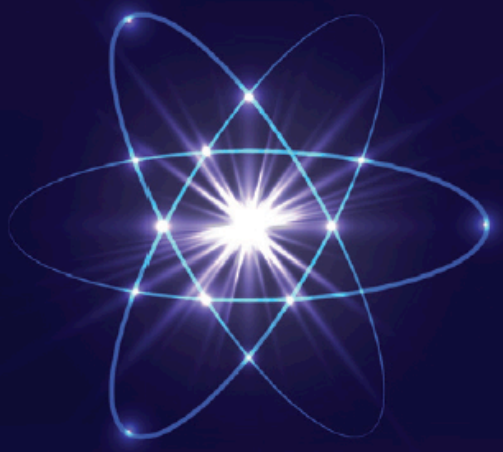
NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM

Five Year Execution Plan –
for the
Mission and Vision
of the
United States Department of Energy
Nuclear Criticality Safety Program

FY 2021 through FY 2025

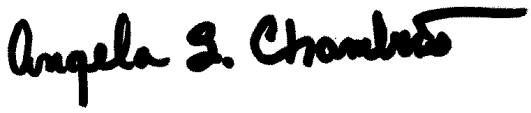


U.S. DEPARTMENT OF ENERGY

NNSA
National Nuclear Security Administration

Department of Energy Nuclear Criticality Safety Program Five-Year Execution Plan for Fiscal Years 2021 through 2025, dated August 2020.

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
INL	Idaho National Laboratory
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
PNNL	Pacific Northwest National Laboratory
POC	Point of Contact
PREPRO	Nuclear cross-section processing code
RPI	Rensselaer 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 2019-2028 (https://ncsp.llnl.gov/docs/NCSP_MISSION_VISION.pdf), are the following:

- 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.

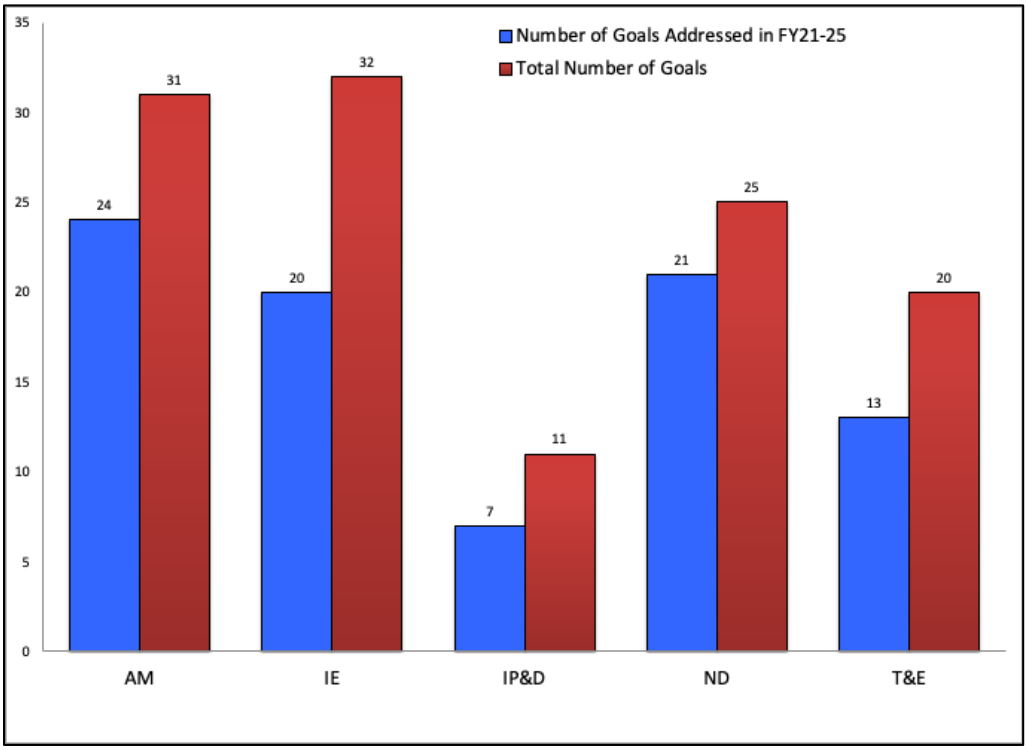
The NCSP is funded by the National Nuclear Security Administration (NNSA). Dr. Angela Chambers (NA-511) is the NCSP Manager. She is supported by the Criticality Safety Support Group (CSSG) and the Nuclear Data Advisory Group (NDAG), regarding technical matters, and by the Criticality Safety Coordinating 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 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 FY21 work tasks will help address a number of NCSP Mission and Vision Goals, and additional goals will be addressed in FY21-FY25. 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 measurement laboratory at NNSS has been completed. These IE goals have been 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 Summary of NCSP Mission and Vision Program Element Goals



The AM 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 supports 24 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. With regard to the overall AM technical gap over the next 5 years, the NCSP is continuing to make a modest investments at each site for succession planning efforts; however, there is only one task (ORNL-AM15) devoted to AM succession planning efforts (funded student at the Massachusetts Institute of Technology). Technical gaps for thermal scattering law data covariance evaluations, coupling NCS radiation transport software with CAD/CAE packages, developing and maintaining time-dependent radiation transport accident analysis capabilities, developing and deploying methods to provide integral experiment correlation data, and providing correlation data for integral benchmark experiments.

The IE 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 20 of 32 IE goals to assess, design, perform, and document integral experiments. The NCERC small sample Rabbit Transfer System task work will be continued until it is functional. 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. The Five-Year Plan tasks specifically support 7 of 11 IP&D goals for preserving and disseminating technical, programmatic, and operational information important for nuclear criticality safety. 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 21 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. Examples of goals not addressed in FY21 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 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 13 of 20 T&E goals during the next five years. The tasks primarily support the development and maintenance of the classroom and "hands-on" training courses at the Nevada Field Office, SNL and NNSS. The NCSP Manager's Course will be modified as a result of CSSG tasking report 2018-01 to include content for Criticality Safety Officers. The new content will be piloted in FY21 (delayed 1 fiscal year due to COVID-19). In FY20, ORNL published a feasibility study for a new subcritical assembly to be located at ORNL to provide hands-on training for fissile material handlers, criticality safety practitioners, university students and those with responsibilities in nuclear criticality safety. Work on this task will continue in FY21. In FY21, LLNL will address the feasibility to develop a mobile CAT III or IV material near-critical hands-on capability and develop a criticality simulator to demonstrate criticality physics fundamentals to process operators. FY21 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 FY21 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); 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 support and accomplish a significant number of Mission and Vision goals (80 of 119) during the next five years. As a result, the NCSP will be able to accomplish the overall mission to provide sustainable expert leadership, direction, and technical infrastructure needed to support safe, efficient fissionable material operations within the DOE.

2.0 Technical Program Elements

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

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

A description of how each of these elements contributes to the enhancement of criticality safety is contained in the NCSP Mission and Vision document. This Five-Year Execution Plan contains the road map for each of the five technical program elements, including a budget, tasks, and milestones for completing the work and achieving the NCSP Vision. All tasks are approved based on their contribution to the achievement of the five- and ten-year goals in the Mission and Vision document. Funding figures 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 for FY2021-2025 are shown in Figures 2.1-2.5.

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/.

Figure 2.1 NCSP Funding Overview (FY2021-FY2025) – Total

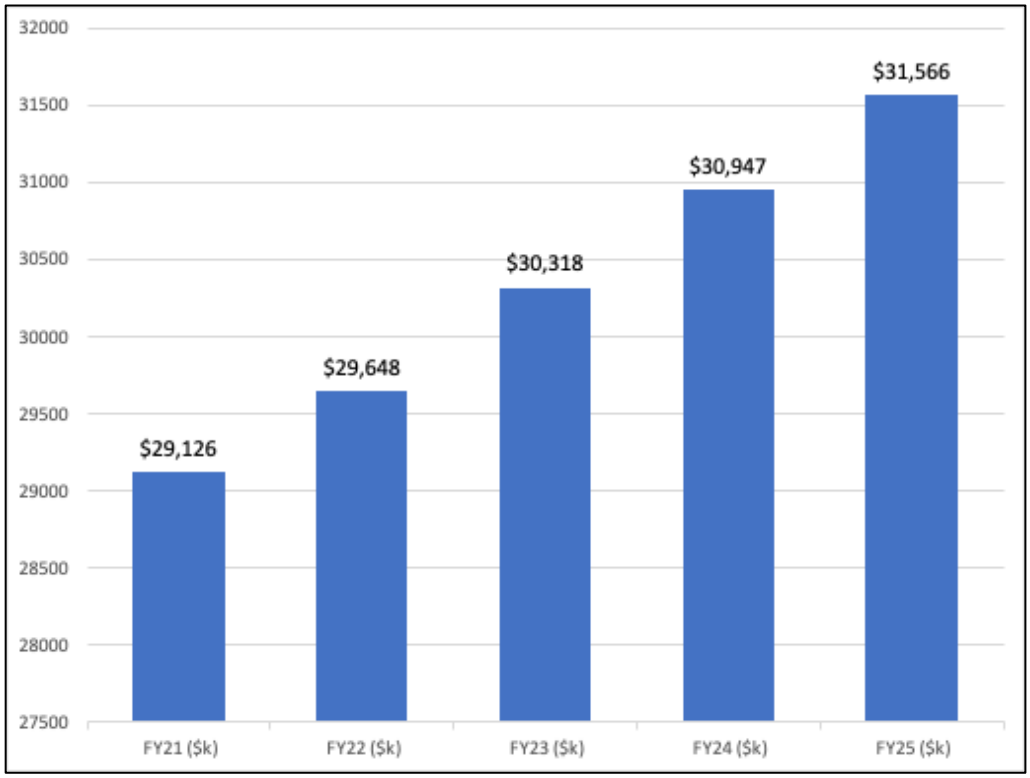


Figure 2.2 NCSP Funding Overview (FY2021) – By Technical Program Element

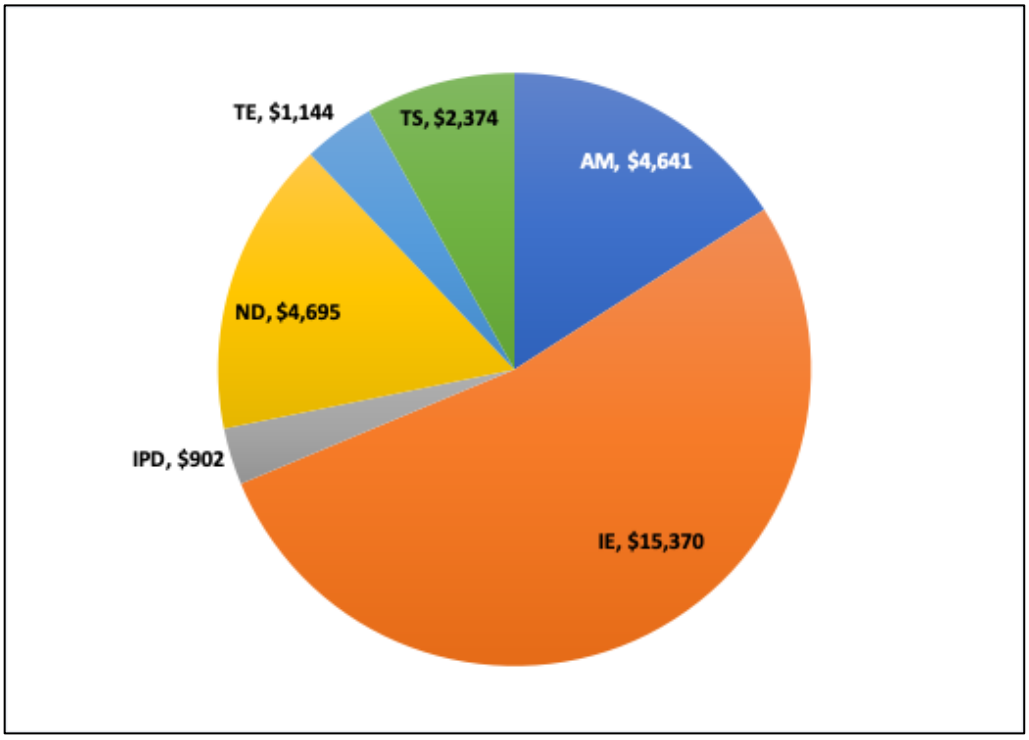


Figure 2.3 NCSP Funding Overview (FY2021-FY2025) – By Technical Program Element

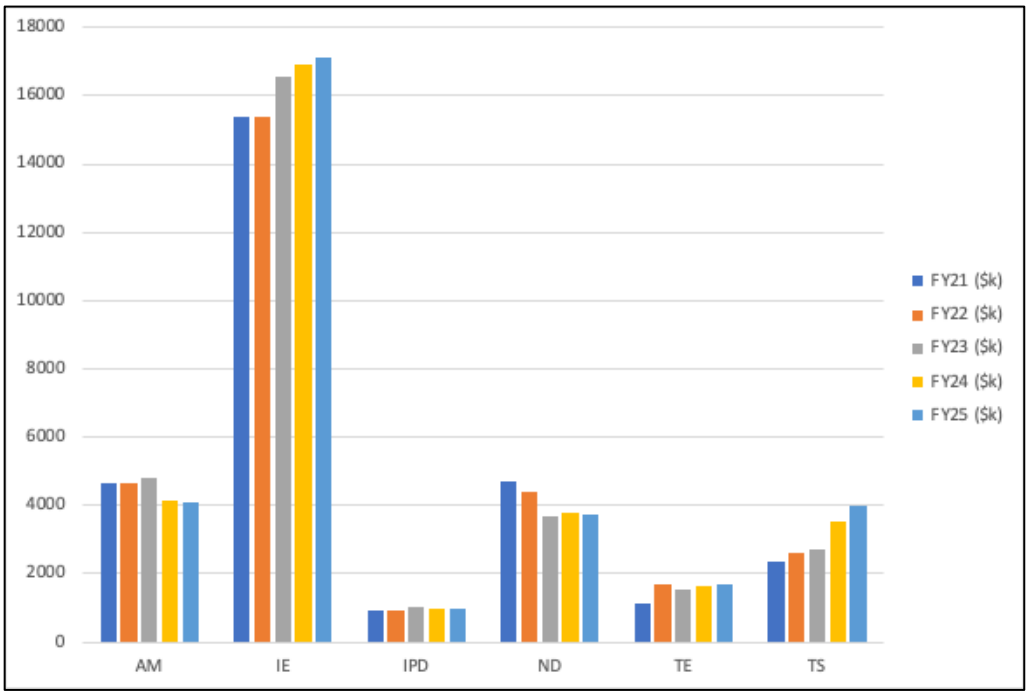


Figure 2.4 NCSP Funding Overview (FY2021-FY2025) – By Site

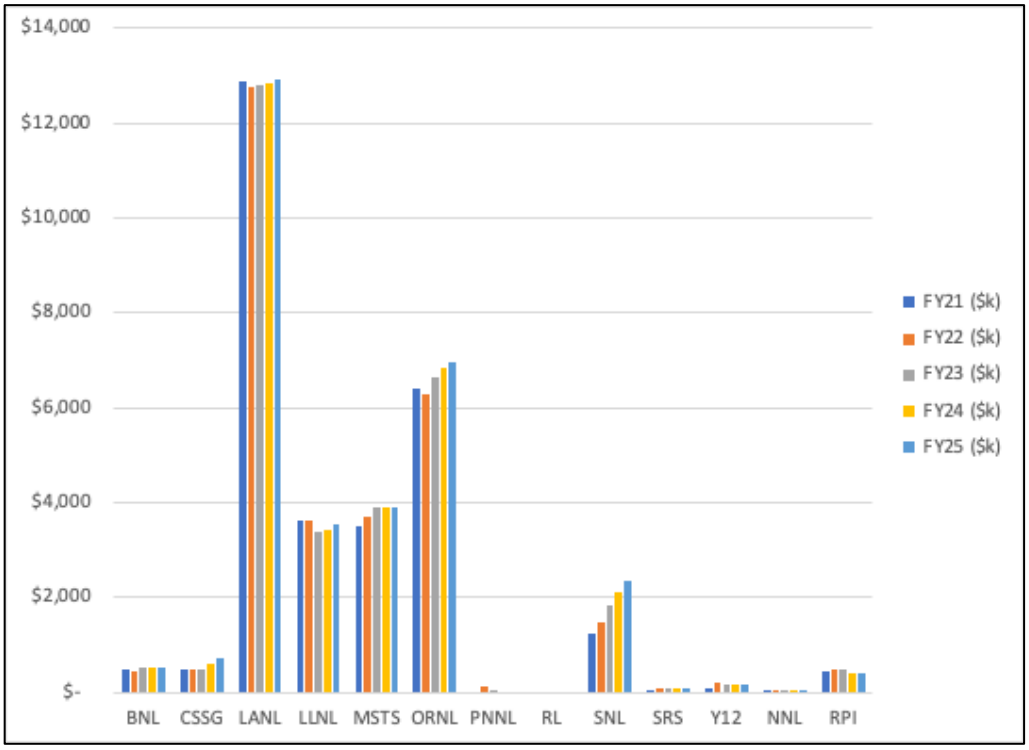


Figure 2.5 NCSP Funding Overview (FY2021) – By Site

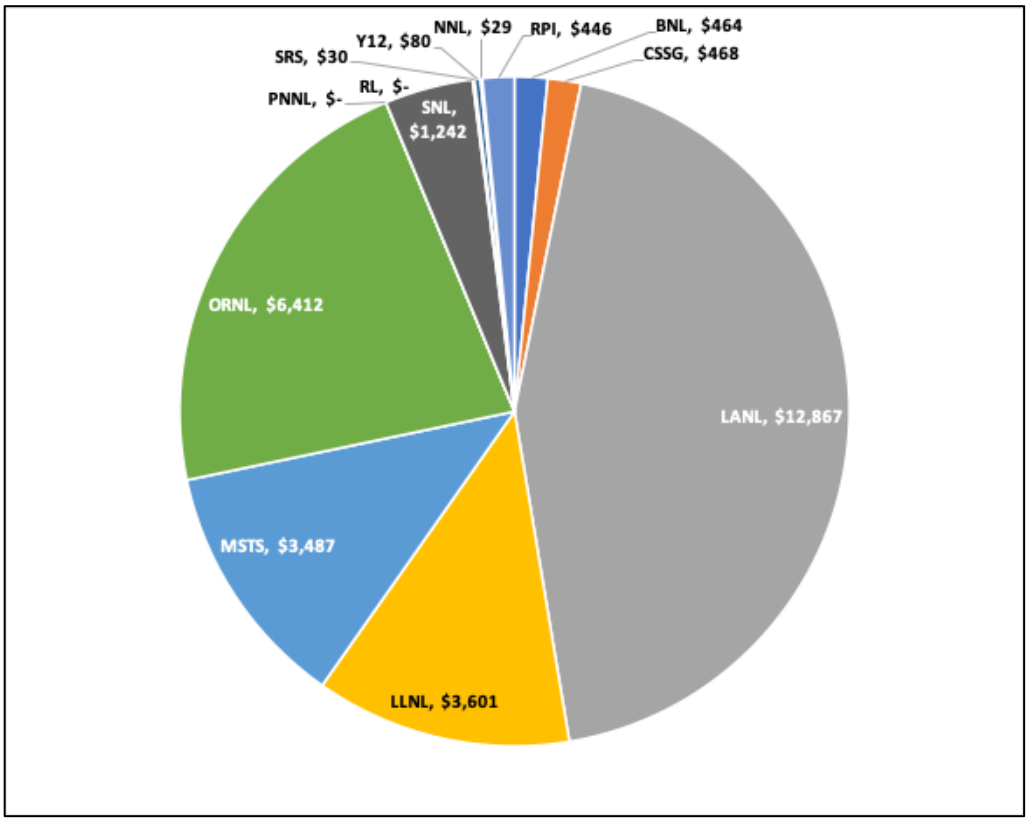


Table 2.1 NCSP Final Site Splits (FY2020 and FY2021)

Site	FY20 Funding ($k)*	FY21 Funding ($k)
BNL	427	464
LANL	12,683	12,992
LLNL	3,987	3,651
NCSP MGR (CSSG discretionary funds)	0	28
MSTS	3,735	3,487
NNL	0	29
ORNL	6,049	6,627
RPI	826	446
SNL	769	1,242
SRS	98	80
Y12	25	80
RL	25	0
Grand Total	**28,624**	**29,126**

*** Figures based on Revision 3 of the FY2020 5-year plan.**

2.1 Analytical Methods Technical Program Element

2.1.1 Description

The Analytical Methods (AM) Technical 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. Figures for each site provide information about the total budget and spending plan for the approved tasks for each FY2021. Following this information, a table is provided with the following: task name, task title, description, budget, collaborators, and FY21 milestones. The list of collaborators may include IRSN, AWE, or another NCSP site. These international collaborators have provided a list of tasks of interest to each organization and are provided in Appendix E (IRSN) and Appendix F (AWE).

2.1.2 Approved Tasks

For each site, the following sections provide a task description, scope, budget and milestones for each Analytical Methods (AM) task approved by the NCSP manager.

Figure 2.1-1 NCSP AM Budget (FY2021-FY2025)

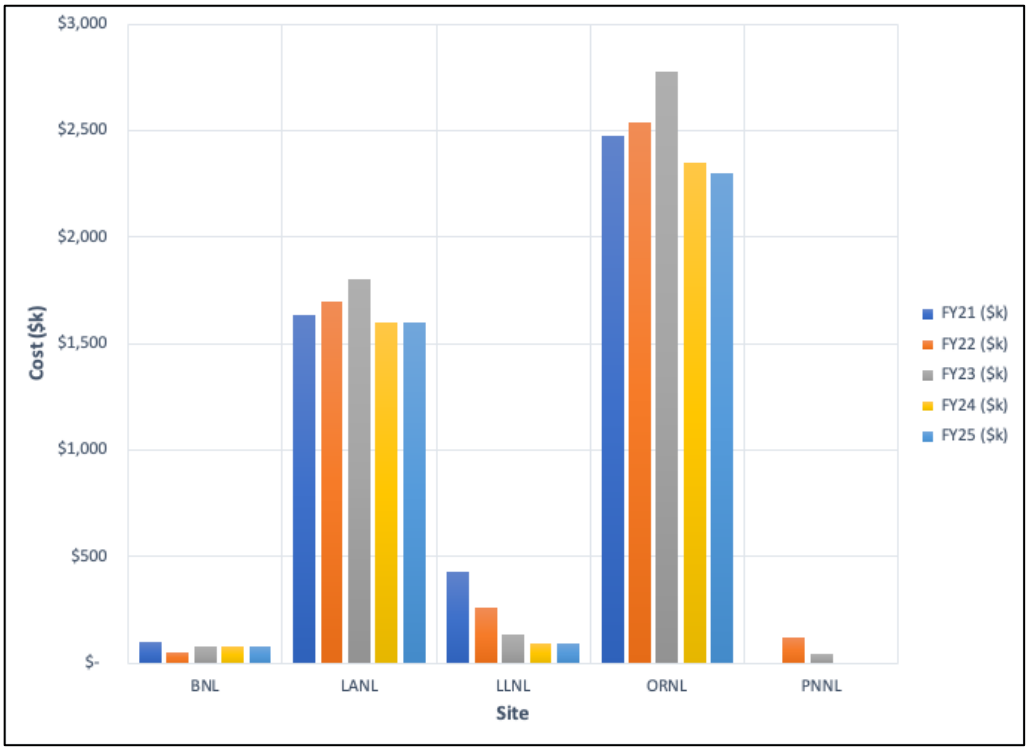
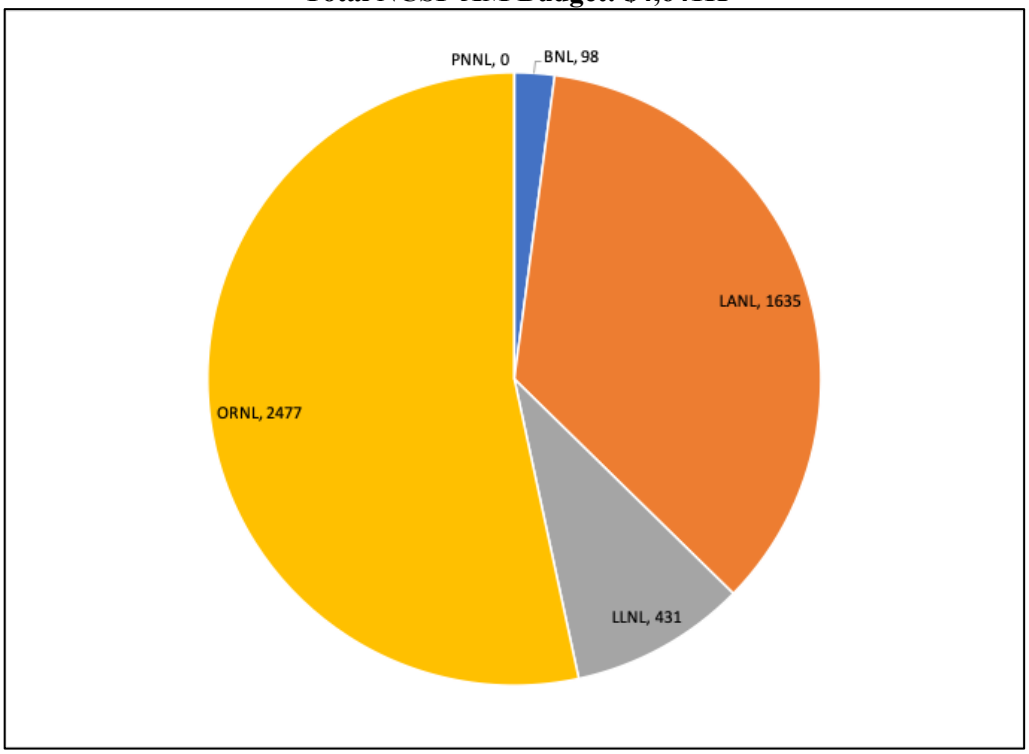


Figure 2.1-2 NCSP AM Budget (FY2021)

