance region discrepancies. Integral experiments in progress to validate Ta cross sections.						
Uranium (^{233}U)							
Basis	^{233}U capture measurements in resonance range. ORNL report on ^{233}U data assessment concluded that a new evaluation with revised (renormalized) fission cross section is needed. New capture cross section measurements (resonance region) needed to support this evaluation. NCS applications at LANL (CMR), ORNL, DAF/NCERC, spare unirradiated LWBR modules at INL.						
Zirconium (^{90,91,92,94,96}Zr)							
Basis	Neutron transmission and capture measurements in resonance range. Isotopically enriched samples likely required. Zirconium is a key structural element that is primarily used in cladding for fuel rods and is currently in consideration for use with advanced nuclear fuel matrices in the form of zirconium hydride. The main application is reactor fuel cladding. ^{nat}Zr transmission measurements were recently completed by ORNL. At RPI ^{nat}Zr neutron scattering measurements in the keV range are in progress for NR, the measurements will provide information on angular distributions. NR continues to be unsatisfied with Zr evaluations in ENDF.						

List Legend	ORNL	RPI	LANL	LLNL/NCSU	IRSN	NNL	Low Priority

Nuclear Data Evaluations							
Materials	**Pre-FY2019**	**FY2019**	**FY2020**	**FY2021**	**FY2022**	**FY2023**	**Post-FY2023**
Cerium (Ce)							
Basis	Neutron transmission and capture of ^{142}Ce in the resonance range. Cerium is an element that is predominately ^{140}Ce (88.450 a/o) and ^{142}Ce (11.114 a/o) and can be found in chemical processing streams because it is commercially used as a catalyst or additive for chemical applications (e.g., glass polishing powder). As a result, cerium appears as an admixed material in process streams. ^{142}Ce is also a stable fission product. The primary interest for cerium cross sections is for poison credit in NCS analyses. The need for improved cerium cross sections has been specifically identified for the Hanford Plutonium Finishing Plant and other similar operations.						
Chlorine (^{35}Cl)							
Basis	Revise ^{35}Cl resonance evaluation based on ^{35}Cl (n,p) measurements. Chlorine is present in fuel cycle facilities in Pu solutions, electrorefining processes, chloride salts, and as brine/drift in some repository environments. Improving ^{35}Cl (n,p) cross sections needed for poison credit in these environments. A need for improved ^{35}Cl cross sections has been specifically identified at LANL and Y-12.						
Dysprosium (Dy)							
Basis	Completion of the new ^{160,162,163,165}Dy resonance evaluations will demonstrate the ability of using the RPI linear accelerator to provide measured data to support the NCSP nuclear data evaluation efforts. In addition, the evaluated nuclear data files do not have evaluated covariance data for the dysprosium isotopes, and completion of the evaluation work will provide much needed evaluated covariance data in the resonance region.						
Gadolinium ($^{155\text{-}158,160}$Gd)							
Basis	Revisit resonance evaluation. Recent work results indicate under-prediction of the capture cross section in the ENDF/B-VIII.0 and over-prediction in ENDF/B-VII.1. NCS need is freshly irradiated fuel and shipping container use in NNSA applications.						
Iron (^{56}Fe)							
Basis	Revise high energy resonance region evaluation. Iron is a key element of structural materials in the DOE Complex (e.g., steel) and is used in many configurations (e.g., tanks, piping, admixed material that can serve as neutron absorber, etc.). ^{56}Fe has numerous resonances in the resonance range. Currently, the latest ^{56}Fe evaluation in the ENDF/B data files does not have detailed resonance parameters; rather, the evaluation provides a pointwise representation. The ^{56}Fe resonance evaluation will significantly improve radiation transport calculations for systems involving iron (i.e., critical benchmark analyses and criticality safety analyses of processes in the DOE Complex). Evaluation work was performed at IRSN in the past but was not apparently included in ENDF (this will be reviewed and considered for inclusion in ENDF).						

Lanthanum (La)							
Basis	^{139}La resonance range evaluation based on ^{nat}La measurements. Lanthanum is an element that is predominantly ^{139}La (99.910 a/o) and a stable fission product. The primary NCS interest is for fission product credit. In the latest version of ENDF nuclear data library, the resonance analysis is based on parameters obtained with an experimental set up which is known to have certain problems. Currently, ENDF/B-VIII evaluations for La do not have adequate covariance data based on experimental data. Improved covariance data are needed to support sensitivity/uncertainty analyses for fission product credit applications.						
Lead (^{208}Pb)							
Basis	Lead is a ubiquitous material in the nuclear industry. Lead possesses not only high photon attenuation properties, which make it almost a universal choice as a gamma-ray shielding material, but also desirable neutronic qualities. Our ability to match experimental data with Pb (reflectors and as a scattering target) is less that we desire. Pb-208 is the majority isotope of natural lead. The current ENDF evaluation is known to suffer from deficiencies in neutron angular distributions. The emphasis of the re-evaluation work is on these angular distributions. We will judge success of this work based on recent semi-integral measurements performed at RPI.						
Molybdenum (^{95}Mo)							
Basis	Resonance region evaluation. ^{95}Mo is a stable fission product and the primary absorbing nuclide in natural molybdenum. Molybdenum isotopes are currently encountered in irradiated fuel as fission products or in molybdenum alloys in research reactors and space reactors. Current primary interest for NCS is for fission product credit for transport casks, irradiated fuel storage, and reprocessing plants (UPu-MoZr deposits in reprocessing plant equipment for example). Needs identified by NR and IRSN for fission product credit and Y-12 for U-Mo applications (lower priority).						
Neptunium (^{237}Np)							
Basis	Fast energy range evaluation. ^{237}Np is an actinide of interest in nuclear criticality safety for applications at ORNL and other sites. Applications include 238Pu production w/ HFIR (low NCSP priority) and fast burst reactor for LANL. Nuclear data improvements will improve critical mass estimates. On the HPRL there is a request for fission cross section in the energy range from 200 keV to 20 MeV. The application list was fast systems, and the required accuracy is 1.5-4%. This requirement comes from the desire to improve the current low accuracy in the covariance matrix (6-8%).						
Rhodium (^{103}Rh)							
Basis	Update resonance evaluation based on RPI transmission and capture measurements in the RRR. ^{103}Rh is a stable fission product, NCS interest is for fission product credit. Integral experiments are in process that will determine need for new evaluations. Evaluation currently low priority - elevate priority if IE results indicate need for new evaluation.						

Plutonium (^{239}Pu)	
Basis	^{239}Pu is one of the three major fissile isotopes of interest in Nuclear Criticality Safety. ^{239}Pu is used at LANL, LLNL, Hanford, SRS, and other locations in sufficient quantities to be an NCS concern. ^{239}Pu is a major factor in countless ICSBEP benchmarks. NCSP driver includes inadequate agreement of computations with PU-SOL-THERM benchmarks (biased high). Major experimental campaigns at LANSCE for ^{239}Pu fission cross section and PFNS are nearing conclusion and the resulting data need to be incorporated into an updated evaluation. ORNL to assist with evaluation work.
Tantalum (Ta)	
Basis	Resonance evaluation based on GELINA and RPI measurements. Tantalum is used at Y-12 for recovering uranium from machine turnings and at LANL for Pu casting operations in PF-4 where it may provide modest moderation and reflection of fissile material. Tantalum is chosen due to its material properties, as it is one of the few materials that can contain molten plutonium metal. Due to this characteristic, tantalum is often used as crucible, distributer, launder, or molds for plutonium casting operations. The wall thickness of these materials varies from a few mm all the way up to a few cm. ^{181}Ta is one of the oldest evaluations in ENDF and long overdue for update. Integral experiments in progress to validate Ta cross sections.
Uranium-233	
Basis	^{233}U is a fissile nuclide of interest to criticality safety. The availability of ^{233}U of importance to NCS mainly at Y-12, ORNL, and at NCERC. 1. New evaluation of the thermal region. Reevaluate differential data to check the renormalization of ORNL fission data. ENDF is not fitting the Guber and n_TOF fission data, which agree within 2% from 10 eV to 100 keV. Above 100 eV, there are serious discrepancies between ENDF and the new experimental fission data (from Guber and n_TOF) of up to 10% in the 1–10 keV range (Guber). Update with the new standards. RPI has ^{233}U capture data, which is likely the Weston data (Danon). 2. New evaluation fast. Fission spectrum is important for intermediate benchmarks. Renormalize to new standards.
Uranium-234	
Basis	While ^{234}U makes up a small fraction of natural uranium, previous studies have shown that ignoring ^{234}U for HEU metal benchmarks can lead to a non-conservative result by as much as 0.4%. Recent advances in the capabilities of the DANCE detector at LANSCE, combined with improved theoretical modeling of the capture reaction (for example, including the M1 scissors-mode contribution to the gamma strength function) have enabled more accurate evaluations of (n,g) cross sections. This work to update the ^{234}U capture cross section will utilize both the experimental and theoretical advances.

Uranium-235							
Basis	^{235}U is one of the three major fissile isotopes of interest in Nuclear Criticality Safety. ^{235}U is used at LANL, LLNL, Hanford, SRS, and GDPs, Y-12, and other locations in sufficient quantities to be an NCS concern. ^{235}U is a major factor in countless ICSBEP benchmarks. Major LANSCE experiments of ^{235}U fission cross section and PFNS are concluding in the next few years, and the resulting data needs to be incorporated into an updated evaluation. Inelastic scattering cross section measurements are also planned, which will allow evaluators to better address these high-uncertainty interactions. Improvement of ^{235}U URR because based on old average resonance parameters.						
Uranium-236							
Basis	^{236}U needs to be considered in modeling of spent fuel. Recent advances in the capabilities of the DANCE detector at LANSCE, combined with improved theoretical modeling of the capture reaction (for example, including the M1 scissors-mode contribution to the gamma strength function) have enabled more accurate evaluations of (n,g) cross sections. This work to update the ^{236}U capture cross section will utilize both the experimental and theoretical advances.						
Uranium-238							
Basis	^{238}U is a ubiquitous isotope in HEU, LEU, natural uranium, and depleted uranium. It's presence in HEU and LEU fuels makes it a significant contributor to their reactivity and performance. NU and DU are often used as reflectors or shielding materials, and ^{238}U is obviously the dominant isotope in these materials. ^{238}U is a major factor in countless ICSBEP benchmarks. Major LANSCE experiments of ^{238}U fission cross section and PFNS are concluding in the next few years, and the resulting data needs to be incorporated into an updated evaluation.						
Vanadium (^{51}V)							
Basis	Vanadium is a key structural element and is predominately ^{51}V (99.75 atom %). Primary NCS application is fire resistant cans. Recent data testing by LANL for ICSBEP critical benchmarks involving vanadium (i.e., HMF25, HMF40, and HMM16) results in an over-predication of the experiment eigenvalue. In addition, the HMF25 series of experiments exhibit an increasing calculated eigenvalue trend with increasing reflector thickness. The integral data testing indicates that there may be deficiencies in either the elastic scattering angular distributions or secondary energy distributions. In addition, the latest ENDF/B-VII.1 resonance evaluation is based on the JENDL-4.0 evaluation and does not have covariance data. Also, the ENDF/B-VII.1 and JENDL 4.0 resonance evaluations are based on the parameters provided in the Atlas of Neutron Resonances up to 42.5 keV, and the entire resolved resonance evaluation (up to 100 keV) is represented by the multi-level Breit Wigner (MLBW) formalism. As a result, the MLBW resonance evaluation does not account for the resonance-resonance interference effects. Therefore, the evaluated resonance parameters are not based on a detailed R-matrix analysis. Differential measurements are needed in the resonance region to accurately predict the neutron resonances, and a corresponding resonance evaluation is needed to provide detailed resonance parameters and covariance data. In addition, the SAMMY evaluation software has the capability to generate angular scattering distributions from the resonance parameters thereby providing detailed resonance scattering structure that will improve the elastic scattering modeling in the evaluation. The request is for ORNL to complete new ^{51}V cross-section measurements and a resonance evaluation to address computational biases with the existing ^{51}V evaluation. New measurement/evaluation of fast scattering angular distribution recommended.						