Total NCSP AM Budget: $4,641K

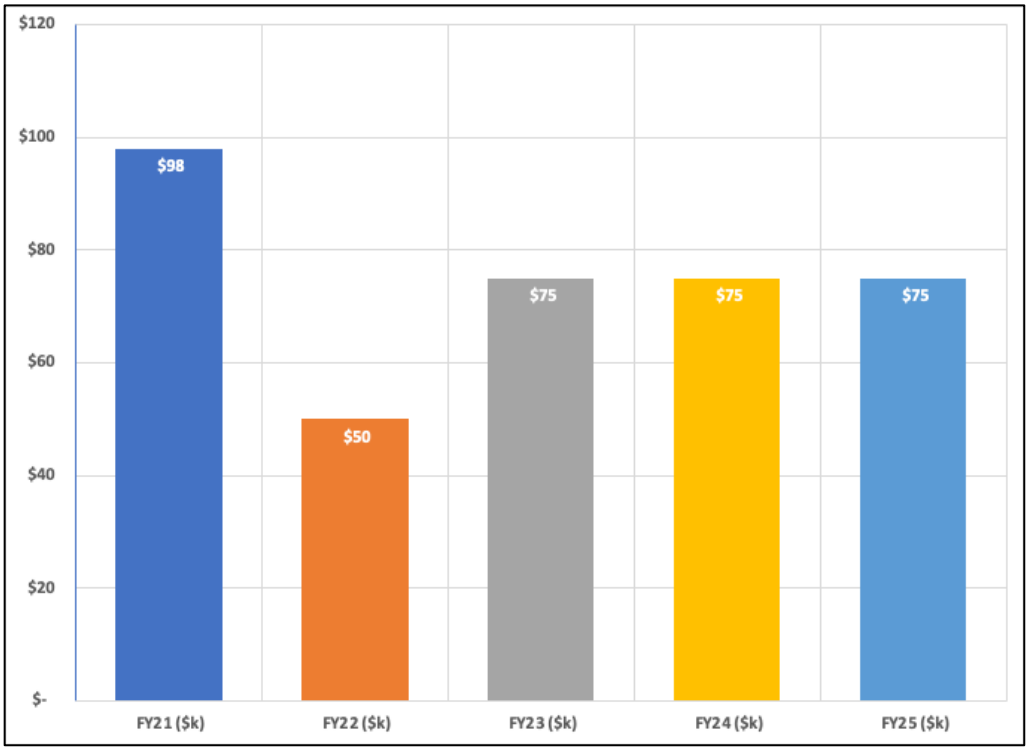


2.1.2.1 Brookhaven National Laboratory (BNL)

Task Name	BNL AM4
Collaborators	LLNL (LLNL-AM4)
Task Title	Thermal Scattering and Self-Shielding in GNDS/FUDGE
Proposal Submitted	FY17 (5-yr task)
Task Budget (FY21)	$48K
Task Description	Add the Thermal Neutron Scattering Law (TNSL) formats to GNDS, including the underlying unprocessed parameters needed to generate and extend the TNSL data. LLNL and BNL will work with NCSU and members of WPEC SG42, which is a new subgroup on thermal scattering kernels S(α,β) focusing on measurement, evaluation and applications. Specifically, the proposal is to add TNSL formats to the next release (post 1.9) of GNDS, including the underlying unprocessed parameters needed to generate and extend the TNSL data. Additionally, this proposal is to update FUDGE to handle and process TNSL data. This latter effort includes collaboration with NCSU to implement the TNSL code they are developing directly into FUDGE or develop a suitable interface.
FY21 Milestones	**All 4 Quarters** o Provide a status report on generating a draft document defining the TNSL code or software interface. (All QTRS)

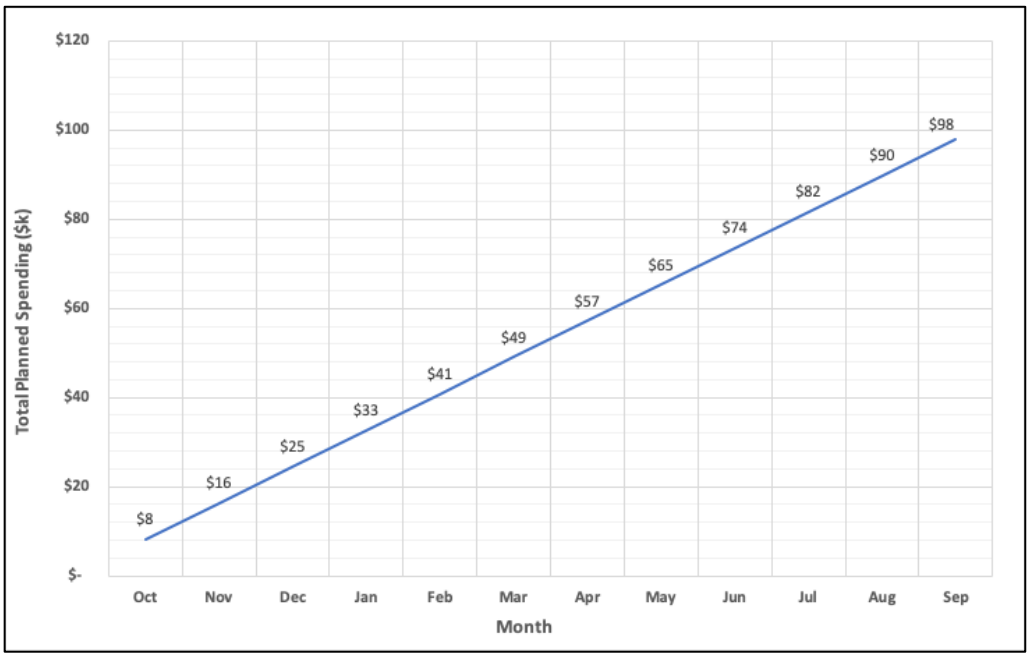
Task Name	BNL AM5
Collaborators	LLNL (LLNL-AM8)
Task Title	FUDGE Generation of a Complete ENDF/B-VIII.0 Library for Testing in Production Codes
Proposal Submitted	FY17
Task Budget (FY21)	$50K
Task Description	This new task is to for LLNL and BNL to collaborate the following: • LLNL and BNL to provide the double differential cross-sections (DDXS) for thermal scattering and probability density functions (PDF) data for the unresolved resonance region in GNDS-1.9 containers • LLNL to test the FUDGE/ GNDS-1.9 data including the new DDXS and PDF data and compare the results to those using legacy codes • In the event of discrepancies, BNL and LLNL to use these results to identify issues and inform further development of the DDXS and PDF algorithm as required • Upon completion of the project, LLNL and BNL to provide the final ENDF/BVIII.0 DDXS and PDF data in GNDS-1.9 containers • LLNL to provide the full test suite to BNL for inclusion in ADVANCE
FY21 Milestones	**All 4 Quarters** o Provide a status report on completing an ENDF/B-VII.0 library with FUDGE. (All QTRS)

Figure 2.1-3 BNL AM Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The decrease in BNL budget from FY21 to FY22 is due to the completion of BNL task BNL-AM5 (FUDGE Generation).

Figure 2.1-4 BNL AM Planned Spending (FY2021)



2.1.2.2 Los Alamos National Laboratory (LANL)

Task Name	LANL AM1
Collaborators	IRSN (IRSN-AM15)
Task Title	MCNP® Maintenance and Support, Uncertainty Analysis Development, and Modernization
Proposal Submitted	Ongoing task
Task Budget (FY21)	$1188K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide a status report on MCNP6 user support o Provide status reports on LANL participation in US and International analytical methods collaborations Quarter 1 o Provide reports on summer intern work accomplished o Continue to distribute MCNP6 with automated acceleration and convergence testing to NCSP early-adopters and collect feedback Quarter 2 o Provide status of all MCNP6 and Whisper progress at the NCSP Technical Program Review o Provide MCNP6 Criticality training course Quarter 3 o Issue an MCNP V&V report, including MCNP6 automated acceleration and convergence Quarter 4 o Release MCNP 6.3 to RSICC o Provide MCNP6 Criticality training course o Develop and demonstrate long-term strategy for distributing all Los Alamos supported ACE files

Task Name	LANL AM2
Collaborators	None
Task Title	NJOY Development and Maintenance, Uncertainty Analysis Development, and Modernization
Proposal Submitted	Ongoing task
Task Budget (FY21)	$297K
Task Description	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), 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. This capability will be necessary if the U.S. desires to design and understand the behavior of uncontrolled prompt critical systems for various applications to include criticality accident analysis fission yields, doses to co-located workers, and various other aspects of interest to NA-10, 20, 40 and 80.
FY21 Milestones	All 4 Quarters o Provide a status report on NJOY user support o Provide status reports on LANL participation in US and International analytical methods collaborations Quarter 1 - None Quarter 2 o Release modernized and integrated versions of THERMR and LEAPR with documentation Quarter 3 - None Quarter 4 o Demonstrate modernized ACER capabilities for processing fast neutron files with NJOY21

Task Name	LANL AM3
Collaborators	Rensselaer Polytechnic Institute
Task Title	Development of an Adaptive-in-temperature Method for fast on-the-fly Sampling of Thermal Neutron Scattering Data in MCNP6
Proposal Submitted	FY17
Task Budget (FY21)	$100K
Task Description	LANL will enhance the physics treatment in MCNP6 so that it can perform fast on-the-fly sampling of S(alpha, beta) data at arbitrary temperature. RPI will develop thermal data libraries for selected materials to support on-the-fly S(alpha, beta) sampling for temperature ranges applicable to NCS and will test the data with MCNP6.
FY21 Milestones	All 4 Quarters o Provide status and updates of work in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 - None Quarter 3 – None Quarter 4 o Provide data files and report for h-h2o and graphite on-the-fly S(alpha,beta) temperature effects.

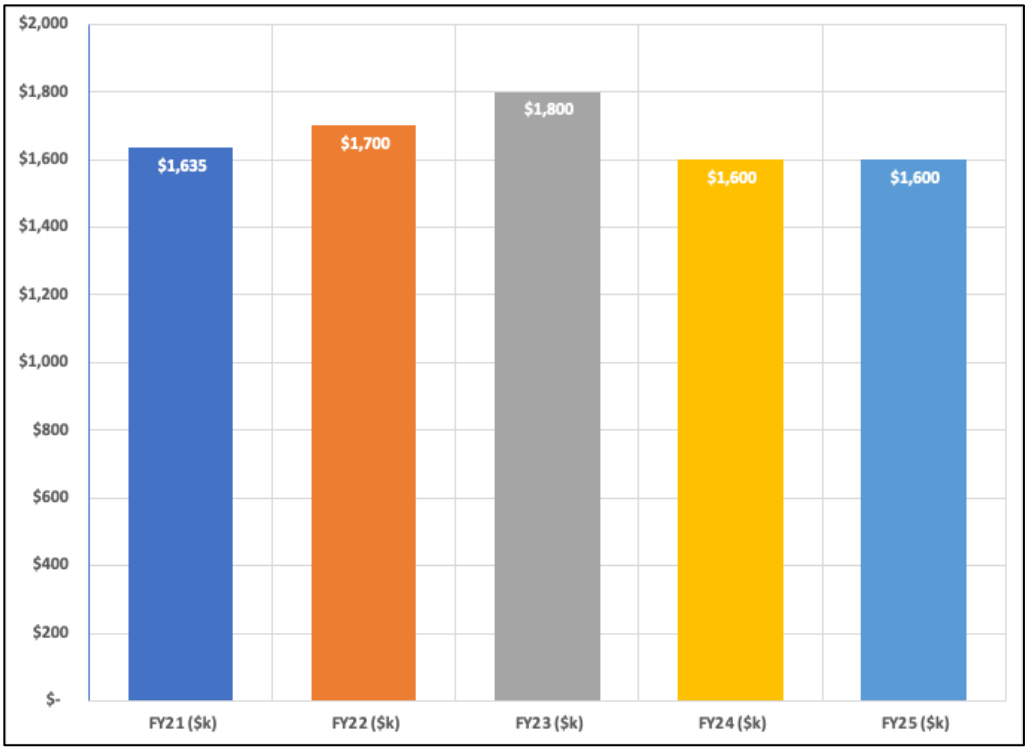
Task Name	LANL AM4
Collaborators	IRSN (IRSN-AM14), ORNL (ORNL-AM9)
Task Title	Sensitivity/Uncertainty Comparison Study with a Focus on Upper Subcritical Limits
Proposal Submitted	FY17
Task Budget (FY21)	$0K (Use carry over from FY20 budget - $50K)
Task Description	Various methods have been developed 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.® This proposal is to have the three Laboratories compare results from the various methods on a small set of benchmark problems. Differences in results will be understood, and one or more of the methods may be improved as a result. Two relevant problems will be chosen each FY, and results such as sensitivity profiles and individual components of the USL will be compared. Each year, the two problems to be compared will be chosen. Nuclear data choices will also be made. For example, year one might study a fast Pu system and a solution system from ICSBEP. For some comparisons we might all employ the same nuclear data; for others a range of evaluated data might be used. We anticipate choosing real-world application problems of interest as well as historical benchmark problems during the lifetime of the project. The NCSP AM Working Group will provide a forum for presenting and discussing results to ensure timely completion of the milestones. LANL will be responsible for one summary report for two of the test cases while the other labs will provide summary reports for their test case work. IRSN will lead the development in the final year of a summary report for the project.
FY21 Milestones	All 4 Quarters o Provide status reports on LANL participation in US and International analytical methods collaborations Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 o Issue report on detailed review, comparisons, and updates to the Sensitivity-Uncertainty Comparison Study (pending carryover funding).

Task Name	LANL AM5
Collaborators	IRSN (IRSN-AM13), ORNL (ORNL-AM10), LLNL (LLNL-AM5)
Task Title	Proposed Benchmark Intercomparison Study
Proposal Submitted	FY17
Task Budget (FY21)	$50K
Task Description	CEA and IRSN published a summary of the results of an extensive benchmark Intercomparison study of French analytic methods using JEFF-3.1.1 nuclear data in the proceedings of the International Conference on Nuclear Criticality Safety (ICNC 2015). While JEFF data is available in many NCSP codes (e.g.,

	COG, MCNP), due to resource limitations it has not been tested as rigorously as the US national database ENDF/B. The proposal is for IRSN to lead a new Intercomparison 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). Due to the large number of benchmarks involved, this effort is envisioned to take three years with an additional year for IRSN to complete a summary report. The benchmark development will be performed independently to minimize modeling errors through discovery and resolution of discrepant results. A summary report will be generated (led by IRSN) to document the results of this study.
FY21 Milestones	All 4 Quarters o Provide status reports on LANL participation in US and International analytical methods collaborations Quarter 1 – None Quarter 2 - None Quarter 3 – None Quarter 4 o Issue final report on all LANL results related to the ICSBEP Benchmark Comparison Study

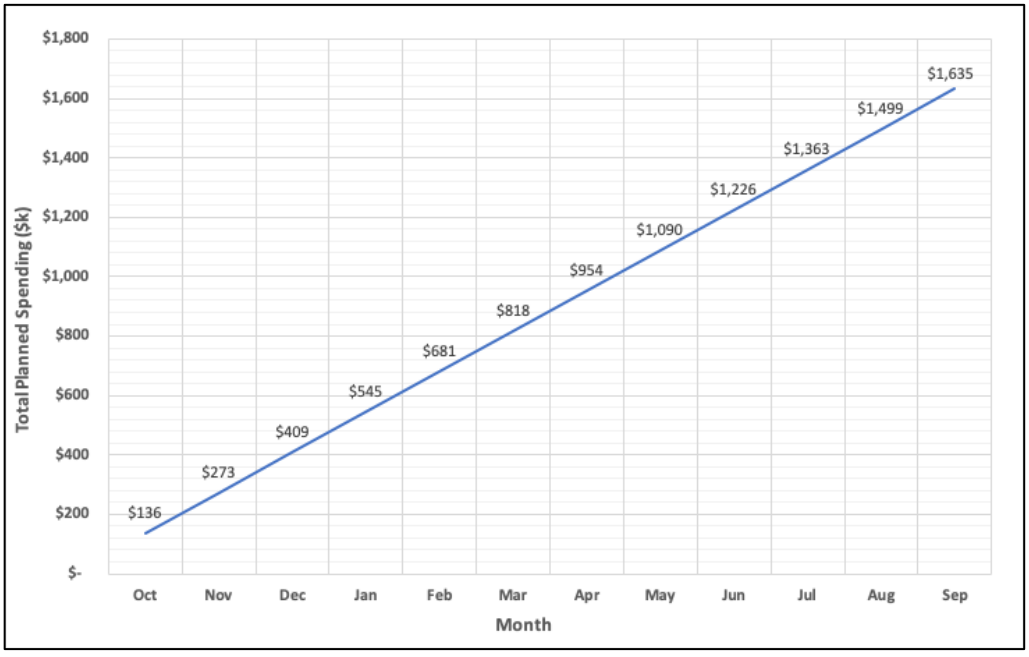
Task Name	LANL AM7
Collaborators	University of Michigan
Task Title	Incorporation of Benchmark Experiment Correlations into the Whisper Nuclear Criticality Safety Software
Proposal Submitted	FY20
Task Budget (FY21)	$0K (Use carry over from FY20 budget - $50K)
Task Description	The proposed project will work with LANL to develop and implement methodologies for incorporating benchmark experiment correlations into the Whisper calculational margin sequence. The goal is to allow Whisper to obtain more defensible conservative estimates of baseline upper subcritical limits in cases where the selected benchmarks in the validation set are correlated.
FY21 Milestones	All 4 Quarters o Provide status report for this task. Quarter 1– None Quarter 2 – None Quarter 3 – None Quarter 4 o Deliver final modified version of Whisper to LANL with an ANS conference paper to disseminate the work

Figure 2.1-5 LANL AM Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The increases in LANL AM budget between FY21-FY23 are due to out-year increases in LANL-AM1 (MCNP) and LANL-AM2 (NJOY).

Figure 2.1-6 LANL AM Planned Spending (FY2021)



2.1.2.3 Lawrence Livermore National Laboratory (LLNL)

Task Name	LLNL AM2
Collaborators	
Task Title	Multi-Physics Methods for Simulation of Criticality Excursions
Proposal Submitted	FY14
Task Budget (FY21)	$138K
Task Description	This is an ongoing approved task to support and build upon existing LLNL state-of-the-art 3-D analytical and multi-physics methods. The funding from this task will be used to simulate the IER 268 dynamic Godiva IV excursions including surface motion and neutron and photon leakage. The simulations will feed into the IER 268 experimental report. This task is to support IER 268 (PDV), which is discussed in the IE section of the 5-year plan for FY2021.
FY21 Milestones	All 4 Quarters o Provide status on LLNL AM activities in NCSP Quarterly Progress Reports Quarter 1– None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL AM3
Collaborators	IRSN (IRSN-AM5), (AWE-AM1), ORNL (ORNL-AM6)
Task Title	Slide Rule Application
Proposal Submitted	FY15
Task Budget (FY21)	$50K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status on LLNL AM activities in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL AM4
Collaborators	BNL (BNL AM4)
Task Title	Thermal Scattering and Self-Shielding in GNDS/FUDGE
Proposal Submitted	FY2017 (5-yr task)
Task Budget (FY21)	$94K
Task Description	Add the Thermal Neutron Scattering Law (TNSL) formats to GNDS, including the underlying unprocessed parameters needed to generate and extend the TNSL data. LLNL and BNL will work with NCSU and members of WPEC SG42, which is a new subgroup on thermal scattering kernels S(α,β) focusing on measurement, evaluation and applications. Specifically, the proposal is to add TNSL formats to GNDS, including the underlying unprocessed parameters needed to generate and

	extend the TNSL data. Additionally, this proposal is to update FUDGE to handle and process TNSL data. This latter effort includes collaboration with NCSU to implement the TNSL code they are developing directly into FUDGE or develop a suitable interface.
FY21 Milestones	**All 4 Quarters** o Provide a status report on generating a draft document defining the TNSL code or software interface. (All QTRS) Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

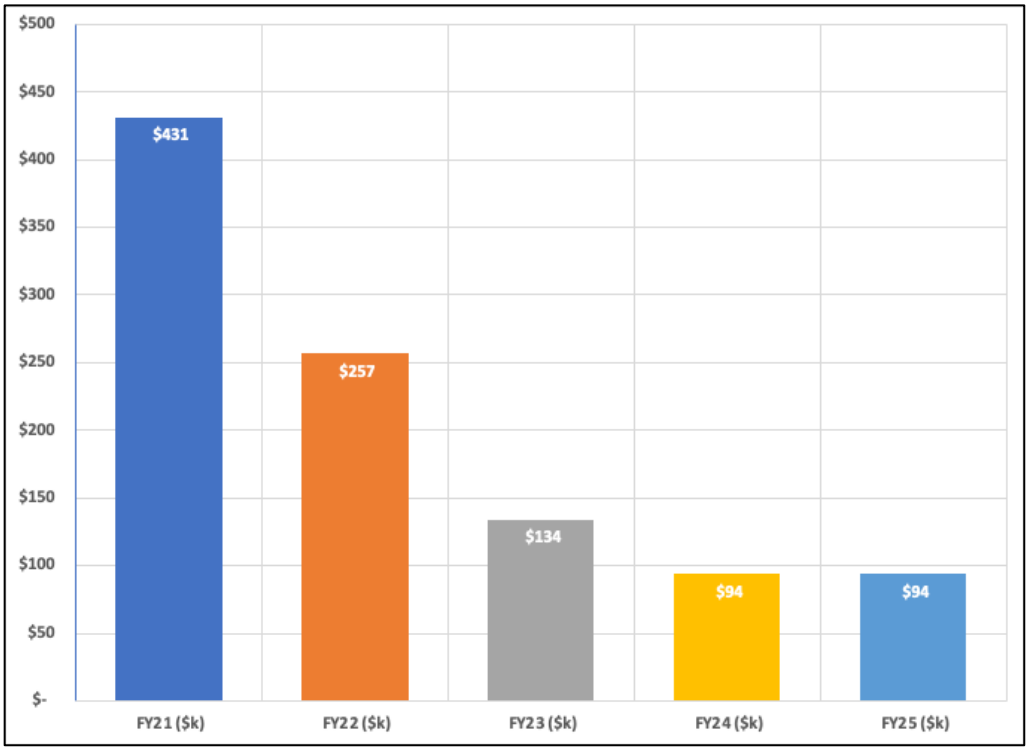
Task Name	LLNL-AM5
Collaborators	IRSN (IRSN-AM13), ORNL (ORNL-AM10), LANL (LANL-AM5)
Task Title	Proposed Benchmark Intercomparison Study
Proposal Submitted	FY17
Task Budget (FY21)	$50K
Task Description	CEA and IRSN published a summary of the results of an extensive benchmark Intercomparison study of French analytic methods using JEFF-3.1.1 nuclear data in the proceedings of the International Conference on Nuclear Criticality Safety (ICNC 2015). While JEFF data is available in many NCSP codes (e.g., COG, MCNP), due to resource limitations it has not been tested as rigorously as the US national database ENDF/B. The proposal is for IRSN to lead a new Intercomparison 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). Due to the large number of benchmarks involved, this effort is envisioned to take three years with an additional year for IRSN to complete a summary report. The benchmark development will be performed independently to minimize modeling errors through discovery and resolution of discrepant results. A summary report will be generated (led by IRSN) to document the results of this study.
FY21 Milestones	All 4 Quarters o Provide status on LLNL AM activities in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL-AM6
Collaborators	ORNL (ORNL-AM11), University of Arizona
Task Title	Proposed 1-D Multipoint Analytical Benchmark Comparison
Proposal Submitted	FY18
Task Budget (FY21)	$0K (FY18/FY19 funds to be used)
Task Description	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, 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. The deliverable will summarize a comparison of LLNL COG, ORNL SCALE and 1-D Analytical benchmark calculations. This task was not initiated on time due to the availability of the staff from the University of Arizona.
FY21 Milestones	All 4 Quarters o Provide status on LLNL AM activities in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

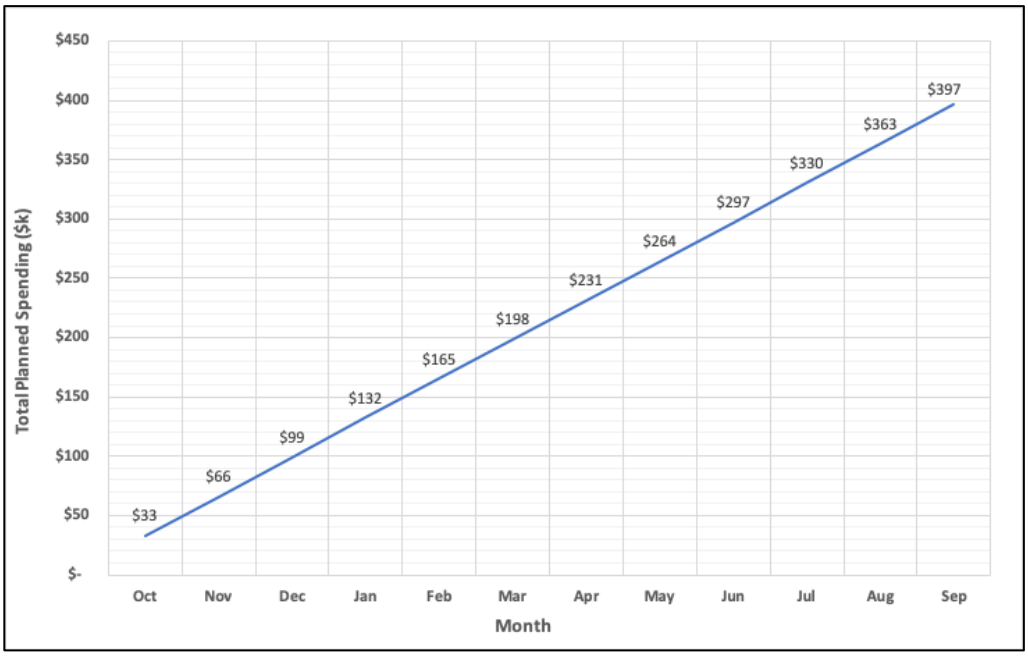
Task Name	LLNL-AM8
Collaborators	(BNL) BNL-AM5
Task Title	FUDGE Generation of a Complete ENDF/B-VIII.0 Library for Testing in Production Codes
Proposal Submitted	FY17
Task Budget (FY21)	$99K
Task Description	This new task is to for LLNL and BNL to collaborate the following: • LLNL and BNL to provide the double differential cross-sections (DDXS) for thermal scattering and probability density functions (PDF) data for the unresolved resonance region in GNDS containers • LLNL to test the FUDGE/GNDS data including the new DDXS and PDF data and compare the results to those using legacy codes • In the event of discrepancies, BNL and LLNL to use these results to identify issues and inform further development of the DDXS and PDF algorithm as required • Upon completion of the project, LLNL and BNL to provide the final ENDF/BVIII.0 DDXS and PDF data in GNDS containers • LLNL to provide the full test suite to BNL for inclusion in ADVANCE
FY21 Milestones	All 4 Quarters o Provide status on LLNL AM activities in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.1-7 LLNL AM Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The LLNL AM budget decreases after FY21 due to the completion of the LLNL-AM5, "Benchmark Intercomparison Study," and LLNL-AM8 "FUDGE Generation of a Complete ENDF/B-VIII.0 Library for Testing in Production Codes," tasks. The AM budget goes is reduced further by completion of LLNL-AM2, "Multi-Physics Methods for Simulation of Criticality Excursions," in FY22 and planned completion of the LLNL-AM3, "Slide Rule Application" task (led by IRSN) in FY23.

Figure 2.1-8 LLNL AM Planned Spending (FY2021)*



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

2.1.2.4 Oak Ridge National Laboratory (ORNL)

Task Name	ORNL-AM1
Collaborators	None
Task Title	Radiation Safety Information Computational Center (RSICC)
Proposal Submitted	FY17
Task Budget (FY21)	$674K
Task Description	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.
FY21 Milestones	All 4 Quarters o Continue distribution of available and newly packaged software to the NCS community requesters (at no direct cost to them) and provide distribution totals quarterly. o Provide status on RSICC activities in NCSP Quarterly Progress Reports. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	ORNL-AM2
Collaborators	IRSN (IRSN-AM1)
Task Title	SCALE/KENO/TSUNAMI Maintenance and Support/Cross-Section and Generation/Modernization
Proposal Submitted	Ongoing
Task Budget (FY21)	$1188K
Task Description	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, and training. 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.
FY21 Milestones	All 4 Quarters o 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.

	o Provide status on ORNL AM2 activities in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 – Issue an annual SCALE maintenance report to the NCSP Manager. Quarter 3 – None Quarter 4 o Publish annual newsletter to users to communicate software updates, user notices, generic technical advice, and training course announcements.

Task Name	ORNL-AM3
Collaborators	IRSN (IRSN-AM9)
Task Title	AMPX Maintenance and Modernization
Proposal Submitted	Ongoing
Task Budget (FY21)	$297K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status on ORNL AM3 activities in NCSP Quarterly Progress Reports. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 o Document AMPX modernization and technical support for SCALE CE, multigroup, and covariance libraries and report status annually to the NCSP Manager.

Task Name	ORNL-AM6
Collaborators	IRSN (IRSN-AM5), AWE (AWE-AM1), LLNL (LLNL-AM3)
Task Title	Slide Rule Application
Proposal Submitted	FY15
Task Budget (FY21)	$30K
Task Description	This is a continuing task with IRSN, ORNL, and LLNL to modernize the existing SlideRule accident response tool. ORNL developed the initial SlideRule, and under this task, IRSN will update the SlideRule using modern radiation transport tools (e.g., SCALE, MCNP, COG, etc.) and expand the SlideRule capabilities. IRSN, ORNL, and LLNL on the SlideRule modernization effort and perform review tasks as needed to assess the performance of the updated SlideRule capability.
FY21 Milestones	All 4 Quarters

	o Provide status on ORNL AM6 activities in NCSP Quarterly Progress Reports. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	ORNL-AM9
Collaborators	IRSN (IRSN-AM14), LANL (LANL-AM4)
Task Title	Sensitivity/Uncertainty Comparison Study with a Focus on Upper Subcritical Limits
Proposal Submitted	FY17
Task Budget (FY21)	$0K (Use carry over from FY20 budget - $50K)
Task Description	Various methods 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.® This proposal is to have the three Laboratories compare results from the various methods on a small set of benchmark problems. Differences in results will be understood, and one or more of the methods may be improved as a result. Two relevant problems will be chosen each FY, and results such as sensitivity profiles and individual components of the USL will be compared. Each year, the two problems to be compared will be chosen. Nuclear data choices will also be made. For example, year one might study a fast Pu system and a solution system from ICSBEP. For some comparisons we might all employ the same nuclear data; for others a range of evaluated data might be used. We anticipate choosing real-world application problems of interest as well as historical benchmark problems during the lifetime of the project. The NCSP AM Working Group will provide a forum for presenting and discussing results to ensure timely completion of the milestones. LANL will be responsible for one summary report for two of the test cases while the other labs will provide summary reports for their test case work. IRSN will lead the development in the final year of a summary report for the project.
FY21 Milestones	All 4 Quarters o Provide status on ORNL AM9 activities in NCSP Quarterly Progress Reports. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	ORNL-AM10
Collaborators	IRSN (IRSN-AM13), LLNL (LLNL-AM5), LANL (LANL-AM5)
Task Title	Proposed Benchmark Intercomparison Study
Proposal Submitted	FY17
Task Budget (FY21)	$50K
Task Description	CEA and IRSN published a summary of the results of an extensive benchmark Intercomparison study of French analytic methods using JEFF-3.1.1 nuclear data in the proceedings of the International Conference on Nuclear Criticality Safety (ICNC 2015). While JEFF data is available in many NCSP codes (e.g., COG, MCNP), due to resource limitations it has not been tested as rigorously as the US national database ENDF/B. The proposal is for IRSN to lead a new Intercomparison 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). Due to the large number of benchmarks involved, this effort is envisioned to take three years with an additional year for IRSN to complete a summary report. The benchmark development will be performed independently to minimize modeling errors through discovery and resolution of discrepant results. A summary report will be generated (led by IRSN) to document the results of this study.
FY21 Milestones	All 4 Quarters o Provide status on ORNL AM10 activities in NCSP Quarterly Progress Reports. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

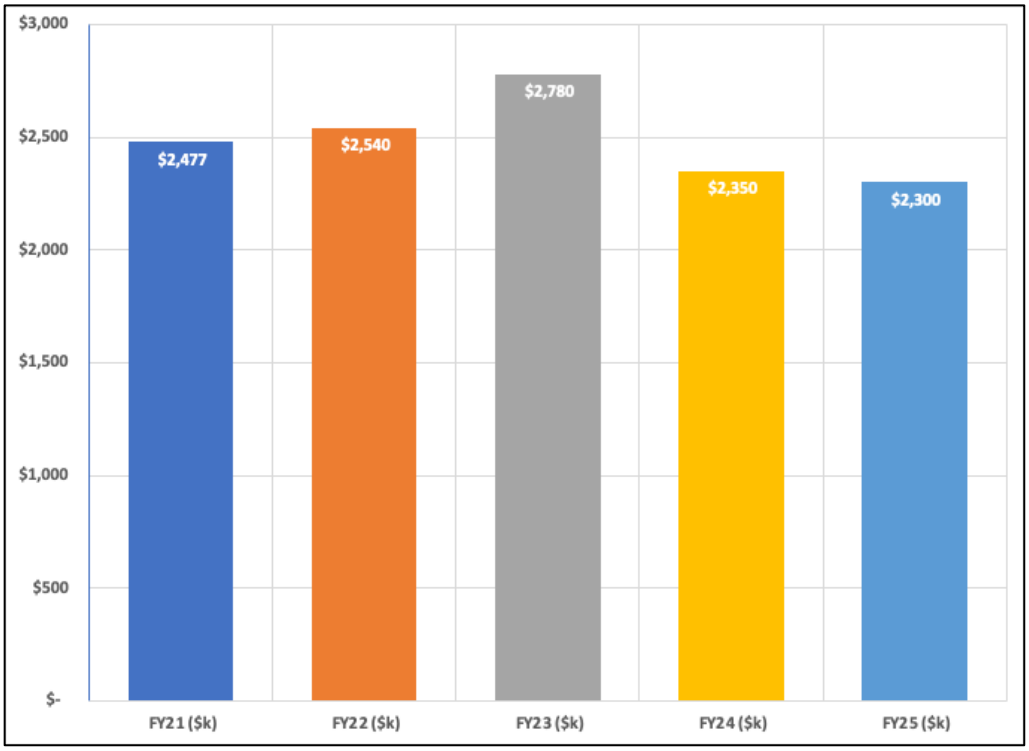
Task Name	ORNL-AM11
Collaborators	LLNL (LLNL-AM6), University of Arizona
Task Title	Proposed 1-D Multipoint Analytical Benchmark Intercomparison
Proposal Submitted	FY17
Task Budget (FY21)	$0K (FY18/FY19 funds to be used)
Task Description	This task involves the completion of a comparison of several computational 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. The deliverable will summarize a comparison of LLNL COG, ORNL SCALE and 1-D Analytical benchmark calculations. This task was not initiated on time due to the availability of the staff from the University of Arizona.
FY21 Milestones	All 4 Quarters

	o Provide status on ORNL AM11 activities in NCSP Quarterly Progress Reports. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	ORNL-AM15
Collaborators	Massachusetts Institute of Technology
Task Title	The Effects of Temperature on the Propagation of Nuclear Data Uncertainty in Nuclear Criticality Safety Calculations
Proposal Submitted	FY17
Task Budget (FY21)	$99K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status on ORNL AM15 activities in NCSP Quarterly Progress Reports. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

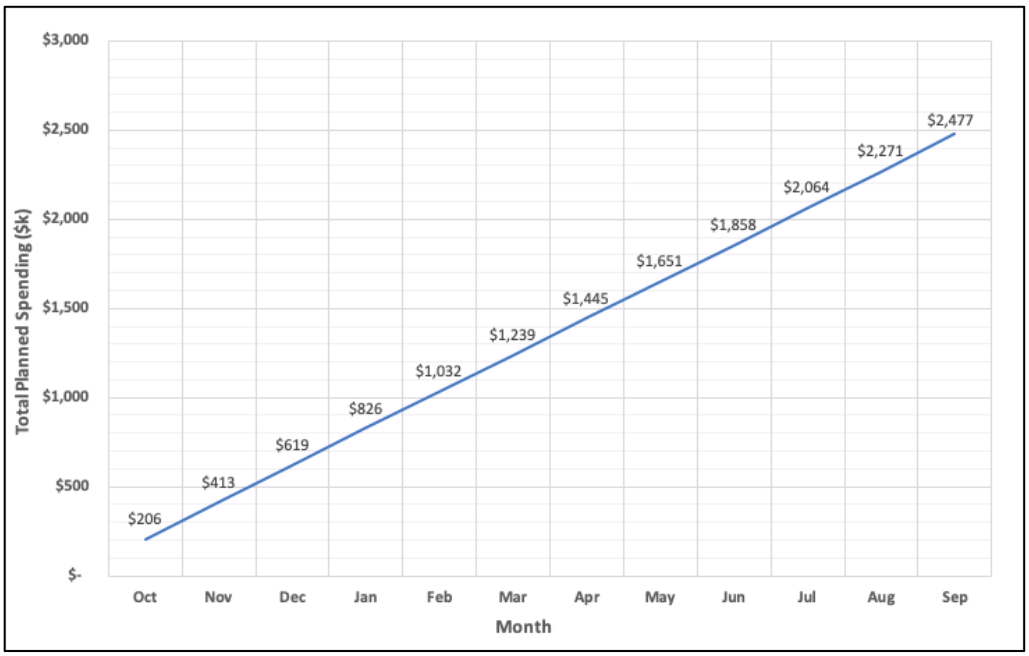
Task Name	ORNL-AM17
Collaborators	Expansion of the Verified, Archived, Library of Inputs and Data (VALID)
Task Title	Improve analytical methods and nuclear data tools for ensuring accurate criticality safety analyses that appropriately balance safety margins with operational flexibility. This task will generate TSUNAMI models for the 190 233U KENO models already in VALID, add deuterium-moderated models generated in FY18 University Task, and identify high-value benchmark experiments and add them to the library.
Proposal Submitted	FY20
Task Budget (FY21)	$139K
Task Description	Improve analytical methods and nuclear data tools for ensuring accurate criticality safety analyses that appropriately balance safety margins with operational flexibility
FY21 Milestones	All 4 Quarters o Provide status on ORNL AM17 activities in NCSP Quarterly Progress Reports. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.1-9 ORNL AM Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
New, 2-year tasks start in FY22: ORNL-AM18, "Determination of Appropriate Integral Parameters for Critical Experiment," and ORNL-AM19, "Analysis of Sum-of-Fractions for Nuclide Mixtures" resulting in modest increases in the FY22 and FY23 budgets.

Figure 2.1-10 ORNL AM Planned Spending (FY2021)



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.

Figure 2.2-1 IP&D Budget (FY2021-FY2025)

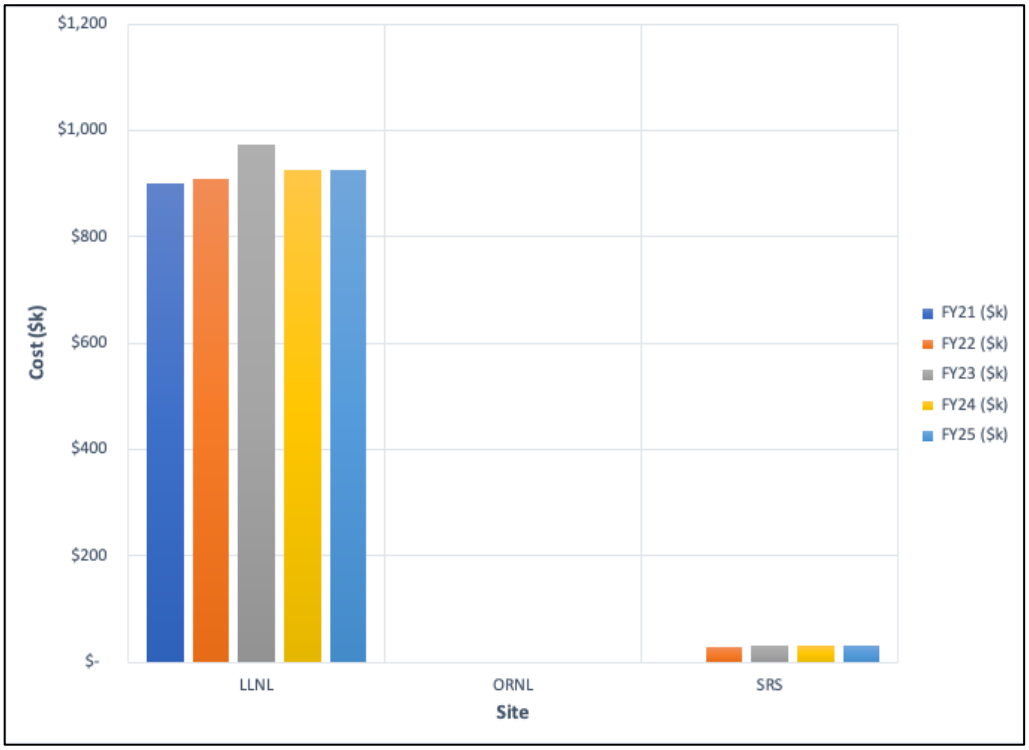
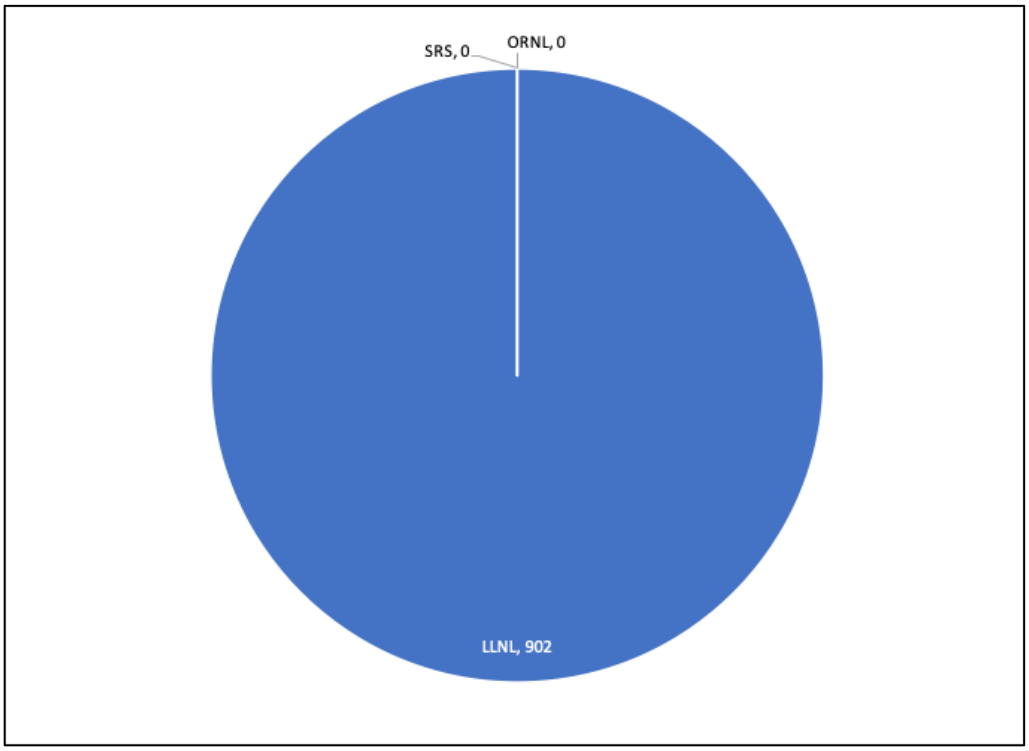


Figure 2.2-2 IP&D Budget (FY2021)

Total NCSP IP&D Budget: $902K



2.2.2 Approved Tasks

2.2.2.1 Lawrence Livermore National Laboratory (LLNL)

Task Name	LLNL IPD1
Collaborators	IRSN (IRSN-IPD1), AWE (AWE-IPD1)
Task Title	Conduct ICSBEP for Benchmarks of the 5-Year Plan and publish annual revision to the Handbook
Proposal Submitted	Ongoing
Task Budget (FY21)	$283K
Task Description	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.
FY21 Milestones	All 4 Quarters o Manage all aspects of the DOE NCSP participation in the ICSBEP as required to ensure the finalizing and publishing ICSBEP evaluations per IE schedule. o 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. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL IPD2
Collaborators	None
Task Title	Maintain the NCSP Website and Systems
Proposal Submitted	Ongoing
Task Budget (FY21)	$198K
Task Description	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.
FY21 Milestones	All 4 Quarters o Maintain, operate and modernize he NCSP website, databases, and provide user assistance as required. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL IPD4
Collaborators	None
Task Title	Benchmark Evaluation of Hot Box, LLNL Historical Critical Configurations at High Temperature
Proposal Submitted	FY19
Task Budget (FY21)	$0K (FY20 carryover to be used)
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

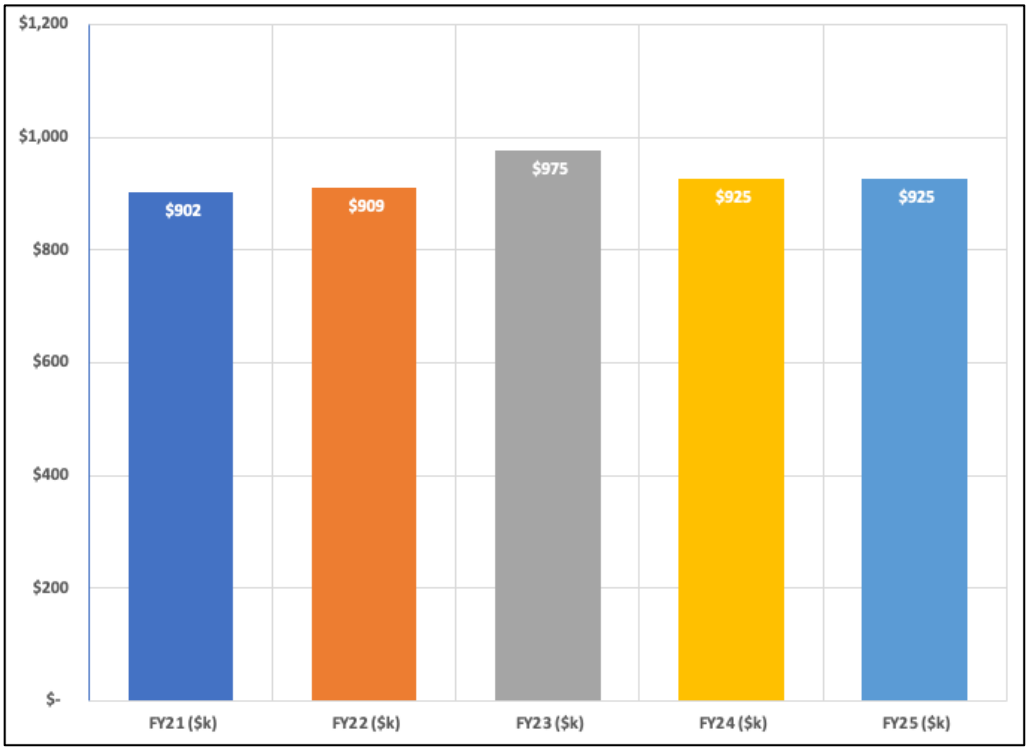
Task Name	LLNL IPD5
Collaborators	None
Task Title	IT Support at NNSS
Proposal Submitted	Ongoing
Task Budget (FY21)	$297K
Task Description	This task is to provide IT support at the NNSS, e.g., Classified computing, etc.
FY21 Milestones	All 4 Quarters o Provide status report on progress for IPD5. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL IPD6
Collaborators	None
Task Title	Benchmark Evaluation of LLNL 'Pulsed Spheres'
Proposal Submitted	FY20
Task Budget (FY21)	$99K
Task Description	This task for LLNL will involve formally evaluating the LLNL 'Pulse Sphere' experimental campaign for inclusion into the ICSBEP Handbook and/or SINBAD compendium. Dr. Luisa Hansen, the Principal Investigator (PI), is still available and willing to assist in this effort as the internal reviewer. LLNL is thus uniquely qualified to perform this task as we have access to the PI, data, drawings, interim reports, etc., and have state-of-the-art 'open' and 'closed' analytical methods

	capable of performing simulations from first principles starting with the charged particle deuteron beam. This is particularly important because the beam is not fully stopped in the tritiated target, and so must be more realistically Nuclear Criticality Safety Program Proposal Template for FY2020 – FY2024 simulated, which it appears has not been done prior to 2012 due to limitations in popular codes. Lastly, it should be noted that these experiments are unique and important in that they are especially sensitive to elastic and inelastic scattering whereas critical assembly experiments of all types are dominated by fission and capture.
FY21 Milestones	All 4 Quarters o Provide status report on progress for IPD6. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

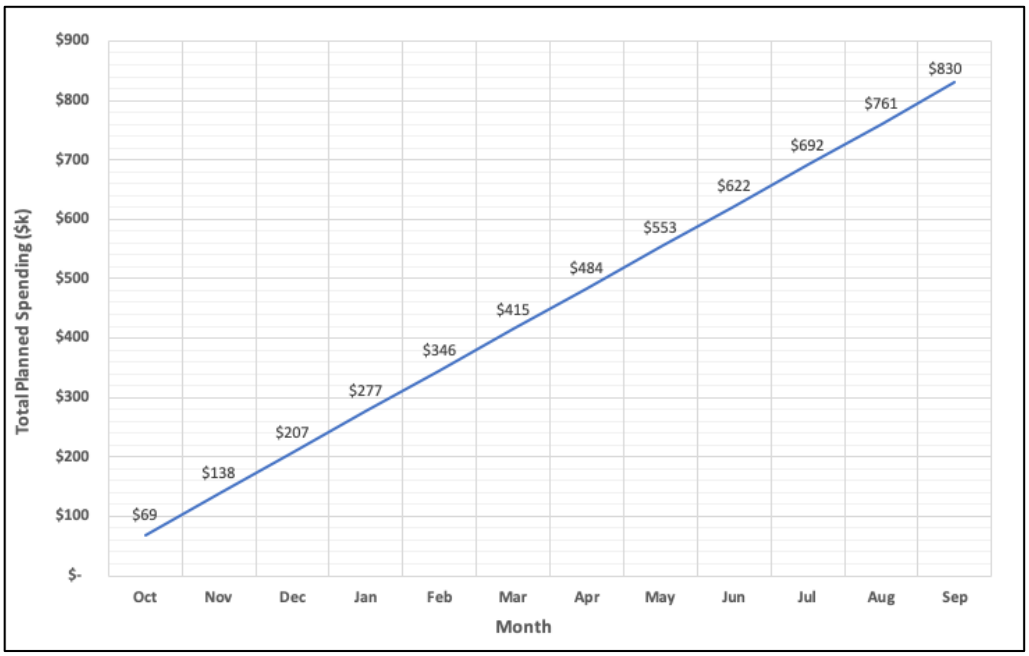
Task Name	LLNL IPD7
Collaborators	None
Task Title	LLNL - NDA Website Support
Proposal Submitted	Ongoing
Task Budget (FY21)	$25K
Task Description	This task is to provide support for the new NDA website that went online in FY19. Extensive updates to the website are envisioned to support NDA program development.
FY21 Milestones	All 4 Quarters o Provide the NCSP manager an update of NDA Website Support Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.2-3 LLNL IPD Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The increase in funding from FY22 to FY23 is due to modest increases in the LLNL-IPD1, "ICSBEP Support" budget but decreases in FY24 after task LLNL-IPD6, "Benchmark Evaluation of LLNL 'Pulsed Spheres'," is completed.