Zirconium (^{90,91,92,94,96}Zr)							
Basis	Resonance evaluations. Zirconium is a key structural element that is primarily used in cladding for fuel rods and is currently in consideration for use with advanced nuclear fuel matrices in the form of zirconium hydride. The latest ENDF/B-VII.1 resonance evaluation relies on JENDL-4 data and resonance parameters from the Atlas of Neutron Resonances. As a result, the evaluated resonance parameters are not based on detailed R-matrix analyses. In addition, newer RPI total cross-section measurements on natural zirconium indicate that the older ENDF/B-VI.8 data match the recent RPI measurements better than the newer isotopic evaluations. Furthermore, improved differential measurements of the zirconium isotopes have been identified on the OECD/NEA nuclear data High Priority Request List (HPRL). Differential measurements are needed in the resonance region to accurately predict the neutron resonances for the zirconium isotopes, and corresponding resonance evaluations are needed to provide detailed resonance parameters and covariance data. In addition, the SAMMY evaluation software has the capability to generate angular scattering distributions from the resonance parameters thereby providing detailed resonance scattering structure that will improve the elastic scattering modeling for the zirconium isotope evaluations. NR continues to be unsatisfied with Zr evaluations in ENDF.						
Water (H_2O)							
Basis	TSL evaluation. Water is this most important moderator and moderating reflector material for criticality safety and light water reactor physics. Problems with evaluations submitted by CAB at elevated temperatures (that were noticed during the ENDF/B-VIII.0 evaluation process) warrant re-evaluating this essential material using the latest methods developed under LLNL ND2, ND3.						
Hydrofluoric Acid (HF)							
Basis	TSL evaluation. HEU-SOL-THERM-039, "Mixture of Uranium (93%) Hexafluoride and Hydrofluoric Acid (Low H/U Ratio) in a Hot-Water-Reflected Spherical Tank," critical experiments overpredict k-eff from 2-6% regardless of cross-section library or code utilized. An appropriate thermal scattering law for the liquid Hydrofluoric acid (HF) moderator will likely resolve this calculational discrepancy.						
Uranium Hexafluoride (UF_6)							
Basis	TSL evaluation. As the H/U ratio is "low" in HEU-SOL-THERM-039, correcting for F in UF_6 may be necessary as a moderator. A thermal scattering law for this fissile compound will be useful for the advanced Doppler broadening methods currently under development as LLNL ND5.						
Hydraulic Fluid (Silicone Oil)							
Basis	TSL evaluation. Requested by the Naval Nuclear Laboratory for use in criticality safety evaluations.						
Paraffin (C_nH_{2n+2})							
Basis	TSL evaluation. A common moderator and moderating reflector material for which there are numerous critical benchmarks in the ICSBEP Handbook. A thermal scattering law for paraffin will improve simulations through higher fidelity and reduce uncertainties.						
Triuranium Octoxide (U_3O_8)							
Basis	TSL evaluation. A common fissile compound for which there are numerous critical experiments in the ICSBEP Handbook. A thermal scattering law for U_3O_8 will improve Doppler broadening using advanced methods currently under development as LLNL ND5.						
Uranyl Fluoride (UO_2F_2)							
Basis	TSL evaluation. A common fissile compound for which there are numerous critical experiments in the ICSBEP Handbook. A thermal scattering law for UO_2F_2 will improve Doppler broadening using advanced methods currently under development as LLNL ND5.						

Uranium Silicide (U_3Si_2)							
Basis	TSL evaluation. A common fissile compound in use in advanced nuclear reactor fuel. A thermal scattering law for U_3Si_2 will improve Doppler broadening using advanced methods currently under development as LLNL ND5.						
Uranium Carbide (UC)							
Basis	TSL evaluation. A common fissile compound under consideration for high-temperature advanced nuclear reactor fuel. A thermal scattering law for UC will improve Doppler broadening using advanced methods currently under development as LLNL ND5.						
Plutonium Oxide (PuO_2)							
Basis	TSL evaluation. A common fissile compound for which there are critical experiments in the ICSBEP Handbook. A thermal scattering law for PuO_2 will improve Doppler broadening using advanced methods currently under development as LLNL ND5.						
Uranium Hydride (UH_3)							
Basis	TSL evaluation. A common fissile compound in use in fissile material operations using hydride/de-hydride processes. A thermal scattering law for UH_3 will improve Doppler broadening using advanced methods currently under development as LLNL ND5.						
Plutonium Hydride (PuH_{2+x})							
Basis	TSL evaluation. A common fissile compound in use in fissile material operations using hydride/de-hydride processes. A thermal scattering law for PuH_{2+X} will improve Doppler broadening using advanced methods currently under development as LLNL ND5.						

List Legend	ORNL	RPI	LANL	LLNL/NCSU	IRSN	NNL	Low Priority

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

- B-1.1 Cerium (Ce)
- B-1.2 Chlorine (Cl-35)
- B-1.3 Dysprosium (Dy-161, 162, 163, 164)
- B-1.4 Gadolinium (Gd-155, 156, 157, 158, 160)
- B-1.5 Iron (Fe-54,56)
- B-1.6 Lanthanum (La)
- B-1.7 Lead (Pb-208)
- B-1.8 Molybdenum (Mo-95)
- B-1.9 Neptunium (Np-237)
- B-1.10 Plutonium (Pu-239)
- B-1.11 Rhodium (Rh-103)
- B-1.12 Strontium (Sr-90)
- B-1.13 Tantalum (Ta)
- B-1.14 Uranium-233 (U-233)
- B-1.15 Uranium-234 (U-234)
- B-1.16 Uranium-235 (U-235)
- B-1.17 Uranium-236 (U-236)
- B-1.18 Uranium-238 (U-238)
- B-1.19 Vanadium (V-51)
- B-1.20 Zirconium (Zr-90, 91, 92, 94, 96)

Completed Work

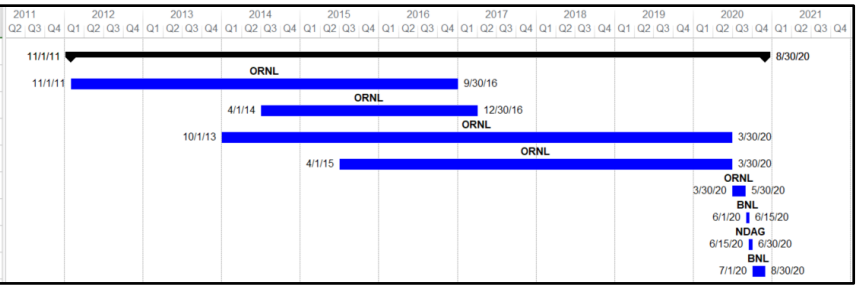
- Calcium (Ca)
- Cobalt (Co-59)
- Copper (Cu-63, 65)
- Nickel (Ni-58, 60)
- Oxygen (O-16)
- Tungsten (W-182, 183, 184, 186)

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.)

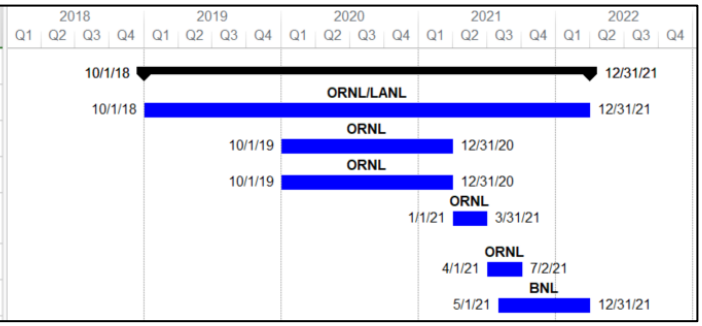
B-1.1 Cerium (Ce)

Task Name	Start	Finish	Resources
Cerium (Ce)	Tue 11/1/11	Sun 8/30/20	
Transmission and Capture Measurements	Tue 11/1/11	Fri 9/30/16	ORNL
Experimentalist Data Reduction and Testing	Tue 4/1/14	Fri 12/30/16	ORNL
Resolved Resonance Region Evaluation	Tue 10/1/13	Mon 3/30/20	ORNL
Assess Data for URR Evaluation and Complete	Wed 4/1/15	Mon 3/30/20	ORNL
Finalize Resonance Evaluation and Deliver to N	Mon 3/30/20	Sat 5/30/20	ORNL
Phase I Testing, Post to ENDF/A and Broadcas	Mon 6/1/20	Mon 6/15/20	BNL
CSEWG Validation Testing	Mon 6/15/20	Tue 6/30/20	NDAG
CSEWG Approval of Complete Evaluation	Wed 7/1/20	Sun 8/30/20	BNL



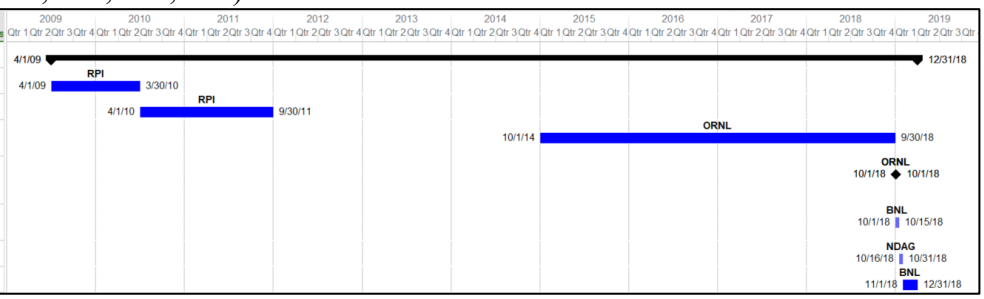
B-1.2 Chlorine (Cl-35)

Task Name	Start	Finish	Resources
Chlorine (Cl-35)	Mon 10/1/18	Fri 12/31/21	
Perform (n,p) Measurements	Mon 10/1/18	Fri 12/31/21	ORNL/LANL
Perform SAMMY Analysis of Measured Data	Tue 10/1/19	Thu 12/31/20	ORNL
Resolve Resonamce Region Evaluation	Tue 10/1/19	Thu 12/31/20	ORNL
Finalize isotopic Evaluation Resonance Region Evaluation and Deliver to NNDC	Fri 1/1/21	Wed 3/31/21	ORNL
Phase I testing , Post to ENDF/A and Broadcast	Thu 4/1/21	Fri 7/2/21	ORNL
CSEWG Validation Testing	Sat 5/1/21	Fri 12/31/21	BNL



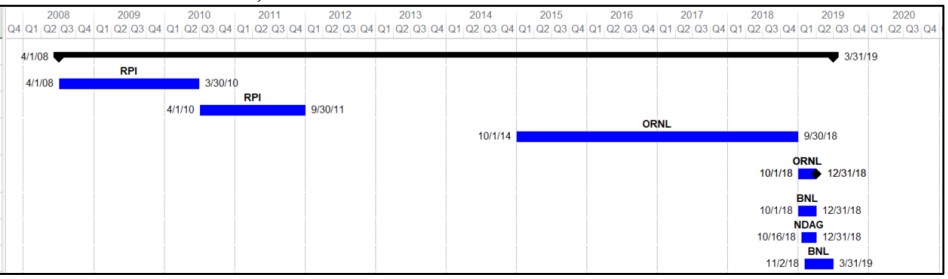
B-1.3 Dysprosium (Dy-161, 162, 163, 164)

Task Name	Start	Finish	Resources
Dysprosium (Dy-161,162,163,164)	Wed 4/1/09	Mon 12/31/18	
Perform Capture Measurements	Wed 4/1/09	Tue 3/30/10	RPI
Perform SAMMY Analysis	Thu 4/1/10	Fri 9/30/11	RPI
Resolve Resonance Region Evaluation for DY-161,162,163,164	Wed 10/1/14	Sun 9/30/18	ORNL
Finalize isotopic Evaluation Resonance Region Evaluation and Deliver to NNDC	Mon 10/1/18	Mon 10/1/18	ORNL
Phase I testing , Post to ENDF/A and Broadcast	Mon 10/1/18	Mon 10/15/18	BNL
CSEWG Validation Testing	Tue 10/16/18	Wed 10/31/18	NDAG
CSEWG Approval of Complete Evaluation	Thu 11/1/18	Mon 12/31/18	BNL



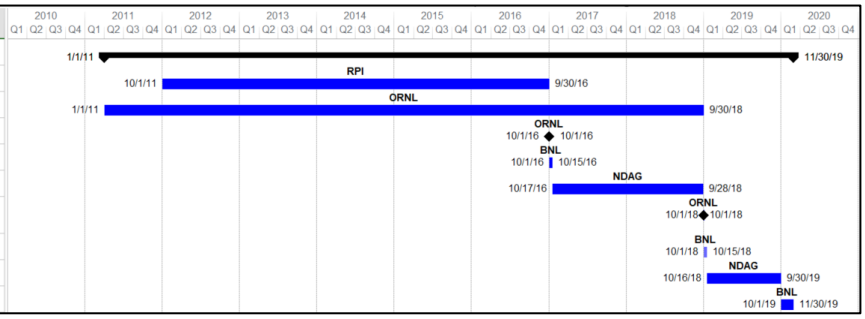
B-1.4 Gadolinium (Gd-155, 156, 157, 158, 160)

Task Name	Start	Finish	Resources
Gadolinium (Gd-155,156,157,158,160)	Tue 4/1/08	Sun 3/31/19	
Perform Capture Measurements	Tue 4/1/08	Tue 3/30/10	RPI
Perform SAMMY Analysis	Thu 4/1/10	Fri 9/30/11	RPI
Resolve Resonamce Region Evaluation for Gd-155,156,157,158,160	Wed 10/1/14	Sun 9/30/18	ORNL
Finalize Resonance Region Evaluation and Deliver to NNDC	Mon 10/1/18	Mon 12/31/18	ORNL
Phase I Testing , Post to ENDF/A and Broadcast	Mon 10/1/18	Mon 12/31/18	BNL
CSEWG Validation Testing	Tue 10/16/18	Mon 12/31/18	NDAG
CSEWG Approval of Complete Evaluations	Fri 11/2/18	Sun 3/31/19	BNL



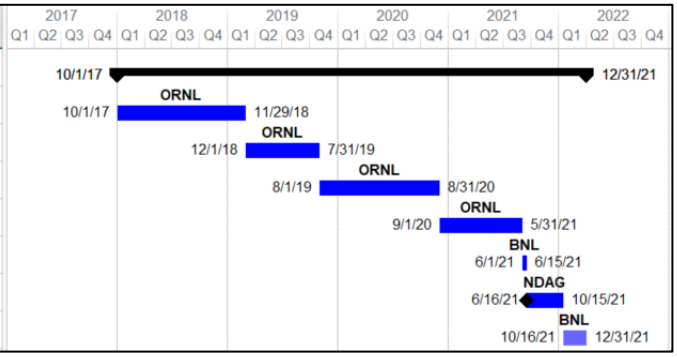
B-1.5 Iron (Fe-54,56)