Figure 2.2-4 LLNL IP&D Planned Spending (FY2021)*



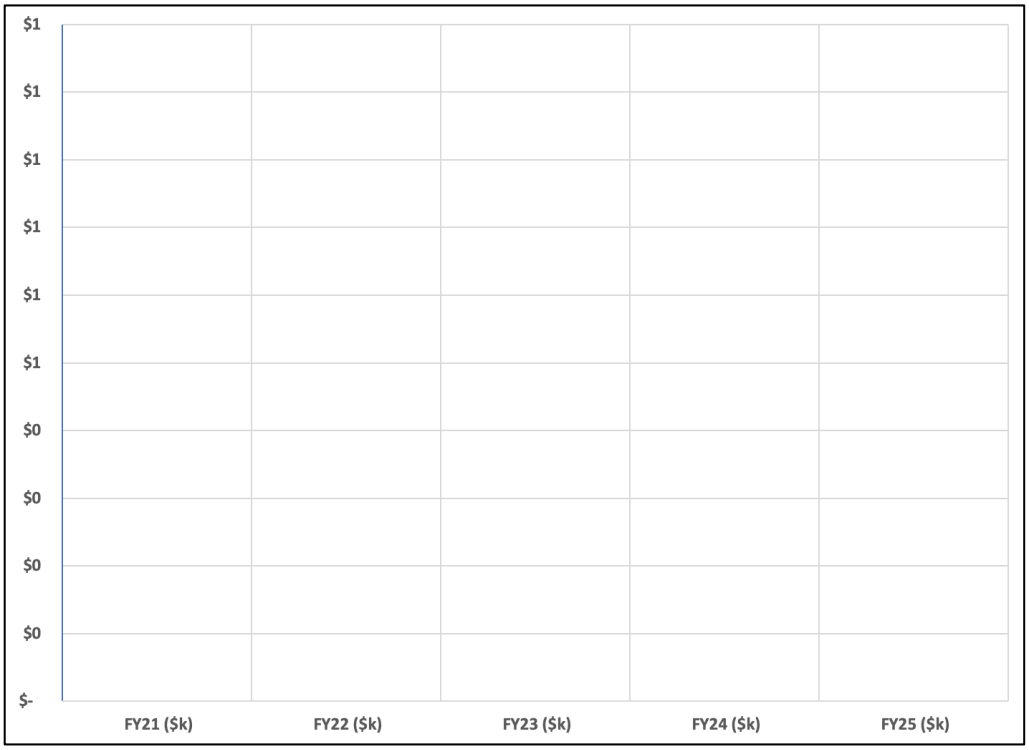
* LLNL Planned Spending reduced by approximately 8% to account for required laboratory hold-back during FY CR funding uncertainty.

2.2.2.2 Oak Ridge National Laboratory (ORNL)

Task Name	ORNL IPD5
Collaborators	None
Task Title	Oak Ridge Health Physics Research Reactor CAAS Benchmark Evaluation
Proposal Submitted	FY19
Task Budget (FY21)	$0K (FY20 carryover to be used)
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide a status report on progress made on IPD5 tasks. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

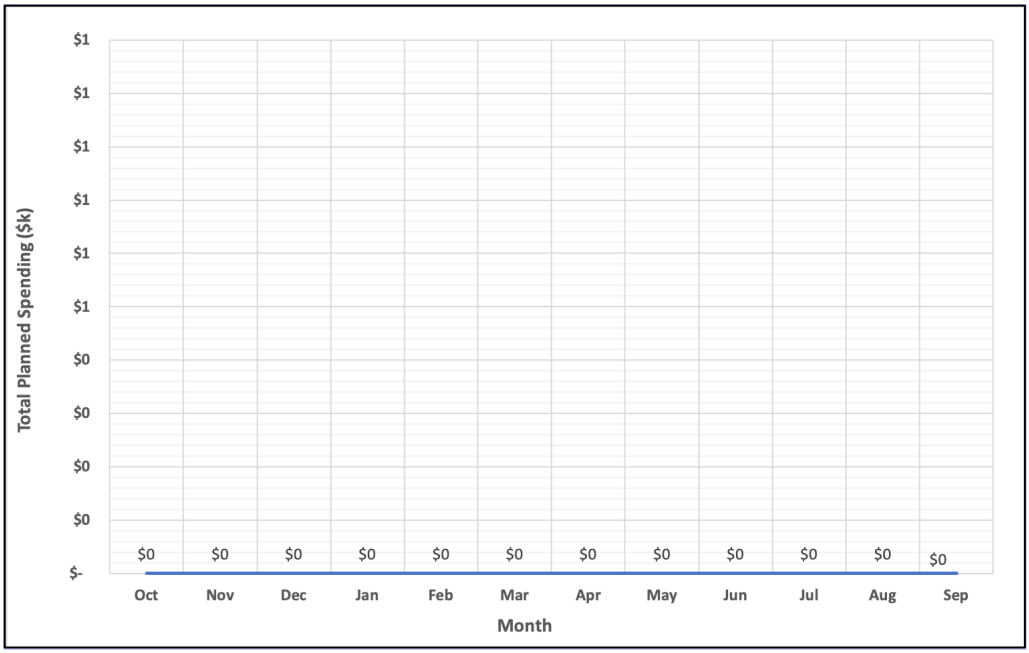
Task Name	ORNL IPD7
Collaborators	None
Task Title	Preserving the “Howard Dyer” Library at ORNL
Proposal Submitted	FY20
Task Budget (FY21)	$0K (FY20 carryover to be used)
Task Description	The purpose of this proposal is to convert the “Howard Dyer” library at ORNL from hard copy format to electronic format to share with the NCS community. The PDF files will be provided to LLNL for inclusion on the NCSP website.
FY21 Milestones	All 4 Quarters o Provide a status report on progress made on IPD7 tasks. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.2-5 ORNL IPD Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
No new funds are projected for FY21-25. Carryover funds are used to complete ORNL IPD tasks.

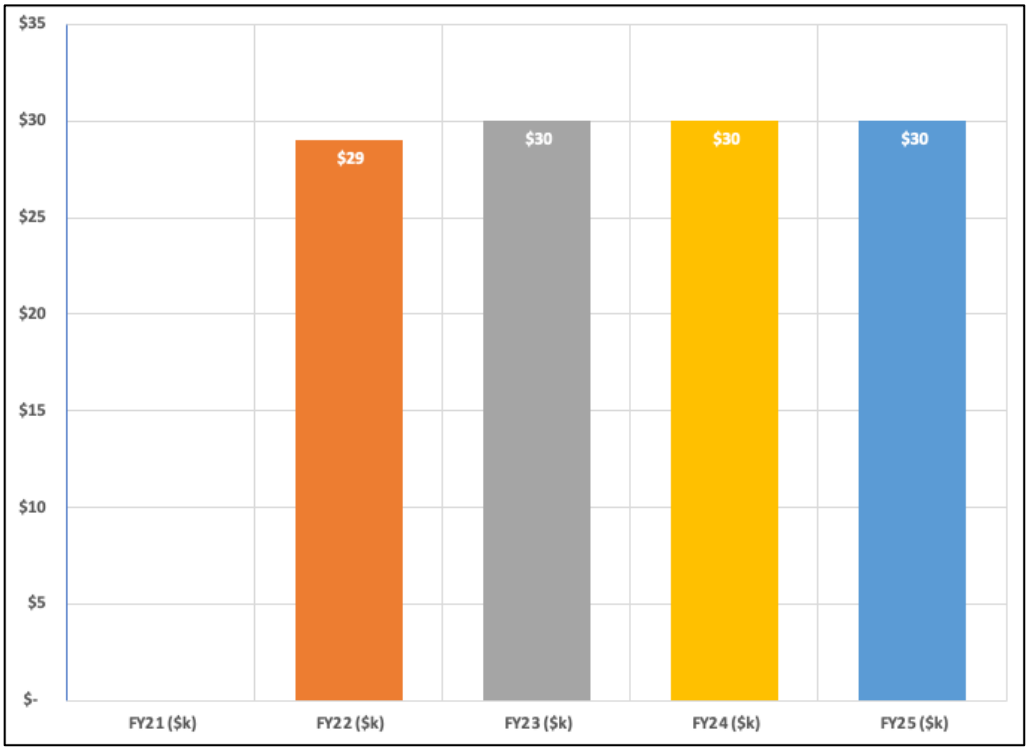
Figure 2.2-6 ORNL IPD Planned Spending (FY2021)



2.2.2.3 Savannah River Site (SRS)

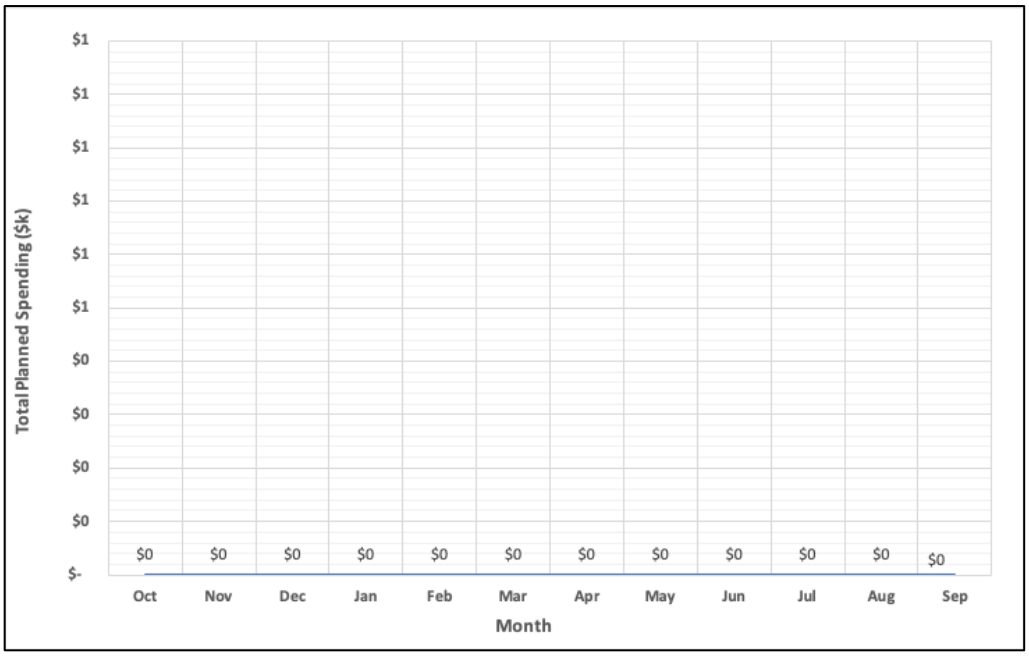
Task Name	SRS IPD1
Collaborators	None
Task Title	ARH-600 Reissue (CritView)
Proposal Submitted	FY16/FY18
Task Budget (FY21)	$0K
Task Description	The following three tasks are identified for ongoing CritView development. Each could likely be performed by a summer intern, or other new CS engineer, with sufficient skills/knowledge. Each would be broken into stages as appropriate, and would proceed over the upcoming FYs, as annual funding and resources allow. A more detailed plan including appropriate FY milestones, and accounting for the upcoming FY funding including potential carryover, would be provided to NCSP Management for confirmation/approval prior to commencing on any specific task and/or stage, as appropriate. The timing of the detailed plan is TBD. 1. Update current MCNP calculations using a recent version of MCNP and cross sections. Document results, and update/distribute CritView database. 2. Digitize LA-10860 curves (similar to what was completed for ARH-600). Document results and incorporate into CritView database for distribution. 3. Develop SCALE calculations, similar to MCNP, using a recent version of SCALE and cross sections. Document results and incorporate into CritView database for distribution. In addition, as necessary, support the code users. It is expected that each of the tasks could encompass one FY, or more, depending on resources available to perform the work.
FY21 Milestones	All 4 Quarters o Provide status reports on SRS progress with CritView. Quarter 1 o NCSP Approved Scope for FY21. Quarter 2 o TBD based on Approved Scope. Quarter 3 o TBD based on Approved Scope. Quarter 4 o Provide updated CritView database for user testing.

Figure 2.2-7 SRS IP&D Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The budget for SRS IPD is zero in FY21 due to having carryover funds to cover the SRS-IPD1, "ARH-600 Reissue," task. The budget is essentially constant from FY22-25.

Figure 2.2-8 SRS IP&D Planned Spending (FY2021)



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.

Figure 2.3-1 NCERC Availability

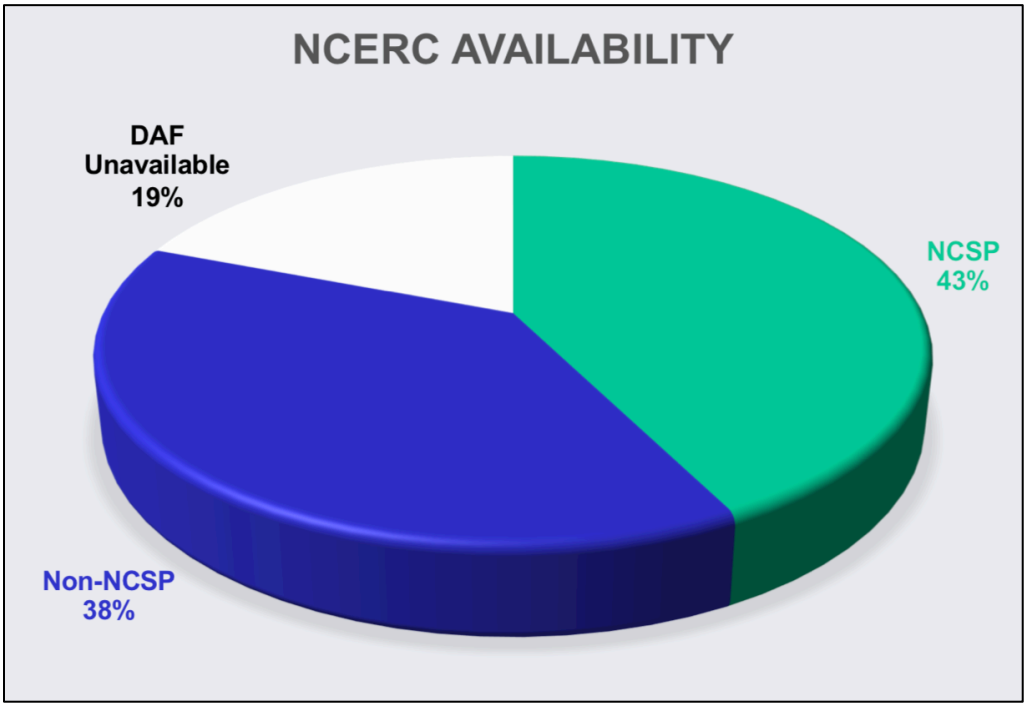


Figure 2.3-2 IE Budget (FY2021-FY2025)

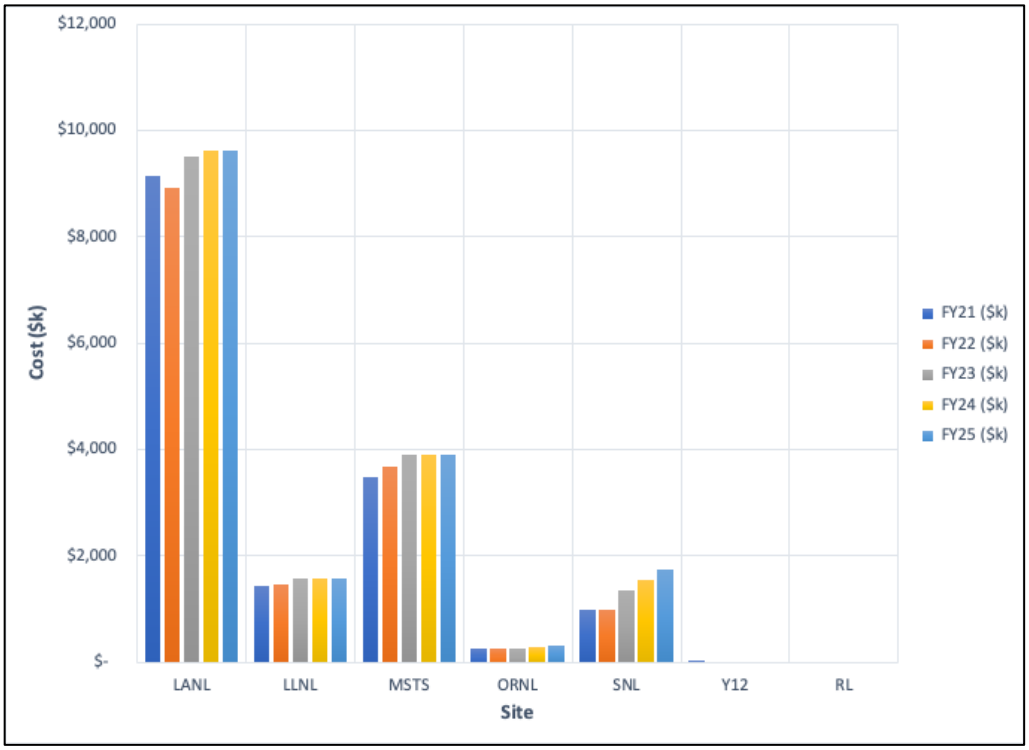
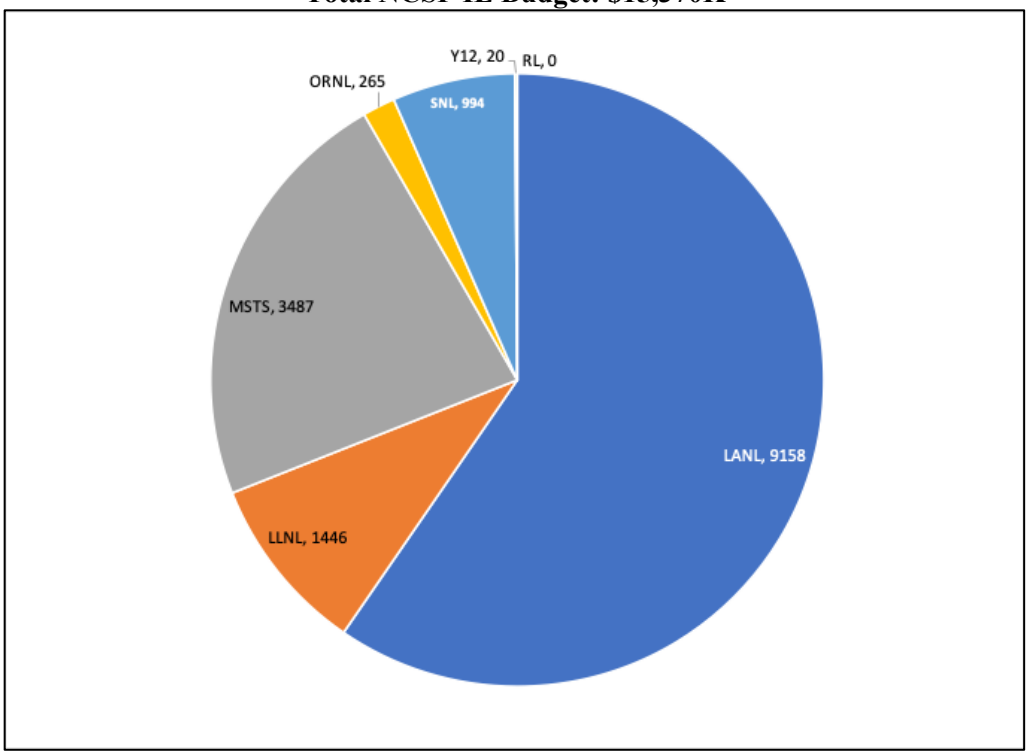


Figure 2.3-3 IE Budget (FY2021)

Total NCSP IE Budget: $15,370K



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 FY2021 through FY2025 schedule, milestones, and deliverables associated with specific nuclear data measurement, evaluation, and publication. Milestones not contained in Appendix B are delineated below.

Figure 2.4-1 ND Budget (FY2021-FY2025)

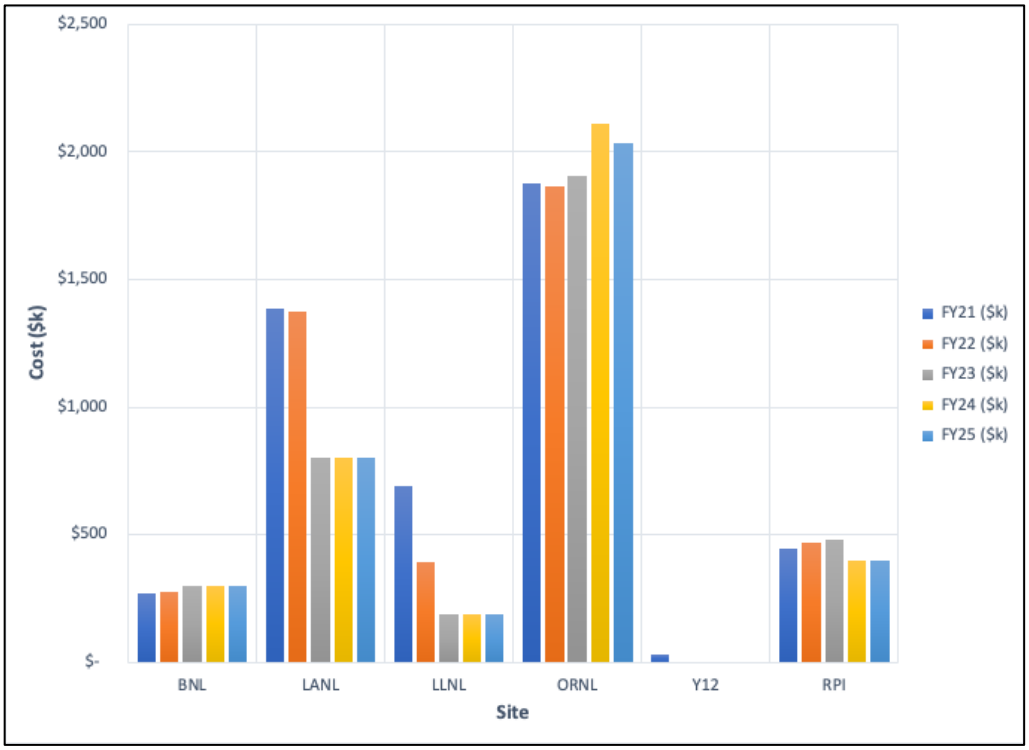
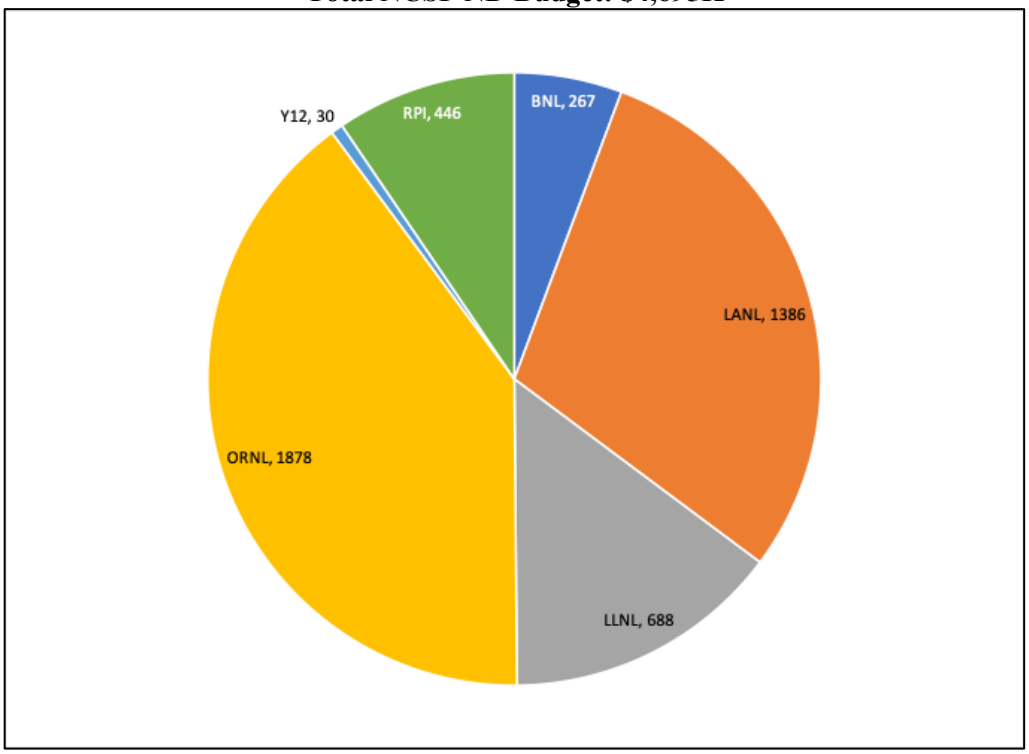


Figure 2.4-2 ND Budget (FY2020)

Total NCSP ND Budget: $4,695K

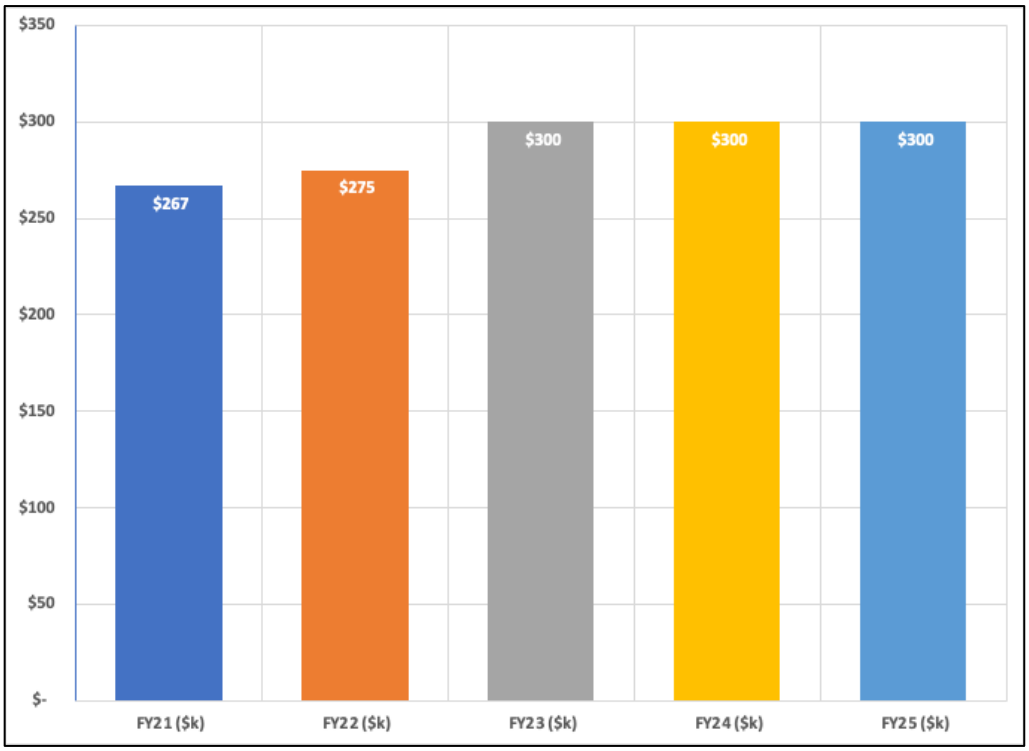


2.4.2 Approved Tasks

2.4.2.1 Brookhaven National Laboratory (BNL)

Task Name	BNL ND1
Collaborators	None
Task Title	National Nuclear Data Center (NNDC) Support to the NCSP
Proposal Submitted	Ongoing
Task Budget (FY21)	$267K
Task Description	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) Gitlab 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.
FY21 Milestones	All 4 Quarters o 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. o If mandated by CSEWG, release new ENDF library. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

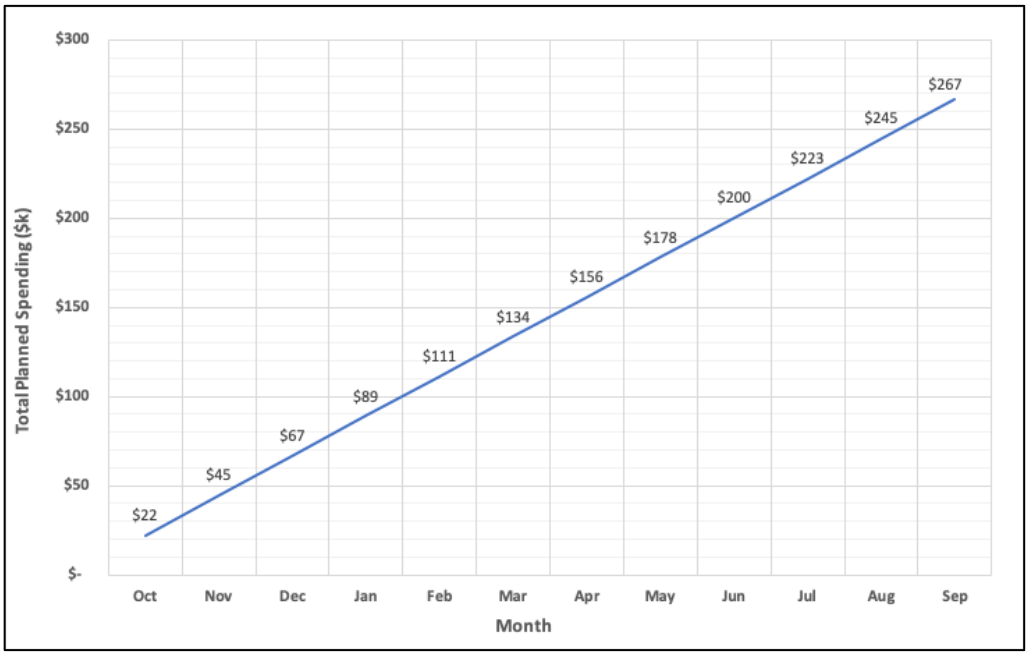
Figure 2.4-3 BNL ND Budget Trend (FY2021-FY2025)



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

Task BNL-ND1, "National Nuclear Data Center (NNDC) Support to the NCSP," has modest budget increases from FY21-FY23 due to increases in the cost of doing business.