Task Name	Start	Finish	Resources
Iron (Fe-56)	Sat 1/1/11	Sat 11/30/19	
Scattering Measurements	Sat 10/1/11	Fri 9/30/16	RPI
Re-evaluation of Resonance Region for Fe-56	Sat 1/1/11	Sun 9/30/18	ORNL
Finalize Resonance Region Evaluation and Deliver to NNDC	Sat 10/1/16	Sat 10/1/16	ORNL
Phase I Testing; Post to ENDF/A and Broadcast	Sat 10/1/16	Sat 10/15/16	BNL
CSEWG Validation Testing	Mon 10/17/16	Fri 9/28/18	NDAG
Finalize Thermal Scattering Evaluations and Deliver to NNDC	Mon 10/1/18	Mon 10/1/18	ORNL
Phase I Testing, Post to ENDF/A and Broadcast	Mon 10/1/18	Mon 10/15/18	BNL
CSEWG Validation Testing	Tue 10/16/18	Mon 9/30/19	NDAG
CSEWG Approval of Complete Evaluations	Tue 10/1/19	Sat 11/30/19	BNL



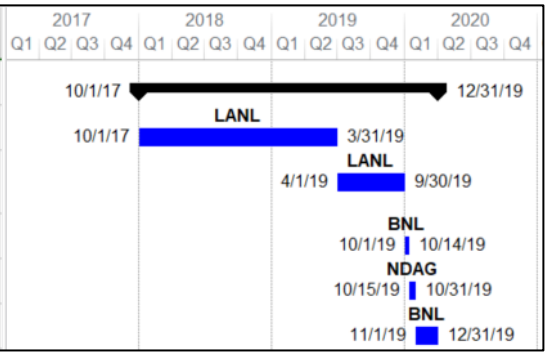
B-1.6 Lanthanum (La)

Task Name	Start	Finish	Resources
Lanthanum (La)	Sun 10/1/17	Fri 12/31/21	
Transmission and Capture Measurements	Sun 10/1/17	Thu 11/29/18	ORNL
Experimentalist Data Reduction and Testing	Sat 12/1/18	Wed 7/31/19	ORNL
Resolved Resonance Region Evaluation	Thu 8/1/19	Mon 8/31/20	ORNL
Finalize Resonance Evaluation and Deliver to NNDC	Tue 9/1/20	Mon 5/31/21	ORNL
Phase I Testing, Post to ENDF/A and Broadcast	Tue 6/1/21	Tue 6/15/21	BNL
CSEWG Validation Testing	Wed 6/16/21	Fri 10/15/21	NDAG
CSEWG Approval of Complete Evaluation	Sat 10/16/21	Fri 12/31/21	BNL



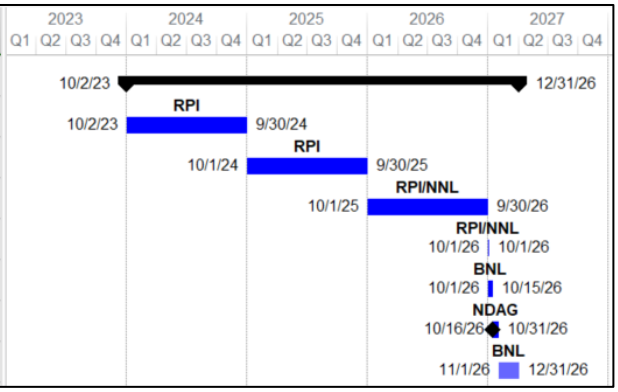
B-1.7 Lead (Pb-208)

Task Name	Start	Finish	Resources
Lead (Pb-208)	Sun 10/1/17	Tue 12/31/19	
Update High-Energy Neutron Angular Distributions	Sun 10/1/17	Sun 3/31/19	LANL
Test New Scattering Data Using Semi-Integral Experiment and Recommend Path Forward	Mon 4/1/19	Mon 9/30/19	LANL
Phase I Testing, Post to ENDF/A and Broadcast	Tue 10/1/19	Mon 10/14/19	BNL
CSEWG Validation Testing	Tue 10/15/19	Thu 10/31/19	NDAG
CSEWG Approval of Complete Evaluation	Fri 11/1/19	Tue 12/31/19	BNL



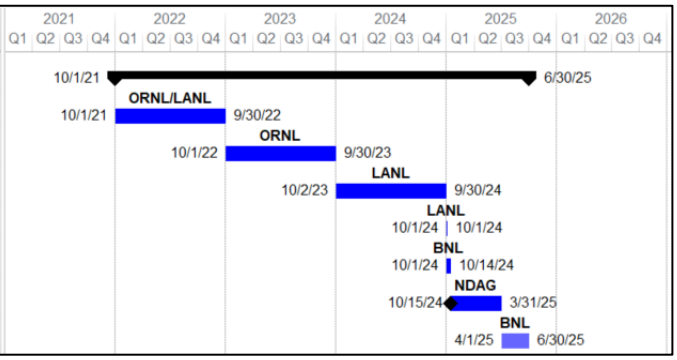
B-1.8 Molybdenum (Mo-95)

Task Name	Start	Finish	Resources
Molybdenum (Mo-95)	Mon 10/2/23	Thu 12/31/26	
Transmission and Capture Measurements	Mon 10/2/23	Mon 9/30/24	RPI
Experimentalist Data Reduction and Testing	Tue 10/1/24	Tue 9/30/25	RPI
Resolved Resonance Region Evaluation	Wed 10/1/25	Wed 9/30/26	RPI/NNL
Finalize Resonance Evaluation and Deliver to NNDC	Thu 10/1/26	Thu 10/1/26	RPI/NNL
Phase I Testing, Post to ENDF/A and Broadcast	Thu 10/1/26	Thu 10/15/26	BNL
CSEWG Validation Testing	Fri 10/16/26	Sat 10/31/26	NDAG
CSEWG Approval of Complete Evaluation	Sun 11/1/26	Thu 12/31/26	BNL



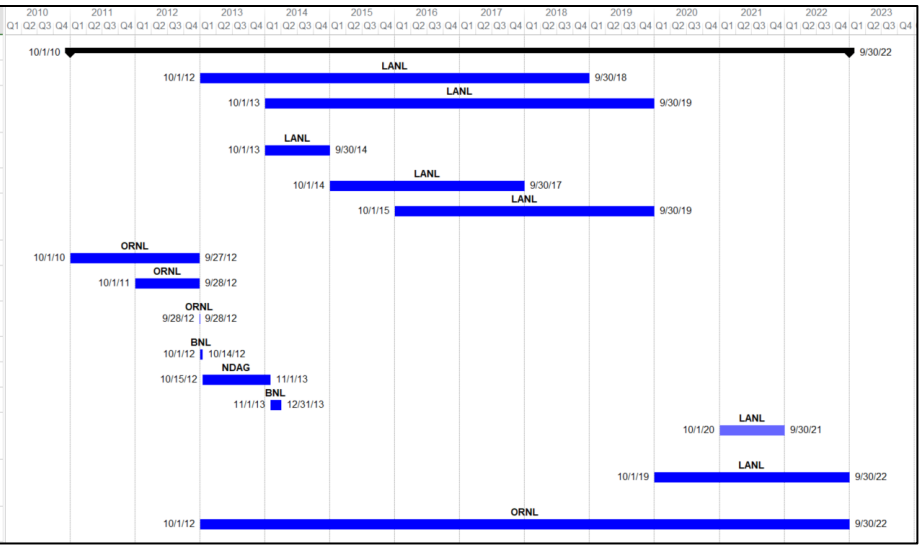
B-1.9 Neptunium (Np-237)

Task Name	Start	Finish	Resources
Neptunium (Np-237)	Fri 10/1/21	Mon 6/30/25	
Fission, Transmission and Capture Measurements	Fri 10/1/21	Fri 9/30/22	ORNL/LANL
Experimentalist Data Reduction and Testing	Sat 10/1/22	Sat 9/30/23	ORNL
Fast Region Evaluation	Mon 10/2/23	Mon 9/30/24	LANL
Finalize Fast Region Evaluation and Deliver to NNDC	Tue 10/1/24	Tue 10/1/24	LANL
Phase I Testing, Post to ENDF/A and Broadcast	Tue 10/1/24	Mon 10/14/24	BNL
CSEWG Validation Testing	Tue 10/15/24	Mon 3/31/25	NDAG
CSEWG Approval of Complete Evaluation	Tue 4/1/25	Mon 6/30/25	BNL



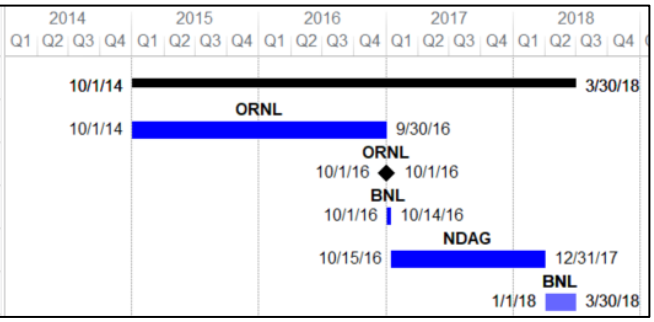
B-1.10 Plutonium (Pu-239)

Task Name	Start	Finish	Resources
Plutonium (Pu-239)	Fri 10/1/10	Fri 9/30/22	
Deliver p(nu) Data in ENDF/B format	Mon 10/1/12	Sun 9/30/18	LANL
Update Prompt Fission Neutron Spectra Based on LANSCE Low-Energy Emission Data	Tue 10/1/13	Mon 9/30/19	LANL
Deliver Multiplicity-Dependent Fission Spectra	Tue 10/1/13	Tue 9/30/14	LANL
Deliver Prompt Fission Gamma Spectra	Wed 10/1/14	Sat 9/30/17	LANL
Update Prompt Fission Neutron Spectra Based on LANSCE High-Energy Emission Data	Thu 10/1/15	Mon 9/30/19	LANL
WPEC SG34 Improved Resonance Evaluation	Fri 10/1/10	Thu 9/27/12	ORNL
URR Evaluation using Hwang-Leal Methololodogy	Sat 10/1/11	Fri 9/28/12	ORNL
Finalize Resonance Region Evaluation and Deliver to NNDC	Fri 9/28/12	Fri 9/28/12	ORNL
Phase I testing, Post to ENDF/A and Broadcast	Mon 10/1/12	Sun 10/14/12	BNL
CSEWG Validation Testing	Mon 10/15/12	Fri 11/1/13	NDAG
CSEWG Approval of Complete Evaluation	Fri 11/1/13	Tue 12/31/13	BNL
Use CGMF to evaluate PFNS and multiplicity consistently, including angular information about prompt neutrons	Thu 10/1/20	Thu 9/30/21	LANL
Update Fission Cross-Section Based on TPC Results (based on Pu239/U235 ratio data)	Tue 10/1/19	Fri 9/30/22	LANL
Update Evaluation Based on LANL Updates and CSEWG & WPEC Testing	Mon 10/1/12	Fri 9/30/22	ORNL



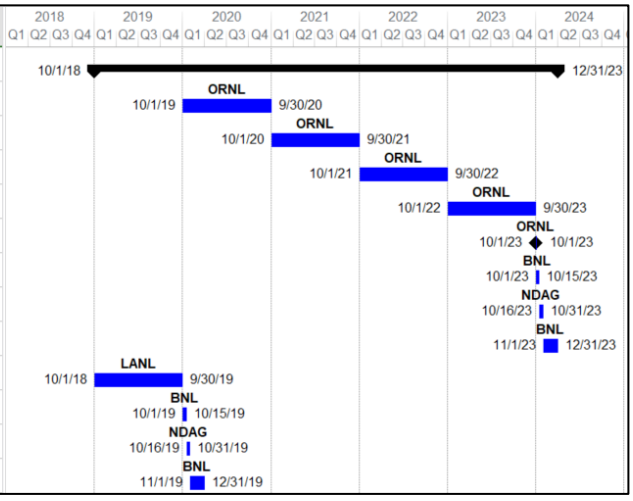
B-1.11 Rhodium (Rh-103)

Task Name	Start	Finish	Resources
Rhodium (Rh-103)	Wed 10/1/14	Fri 3/30/18	
Assess data for Unresolved Resonance Region Evaluation	Wed 10/1/14	Fri 9/30/16	ORNL
Finalize Resonance Evaluation and Deliver to NNDC	Sat 10/1/16	Sat 10/1/16	ORNL
Phase I Testing, Post to ENDF/A and Broadcast	Sat 10/1/16	Fri 10/14/16	BNL
CSEWG Validation Testing	Sat 10/15/16	Sun 12/31/17	NDAG
CSEWG Approval of Complete Evaluation(s)	Mon 1/1/18	Fri 3/30/18	BNL



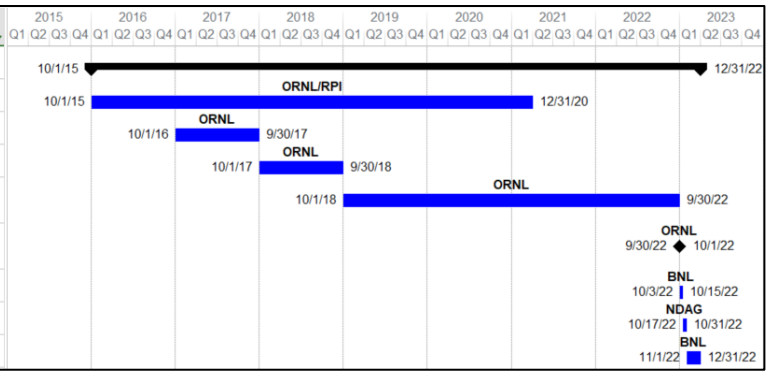
B-1.12 Strontium (Sr-90)

Task Name	Duration	Start	Finish	Resources
Strontium (Sr)	**1370 days?**	**Mon 10/1/18**	**Sun 12/31/23**	
Transmission and Capture Measurements	262 days?	Tue 10/1/19	Wed 9/30/20	ORNL
Experimentalist Data Reduction and Testing	261 days?	Thu 10/1/20	Thu 9/30/21	ORNL
Resolved Resonance Region Evaluation	261 days?	Fri 10/1/21	Fri 9/30/22	ORNL
Assess Data for URR Evaluation and Complete URR Evaluation	262 days	Sat 10/1/22	Sat 9/30/23	ORNL
Finalize Resonance Evaluation and Deliver to NNDC	1 day?	Sun 10/1/23	Sun 10/1/23	ORNL
Phase I Testing, Post to ENDF/A and Broadcast	12 days	Sun 10/1/23	Sun 10/15/23	BNL
CSEWG Validation Testing	12 days?	Mon 10/16/23	Tue 10/31/23	NDAG
CSEWG Approval of Complete Evaluation	43 days	Wed 11/1/23	Sun 12/31/23	BNL
Deliver Updated High-Energy Evaluation of Sr-88	261 days?	Mon 10/1/18	Mon 9/30/19	LANL
Phase I Testing, Post to ENDF/A and Broadcast	11 days?	Tue 10/1/19	Tue 10/15/19	BNL
CSEWG Validation Testing	12 days?	Wed 10/16/19	Thu 10/31/19	NDAG
CSEWG Approval of Complete Evaluation	43 days	Fri 11/1/19	Tue 12/31/19	BNL



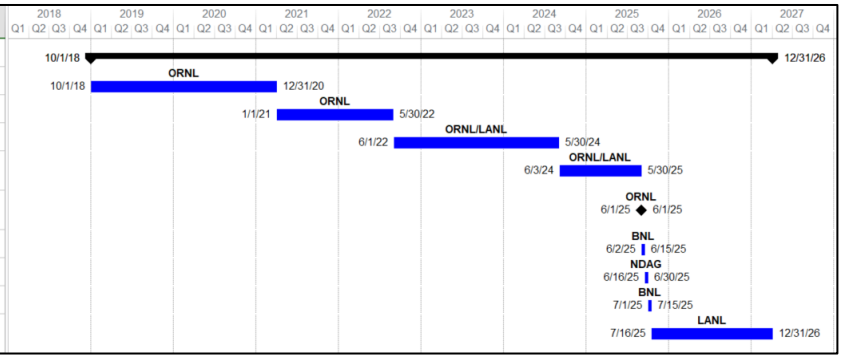
B-1.13 Tantalum (Ta)

Task Name	Start	Finish	Resources
Tantalum (Ta)	Thu 10/1/15	Sat 12/31/22	
Transmission and Capture Measurements	Thu 10/1/15	Thu 12/31/20	ORNL/RPI
Experimentalist Data Reduction and Testing	Sat 10/1/16	Sat 9/30/17	ORNL
Resolved Resonance Region Evaluation	Sun 10/1/17	Sun 9/30/18	ORNL
Assess Data for URR Evaluation and Complete URR Evaluation	Mon 10/1/18	Fri 9/30/22	ORNL
Finalize Resonance Evaluation and Deliver to NNDC	Fri 9/30/22	Sat 10/1/22	ORNL
Phase I Testing, Post to ENDF/A and Broadcast	Mon 10/3/22	Sat 10/15/22	BNL
CSEWG Validation Testing	Mon 10/17/22	Mon 10/31/22	NDAG
CSEWG Approval of Complete Evaluation	Tue 11/1/22	Sat 12/31/22	BNL



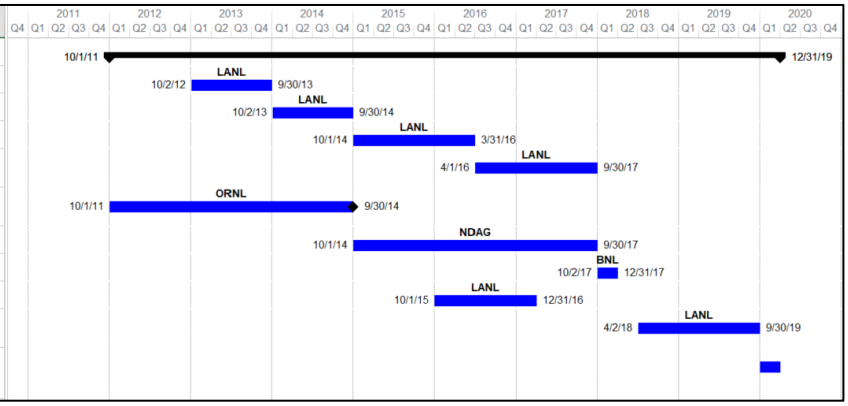
B-1.14 Uranium-233 (U-233)

Task Name	Start	Finish	Resources
Uranium (U-233)	Mon 10/1/18	Thu 12/31/26	
Capture Measurements	Mon 10/1/18	Thu 12/31/20	ORNL
Experimentalist Data Reduction and Testing	Fri 1/1/21	Mon 5/30/22	ORNL
Resolved Resonance Region Evaluation	Wed 6/1/22	Thu 5/30/24	ORNL/LANL
Assess data for Unresolved Resonance Region Evaluation	Mon 6/3/24	Fri 5/30/25	ORNL/LANL
Finalize Resonance Evaluation and Deliver to NNDC	Sun 6/1/25	Sun 6/1/25	ORNL
Phase I testing, Post to ENDF/A and Broadcast	Mon 6/2/25	Sun 6/15/25	BNL
CSEWG ValidationTesting	Mon 6/16/25	Mon 6/30/25	NDAG
CSEWG Approval of Complete Evaluations	Tue 7/1/25	Tue 7/15/25	BNL
Finalize Fast Region Evaluation and Deliver to NNDC	Wed 7/16/25	Thu 12/31/26	LANL



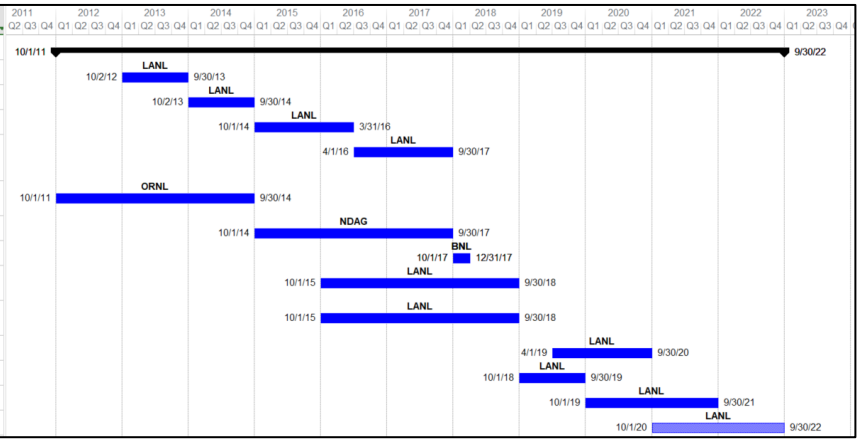
B-1.15 Uranium-234 (U-234)

Task Name	Start	Finish	Resources
Uranium (U-234)	Sat 10/1/11	Tue 12/31/19	
Capture Measurements	Tue 10/2/12	Mon 9/30/13	LANL
Experimentalist Data Reduction and Testing	Wed 10/2/13	Tue 9/30/14	LANL
Resolved Resonance Region Evaluation	Wed 10/1/14	Thu 3/31/16	LANL
Assess data for Unresolved Resonance Region Evaluation	Fri 4/1/16	Sat 9/30/17	LANL
Finalize Resonance Evaluation and Deliver to NNDC	Sat 10/1/11	Tue 9/30/14	ORNL
Phase I testing, Post to ENDF/A and Broadcast	Wed 10/1/14	Sat 9/30/17	NDAG
CSEWG ValidationTesting	Mon 10/2/17	Sun 12/31/17	BNL
CSEWG Approval of Complete Evaluations	Thu 10/1/15	Sat 12/31/16	LANL
Revisit cature cross section and covariance based on new DANCE data	Mon 4/2/18	Mon 9/30/19	LANL
Update U-234 evaluation based on new capture cross secttion and deliver to NNDC	Tue 10/1/19	Tue 12/31/19	LANL



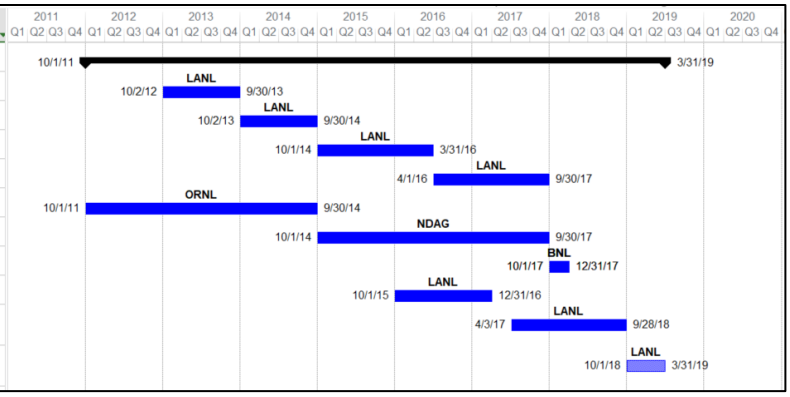
B-1.16 Uranium-235 (U-235)

Task Name	Start	Finish	Resources
Uranium (U-235)	Sat 10/1/11	Fri 9/30/22	
Deliver p(nu) Data in ENDF/B Format	Tue 10/2/12	Mon 9/30/13	LANL
Deliver Multiplicity-Dependent Fission Spectra	Wed 10/2/13	Tue 9/30/14	LANL
Deliver Prompt Fission Gamma Spectra	Wed 10/1/14	Thu 3/31/16	LANL
Review the evaluation of U-235 capture and fission cross sections based on new measurements at LANSCE	Fri 4/1/16	Sat 9/30/17	LANL
Resolved Resonance Capture Evaluation Per WPEC SG29 Recommendations	Sat 10/1/11	Tue 9/30/14	ORNL
CSEWG Validation Testing	Wed 10/1/14	Sat 9/30/17	NDAG
CSEWG Approval of Complete Evaluation(s)	Sun 10/1/17	Sun 12/31/17	BNL
Update Prompt Fission Neutron Spectra Based on LANSCE Low-Energy Emission Data	Thu 10/1/15	Sun 9/30/18	LANL
Update Prompt Fission Neutron Spectra Based on LANSCE High-Energy Emission Data	Thu 10/1/15	Sun 9/30/18	LANL
Use CGMF to evaluate PFNS and multiplicity consistently, including angular information about	Mon 4/1/19	Wed 9/30/20	LANL
Revisit fission cross section and covariance evaluation based on new TPC data	Mon 10/1/18	Mon 9/30/19	LANL
Develop consistent evaluation of fission yields, neutron multiplicity, and spectra from thermal to	Tue 10/1/19	Thu 9/30/21	LANL
Revisit elastic and inelastic cross sections based on planned LANSCE experiments	Thu 10/1/20	Fri 9/30/22	LANL



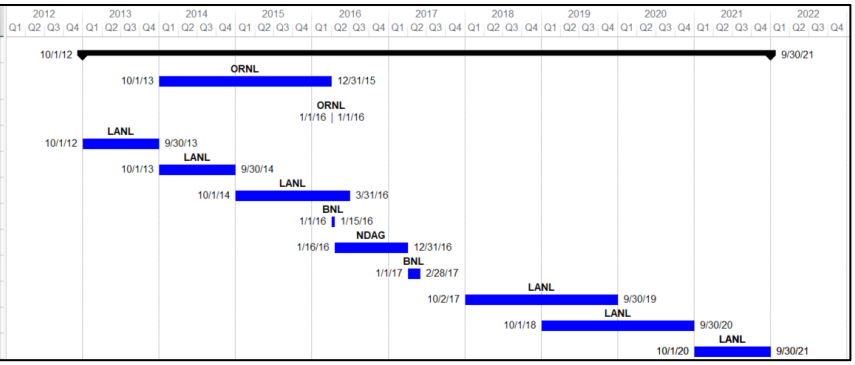
B-1.17 Uranium-236 (U-236)