Figure 2.4-4 BNL ND Planned Spending (FY2021)



2.4.2.2 Los Alamos National Laboratory (LANL)

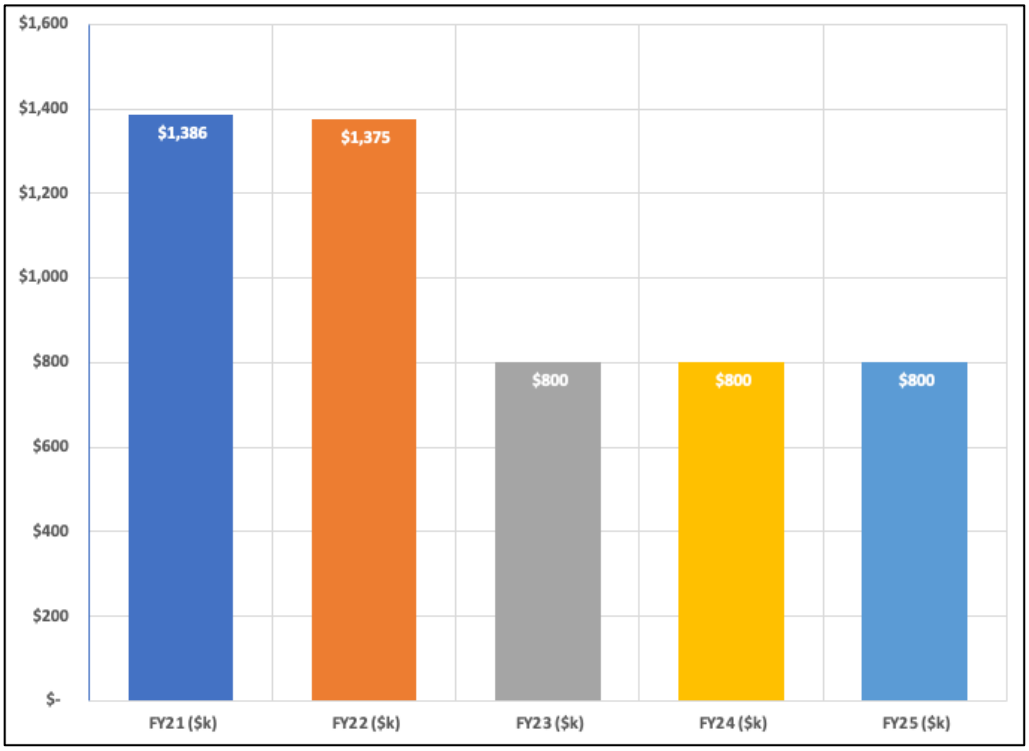
Task Name	LANL ND1
Collaborators	IRSN (IRSN-ND2)
Task Title	Nuclear Data Evaluation and Testing
Proposal Submitted	Ongoing
Task Budget (FY21)	$744K
Task Description	This is an ongoing approved task to provide differential data evaluation and covariance development in the energy region above the resonance 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, INDEN, WPEC, and IAEA CRP. The LANL nuclear data measurements and evaluations are performed in accordance with the milestone schedule in Appendix B.
FY21 Milestones	All 4 Quarters o Provide status reports on LANL participation in US and International Nuclear Data collaborations. Quarter 1 o Conduct CSEWG Evaluation and Covariance sessions. o Report data testing results with ENDF/B-VIII.0 and additional beta release cross sections at CSEWG. Quarter 2 – None Quarter 3 – None Quarter 4 o Deliver nuclear data evaluations as indicated in Appendix B of this document.

Task Name	LANL ND2
Collaborators	IRSN (IRSN-ND2); LLNL (LLNL-ND11)
Task Title	Prompt Fission Neutron Spectra (PFNS) Measurement of Plutonium-240
Proposal Submitted	FY20
Task Budget (FY21)	$175K (task total FY21 cost is $323K with $147K allocated to LLNL for a PPAC target)
Task Description	Building upon recent improvements in measurements techniques for uranium-235, plutonium239 and uranium-238 (ongoing), this work is to measure the prompt fission neutron spectra (PFNS) for plutonium-240. This work has low technical risk, building upon previously established measurement and evaluation techniques. This work will be done using the Chi-Nu detectors at WNR, part of the LANSCE/LANL facility, with analysis carried out by a postdoc (to be hired) supervised by senior staff. Please note the Chi-Nu detectors include a liquid scintillator array for the high-energy (HE) tail and a lithium glass array for the low-energy (LE) tail with measurements performed separately. The Pu240 fission detector will be fabricated and tested by LLNL, starting with procurement in Q4 FY2020.
FY21 Milestones	All 4 Quarters o Provide status report on ND2 progress Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 o Start taking Pu240 PFNS data

Task Name	LANL ND3
Collaborators	None
Task Title	Unresolved and Fast Measurements of Uraunium-233 (n,gamma)
Proposal Submitted	FY20
Task Budget (FY21)	$322K
Task Description	Building upon recent improvements in measurements techniques for capture cross section (and alpha, the capture to fission ratio) that have been successfully applied for U235 and Pu239, this work is to measure the uranium-233 capture cross section. This is a low-risk measurement based upon now well-established techniques that have yielded 2% uncertainties on alpha in the keV region to 10% uncertainties around 1 MeV. These measurements will complement and extend previous uranium-233 total and capture measurements at lower energies. This work will be done using the DANCE detector at the Lujan center, part of the LANSCE/LANL facility, with analysis carried out by a postdoc supervised by senior staff.
FY21 Milestones	All 4 Quarters o Provide status report on ND3 progress Quarter 1 o Complete review of previous "thin" target U233 measurements and finalize specifications for new "thick" U233 target Quarter 2 – None Quarter 3 o Complete fabrication of new "thick" U233 target Quarter 4 o Acquire initial U233 thick-target data

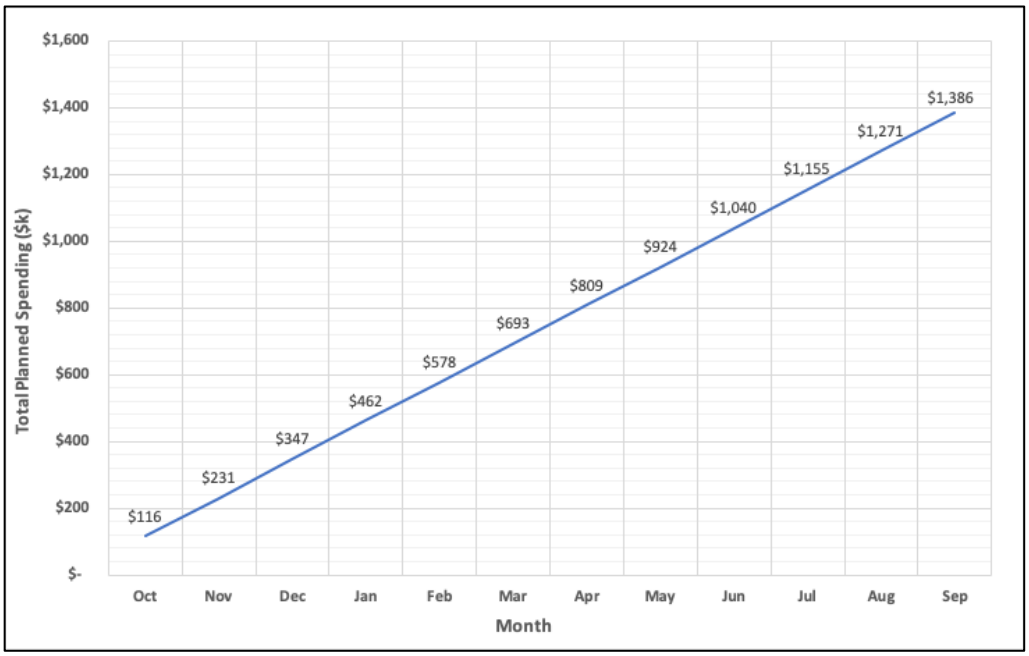
Task Name	LANL ND4
Collaborators	IRSN
Task Title	^{95}Mo neutron capture and transmission measurements in the resolved and unresolved resonance regions, resonance spin/parity measurements, and resonance evaluation
Proposal Submitted	FY21
Task Budget (FY21)	$145K
Task Description	At LANL, we propose to finish analysis of ^{95}Mo neutron capture, transmission, and resonance spin/parity data taken at ORELA, publish these data, and make them available to the general community. IRSN will then use these data in a new ^{95}Mo evaluation.
FY21 Milestones	All 4 Quarters o Provide status report on ND4 progress Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 o Finalize the analysis, submit the results for publication, and make the data available to IRSN and EXFOR.

Figure 2.4-5 LANL ND Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The LANL ND overall budget is stable from FY21-FY22 and significantly decreases in FY23-FY25 due to the completion of two nuclear data measurement tasks, LANL-ND2, "Prompt Fission Neutron Spectra (PFNS) Measurement of Plutonium-240," and LANL-ND3, "Unresolved and Fast Measurements of U233 (n,gamma)."

Figure 2.4-6 LANL ND Planned Spending (FY2021)



2.4.2.3 Lawrence Livermore National Laboratory (LLNL)

Task Name	LLNL ND1a
Collaborators	IRSN (IRSN ND4)
Task Title	Subtask 1 – Delayed Fission Gamma Multiplicity and Spectra
Proposal Submitted	FY16
Task Budget (FY21)	$45K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status on LLNL/NCSU nuclear data activities to NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL ND1b
Collaborators	IRSN (IRSN ND4)
Task Title	Subtask 2 – Delayed Fission Gamma Multiplicity and Spectra
Proposal Submitted	FY17
Task Budget (FY21)	$55K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status on LLNL/NCSU nuclear data activities to NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL ND2
Collaborators	North Carolina State University and Naval Nuclear Laboratory
Task Title	Generation and Benchmarking of Thermal Neutron Scattering Cross Sections in Support of Advanced Nuclear Reactor Concepts
Proposal Submitted	Ongoing
Task Budget (FY21)	$49K
Task Description	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 modules in FLASHH and NJOY (if possible) 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.
FY21 Milestones	All 4 Quarters o Provide status on LLNL/NCSU nuclear data activities to NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 o Deliver thermal neutron scattering data evaluations as indicated in Appendix B of the 5-Year Plan.

Task Name	LLNL ND3
Collaborators	North Carolina State University and Naval Nuclear Laboratory
Task Title	Development and Implementation of an Advanced and Rigorous Computational Platform for Thermal Neutron Scattering Analysis
Proposal Submitted	FY16
Task Budget (FY21)	$99K
Task Description	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(**r**,t)) for exact calculations of the full S(α,β) of a given material including the self and distinct components. Furthermore, advanced, physics-based S(α,β) 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.
FY21 Milestones	All 4 Quarters o Provide status on LLNL/NCSU nuclear data activities to NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL ND5
Collaborators	North Carolina State University and Naval Nuclear Laboratory
Task Title	Development and Implementation of a Modern Doppler Broadening Approach Including Atomic Binding Effects
Proposal Submitted	FY18
Task Budget (FY21)	$89K
Task Description	This is a 5-year 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 $50K in matching funding.
FY21 Milestones	All 4 Quarters o Provide status on LLNL/NCSU nuclear data activities to NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL ND6
Collaborators	None
Task Title	Evaluate Neutron Radiative Capture Gamma Production in Cadmium
Proposal Submitted	Ongoing
Task Budget (FY21)	$0K (Use FY20 Carryover funding)
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status on LLNL/NCSU nuclear data activities to NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL ND7
Collaborators	None
Task Title	'Alpha-N' Benchmark Measurements
Proposal Submitted	Ongoing
Task Budget (FY21)	$104K
Task Description	The proposal is to utilize LLNL's hybrid neutron time-of-flight spectrometer to measure the neutron emission rate and spectrum for materials of interest. Note that this spectrometer has already been successfully used to measure the high-energy portion of the Godiva spectrum as part of IER-147. LLNL also has a number of MSA 'HEX' cans containing significant quantities of pure $^{239}PuO_2$. In FY-2019, the proposal is to modernize the data acquisition system and calibrate the spectrometer using reference mono-energetic neutron fields. In FY-2020, LLNL will deploy this instrument to measure the $^{239}PuO_2$ (α,n) and spontaneous fission neutron emission spectrum and compare the results to COG and MC21 calculated results. NNL has agreed to provide independent analysis of the proposed experiment free of charge to NCSP. If successful, a separate proposal will be developed in consultation with NNL and other laboratories to measure other materials of interest (e.g., UF_6, UF_4, PuF_4, Am-Be, Am-B, Am-Li). These are also candidates for future NA-22/NP nuclear data proposals (FY-2020+) as there was considerable discussion at the recent NDREW meeting regarding the national need for such (α,n) nuclear data (measurements, evaluations), and validation benchmarks). NNL has also expressed interest in LLNL measuring a production Am-Be neutron test source as used in the fleet. This proposal furthers the ongoing collaboration between LLNL and NNL and provides fundamental nuclear reaction data needed for applications ranging from nuclear fuel burnup monitoring (NR) to probability of initiation (DP) and "alpha ratio" (NCSP, NCT).
FY21 Milestones	All 4 Quarters o Provide status on LLNL/NCSU nuclear data activities to NCSP Manager Quarter 1 – None

	Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL ND8
Collaborators	IRSN (IRSN-ND3)
Task Title	Study: Fission TPC Measurement of the U-233/U-235 (n,f) Cross Section Ratio
Proposal Submitted	FY19
Task Budget (FY21)	$1K (Use FY20 Carryover funding)
Task Description	Design an experiment to measure the U-233(n,f)/U-235 (n,f) cross section ratio over an energy range and to a precision relevant to NA-50 program requirements.
FY21 Milestones	All 4 Quarters o Provide status on ND8 to NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

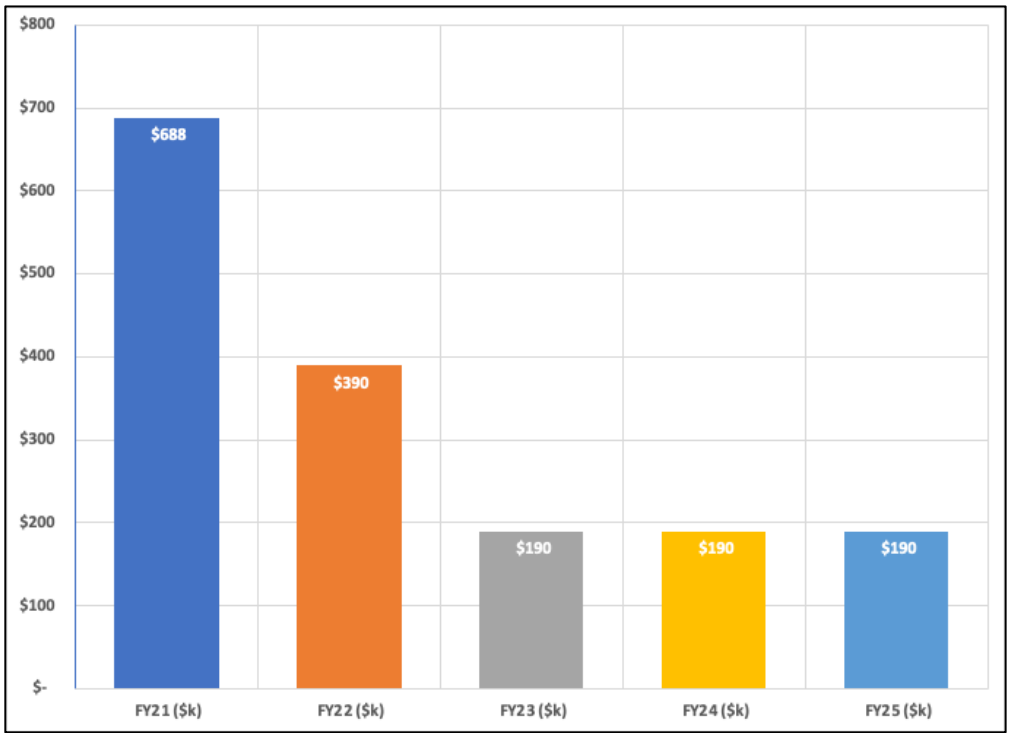
Task Name	LLNL ND9
Collaborators	None
Task Title	Scoping Study: Li-6 Doped Liquid Scintillator Array for Fission Correlations
Proposal Submitted	FY19
Task Budget (FY21)	$1K (Use FY20 Carryover funding)
Task Description	Assess the conceptual design of a modular system that could efficiently and simultaneously measure the Prompt Fast Neutron Spectrum (PFNS), the prompt fission neutron multiplicity (υ), the prompt fission g-ray multiplicity and spectrum, as well as temporal and angular correlations between these quantities.
FY21 Milestones	All 4 Quarters o Provide status on ND9 to NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL ND10
Collaborators	NNL
Task Title	Development and Implementation of Machine Learning Methods for Thermal Scattering Law Evaluations
Proposal Submitted	FY21
Task Budget (FY21)	$99K
Task Description	This NCSU/LLNL task will involve a new paradigm for the evaluation and representation of TSL data that utilizes a machine/deep learning (ML/DL) approach for the generation of the required data. Specifically, the multi-dimensional discrete TSL phase space will be reconstructed continuously using artificial neural networks (ANN) and cast into a form that can be used on-the-fly by multi-physics neutronic simulation systems.
FY21 Milestones	All 4 Quarters o Provide status on ND10 to NCSP Manager

	Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None Provide an update on the development and testing of NeTS modules for selected materials such as light water, graphite, etc.

Task Name	LLNL ND11
Collaborators	LANL (LANL-ND2)
Task Title	Fabricate the Pu240 PPAC targets and fission detector components
Proposal Submitted	FY21
Task Budget (FY21)	$146K (task costs are $323K with $176K allocated to LANL for measurements)
Task Description	LLNL to fabricate and provide PPAC target for Pu240 PFNS measurement at LANSCE. The funding also enables LLNL participation in the experimental measurement at LANL and subsequent analysis of the experimental results with LANL researchers.
FY21 Milestones	All 4 Quarters o Provide status report PPAC target fabrication progress. Quarter 1 o Fabricate the Pu240 PPAC targets and fission detector components Quarter 2 o Assemble and test the Pu240 fission detector Quarter 3 – None Quarter 4– None

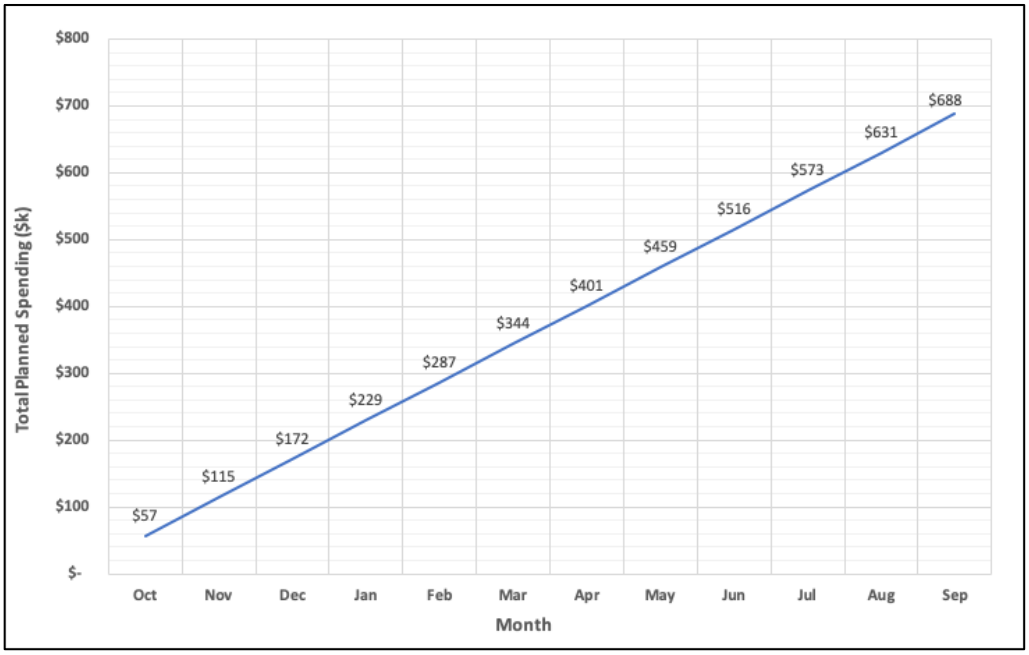
Figure 2.4-7 LLNL ND Budget Trend (FY2021-FY2025)



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

The LLNL ND budget decreases significantly between FY21 and FY23 due to the completion of LLNL-ND1a/b, "Delayed Fission Gamma Multiplicity and Spectra," LLNL-ND3, "Development and Implementation of an Advanced and Rigorous Computational Platform for Thermal Neutron Scattering Analysis," LLNL-ND5, "Development and Implementation of a Modern Doppler Broadening Approach Including Atomic Binding Effects," and LLNL-ND7, "'Alpha-N' Benchmark Measurements." LLNL budgets for LLNL-ND8, "Study: Fission TPC Measurement of the U-233/U-235 (n,f) Cross Section Ratio," and LLNL-ND9, "Scoping Study: Li-6 Doped Liquid Scintillator Array for Fission Correlations," were reduced due to use FY20 carryover funding.

Figure 2.4-8 LLNL ND Planned Spending (FY2021)*



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

2.4.2.4 Oak Ridge National Laboratory (ORNL)

Task Name	ORNL ND1
Collaborators	IRSN (IRSN-ND1), JRC-Geel
Task Title	Nuclear Data Measurement and Evaluation
Proposal Submitted	Ongoing
Task Budget (FY21)	$1140K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports o 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 o Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	ORNL ND3
Collaborators	JRC-Geel, Rensselaer Polytechnic Institute
Task Title	Isotopic Sample Leases to Support ND1 ND Measurements
Proposal Submitted	Ongoing
Task Budget (FY21)	$50K
Task Description	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).
FY21 Milestones	All 4 Quarters o Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports o 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 o Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

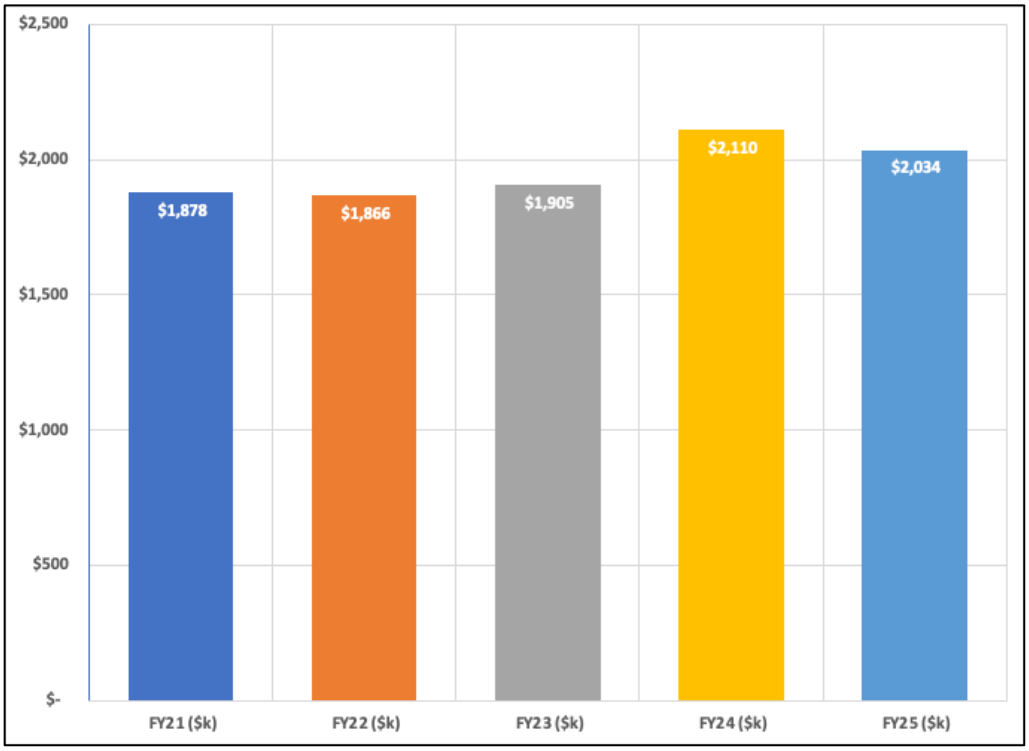
Task Name	ORNL ND4
Collaborators	(NNL-ND2), Rensselaer Polytechnic Institute
Task Title	Thermal Neutron Total Cross Section Measurements for Improvement of Criticality Calculations and Propagation of Scattering Kernel Uncertainties
Proposal Submitted	Ongoing
Task Budget (FY21)	$148K
Task Description	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 NNL-ND2.
FY21 Milestones	All 4 Quarters o Provide status reports on all ND4 activities in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	ORNL ND6
Collaborators	JRC-Geel, Rensselaer Polytechnic Institute
Task Title	SAMMY Nuclear Data Evaluation Code Modernization
Proposal Submitted	Ongoing
Task Budget (FY21)	$392K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status reports on all ND4 activities in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4

	o Document SAMMY modernization progress and report status annually to the NCSP Manager

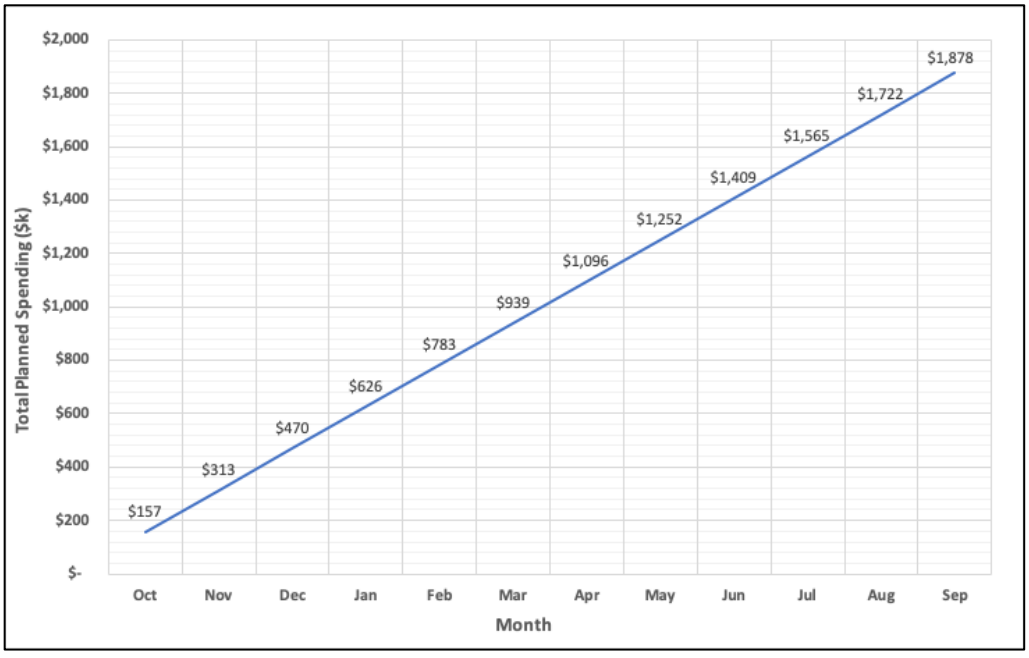
Task Name	ORNL ND10
Collaborators	None
Task Title	Monte Carlo Evaluation of Differential and Integral Data
Proposal Submitted	FY19
Task Budget (FY21)	$148K
Task Description	This is new work to build on ORNL's recent applications of Monte Carlo method to some of the VALID library IBEs (350), and to the 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.
FY21 Milestones	All 4 Quarters o Provide status reports on all ND4 activities in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.4-9 ORNL ND Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The ORNL ND budget is relatively constant from FY21-FY23. The modest increases to ORNL-ND1, "Nuclear Data Measurement and Evaluation," (to support scope in Appendix B, "Nuclear Data Priorities) is reflected in the FY24 funding increase. The decrease in the FY25 budget is due to the completion of ORNL-ND9, "Evaluation of Thermal and Resolved Resonance Ranges of UO_2 and PuO_2" in FY24.

Figure 2.4-10 ORNL ND Planned Spending (FY2021)



2.4.2.5 Rensselaer Polytechnic Institute (RPI)

Per agreement between Naval Reactors (NA-30) and the Nuclear Criticality Safety Program, the NNL acts as the Maintenance and Operations Contractor (MOC) for work conducted at the RPI linear accelerator facility. NNL voluntarily administers NCSP contracts supporting these RPI tasks in conjunction with the Naval Reactors nuclear data measurements and evaluations program.

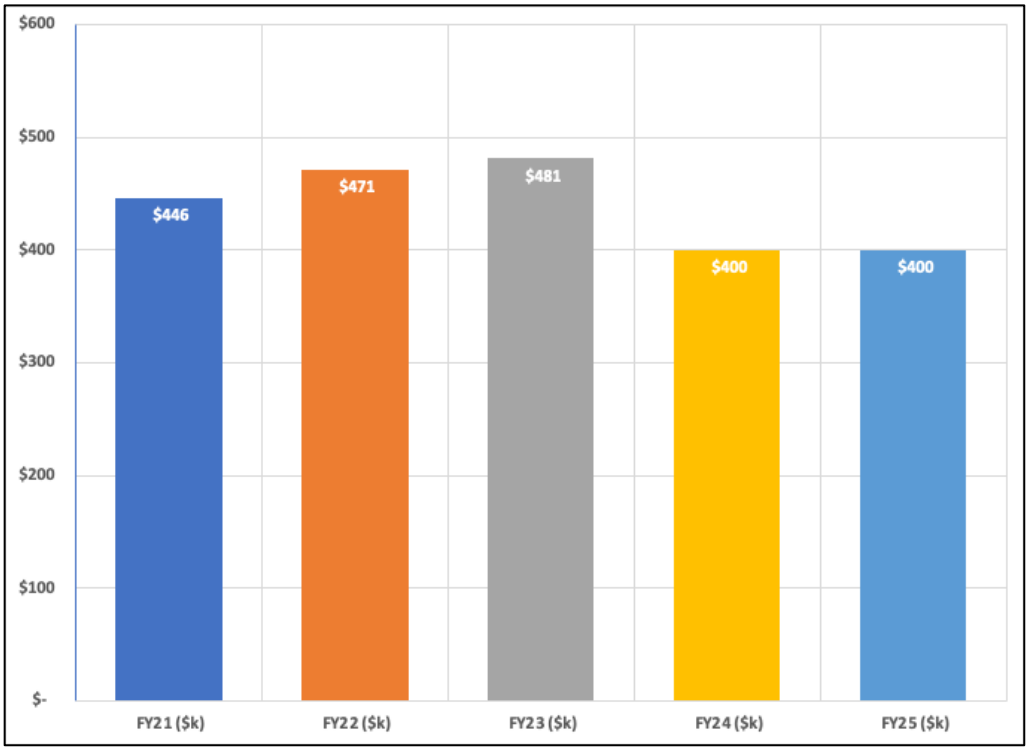
Task Name	RPI ND1
Collaborators	IRSN (IRSN-ND1), ORNL (ORNL-ND1), Naval Nuclear Laboratory
Task Title	Resonance Region Nuclear Data Measurement Capability
Proposal Submitted	Ongoing
Task Budget (FY21)	$446K
Task Description	This is an ongoing approved task in collaboration with IRSN and ORNL to support the resonance region Nuclear Data Measurement Capability at NNL and to perform cross-section measurements and qualification of the new capabilities. Aligns with LANL-ND1 and ORNL-ND1 (evaluation) and IRSN-ND1 (evaluation).
FY21 Milestones	All 4 Quarters o Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports o Provide status reports on NNL 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 Quarter 1 o Complete analysis of measurement from FY-20 Quarter 2 – None Quarter 3 o Complete nuclear data measurements (transmission/capture or scattering) per the nuclear data schedule in Appendix B Quarter 4 o Complete measurements data analysis and provide the data to ORNL as needed to support the evaluation effort per the nuclear data schedule in Appendix B

Task Name	RPI ND2
Collaborators	ORNL (ORNL ND4), Naval Nuclear Laboratory
Task Title	Thermal Neutron Scattering Measurement for Improvement of Criticality Calculations and Propagation of Scattering Kernel Uncertainties
Proposal Submitted	Ongoing
Task Budget (FY21)	$0K (Use FY20 carryover funding)
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports o Provide status reports on NNL 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

	Quarter 1 o Complete neutron output testing Quarter 2 o Perform thermal cross section measurements for moderators Quarter 3 o Complete thermal cross section measurements Quarter 4 o Complete documentation (PhD thesis) and publication.

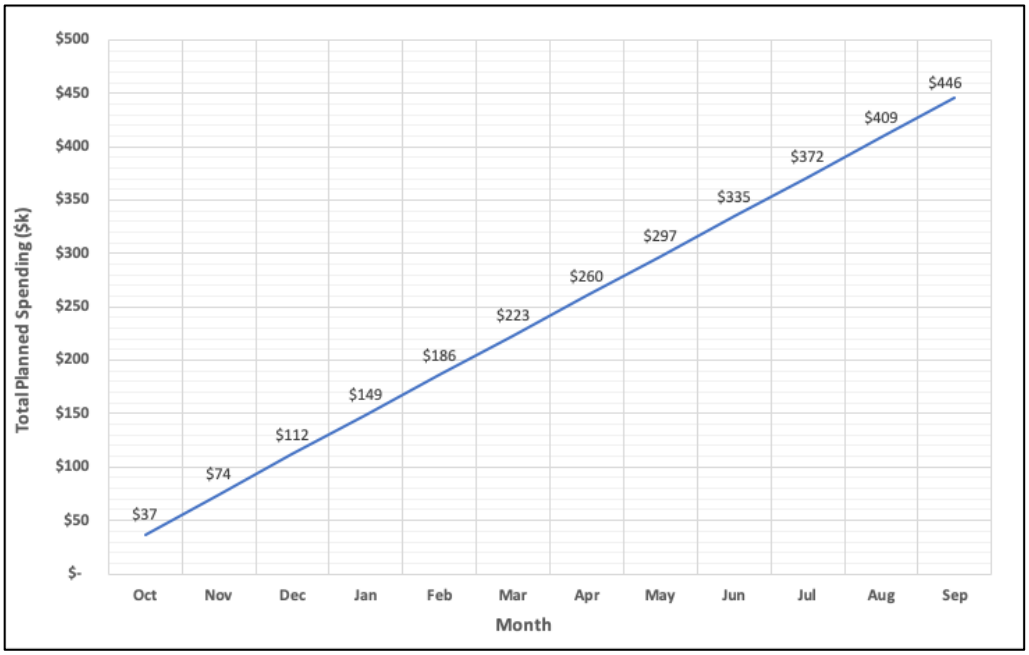
Task Name	RPI ND3
Collaborators	Naval Nuclear Laboratory
Task Title	LINAC 2020 Nuclear Data Capabilities Maintenance Plan
Proposal Submitted	Ongoing
Task Budget (FY21)	$0K
Task Description	This is an ongoing approved task to support the Linear Accelerator (LINAC) 2020 Nuclear Data Capabilities Maintenance 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.
FY21 Milestones	All 4 Quarters o Provide status report LINAC refurbishment activities in NCSP Quarterly Progress Reports Quarter 1 o Complete RF window qualification (ND3). o Complete of SOL 1 Accelerator Section RF Conditioning (ND3). Quarter 2 o Complete TPV Accelerator Section RF Conditioning (ND3). Quarter 3 Quarter 4 o Complete Medium Voltage Electrical Distribution Upgrade (ND3).

Figure 2.4-11 RPI ND Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The budget increases slightly through FY23, due to increases in ND1 funding, primarily in support of the LINAC refurbishment. The drop in FY24 reflects a return to normal LINAC operations following the refurbishment.

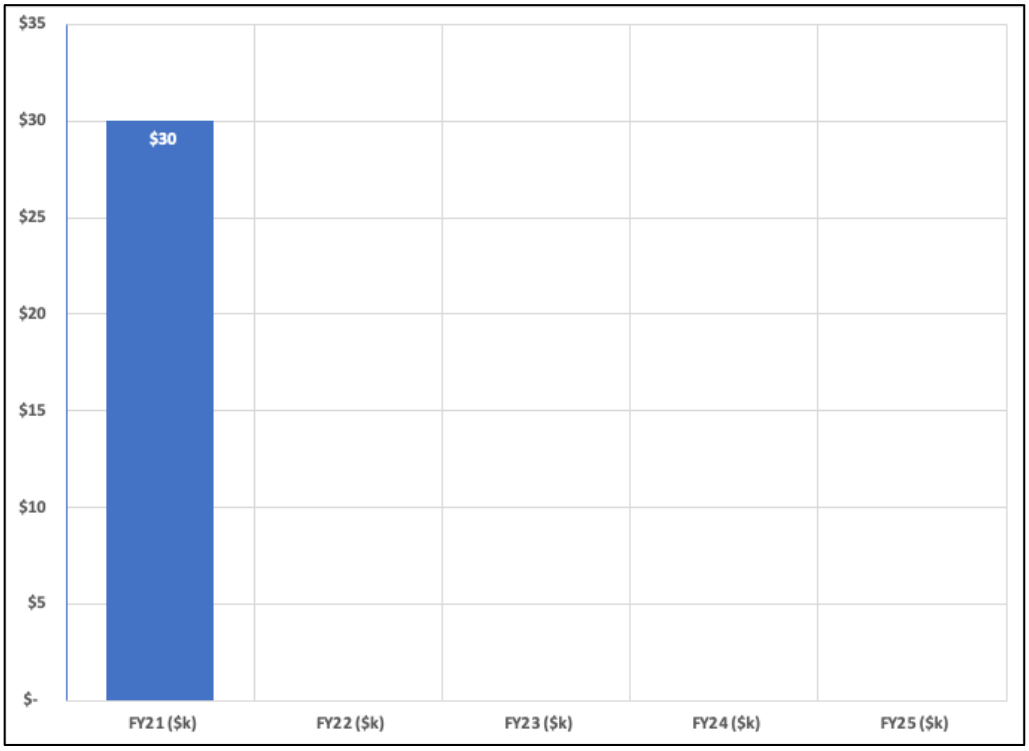
Figure 2.4-12 RPI ND Planned Spending (FY2021)



2.4.2.6 Y-12 National Security Complex

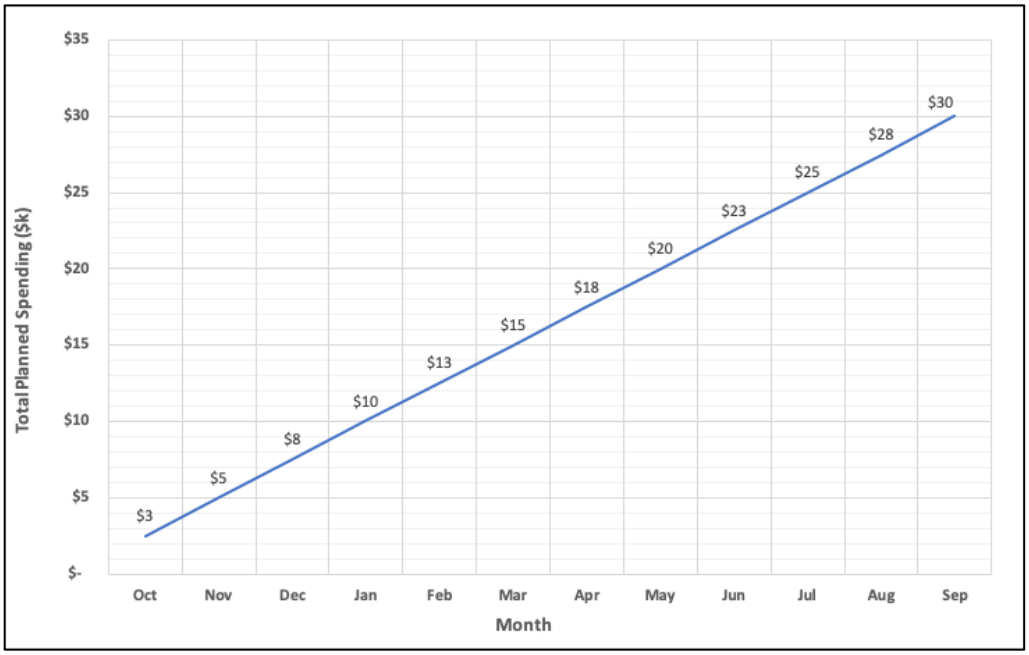
Task Name	Y12 ND1
Collaborators	IRMM
Task Title	Y-12 Fabrication of New Uranium Target for IRMM/GELINA for Cross-section Measurements
Proposal Submitted	FY19
Task Budget (FY21)	$30K (Use FY19 carryover funding)
Task Description	This FY2019 task involves the fabrication of a new depleted uranium/molybdenum 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.
FY21 Milestones	All 4 Quarters ○ As necessary, provide a status report of the fabrication of a depleted uranium/molybdenum target per IRMM/GELINA specifications to the NCSP Manager. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.4-13 Y-12 ND Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The Y12-ND1, "Y-12 Fabrication of New Uranium Target for IRMM/GELINA for Cross-Section Measurements" will be completed in FY21. No new tasks are envisioned for Y-12 beyond FY21.

Figure 2.4-14 Y-12 ND Planned Spending (FY2021)



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.

Figure 2.5-1 TE Budget (FY2021-FY2025)

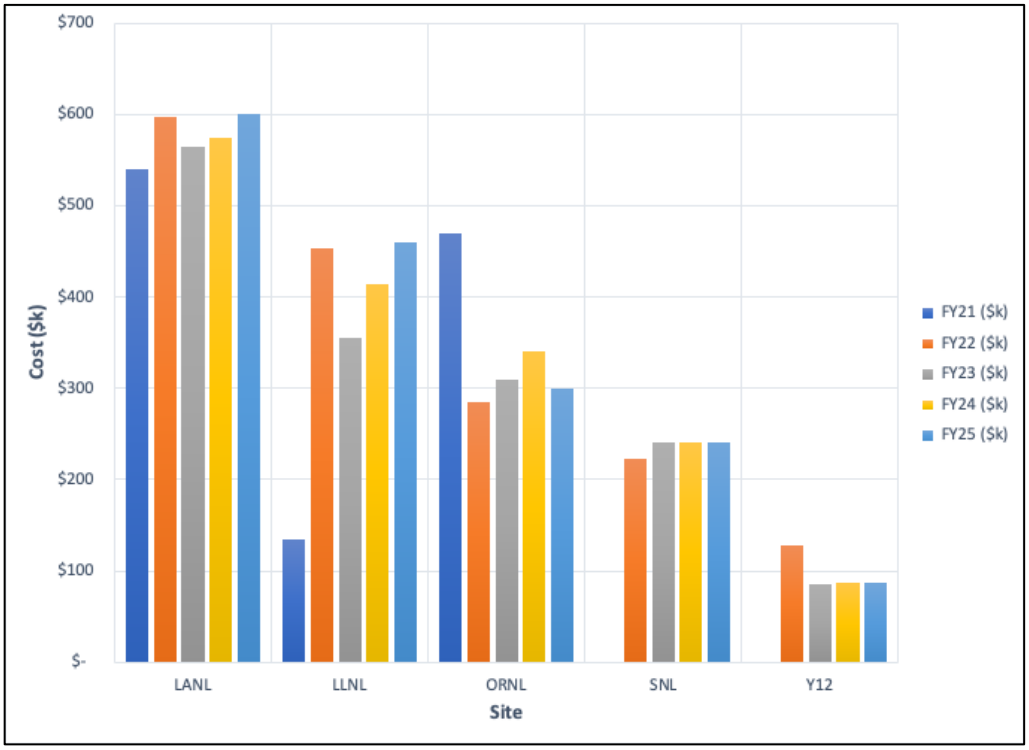
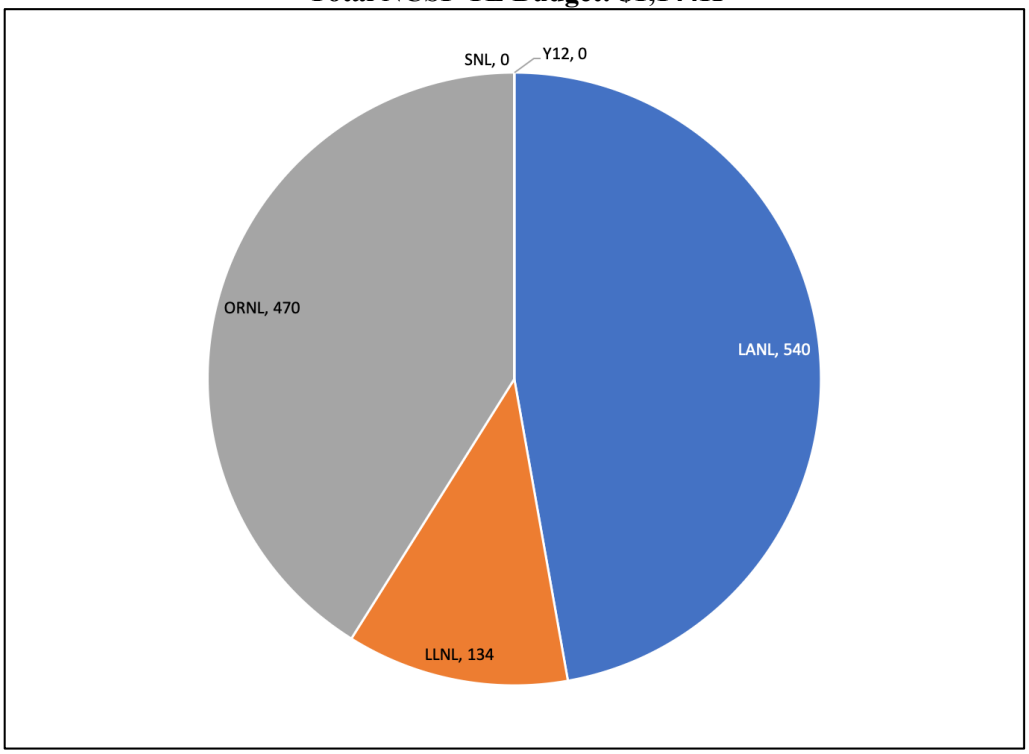


Figure 2.5-2 TE Budget (FY2021)

Total NCSP TE Budget: $1,144K



2.5.2 Approved Tasks

2.5.2.1 Los Alamos National Laboratory (LANL)

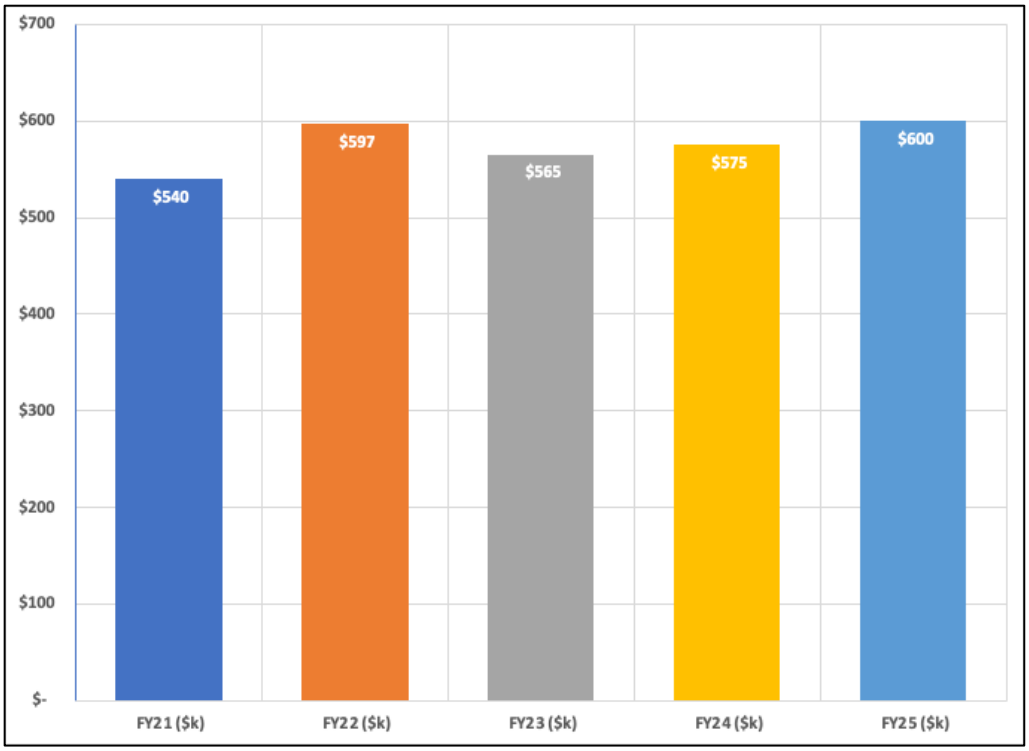
Task Name	LANL TE3
Collaborators	None
Task Title	Conduct Hands-On Criticality Safety Training Course at NCERC
Proposal Submitted	Ongoing
Task Budget (FY21)	$490K
Task Description	This is an ongoing approved task to conduct criticality safety hands-on training at NCERC according to an integrated schedule developed by ORNL and approved by the NCSP manager. The cost reflects a special 2-week course for Y-12.
FY21 Milestones	All 4 Quarters o Provide status reports on all training activities to the NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LANL TE4
Collaborators	ORNL (ORNL-TE5)
Task Title	On-Site Introductory Training for the NCS Practitioner on Modern Approaches to Validation using Sensitivity and Uncertainty Analysis Tools
Proposal Submitted	Directed by NCSP Manager
Task Budget (FY21)	$0K (Use FY20 carryover funding)
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status reports on all training activities to the NCSP Manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 o In collaboration with ORNL, provide introductory 1-day S/U workshop training to one or more DOE sites in FY21.