Task Name	Start	Finish	Resources
Uranium (U-236)	Sat 10/1/11	Sun 3/31/19	
Capture Measurements	Tue 10/2/12	Mon 9/30/13	LANL
Experimentalist Data Reduction and Testing	Wed 10/2/13	Tue 9/30/14	LANL
Resolved Resonance Region Evaluation	Wed 10/1/14	Thu 3/31/16	LANL
Assess data for Unresolved Resonance Region Evaluation	Fri 4/1/16	Sat 9/30/17	LANL
Finalize Resonance Evaluation and Deliver to NNDC	Sat 10/1/11	Tue 9/30/14	ORNL
Phase I testing, Post to ENDF/A and Broadcast	Wed 10/1/14	Sat 9/30/17	NDAG
CSEWG ValidationTesting	Sun 10/1/17	Sun 12/31/17	BNL
CSEWG Approval of Complete Evaluations	Thu 10/1/15	Sat 12/31/16	LANL
Revisit cature cross section and covariance based on new DANCE data	Mon 4/3/17	Fri 9/28/18	LANL
Update U-236 evaluation based on new capture cross secttion and deliver to NNDC	Mon 10/1/18	Sun 3/31/19	LANL



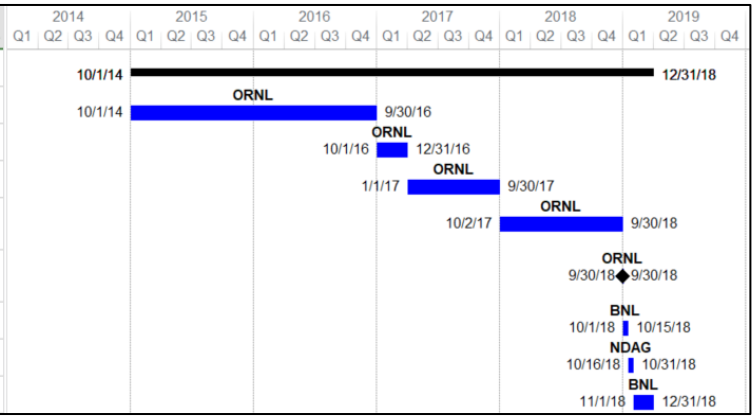
B-1.18 Uranium-238 (U-238)

Task Name	Start	Finish	Resource
Uranium (U-238)	Mon 10/1/12	Thu 9/30/21	
Unresolved Resonance Region Evaluation Using the Hwang-Leal Methodology	Tue 10/1/13	Thu 12/31/15	ORNL
Finalize URR Evaluation and Deliver to NNDC	Fri 1/1/16	Fri 1/1/16	ORNL
Deliver p(nu) Data in ENDF/B Format	Mon 10/1/12	Mon 9/30/13	LANL
Deliver Multiplicity-Dependent Fission Spectra	Tue 10/1/13	Tue 9/30/14	LANL
Deliver Prompt Fission Gamma Spectra	Wed 10/1/14	Thu 3/31/16	LANL
Phase I Testing, Post to ENDF/A and Broadcast	Fri 1/1/16	Fri 1/15/16	BNL
CSEWG Validation Testing	Sat 1/16/16	Sat 12/31/16	NDAG
CSEWG Approval of Complete Evaluation(s)	Sun 1/1/17	Tue 2/28/17	BNL
Revisit fission cross section and covariance evaluation based on new TPC data (based on	Mon 10/2/17	Mon 9/30/19	LANL
Finalize Prompt Fission Neutron Spectra Based on LANSCE Chi-Nu Data	Mon 10/1/18	Wed 9/30/20	LANL
Use CGMF to evaluate PFNS and multiplicity consistently, including angular information about	Thu 10/1/20	Thu 9/30/21	LANL



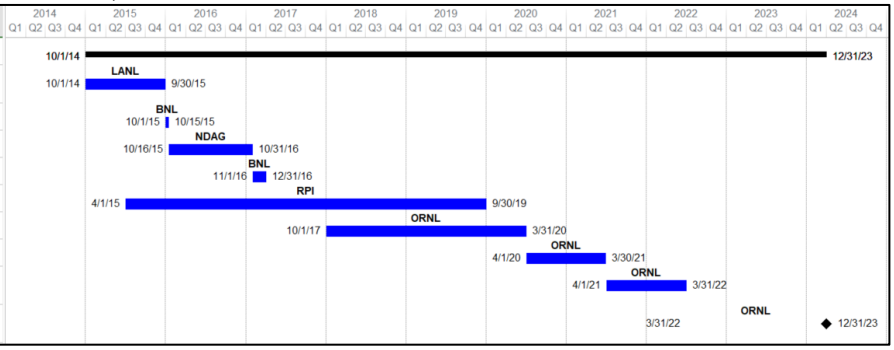
B-1.19 Vanadium (V-51)

Task Name	Start	Finish	Resource
Vanadium (V-51)	Wed 10/1/14	Mon 12/31/18	
Complete Resonance Region Measurements	Wed 10/1/14	Fri 9/30/16	ORNL
Experimentalist Data Reduction and Testing	Sat 10/1/16	Sat 12/31/16	ORNL
Resolved Resonance Region Evaluation	Sun 1/1/17	Sat 9/30/17	ORNL
Assess data for Unresolved Resonance Region Evaluation	Mon 10/2/17	Sun 9/30/18	ORNL
Finalize Resonance Evaluation and Deliver to NNDC	Sun 9/30/18	Sun 9/30/18	ORNL
Phase I Testing, Post to ENDF/A and Broadcast	Mon 10/1/18	Mon 10/15/18	BNL
CSEWG Validation Testing	Tue 10/16/18	Wed 10/31/18	NDAG
CSEWG Approval of Complete Evaluation(s)	Thu 11/1/18	Mon 12/31/18	BNL



B-1.20 Zirconium (Zr-90, 91, 92, 94, 96)

Task Name	Start	Finish	Resource
Zirconium (Zr-90,91,92,94,96)	Wed 10/1/14	Sun 12/31/23	
Deliver Updated High-Energy Evaluation of Zr-90	Wed 10/1/14	Wed 9/30/15	LANL
Phase I Testing, Post to ENDF/A and Broadeast	Thu 10/1/15	Thu 10/15/15	BNL
CSEWG Validation Testing	Fri 10/16/15	Mon 10/31/16	NDAG
CSEWG Approval of Complete Evaluations	Tue 11/1/16	Sat 12/31/16	BNL
Transmission and Capture Measurements	Wed 4/1/15	Mon 9/30/19	RPI
Experimentalist Data Reduction and Testing	Sun 10/1/17	Tue 3/31/20	ORNL
Resolved Resonance Region Evaluation	Wed 4/1/20	Tue 3/30/21	ORNL
Assess Data for URR Evaluation and Complete URR Evaluation	Thu 4/1/21	Thu 3/31/22	ORNL
Finalize Resonance Evaluation and Deliver to NNDC	Thu 3/31/22	Sun 12/31/23	ORNL



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

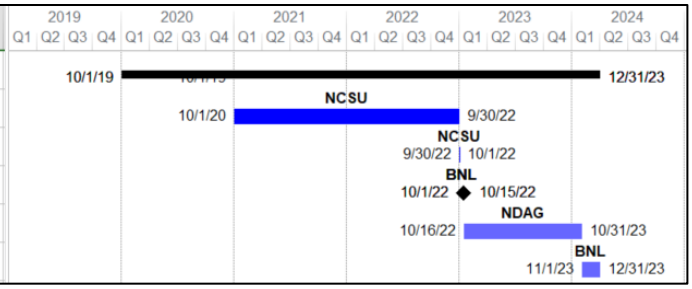
- B-2.1 Hydraulic Fluid (Silicone Oil)
- B-2.2 Hydrofluoric Acid (HF)
- B-2.3 Paraffin (C_nH_{2n+2})
- B-2.4 Plutonium Hydride (PuH_{2+x})
- B-2.5 Plutonium Oxide **(**PuO_2)
- B-2.6 Polyethylene (CH_2)
- B-2.7 Uranium Carbide (UC)
- B-2.8 Uranium Fluoride (UO_2F_2)
- B-2.9 Uranium Hexafluoride (UF_6)
- B-2.10 Uranium Oxide (U_3O_8)
- B-2.11 Uranium Silicide (U_3Si_2)
- B-2.12 Water (H_2O)

<u>Completed Work</u>

- Lucite **(**$C_5O_2H_8$)
- Polyethylene $(CH_2)_n$
- Beryllium (metal)
- Beryllium Oxide (BeO)
- Crystal Graphite
- Reactor Graphite
- Silicon Carbide (SiC)
- Silicon Dioxide (SiO_2)
- Uranium Dioxide (UO_2)
- Uranium Nitride (UN)
- Hexagonal Ice (H_2O) – evaluated by NNL
- Yttrium Hydride (YH_2) – evaluated by NNL
- FLiBe liquid
- Paraffinic Oil

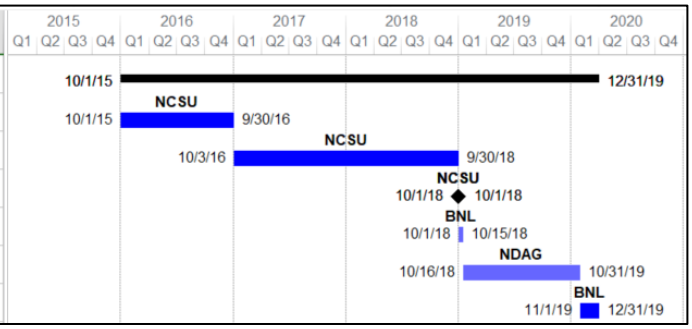
B-2.1 Hydraulic Fluid (Silicone Oil)

Task Name	Start	Finish	Resource
Hydraulic Fluid (Silicone Oil)	Tue 10/1/19	Sun 12/31/23	
Thermal Scattering Evaluation	Thu 10/1/20	Fri 9/30/22	NCSU
Finalize and Deliver Evaluation to NNDC	Fri 9/30/22	Sat 10/1/22	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Sat 10/1/22	Sat 10/15/22	BNL
CSEWG Validation Testing	Sun 10/16/22	Tue 10/31/23	NDAG
CSEWG Approval of Complete Evaluation	Wed 11/1/23	Sun 12/31/23	BNL



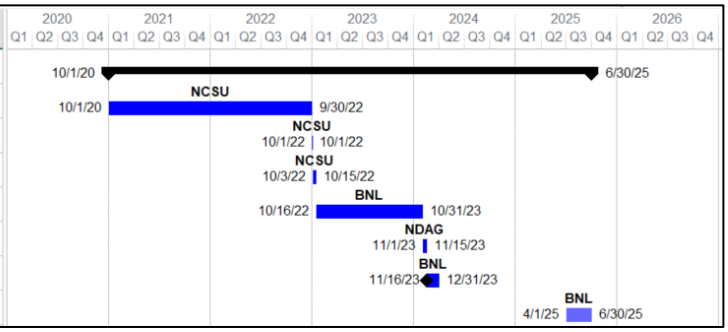
B-2.2 Hydrofluoric Acid (HF)

Task Name	Start	Finish	Resource
Hydrofluoric Acid (HF)	Thu 10/1/15	Tue 12/31/19	
Thermal Scattering Measurements	Thu 10/1/15	Fri 9/30/16	NCSU
Thermal Scattering Evaluation	Mon 10/3/16	Sun 9/30/18	NCSU
Finalize and Deliver Evaluation to NNDC	Mon 10/1/18	Mon 10/1/18	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Mon 10/1/18	Mon 10/15/18	BNL
CSEWG Validation Testing	Tue 10/16/18	Thu 10/31/19	NDAG
CSEWG Approval of Complete Evaluation	Fri 11/1/19	Tue 12/31/19	BNL



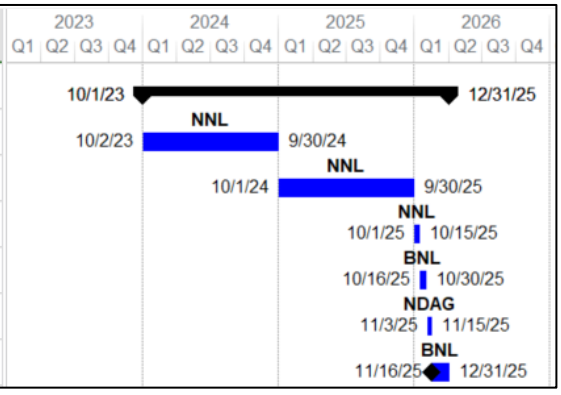
B-2.3 Paraffin (C_nH_{2n+2})

Task Name	Start	Finish	Resources
Paraffin (CnH2n+2)	Thu 10/1/20	Mon 6/30/25	
Thermal Scattering Measurements	Thu 10/1/20	Fri 9/30/22	NCSU
Thermal Scattering Evaluation	Sat 10/1/22	Sat 10/1/22	NCSU
Finalize and Deliver Evaluation to NNDC	Mon 10/3/22	Sat 10/15/22	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Sun 10/16/22	Tue 10/31/23	BNL
CSEWG Validation Testing	Wed 11/1/23	Wed 11/15/23	NDAG
CSEWG Approval of Complete Evaluation	Thu 11/16/23	Sun 12/31/23	BNL
CSEWG Approval of Complete Evaluation	Tue 4/1/25	Mon 6/30/25	BNL



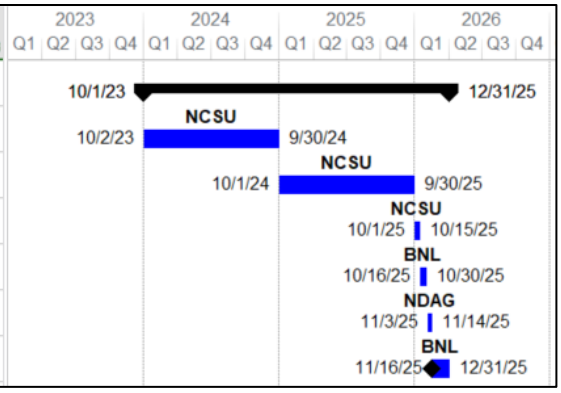
B-2.4 Plutonium Hydride (PuH_{2+x})

Task Name	Start	Finish	Resources
Plutonium Hydride (PuH2+x)	Sun 10/1/23	Wed 12/31/25	
Thermal Scattering Measurements	Mon 10/2/23	Mon 9/30/24	NNL
Thermal Scattering Evaluation	Tue 10/1/24	Tue 9/30/25	NNL
Finalize and Deliver Evaluation to NNDC	Wed 10/1/25	Wed 10/15/25	NNL
Phase 1 Testing, Post to ENDF/A and Broadcast	Thu 10/16/25	Thu 10/30/25	BNL
CSEWG Validation Testing	Mon 11/3/25	Sat 11/15/25	NDAG
CSEWG Approval of Complete Evaluation	Sun 11/16/25	Wed 12/31/25	BNL



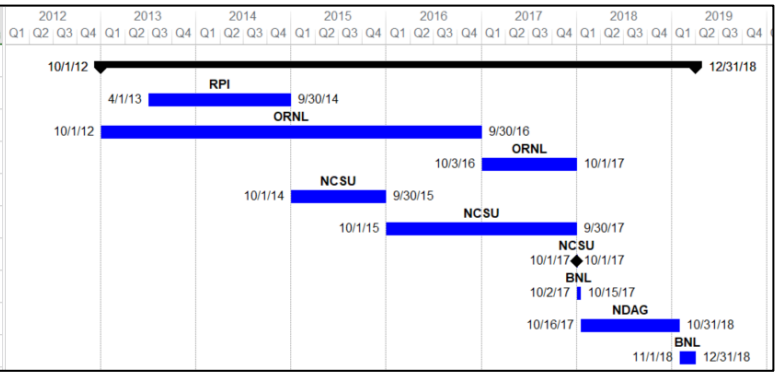
B-2.5 Plutonium Oxide (PuO_2)

Task Name	Start	Finish	Resources
Plutonium Oxide (PuO2)	Sun 10/1/23	Wed 12/31/25	
Thermal Scattering Measurements	Mon 10/2/23	Mon 9/30/24	NCSU
Thermal Scattering Evaluation	Tue 10/1/24	Tue 9/30/25	NCSU
Finalize and Deliver Evaluation to NNDC	Wed 10/1/25	Wed 10/15/25	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Thu 10/16/25	Thu 10/30/25	BNL
CSEWG Validation Testing	Mon 11/3/25	Fri 11/14/25	NDAG
CSEWG Approval of Complete Evaluation	Sun 11/16/25	Wed 12/31/25	BNL



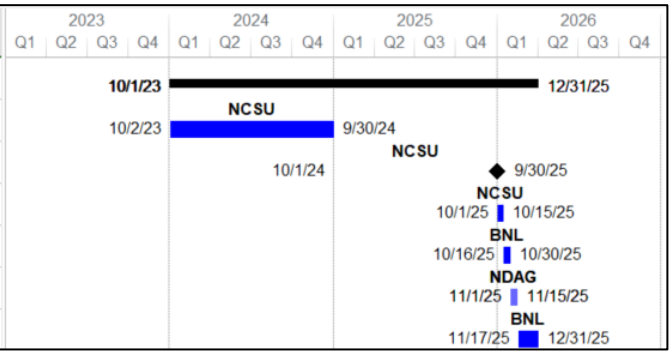
B-2.6 Polyethylene (CH_2)

Task Name	Start	Finish	Resources
Polyethylene (CH2)	Mon 10/1/12	Mon 12/31/18	
Thermal Scattering Measurements	Mon 4/1/13	Tue 9/30/14	RPI
Thermal Scattering Evaluation	Mon 10/1/12	Fri 9/30/16	ORNL
Finalize and Deliver Evaluation to NNDC	Mon 10/3/16	Sun 10/1/17	ORNL
Thermal Scattering Measurements	Wed 10/1/14	Wed 9/30/15	NCSU
Thermal Scattering Evaluation	Thu 10/1/15	Sat 9/30/17	NCSU
Finalize and Deliver Evaluation to NNDC	Sun 10/1/17	Sun 10/1/17	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Mon 10/2/17	Sun 10/15/17	BNL
CSEWG Validation Testing	Mon 10/16/17	Wed 10/31/18	NDAG
CSEWG Approval of Complete Evaluation	Thu 11/1/18	Mon 12/31/18	BNL



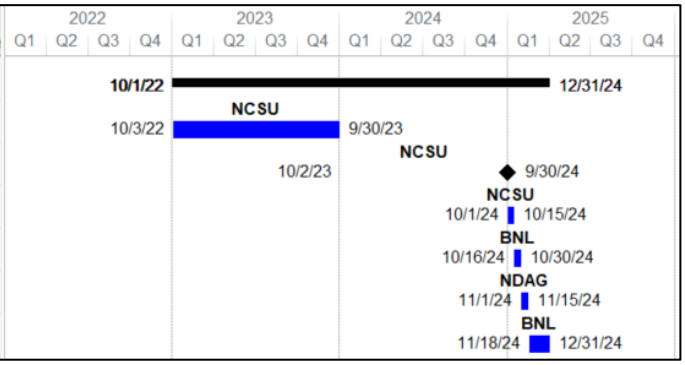
B-2.7 Uranium Carbide (UC)

Task Name	Start	Finish	Resource
Uranium Carbide (UC)	Sun 10/1/23	Wed 12/31/25	
Thermal Scattering Measurements	Mon 10/2/23	Mon 9/30/24	NCSU
Thermal Scattering Evaluation	Tue 10/1/24	Tue 9/30/25	NCSU
Finalize and Deliver Evaluation to NNDC	Wed 10/1/25	Wed 10/15/25	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Thu 10/16/25	Thu 10/30/25	BNL
CSEWG Validation Testing	Sat 11/1/25	Sat 11/15/25	NDAG
CSEWG Approval of Complete Evaluation	Mon 11/17/25	Wed 12/31/25	BNL



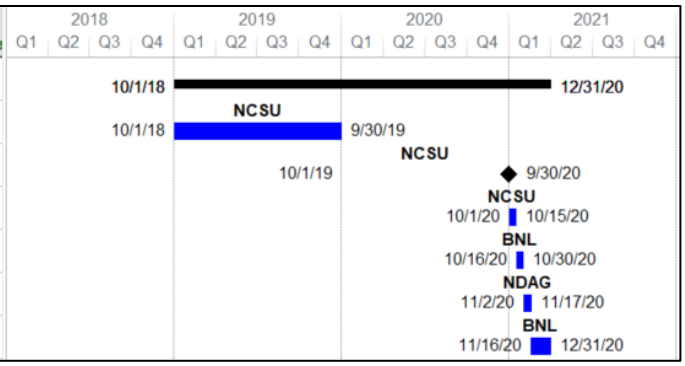
B-2.8 Uranium Fluoride (UO_2F_2)

Task Name	Start	Finish	Resource
Uranyl Fluoride (UO2F2)	Sat 10/1/22	Tue 12/31/24	
Thermal Scattering Measurements	Mon 10/3/22	Sat 9/30/23	NCSU
Thermal Scattering Evaluation	Mon 10/2/23	Mon 9/30/24	NCSU
Finalize and Deliver Evaluation to NNDC	Tue 10/1/24	Tue 10/15/24	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Wed 10/16/24	Wed 10/30/24	BNL
CSEWG Validation Testing	Fri 11/1/24	Fri 11/15/24	NDAG
CSEWG Approval of Complete Evaluation	Mon 11/18/24	Tue 12/31/24	BNL



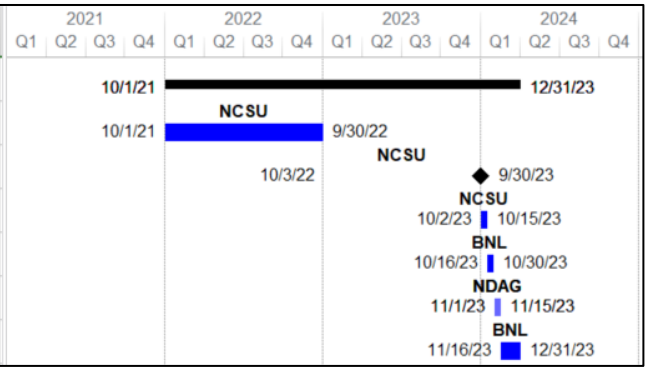
B-2.9 Uranium Hexafluoride (UF_6)

Task Name	Start	Finish	Resource
Uranium Hexafluoride (UF6)	Mon 10/1/18	Thu 12/31/20	
Thermal Scattering Measurements	Mon 10/1/18	Mon 9/30/19	NCSU
Thermal Scattering Evaluation	Tue 10/1/19	Wed 9/30/20	NCSU
Finalize and Deliver Evaluation to NNDC	Thu 10/1/20	Thu 10/15/20	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Fri 10/16/20	Fri 10/30/20	BNL
CSEWG Validation Testing	Mon 11/2/20	Tue 11/17/20	NDAG
CSEWG Approval of Complete Evaluation	Mon 11/16/20	Thu 12/31/20	BNL



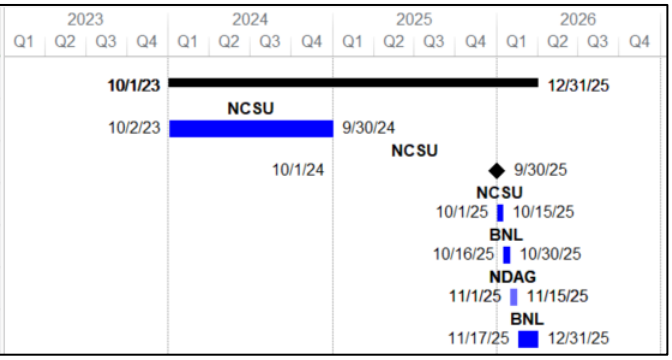
B-2.10 Uranium Oxide (U_3O_8)

Task Name	Start	Finish	Resource
Triuranium Octoxide (U3O8)	Fri 10/1/21	Sun 12/31/23	
Thermal Scattering Measurements	Fri 10/1/21	Fri 9/30/22	NCSU
Thermal Scattering Evaluation	Mon 10/3/22	Sat 9/30/23	NCSU
Finalize and Deliver Evaluation to NNDC	Mon 10/2/23	Sun 10/15/23	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Mon 10/16/23	Mon 10/30/23	BNL
CSEWG Validation Testing	Wed 11/1/23	Wed 11/15/23	NDAG
CSEWG Approval of Complete Evaluation	Thu 11/16/23	Sun 12/31/23	BNL



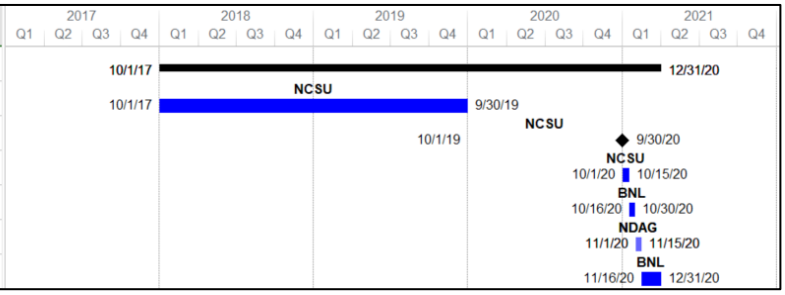
B-2.11 Uranium Silicide (U_3Si_2)

Task Name	Start	Finish	Resource
Uranium Silicide (U3Si2)	Sun 10/1/23	Wed 12/31/25	
Thermal Scattering Measurements	Mon 10/2/23	Mon 9/30/24	NCSU
Thermal Scattering Evaluation	Tue 10/1/24	Tue 9/30/25	NCSU
Finalize and Deliver Evaluation to NNDC	Wed 10/1/25	Wed 10/15/25	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Thu 10/16/25	Thu 10/30/25	BNL
CSEWG Validation Testing	Sat 11/1/25	Sat 11/15/25	NDAG
CSEWG Approval of Complete Evaluation	Mon 11/17/25	Wed 12/31/25	BNL



B-2.12 Water (H_2O)

Task Name	Start	Finish	Resource
Water (H2O)	Sun 10/1/17	Thu 12/31/20	
Thermal Scattering Measurements	Sun 10/1/17	Mon 9/30/19	NCSU
Thermal Scattering Evaluation	Tue 10/1/19	Wed 9/30/20	NCSU
Finalize and Deliver Evaluation to NNDC	Thu 10/1/20	Thu 10/15/20	NCSU
Phase 1 Testing, Post to ENDF/A and Broadcast	Fri 10/16/20	Fri 10/30/20	BNL
CSEWG Validation Testing	Sun 11/1/20	Sun 11/15/20	NDAG
CSEWG Approval of Complete Evaluation	Mon 11/16/20	Thu 12/31/20	BNL