Task Name	LANL TE6
Collaborators	None
Task Title	Development of University Pipeline for Criticality Safety Professionals
Proposal Submitted	FY18
Task Budget (FY21)	$50K

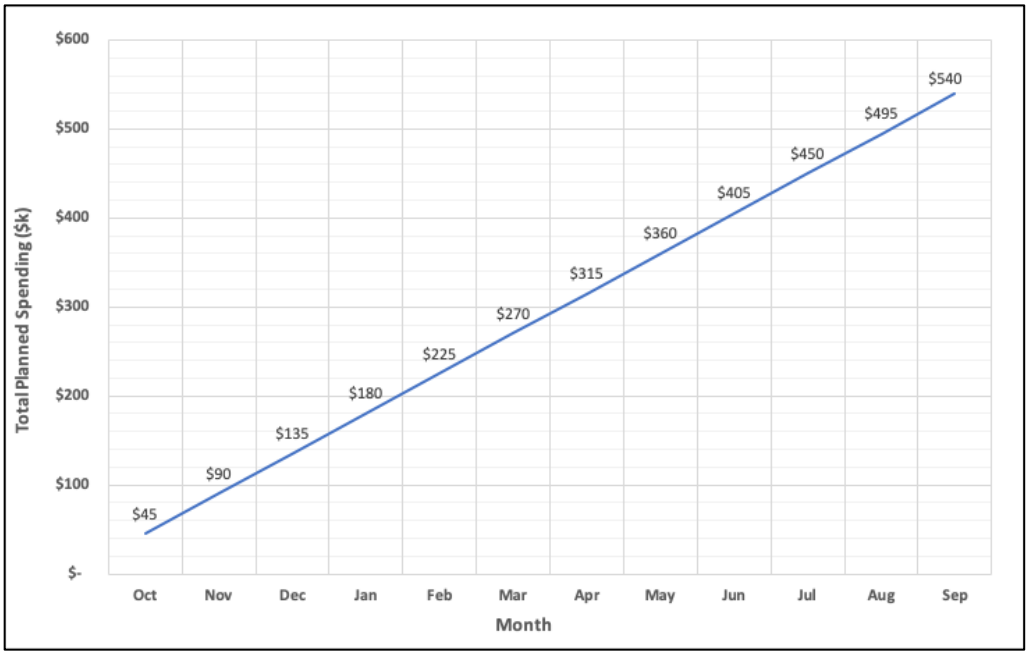
Task Description	Development of a University Pipeline for Criticality Safety Professionals.
FY21 Milestones	All 4 Quarters ○ Provide status reports on all training activities to the NCSP Manager, to include photos and content for the quarterly newsletter Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.5-3 LANL TE Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The modest increase in the FY22 budget trend is due to the start of task LANL-TE8, "Reactivity Simulation Aids." The LANL-TE6, "Development of University Pipeline for Criticality Safety Professionals" task is slated for completion in FY23. The modest increases in FY23-FY25 are due to cost increases in task LANL-TE3, "Conduct Hands-on Criticality Safety Training Courses at NCERC."

Figure 2.5-4 LANL TE Planned Spending (FY2021)



2.5.2.2 Lawrence Livermore National Laboratory (LLNL)

Task Name	LLNL TE1
Collaborators	None
Task Title	Conduct Hands-on Training at the DAF (TACS)
Proposal Submitted	Ongoing
Task Budget (FY21)	$1K (Use FY20 Carryover funding)
Task Description	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. FY20 costs reflect a special 2-week course for Y-12.
FY21 Milestones	All 4 Quarters o Provide a status report on TE1 activities to the NCSP manager. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

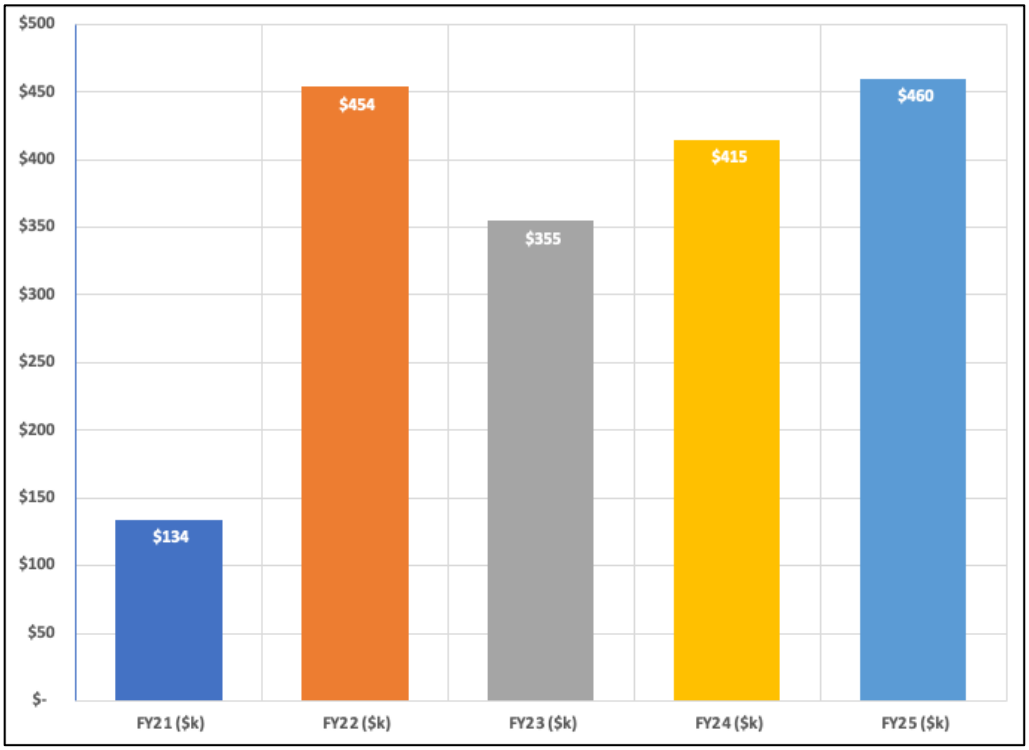
Task Name	LLNL TE3
Collaborators	None
Task Title	Classroom Criticality Safety Training
Proposal Submitted	Ongoing
Task Budget (FY21)	$83K
Task Description	This is an ongoing approved task to provide LLNL support for FY2019 classroom instruction at the Nevada Site Facility and participation in T&E development activities. The cost reflects a special 2-week course for Y-12.
FY21 Milestones	All 4 Quarters o Provide a status report on TE3 activities to the NCSP manager. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	LLNL TE6
Collaborators	None
Task Title	Mobile (CAT III or IV material) Hands on Critical or Near Critical Demonstration Capability
Proposal Submitted	FY13
Task Budget (FY21)	$0K (FY21 task funding moved to FY22. Proceed with FY20 carryover only).
Task Description	This task is for a feasibility study to look at the possibility of developing a mobile CAT III or CAT IV for performing hands-on critical or near-critical operations to support NCSP training missions.
FY21 Milestones	All 4 Quarters o Provide a status report on TE6 activities to the NCSP manager. Quarter 1 – None Quarter 2 – None

	Quarter 3 – None Quarter 4 – None

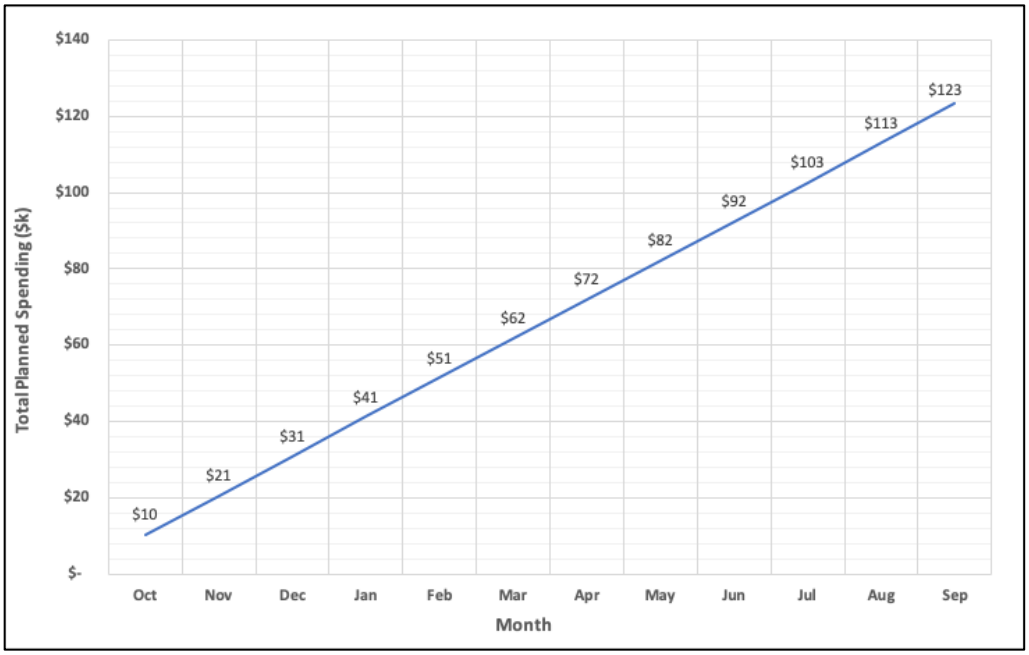
Task Name	LLNL TE8
Collaborators	LANL (LANL TE6)
Task Title	Development of University Pipeline for Criticality Safety Professionals
Proposal Submitted	FY20 – Direct request to the NCSP Manager
Task Budget (FY21)	$50K
Task Description	Development of a University Pipeline for Criticality Safety Professionals.
FY21 Milestones	All 4 Quarters ○ Provide status reports on all training activities to the NCSP Manager, to include photos and content for the quarterly newsletter Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.5-5 LLNL TE Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The budget increase from FY21 to FY22 reflects a decision by the NCSP Manager for LLNL to use FY20 carryover funding for task LLNL-TE1, "Conduct Hands-on Training at the DAF (TACS) and the last year of task LLNL-TE6, "Mobile Hands-on Critical or Near Critical Demonstration Capability." Increases in the LLNL TE budget from FY23-FY25 is due to modest increases in task LLNL-TE1, "Conduct Hands-on Training at the DAF (TACS)."

Figure 2.5-6 LLNL TE Planned Spending (FY2021)*



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

2.5.2.3 Oak Ridge National Laboratory (ORNL)

Task Name	ORNL TE1
Collaborators	IRSN (IRSN TE1), AWE (AWE TE1)
Task Title	Manage and Provide Instruction for the DOE Nuclear Criticality Safety Training & Education Program
Proposal Submitted	Ongoing
Task Budget (FY21)	$99K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide a status report in NCSP Quarterly Progress Reports on implementation of the NCS training program Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	ORNL TE3
Collaborators	None
Task Title	Hand-calculation Primer Expansion, LA-14244-M
Proposal Submitted	FY14
Task Budget (FY21)	$99K
Task Description	This task is to expand the current Hand Calculation Primer, LA-14244-M, to include new methods, examples, and to fix errors. This document will be generated as an ORNL document.
FY21 Milestones	All 4 Quarters o Provide a status report of progress on TE3 to the NCSP Manager. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

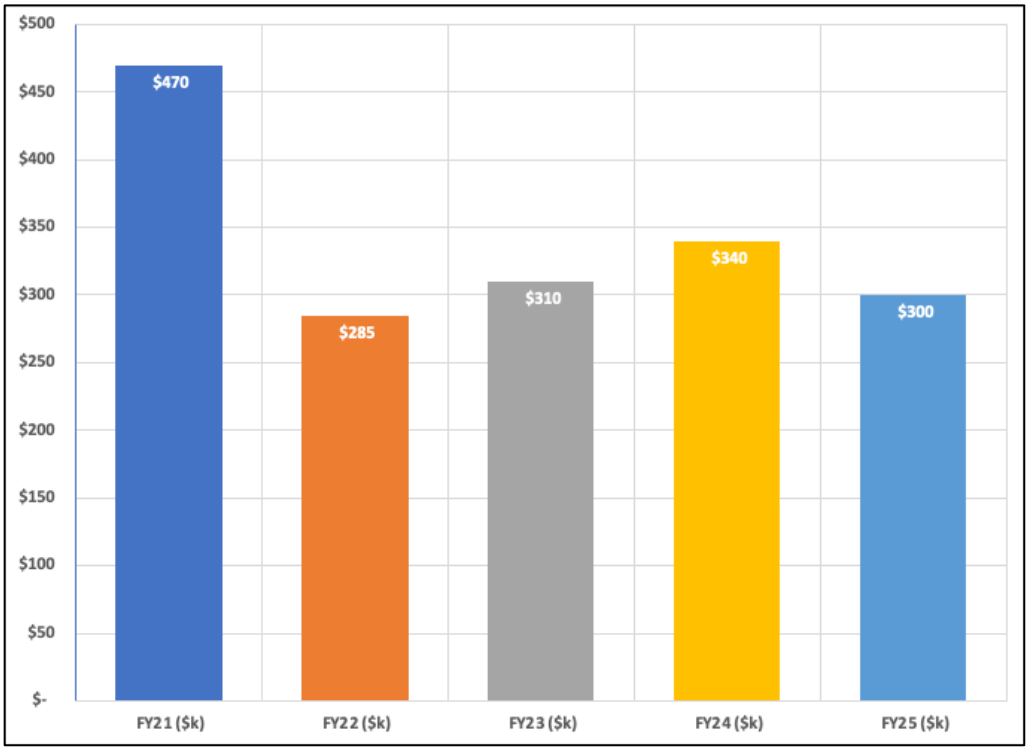
Task Name	ORNL TE5
Collaborators	LANL (LANL-TE4)
Task Title	On-Site Introductory Training for the NCS Practitioner on Modern Approaches to Validation using Sensitivity and Uncertainty Analysis Tools
Proposal Submitted	Directed by NCSP Manager
Task Budget (FY21)	$0K (Use FY20 carryover funding)
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide a status report of progress on TE5 to the NCSP Manager. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	ORNL TE11
Collaborators	None
Task Title	Revision of the LA-12808 Nuclear Criticality Safety Guide
Proposal Submitted	FY21
Task Budget (FY21)	$148K
Task Description	ORNL to revise this document to make clarifications and enhancements as a result of almost 25 years of NCS lessons learned since the last revision.
FY21 Milestones	All 4 Quarters o Provide a status report of progress on TE11 to the NCSP Manager. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

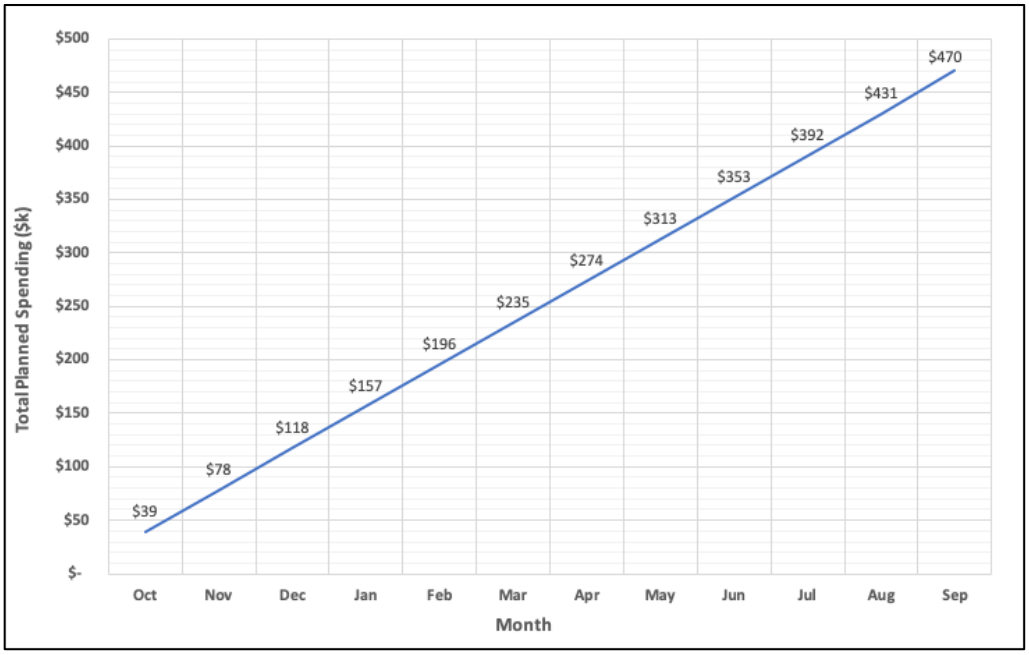
Task Name	ORNL TE12
Collaborators	None
Task Title	Design of a Subcritical/Critical Assembly at ORNL for Use with the CSO/FMH Courses
Proposal Submitted	FY21
Task Budget (FY21)	$124K
Task Description	This is a continuing task based on the results of a feasibility study or preliminary design performed in FY2019. The inclusion of a subcritical assembly located at Oak Ridge National Laboratory allows the CSO/FMH course to be taught in close proximity to many sites in the eastern United States with CSOs and FHMs. Many sites will not invest travel and labor costs sending CSOs and FMHs to NCS courses and this can be a way to attract as many CSOs and FMHs to the training course. Further, this assembly can be used to offset facility issues at either NCERC or Sandia and can be used to train university students in the southeast United States.
FY21 Milestones	All 4 Quarters o Provide a status report of progress on TE12 to the NCSP Manager. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.5-7 ORNL TE Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The reduction in funding from FY21 to FY22 reflects completion of the ORNL-TE3, "Hand-calculation Primer Expansion, LA-14244-M," ORNL-TE7, "Criticality Safety Tutorials," and ORNL-TE12, "Design of an Subcritical/Critical Assembly at ORNL for Use with the CSO/FMH Courses" in FY21.

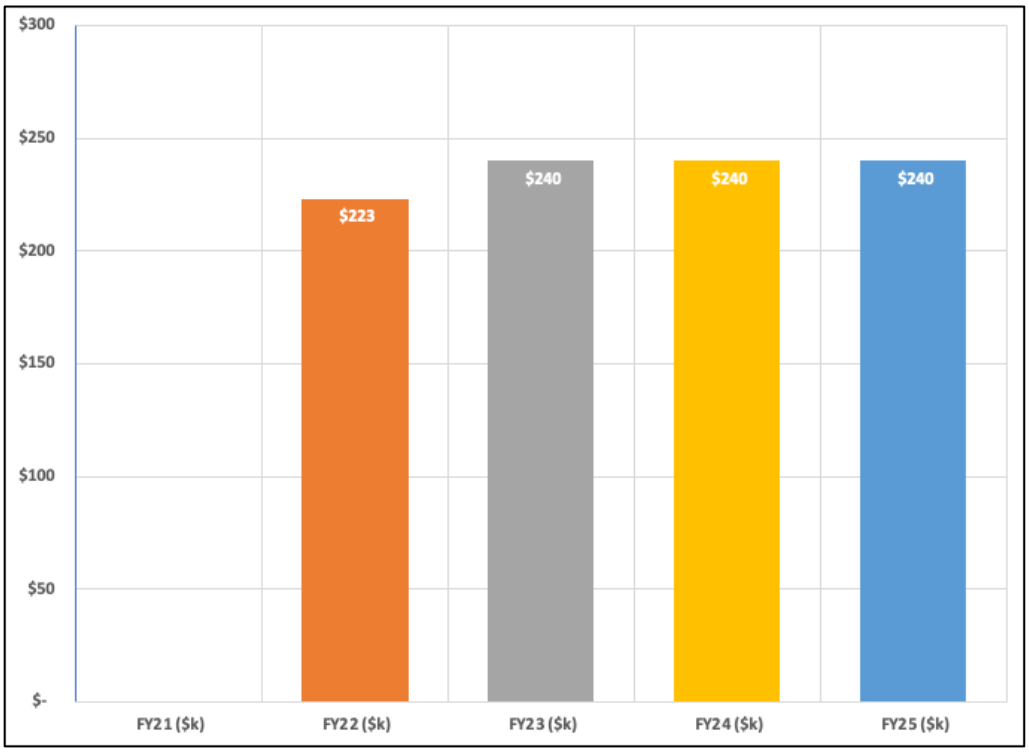
Figure 2.5-8 ORNL TE Planned Spending (FY2021)



2.5.2.4 Sandia National Laboratories (SNL)

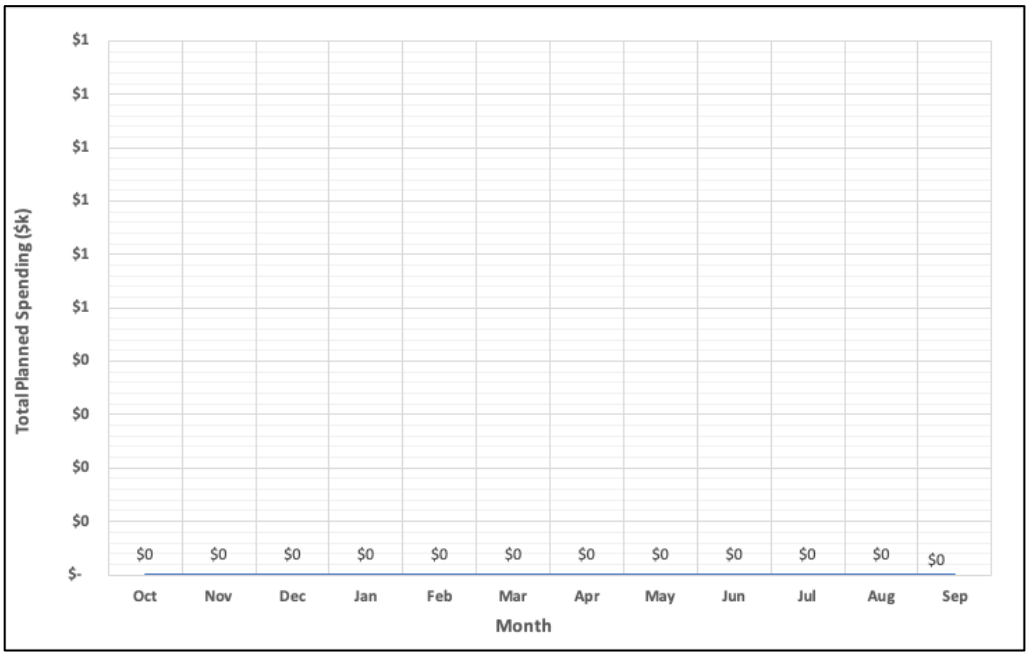
Task Name	SNL TE1
Collaborators	IRSN (IRSN-TE1), AWE (AWE-TE1)
Task Title	Prepare for and Conduct Hands-on Criticality Safety Training at SNL
Proposal Submitted	Ongoing
Task Budget (FY21)	$0K (FY20 carryover to be used to fund FY21 activities)
Task Description	This is an ongoing approved task to conduct 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. Due to excessive FY20 carry over, the FY21 budget was reduced. It is acceptable to spend carry-over funds to supplement this funding.
FY21 Milestones	All 4 Quarters o 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. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.5-9 SNL TE Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The budget increase from FY21 to FY22 reflects a decision by the NCSP Manager for SNL to use FY20 carryover funding for task SNL-TE1, "Prepare for and Conduct Hands-on Criticality Safety Training at SNL." The remaining budgets beyond FY21 are stable.