Appendix C

Fiscal Year 2019 Projected Foreign Travel

Destination	Date	Labs	Count	Costs ($)	One Sentence Description	Task	Milestone	Justification
OECD/NEA Paris, France	Oct-18	LANL (3) LLNL (4) SNL (2)	9	45,000	ICSBEP and IRPhE Technical Review Meetings (Ames, Bahran, Harms, Heinrichs, Hutchinson, Keefer, McKenzie, Nelson, Verbeke)	IE, IP&D, TS3, TS4, TS5, TS7	Provide brief trip summary report to NCSP Manager (Q2).	ICSBEP and IRPhE Technical Review Meetings.
Sydney, Australia	Nov-18	LLNL	2	12,000	IEEE Nuclear Science Symposium (Heckmaier, Nelson)	ND7, TS5	Provide brief trip summary report to NCSP Manager (Q2).	Preeminent conference devoted to nuclear science and advanced radiation detectors.
Beijing, China	May-19	LLNL	2	12,000	ND2019 (Heinrichs, Percher)	ND, TS5	Provide brief trip summary report to NCSP Manager (Q3).	Preeminent conference devoted to nuclear data.
OECD/NEA Paris, France	May-19	LLNL	2	10,000	WPEC Meeting (Heinrichs, Percher)	ND, TS5	Provide brief trip summary report to NCSP Manager (Q3).	Technical meeting of international experts on nuclear data including SG38 (GND) and SG42 (Thermal scattering law).
Lisbon, Portugal	May-19	LLNL	2	10,000	ICDA-3 (Nelson, Scorby)	IE, ND, TS5	Provide brief trip summary report to NCSP Manager (Q3).	Pre-eminent international conference on dosimetry and their applications including high dose accident dosimetry.
OECD/NEA Paris, France	Jun-19	LLNL	2	10,000	Participate in WPNCS annual meeting (Percher, Scorby)	IPD1 TS5	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-19	LLNL	4	20,000	ICNC (Coleman, Heinrichs, Percher, Zywiec)	AM, IE, IP&D, ND, T&E, TS5	Provide brief trip summary report to NCSP Manager (Q4).	Pre-eminent conference devoted to criticality safety.
Aldermaston, United Kindgom	TBD	LLNL	2	10,000	JOWOG29/30 Meetings (Heinrichs, Zywiec)	AM, IE, IP&D, ND, TS5	Provide brief trip summary report to NCSP Manager (Q4).	Coordinate joint AWE-LLNL work per 5YP.
Paris, France	TBD	LLNL	2	10,000	Coordinate International Collaboration Efforts with IRSN (Heinrichs, Percher)	AM, IE, IP&D, ND, TS5	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.
OECD/NEA Paris, France	May-19	NDAG Chair	1	5,000	Participate in WPEC annual meeting (Zerkle)	NCSP-TS9	Provide brief trip summary report to NCSP Manager (Q3).	As NDAG Chair, participate in WPEC.
OECD/NEA Paris, France	Oct-19	NDAG Chair	1	5,000	ICSBEP and IRPhE Technical Review Meetings (Zerkle)	NCSP-TS9	Provide brief trip summary report to NCSP Manager (Q2).	Provide oversight of NCSP IE tasks as ICSBEP tasks are the end product of the NCSP IE process.

Destination	Date	Labs	Count	Costs ($)	One Sentence Description	Task	Milestone	Justification
Paris, France	Sep-19	NDAG Chair	1	5,000	ICNC (Zerkle)	NCSP-TS9	Provide brief trip summary report to NCSP Manager (Q4).	Pre-eminent conference devoted to criticality safety.
OECD/NEA Paris, France	May-19	RPI	2	10,000	Participate in WPEC, SG-42, subgroup C, and WPEC (Danon, Lui)	ND1 ND2	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.
OECD/NEA Paris, France	May-19	LANL	2	10,000	Attend annual WPEC meeting and associated Sub-Group meetings (Conlin, Haeck)	AM2	Provide brief trip summary report to NCSP Manager (Q3).	Contributor to multiple sub-groups. Conlin co-leads SG43.
OECD/NEA Paris, France	May-19	LANL	1	5,000	Attend annual WPEC meeting and associated Sub-Group meetings (Talou)	ND1	Provide brief trip summary report to NCSP Manager (Q3).	CSEWG representation to WPEC. Contributor to multiple sub-groups.
Beijing, China	May-19	LANL	5	30,000	Attend triennial international nuclear data conference (Conlin, Haeck, Kawano, Talou,Thompson)	ND1 / ND2/IE	Provide brief trip summary report to NCSP Manager (Q3).	Premier nuclear data conference that occurs only once every three years.
OECD/NEA Paris, France	Jun-19	LANL	3	16,000	OECD Expert Group Meetings for NCSP, collaboration with IRSN on NCS (Brown, Rising, Alwin)	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.
Paris, France	Sep-19	LANL	15	94,000	ICNC 2019 Meeting (Brown, Rising, Alwin, Hayes, Myers, Hutchinson, Cutler, Goda, McKenzie, Sanchez, McSpaden, Thompson, Arthur, Conlin, Haeck)	AM1/AM2, IE	Provide brief trip summary report to NCSP Manager (Q4).	This meeting is held every 4 years, and is one of the principal world meetings on nuclear criticality safety.
OECD/NEA Paris, France	Oct-19	ORNL	2	10,000	ICSBEP and IRPhE Technical Review Meetings (Bowen, Marshall)	TS1 IE AM2	Provide brief trip summary report to NCSP Manager (Q2).	Provide oversight of NCSP IE tasks as ICSBEP tasks are the end product of the NCSP IE process.
IRMM Mol, Belgium	Jan-19 Apr-19 Jun-19 Sep-19	ORNL	1	65,000	Perform resonance region nuclear data measurements using GELINA facility at IRMM in accordance with Appendix B of the Five-Year Plan (Guber)	ND TS7	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.

Destination	Date	Labs	Count	Costs ($)	One Sentence Description	Task	Milestone	Justification
Berlin, Germany	May-19	ORNL	1	5,500	ISO TC85/SC5 Plenary and WG8 Nuclear Criticality Safety Meetings (Bowen)	NCSP-TS1	Provide brief trip summary report to NCSP Manager (Q3).	Continue to provide US leadership with ISO Nuclear Criticality Safety Standards
Reading, UK & Paris, France	Jun-19	ORNL	1	5,000	Travel to AWE/IRSN to status NCSP tasks for FY2019 and to conduct planning for FY2020 (Bowen)	TS1 IE	Provide brief trip summary report to NCSP Manager (Q4).	Conduct face-to-face meetings with international collaborators (AWE/IRSN) on the status and planning of annual NCSP tasks.
Paris, France	Sep-19	ORNL	5	25,000	ICNC Meeting (Bowen, Marshall, Clarity, Miller or Saylor)	AM, IE, IP&D, ND, T&E, TS7	Provide brief trip summary report to NCSP Manager (Q4).	Pre-eminent conference devoted to criticality safety. Meet with international collaborators and domestic NCS community.
Beijing, China	May-19	LLNL	3	18,000	ND2019 (Sobes, Pigni or Arbanas)	ND, TS5	Provide brief trip summary report to NCSP Manager (Q3).	Preeminent conference devoted to nuclear data.
OECD/NEA Paris, France	May-19	ORNL	2	10,000	Participate in WPEC annual meeting, coordinate international nuclear data collaborations for the NCSP, and present NCSP/ORNL nuclear data evaluation work (Sobes, Pigni or Wiarda)	ND1	Provide brief trip summary report to NCSP Manager (Q3).	Technical meeting of international experts on nuclear data including SG38 (GND), EG-GNDS, SG42 (thermal scatter), SG44 (covariance), SG45 (validation), SG46 (IE for ND evaluation)
Vienna, Austria	Nov-18	ORNL	1	5,000	Participate in IAEA working group meeting to improve nuclear data evaluations to support new evaluations of interest to the NCSP (Bowen)	ND1	Provide brief trip summary report to NCSP Manager (Q3).	Consultancy Meeting on Meeting of INDEN - International Nuclear Data Evaluation Network I - on the Resonance Parameter Evaluation of the Fissile Actinides
OECD/NEA Paris, France	Sep-19	ORNL	2	10,000	WPNCS Meetings (Marshall, Bowen or Wieselquist)	TS1, IE, AM2	Provide brief trip summary report to NCSP Manager (Q4).	AM collaboration; provide relationship between IAEA and ISO with respect to NCS standards
Paris, France	TBD	ORNL	4	20,000	IRSN Meetings (Miller, Sobes, Wiarda, Holcomb)	AM, IE, IP&D, ND1, TS7	Provide brief trip summary report to NCSP Manager (Q3).	Coordinate joint IRSN-ORNL work per 5YP such as the Pu SlideRule; Perform AMPX training for IRSN per agreement in June 2018.

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 FY2019

Baseline budget need for the FY2019 Nuclear Criticality Safety Program (NCSP) is $26,887K 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 2019-2028.* 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. Also, development of 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. ~4 new ICSBEP evaluations and publications (OECD collaboration). Provide experimental uncertainty correlations.
- Integral Experiments
  - Execution of ~28 critical/subcritical experiment and 6 critical/subcritical experiment evaluations published (NCERC and SNL). ~26 FTEs supported. 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.
  - The NCSP will complete data processing and publication activities for the KRUSTY "cold" and "hot" critical and delayed supercritical experiments.
  - Additional funding requirement to fund both Laboratory logistics costs and NNSS safety basis work.
- Nuclear Data
  - Nuclear data evaluations and measurements documented prioritized in FY2019 are shown in Appendix B. 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
  - Develop the course materials for a Criticality Safety Officer/Fissile Material Handler pilot course in FY2020.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~2 FTEs supported.

Over target budget need for FY2019 NCSP is $1.05M that would support 5 additional high priority tasks to address key Mission and Vision goals not addressed within the current budget target:

- Develop and deploy a mobile (CAT III or IV) critical/near critical hands-on demo capability ($200K)
- NCERC Integral Experiments Backlog and new Np experiment ($350K)
- Non-destructive Assay Technical Support Group ($300K)
- Expand radiochemistry laboratory capabilities at NNSS ($100K)
- Computer code (MCNP and SCALE) NCS analysis capability modernization ($100K)

Baseline Budget Needs for Execution Year FY2020

Baseline budget need for the FY2019 Nuclear Criticality Safety Program (NCSP) is $28,472K with 95% of funding supporting NCSP FTE's, equating to approximately 53 national laboratory or facility contractor employees, who provide programmatic needs as outlined in the NCSP *The Mission and Vision of the United States Department of Energy Nuclear Criticality Safety Program for the Fiscal Years 2019-2028.* All tasks are approved based on their contribution to the achievement of the five- and ten-year goals as outlined in the Mission and Vision document.

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

- Analytical Methods
  - Criticality Safety Computer Codes SCALE and MCNP support. Maintain Radiation Safety Information Computational Center who distributes all software. Development of NCS excursion analysis capability, including an updated Criticality SlideRule capability. ~7 FTEs supported. International collaborations: SCALE, NJOY, MCNP, AMPX work with AWE and IRSN.
- Information Preservation and Dissemination
  - NCSP website upgrade and maintenance. ~6 new ICSBEP evaluations and publications (OECD collaboration). Provide experimental uncertainty correlations.
- Integral Experiments
  - Execution of ~18 critical/subcritical experiment and 6 critical/subcritical experiment evaluations published (NCERC and SNL). Permanent party staff supported. Initiate design efforts for neptunium and Jezebel critical experiments. DSA changes and facility modifications for pneumatic rabbit system and NAD lab construction. International collaborations: TEX experiments with IRSN and AWE, CAAS experiment design with AWE, IRSN, Japan, SNL experiment design and execution with IRSN.
- Nuclear Data
  - Nuclear data evaluations and measurements documented prioritized in FY2020 are shown in Appendix B. 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 pilot Criticality Safety Officer Course.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~2.5 FTEs supported.

Over target budget need for FY2019 NCSP is $2.0M that would support 5 additional high priority tasks to address key Mission and Vision goals not addressed within the current budget target:

- Develop and deploy a mobile (CAT III or IV) critical/near critical hands-on demo capability ($200K)
- NCERC Integral Experiments Backlog and new Np experiment ($350K)
- Non-destructive Assay Technical Support Group ($300K)
- Expand radiochemistry laboratory capabilities at NNSS ($100K)
- Computer code (MCNP and SCALE) NCS analysis capability modernization ($100K)
- Thermal scattering and self-shielding ($100K)
- U-233 Resonance region evaluation ($100K)
- Purchase enriched samples for cross-section measurements ($200K)
- New building startup for NCERC (material staging and new activities) ($550K)

Baseline Budget Needs for Execution Year FY2021

Baseline budget need for the FY2021 Nuclear Criticality Safety Program (NCSP) is $28,561K 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 2019-2028.* 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 FY2021:

- Analytical Methods
  - Criticality Safety Computer Codes SCALE and MCNP support. Maintain Radiation Safety Information Computational Center who distributes all software. Development of NCS excursion analysis capability, including an updated Criticality SlideRule capability. ~8 FTEs supported. International collaborations: SCALE, NJOY, MCNP, AMPX work with AWE and IRSN.
- Information Preservation and Dissemination
  - NCSP website upgrade and maintenance. ~9 new ICSBEP evaluations and publications (OECD collaboration). Provide experimental uncertainty correlations.
- Integral Experiments
  - Execution of ~18 critical/subcritical experiment and 9 critical/subcritical experiment evaluations published (NCERC and SNL). Permanent party staff supported. Continue efforts to design and execute neptunium and Jezebel critical experiments. DSA changes and facility modifications for pneumatic rabbit system and NAD lab construction. International collaborations: TEX experiments with IRSN and AWE, CAAS experiment design with AWE, IRSN, Japan, SNL experiment design and execution with IRSN.
- Nuclear Data
  - Nuclear data evaluations and measurements documented prioritized in FY2021 are shown in Appendix B. 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 1-week CSO course at NCERC or Sandia.
  - One "special" week-long course similar to a Sandia or NCERC hands-on class for AWE.
  - Criticality Safety Officer/Fissile Material Handler NCS training pilot course.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~2.5 FTEs supported.

Appendix E

International Collaboration with the Institut de Radioprotection et de Sûreté Nucléaire (IRSN) for FY2019

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 2019 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
Analytical Methods						
IRSN-AM15	MCNP Maintenance and Support / Uncertainty Analysis Development / Modernization / etc.	LANL-AM1	Interest for uncertainty analysis, source convergence development and modernization strategy	E. DUMONTEIL	F. BROWN	LANL
IRSN-AM16	Multi-Physics Methods for Simulation of Criticality Excursions	LLNL-AM2	Technical exchanges on the proposed multiphysics tasks for simulating criticality excursions.	M. DULUC	D. HEINRICHS	LLNL
IRSN-AM1	Validation and qualification methods	ORNL-AM2 ORNL-IPD4	Covariance matrices establishment of the selection of Integral Experiments	I. DUHAMEL	D. BOWEN B. REARDEN	ORNL
IRSN-AM3	Monte Carlo & sensitivity calculations	ORNL-AM2	Technical exchanges on sources convergence issues, sensitivity coefficients calculations and kinetics parameters calculations	B. DECHENAUX	D. BOWEN B. REARDEN	ORNL
IRSN-AM5	Update of the slide rule	ORNL-AM6 LLNL-AM3 AWE-AM1	Subtask 2 of IRSN proposal Update of the "slide rule" for the rapid response estimation of a criticality accident (using COG, MCNP, MAVRIC, ATTILA…)	M. DULUC	D. BOWEN D. HEINRICHS C. WILSON	ORNL LLNL AWE
IRSN-AM7	ACE QA testing and implementation	LANL-AM2	Implementation of the defined QA tests in ACEtk and integration in GAIA	L. LEAL	J. CONLIN	LANL
IRSN-AM8	Analytical Methods Working Group	NCSP-TS2	IRSN participation to NCSP analytical methods Working Group and IRSN participation to TPR meeting	S. EVO	F. BROWN D. BOWEN	NCSP
IRSN-AM9	Cross sections processing validation	ORNL-AM3	Development of an interface between GAIA and AMPX and test interface capabilities. AMPX training desired by IRSN staff in FY2019.	R. ICHOU	D. WIARDA D. BOWEN	ORNL
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. (Completion of this task before ORNL-AM9 and LANL-AM4 would be useful to identify common benchmarks.)	I. DUHAMEL	D. HEINRICHS D. BOWEN F. BROWN	LLNL ORNL LANL

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2019 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 three test cases Calculations and intercomparison technical report	I. DUHAMEL	F. BROWN D. BOWEN	LANL ORNL
IRSN-AM17	Technical Data for the Pitzer Formulation of Solution Compositions to Include Uranium/Plutonium Solutions with Selected Admixed Absorbers	ORNL-AM16 LANL-AM6 LLNL-AM7	Contribution to measurements definition. Comparison of density laws (isopiestic law for instance)..	N. LECLAIRE	D. BOWEN	ORNL
Integral Experiments						
IRSN-IE1 **IER 184**	TEX - Ta experiment	LLNL-IE4	Sensitivity/uncertainty calculations Contribution to the evaluation of the first experiments.	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE3 **IER 209**	New 7uPCX experiment	SNL-IE1	Contribution to ICSBEP reevaluation.	N. LECLAIRE	G. HARMS	SNL
IRSN-IE6 **IER 306**	Rh foils experiment	SNL-IE1	IRSN proposal: preliminary evaluation of experimental uncertainties prior to the experiment's CED-2 report.	N. LECLAIRE	G. HARMS	SNL
IRSN-IE7 **IER 305**	Mo foils and rods experiment	SNL-IE1	IRSN proposal: Leading the CED-3a report; Supplying the Mo rods for the experiment.	N. LECLAIRE	G. HARMS	SNL
IRSN-IE8 **IER 451**	Ti experiment	SNL-IE1	Analysis of the experiments Comparison with MIRTE program	N. LECLAIRE	G. HARMS	SNL
IRSN-IE11 **IER 297**	TEX - Hf experiment	LLNL-IE4	Contribution to Jemina plates characterization. Contribution to CED report.	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE15 **IER 253**	International intercomparison exercise using FLATTOP	LLNL-IE1 AWE-IE3	Participation in the design, contribution to the experiments with IRSN materials, and the report.	M. DULUC F. TROMPIER	D. HEINRICHS C. WILSON	LLNL AWE
IRSN-IE19	Solution reactor	Y12-IE2	Strong IRSN interest for participation in the design, specification… of a solution reactor	M. DULUC	P. ANGELO	Y-12
IRSN-IE25 **IER 296**	TEX - MOX experiment	LLNL-IE4	IRSN leads this proposal for design and will author the CED-1 & 2 reports with LLNL support. Characterization of moderator and reflector plates. IRSN contribution to the moderator and reflector plates funding.	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE26 **IER 295**	TEX - Iron experiment	LLNL-IE4	Contribution to the experiments design. Contribution to CED reports and review.	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE27 **IER 175**	GODIVA CAAS benchmark	ORNL-IE4	Participation in the design. Provide IRSN materials for irradiation, analysis of results.	M. DULUC	T. MILLER	ORNL

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2019 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
IRSN-IE28 **IER 406**	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	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	Participation in the design. Provide IRSN materials for irradiation, analysis of results	M. DULUC F. TROMPIER	D. HEINRICHS	LLNL
IRSN-IE34	HEU critical and Subcritical measurements	LANL-IE23	Participation in the definition and the design of the experiment	W. MONANGE	J. HUTCHINSON	LANL
IRSN-IE35 **IER 434**	Godiva benchmark for time dependent code validation	LANL-IE3	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-IE8	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 (On going task)	LANL-IE21	Analysis of the experiments, participation in the final technical report.	E. DUMONTEIL	J. HUTCHINSON	LANL
IRSN-IE39	Thermal/Epithermal Experiments (TEX) Plutonium Experiments at Low Temperatures	LLNL-IE19	Participation in experiments design and CED reports. To be discussed with LLNL.	M. BROVCHENKO	D. HEINRICHS	LLNL
IRSN-IE40	CAAS performance testing	LLNL-IE21	Participation in testing activities. Provide IRSN materials and French CAAS probes. To be discussed with LLNL.	M. DULUC	D. HEINRICHS	LLNL
IRSN-IE41	Thermal/Epithermal Experiments (TEX) with Chlorine and Lithium	LLNL-IE23	Participation in experiments design and CED reports. To be discussed with LLNL.	M. BROVCHENKO	D. HEINRICHS	LLNL
Information Preservation and Dissemination						
IRSN-IPD1	ICSBEP reviewing	LLNL-IPD1	IRSN ICSBEP reviewing tasks are reported in the IE tasks	I. DUHAMEL	D. HEINRICHS	LLNL
IRSN-IPD3	ICSBEP benchmark reviewing	LLNL-IPD1	IRSN ICSBEP reviewing tasks	I. DUHAMEL	J. FAVORITE	LANL

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2019 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
Nuclear Data						
IRSN-ND1	Contribution to new evaluations	ORNL-ND1	Contribution to new evaluation and validation for ^{54}Fe, ^{103}Rh, ^{55}Mn and Gd isotopes	L. LEAL	D. BOWEN	ORNL
IRSN-ND2	Nuclear data processing	LANL-ND1	Benchmark testing of ^{235}U and ^{239}Pu cross section library	L. LEAL	J. CONLIN	LANL
IRSN-ND3	Nuclear data processing	LLNL-ND4	Resonance evaluation of ^{233}U (Pending prioritization of ^{233}U ND tasks for the NCSP)	L. LEAL	D. HEINRICHS	LLNL
Training and Education						
IRSN-TE1	Hands-on criticality safety training	ORNL-TE1 LANL-TE3 LLNL-TE1 SNL-TE1	IRSN attendance to NCSP classes. Possible lectures by IRSN working with NCSP training and education coordinator.	S. EVO	D. BOWEN	NCSP

Appendix F

International Collaboration with the Atomic Weapons Establishment (AWE)

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

Reference			AWE Contributions and POCs			
AWE Reference	**Task Description**	**NCSP Reference**	**FY2018 AWE Contribution**	**AWE Technical POC**	**Collaborator POC**	**DOE Lab**
Analytical Methods						
AWE-AM1	Slide rule update	ORNL-AM6 LLNL-AM3 IRSN-AM5	Perform calculations; attend meetings; review analysis and reports	R. JONES	M. DULUC	ORNL
INTEGRAL EXPERIMENTS						
AWE-IE1	Inaugural international intercomparison of nuclear accident dosimetry using Flattop	LLNL-IE1 IRSN-IE15	Co-author final report (CED-4b)	C. WILSON	D. HICKMAN	LLNL
AWE-IE2	Development of Passive Neutron Spectrometer (PNS)		Fully commission TLD version of the PNS; Perform validation irradiations at NPL; develop unfolding tools for directionality	C. WILSON	D. HICKMAN	LLNL
AWE-IE3 **IER 406**	Cf-252 CAAS benchmark	LLNL-IE1 IRSN-IE28	Perform/support PNS(TLD) measurements with a shadow cone	C. WILSON	D. HEINRICHS	LLNL
AWE-IE4 **IER 175**	Godiva-IV CAAS benchmark	ORNL-IE4 IRSN-IE27	Review of experiment design. Provide measurement capability as required	C. WILSON	T. MILLER	ORNL
AWE-IE5	Correction factor for dosimetry linked to orientation of the victim	LLNL-IE1 IRSN-IE29	Participate in experiment design; use PNS data to determine directional components of neutron fields (Godiva, Flattop, LLNL RCL)	C. WILSON	D. HEINRICHS	LLNL
AWE-IE6	ICSBEP shielding benchmark for shipping containers	LLNL-IE13 IRSN-IE36	Participate in experiment design; PNS(TLD) could be deployed as primary measurement device	C. WILSON	S. KIM	LLNL

Reference			AWE Contributions and POCs			
AWE Reference	**Task Description**	**NCSP Reference**	**FY2018 AWE Contribution**	**AWE Technical POC**	**Collaborator POC**	**DOE Lab**
			AWE to do some preliminary design			
AWE-IE7 **IER 153**	Measure fission neutron spectrum shape using threshold activation detectors	LANL-IE3	Provide input into foil selection; use AWE unfolding codes to provide independent analysis. TBC AWE to provide foil suggestions per MYERS	C. WILSON	T. CUTLER B. MYERS	LANL
AWE-IE8	Diagnostic development for measurement of correlated leakage radiations	LLNL-IE1	A feasibility study is being developed at AWE to ascertain suitable counting scenarios and methods. An experimental design will then be produced in the following years based upon the outcomes of this study	N. KELSALL	D. HEINRICHS	LLNL
AWE-IE9	(Neutron multiplicity experiments) AWE/LLNL NCT 5 year measurement campaign	LLNL-PROPOSAL 18	Participate in experiment design, measurements and reporting	N. KELSALL	D. HEINRICHS	LLNL
AWE-IE10	Enhanced methods of criticality accident dosimetry No funding for FY19 awe will provide proposal for FY20	LLNL-IE1 IRSN-30 IRSN-33 Naval Dosimetry Center	Develop prototypes, participate in design, execution and reporting of dosimetry experiments	C. WILSON	F. TROMPIER	LLNL
AWE-IE11	International intercomparison of nuclear accident dosimetry AWE to assist in preliminary design FY19 and FY20	LLNL-IE18 SNL-IE4	Produce experiment design; participate in exercise; produce final report. Repeat 2 - 3 years	C. WILSON	D. HICKMAN	LLNL
AWE-IE12	CIDAAS testing	Proposal 20	Deploy AWE CIDAAS for test irradiation. Repeat 2 - 3 years	T. BIRKETT	J. SCORBY	LLNL
AWE-IE13	Characterization of AFRRI TRIGA reactor radiation field AWE will provide onsite measurement	LLNL-IE18 SNL-IE4	Provide support to experiment design	C. WILSON	A. ROMANYUKHA	LLNL

Reference			AWE Contributions and POCs			
AWE Reference	**Task Description**	**NCSP Reference**	**FY2018 AWE Contribution**	**AWE Technical POC**	**Collaborator POC**	**DOE Lab**
INFORMATION PRESERVATION AND DISSEMINATION						
AWE-IPD1	Conduct benchmark evaluations of legacy IEU integral experiments Requires no NCSP funding	LLNL-IPD1	Assess feasibility of sponsoring PhD; determine availability of data	C. WILSON	D. HEINRICHS	LLNL
TRAINING AND EDUCATION						
AWE-TE1	Hands-on criticality safety training	ORNL-TE1 LANL-TE1 LLNL-TE1 LLNL-TE3 SNL-TE1 IRSN-TE1	AWE personnel to attend training course	R. JONES	D. BOWEN B. MYERS D. HEINRICHS G. HARMS S. EVO (IRSN)	ORNL