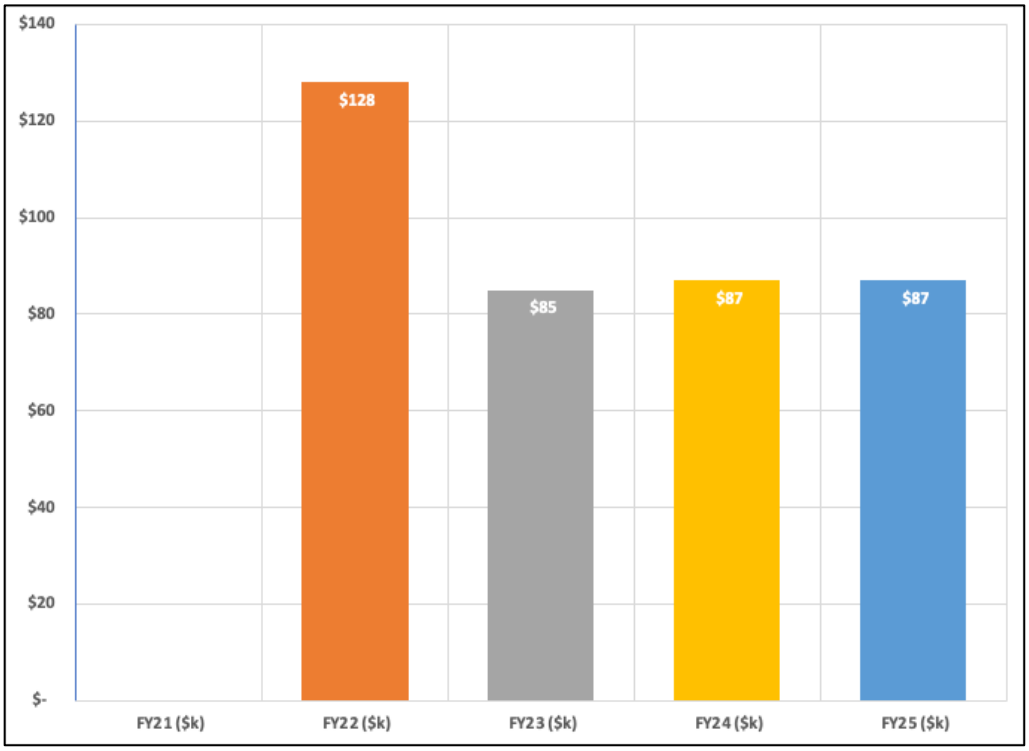
Figure 2.5-10 SNL TE Planned Spending (FY2021)



2.5.2.5 Y-12 National Security Complex

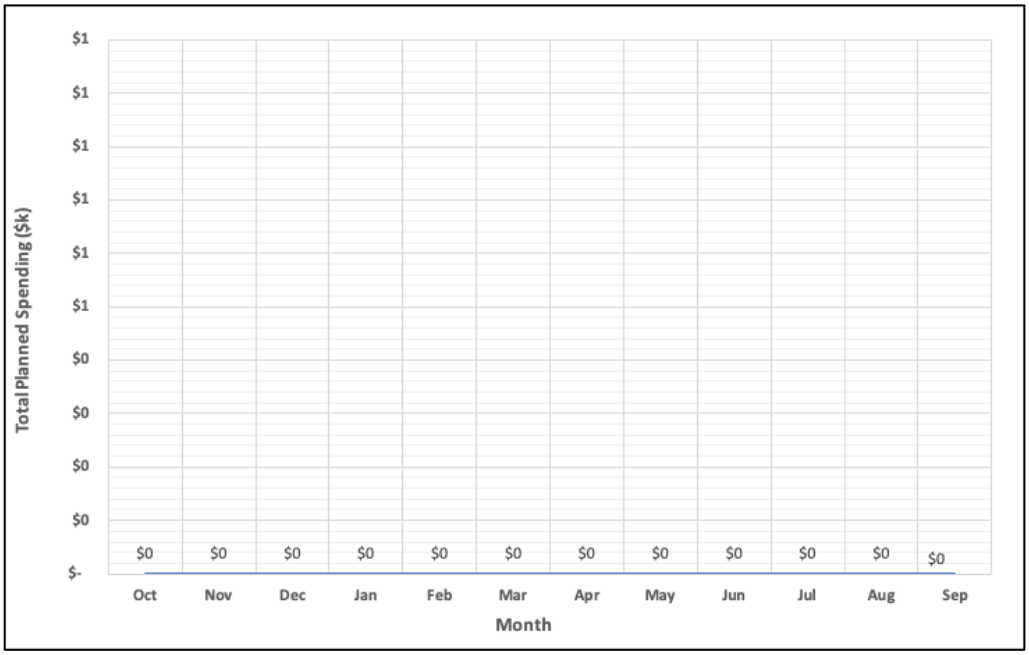
Task Name	Y12 TE1
Collaborators	ORNL (ORNL TE9), LLNL (LLNL TE9), LANL (LANL TE7)
Task Title	Conduct Hands-On Criticality Safety Training Course (Lecture support week 1 of 2-week hands-on course and course material development)
Proposal Submitted	Ongoing
Task Budget (FY21)	$0K (FY20 carryover to be used to fund FY21 activities)
Task Description	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.
FY21 Milestones	All 4 Quarters ○ Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Figure 2.5-11 Y12 TE Budget Trend (FY2021-FY2025)



EOC – for out-year peaks and dips in budget plots:
The FY21 budget was reduced to zero due to the availability of FY20 carryover funding. The budget increase in FY22 is due to the resumption of task Y12-TE1, "Conduct Hands-on Criticality Safety Training Course," and the initiation of task Y12-TE2, "Criticality Safety Tutorials." This 1-year long task will be completed at the end of that year, which accounts for the decrease in budget in FY23. The budgets from FY23-FY25 are stable.

Figure 2.5-12 Y12 TE Planned Spending (FY2021)



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.

Figure 3.1 NCSP Technical Support (FY2021-FY2025) - by Laboratory

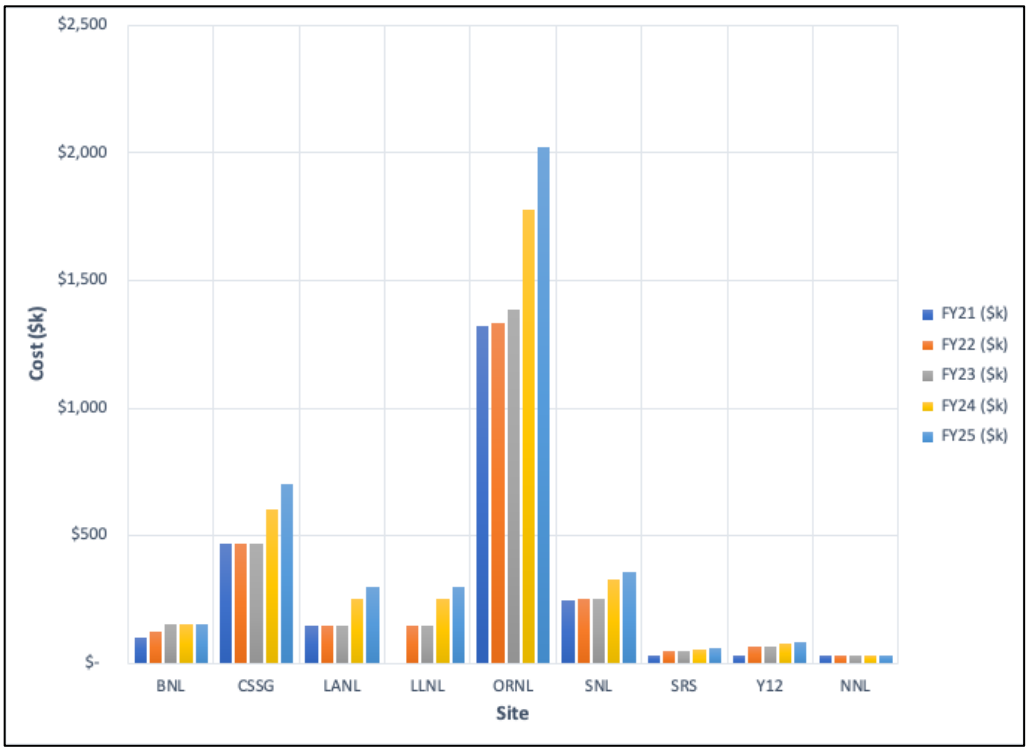
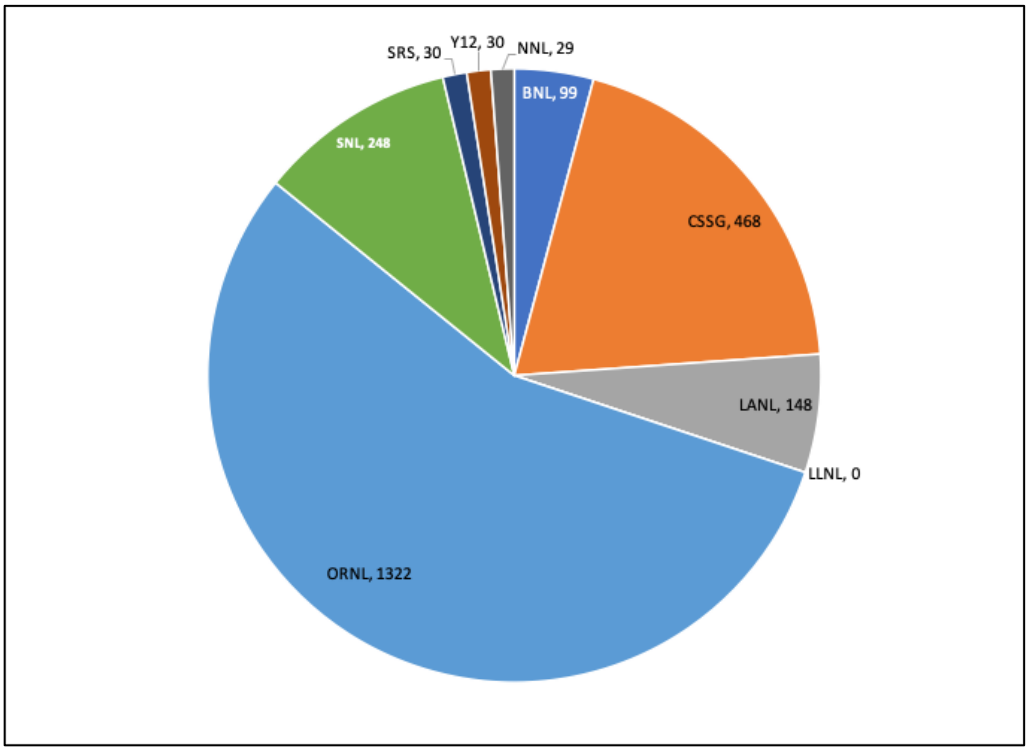


Figure 3.2 NCSP Technical Support (FY2021) - by Laboratory

Total NCSP TS Budget: $2,374K



Task Name	NCSP TS1												
Collaborators	None												
Task Title	CSSG – Support for the Criticality Safety Support Group												
Proposal Submitted	Ongoing												
Task Budget & Member Costs by Site (FY21)	$468K												
	NCSP MGR	ANL	DOE EM	LANL		LLNL	ORNL						SRS
	$28K	$0K	$0K	$60K	$65K	$50K	$35K	$35K	$60K	$5K	$30K	$50K	$50K
Task Description	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.												
FY21 Milestones	All 4 Quarters o Provide a status report of TS1 activities to the NCSP manager Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None												

Task Name	NCSP TS2
Collaborators	None
Task Title	ORNL – Support for Lead Lab to Execute the NCSP
Proposal Submitted	Ongoing
Task Budget (FY21)	$654K
Task Description	Ongoing ORNL task to support the NCSP Management Team in the program management and execution of the NCSP.
FY21 Milestones	All 4 Quarters o 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. o Manage 5-year plan development and maintenance and oversee the CEDT process and manage main 5-year plan and Integral Experiment Request Milestones Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 o Organize and lead the Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY o Publish final Five-Year Plan.

Task Name	NCSP TS3
Collaborators	None
Task Title	SNL – Support for Experimentalist Succession Planning
Proposal Submitted	Ongoing
Task Budget (FY21)	$75K
Task Description	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
FY21 Milestones	All 4 Quarters o Provide NCSP Manager annual report of succession planning efforts. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS4
Collaborators	None
Task Title	LANL – AM, IE, ND Succession Planning
Proposal Submitted	Ongoing
Task Budget (FY21)	$148K

Task Description	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.
FY21 Milestones	All 4 Quarters o Provide NCSP Manager annual report of succession planning efforts. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS5
Collaborators	None
Task Title	LLNL – AM, IE, ND Succession Planning
Proposal Submitted	Ongoing
Task Budget (FY21)	$0K (Use FY21 carryover funding)
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide NCSP Manager annual report of succession planning efforts. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS6
Collaborators	None
Task Title	BNL – ND Succession Planning
Proposal Submitted	Ongoing
Task Budget (FY21)	$99K
Task Description	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.

FY21 Milestones	All 4 Quarters o Provide NCSP Manager annual report of succession planning efforts. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS7
Collaborators	None
Task Title	ORNL – AM, ND Succession Planning
Proposal Submitted	Ongoing
Task Budget (FY21)	$148K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide NCSP Manager annual report of succession planning efforts. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS8
Collaborators	None
Task Title	ORNL – NCSP Program Management Tools Development
Proposal Submitted	Ongoing
Task Budget (FY21)	$198K
Task Description	This task continues work initiated in FY2017 to develop a program management tool that will improve the overall efficiency of managing the NCSP. A new IER database has been created and implemented. This funding will be used to maintain the IER database in the G2 system, fix programming errors, and to modestly enhance the system as needed to support IE 5-year plan objectives.
FY21 Milestones	All 4 Quarters o Provide NCSP Manager a status report of progress on the new IER system in G2 Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS9
Collaborators	None
Task Title	NNL – Support for NDAG Chair activities
Proposal Submitted	Ongoing

Task Budget (FY21)	$29K
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide status report on all NDAG chair activities in NCSP Quarterly Progress Reports Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS11
Collaborators	None
Task Title	ORNL – NCSP C_EdT Manager Support
Proposal Submitted	Ongoing
Task Budget (FY21)	$0K (FY20 carryover funds to be used)
Task Description	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.
FY21 Milestones	All 4 Quarters o Provide the NCSP Manager a status report support provided to manage the C_EdT process and assist CEDT manager as necessary to support IE 5-year plan objectives. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS12
Collaborators	None
Task Title	SNL – NCSP C_EdT Manager Support
Proposal Submitted	Ongoing
Task Budget (FY21)	$173K
Task Description	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.

FY21 Milestones	All 4 Quarters o Provide the NCSP manager with a summary of NCSP C_EdT support Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS13
Collaborators	None
Task Title	NDA Technical Support Group and NDA Technical Infrastructure Project
Proposal Submitted	Ongoing
Task Budget (FY21)	$322K
Task Description	This task involves the creation of an NDA program Mission and Vision document and 5-year plan to initiate a new federal program to resolve criticality safety issues related to fissionable material holdup and other issues related to NDA technology for NCS purposes. A DOE standard, development of ANSI/ANS-8.28 standard for NDA NCS administrative practices, and support for the NDA Technical Support Group (TSG). Sites involved currently are ORNL, SRS, and Y-12. LLNL is currently helping with NDA website development. ORNL will work with NA-50 staff to help lead this task.
FY21 Milestones	All 4 Quarters o Provide the NCSP manager an update of NDA Technical Support Group and NDA Technical Infrastructure Project activities. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS14
Collaborators	None
Task Title	Y-12 - NDA Technical Support Group and NDA Technical Infrastructure Project
Proposal Submitted	Ongoing
Task Budget (FY21)	$30K
Task Description	This task involves the creation of an NDA program Mission and Vision document and 5-year plan to initiate a new federal program to resolve criticality safety issues related to fissionable material holdup and other issues related to NDA technology for NCS purposes. A DOE standard, development of ANSI/ANS-8.28 standard for NDA NCS administrative practices, and support for the NDA Technical Support Group (TSG). Sites involved currently are ORNL, SRS, and Y-12.
FY21 Milestones	All 4 Quarters o Provide the NCSP manager an update of NDA Technical Support Group and NDA Technical Infrastructure Project activities. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

Task Name	NCSP TS15
Collaborators	None
Task Title	SRS - NDA Technical Support Group and NDA Technical Infrastructure Project
Proposal Submitted	Ongoing
Task Budget (FY21)	$30K
Task Description	This task involves the creation of an NDA program Mission and Vision document and 5-year plan to initiate a new federal program to resolve criticality safety issues related to fissionable material holdup and other issues related to NDA technology for NCS purposes. A DOE standard, development of ANSI/ANS-8.28 standard for NDA NCS administrative practices, and support for the NDA Technical Support Group (TSG). Sites involved currently are ORNL, SRS (TSG Chair), and Y-12.
FY21 Milestones	All 4 Quarters o Provide the NCSP manager an update of NDA Technical Support Group and NDA Technical Infrastructure Project activities. Quarter 1 – None Quarter 2 – None Quarter 3 – None Quarter 4 – None

APPENDIX A: Work Authorization Statements for Nuclear Criticality Safety Program Funding for Execution Year FY2021

Provided to the NA-50 Budget Office in August 2020

Brookhaven National Laboratory (BNL): $464K
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) FY21 Five-Year Plan, 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): $12,992K
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) FY21 Five-Year Plan, 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: Joetta Goda (505-667-2812), jgoda@lanl.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Lawrence Livermore National Laboratory (LLNL): $3,651K
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) FY21 Five-Year Plan, 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

Mission Support & Test Services (MSTS): $3,487K
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) FY21 Five-Year Plan.

MSTS POC: Sylvia Wright-Reader (702-2950597), WrightSD@nv.doe.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Naval Nuclear Laboratory (NNL): ($29K)
Task: NDAG Chair Support

Reflects funds NNL to provide NDAG chair support. Funds will be sent to the NNL M&O partner, Fluor Marine Propulsion (FMP).

NDAG Chair funds for Mike Zerkle at NNL - $29K.

NNL POC: Tim Trumbull (518-395-5203), timothy.trumbull@unnpp.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Oak Ridge National Laboratory (ORNL): $6,627K
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) FY21 Five-Year Plan, 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

Rensselaer Polytechnic Institute (RPI): ($446K)
Task: Nuclear Data Support at RPI

Reflects funds to conduct differential measurements as delineated in the Nuclear Criticality Safety Execution (NCSP) FY21 Five-Year Plan and continue work, as defined in the RPI LINAC 2021 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 POC: Yaron Danon (518-276-4008), danony@rpi.edu
NNL POC: Tim Trumbull (518-395-5203), timothy.trumbull@unnpp.gov
DOE POC: Angela Chambers, NNSA (806-573-6407), Angela.Chambers@nnsa.doe.gov

Sandia National Laboratories (SNL): $1,242K
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) FY21 Five-Year Plan 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): $80K
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) FY21 Five-Year Plan, or as directed by the NCSP Manager, to support the NDA Technical Support Group and NDA Technical Infrastructure Project, 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): $80K
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) FY21 Five-Year Plan, or as directed by the NCSP Manager. 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 – $28K
Reflects DOE HQ Hold Back for the CSSG 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-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Chlorine (^{35}Cl)			ORNL	ORNL			
			LANL	LANL	LANL		
Basis	Measurement of the ^{35}Cl (n,p) cross section in the resonance range using LENZ at LANL. 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. (Note that LANL Experiment is Contingent on Funding)						
Chromium (^{53}Cr)		RPI					
Chromium (^{50,53}Cr)					ORNL		
Basis	Measurement of the ^{53}Cr neutron capture cross section in the 2-10 keV energy range is needed to resolve discrepancies observed in historical fast assembly benchmarks containing stainless steel. The RPI measurement will address data request by CSEWG and IAEA. ORNL will measure ^{50,53}Cr neutron capture below 10 keV at GELINA using diluted samples to reduce or minimize multiple scattering and neutron sensitivity effects impacting prior measurements. Cr50 data over the RR range are needed.						
Fluorine (^{19}F)					ORNL		
Basis	Measurement of the ^{19}F inelastic scattering reaction channels at GELINA that appear to be underestimated in the current evaluation. Analysis and evaluation of the angular distributions in the RRR. Errors in fluorine may be contributing to bias in ^{233}U benchmarks. Fluorine is used in the uranium enrichment process and molten salt reactor coolants.						
Iodine							RPI
Basis	Measurement of neutron capture cross section of Iodine at RPI needed to resolve large discrepancies in simulations of large NaI detectors used for neutron capture cross section measurements. Will also support improved modeling of NaI gamma detectors in neutron fields for other DOE and DOD applications.						
Iron (^{54}Fe)		RPI					
Basis	Measurement of the neutron capture cross section for ^{54}Fe in the keV energy range at RPI is needed to support development of consistent Fe cross section evaluations. Recent measurement and evaluation work on ^{56}Fe has highlighted the need for new measurements and evaluation for ^{54}Fe. Iron is a ubiquitous element used in reactor, fuel cycle facility, spent fuel storage, and radiation shielding applications. IRSN is interested in this measurement as well.						
Molybdenum (^{95}Mo)				RPI	RPI	RPI	
				NNL	NNL	NNL	
		LANL					
Basis	Measurement of neutron capture in ^{95}Mo in resonance range, URR at RPI. 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. LANL will also complete the analysis of existing high-quality ORELA capture and transmission data in the resolved and unresolved resonance regions.						

Nuclear Data Measurements							
Materials	**Pre-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Neptunium (^{237}Np)				ORNL	ORNL	ORNL	ORNL
		LANL	LANL	LANL	LANL		
Basis	Measurement of ^{237}Np fission cross section in fast energy range at LANL. ^{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%). (Note that LANL Experiment is Contingent on Funding)						
Plutonium (^{239}Pu)			LANL	LANL	LANL		
Basis	There has been a recent IRSN request for a new measurement of the ^{239}Pu neutron total cross section at low neutron energies to better enable a new resonance evaluation of the plutonium isotopes. This evaluation work is concentrated on the evaluation of ^{239}Pu to improve benchmark calculations for thermal plutonium solutions, which remain problematic despite much work over the years. While transmission (total cross section) data are available in the low-energy region, the majority of these data are not of the quality needed to inform the resonance evaluation. Capabilities afforded by the new DICER (Device for Indirect Capture Experiments on Radionuclides) instrument at LANSCE (Los Alamos) promise higher-quality data to support the evaluation work. (Note that experiment is contingent upon funding.)						
Plutonium (^{240}Pu)	LANL	LANL	LANL				
	LLNL	LLNL	LLNL				
Basis	Measure ^{240}Pu prompt fission neutron energy spectra (PFNS) with Chi-Nu detector at LANL (LANCSE/WNR). The need for more accurate PFNS has been recognized. Supports applications with WG Pu and reactor grade Pu. This is a joint LANL/LLNL measurement.						
Strontium (^{86,87}Sr)							ORNL
Basis	Enriched ^{86,87}Sr transmission and capture measurements at GELINA are needed to supplement existing ^{88}Sr ORNL measurements to support complete RR evaluation for natural strontium isotopes for ENDF/B. ^{86,87}Sr are minor isotopes representing about 18% of natural strontium.						
Uranium (^{233}U)	ORNL	ORNL	ORNL	ORNL			
	LANL	LANL	LANL				
Basis	^{233}U neutron capture measurements in resonance range and the unresolved fast energy range at the Lujan center at LANCE/LANL using the DANCE detector. ORNL report on ^{233}U data assessment concluded that a new evaluation with revised (renormalized) fission cross section is needed. After re-evaluation of the U233, new capture cross section measurements (resonance region) may be needed to support this evaluation. LANL will measure capture cross section using the DANCE detector multiplicity features. NCS applications at LANL (CMR), ORNL, DAF/NCERC, spare unirradiated LWBR modules at INL.						
Uranium (^{236}U)							ORNL
Basis	^{236}U high-resolution transmission measurements in the RRR at GELINA or LANL to complement recent LANL fast energy evaluation. ^{236}U is a minor activation product present in HEU. Improved ^{236}U cross section evaluation supports all DOE programs using HEU.						
Vanadium (^{51}V)					ORNL		
Basis	Recent vanadium measurements showed large multiple scattering corrections needed to be accounted for neutron energies below 10 keV. Additional measurements are needed at GELINA possible using diluted samples on order to reduce or minimize the neutron sensitivity to experimental setup. Vanadium is used in some fissile material containers.						

Nuclear Data Measurements							
Materials	**Pre-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Zirconium (^{90,91,92,94,96}Zr)	ORNL	ORNL	ORNL	ORNL	ORNL		
	RPI						
Basis	Neutron capture and possibly transmission measurements in resonance range at GELINA. Old ORELA transmission data on enriched isotopes are available for analysis. Isotopically enriched samples are 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 and capture measurements were recently completed by ORNL. At RPI ^{nat}Zr neutron scattering measurements in the keV range are in progress under NR funding, the measurements will provide information on angular distributions. NR continues to be unsatisfied with Zr evaluations in ENDF.						
Polystyrene (C_8H_8)	ORNL	ORNL					
	RPI	RPI					
Basis	Polystyrene is a moderator material found in several thermal systems (PCT001, PCT02, MCT012, MCT013, MCT014, MCT016). Currently, polyethylene is used as a surrogate to represent thermal scattering in polystyrene in neutron transport simulations. This SNS measurement and evaluation will determine the validity of this approximation, as well as inform future substitutions for other hydrocarbons found in benchmarks. RPI will perform subthermal transmission measurements to support this TSL evaluation.						
Polyethylene (C_2H_4)	RPI	RPI					
Basis	Polyethylene is a ubiquitous moderator material used in critical assemblies, shipping containers and fuel cycle facilities. RPI will perform subthermal transmission measurements to support TSL evaluation validation.						

List Legend	ORNL	RPI	LANL	LLNL/NCSU	IRSN	NNL	BNL

Nuclear Data Evaluations							
Materials	**Pre-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Beryllium (^{9}Be)	LANL						
Basis	Be-9 evaluations continue to be challenged by benchmark critical experiments. See pg. 167 of the ENDF/B-VIII.0 report. The accompanying text indicates "there is considerable spread in these Be assembly results." The ENDF/B-VIII.0 evaluation of Be-9 carried over cross sections from ENDF/B-VII.1 but adopted JENDL-4.0 evaluations of elastic scattering angular distribution and (n,2n) angular and energy distributions. This leaves a less-than-satisfactory inconsistency between the elastic angular distributions and integrated cross sections that should be resolved. The proposed approach is to employ a new representation of the four-body (2n,2 alpha) breakup channel in the R-matrix analysis.						
Cerium (Ce)	ORNL	ORNL					
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)		ORNL	ORNL	ORNL	ORNL		
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. When measured (n,p) data from nTOF will be available, a new fit to include those can data can be performed together with any new available measurements from LANL						
Chromium (^{50,53}Cr)					ORNL	ORNL	ORNL
Basis	Measurement and evaluation of ^{50,53}Cr neutron capture cross section below 10 keV energy range is needed to resolve discrepancies observed in historical fast assembly benchmarks containing stainless steel. ORNL will measure ^{50,53}Cr neutron capture below 10 keV at GELINA using diluted samples to reduce or minimize multiple scattering and neutron sensitivity effects impacting prior measurements. Cr50 data over the RR range is needed. The cluster of s-wave resonances (mainly for ^{53}Cr) in the neutron energy region between 1-10 keV is the major update to be performed in the ENDF/B-VIII.0 library. As in the current release the magnitude of the capture cross sections is inconsistent with benchmark calculations.						
Copper (^{63,65}Cu)	ORNL	ORNL					
Basis	A revised evaluation of copper isotopes is needed to improve the benchmark performance above 100 keV up to 300 keV. This will include a statistical analysis of the resonance parameters above 100 keV to quantify the impact of the missing resonances in the measured data as well as a guidance in the level spin assignment. Due to the importance of the copper being used in critical assembly applications as reflector, additional work on the angular distributions is needed. Moreover, since benchmark sensitivity extends above 300 keV, a careful analysis of the high energy cross sections might be needed. With the adopted corrections described above, further analyses will be devoted to quantify the impact of the angular distributions in the RRR on benchmarks calculations and neutron scattering measurements.						
Fluorine (^{19}F)					ORNL	ORNL	ORNL
					IRSN	IRSN	IRSN
Basis	The evaluation of the ^{19}F inelastic scattering reaction channel is needed since it appears to be underestimated in the current ENDF/B-VIII.0 evaluation. Further analyses and related evaluation of the angular distributions in the RRR are needed. Since fluorine is used in the uranium enrichment process and molten salt reactor coolants, errors in the ^{19}F evaluated data may be contributing to bias in ^{233}U benchmarks.						

Nuclear Data Evaluations							
Materials	**Pre-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Hafnium (^{176,177,178,179,180}Hf)		ORNL	ORNL	ORNL	ORNL		
		IRSN	IRSN	IRSN	IRSN		
Basis	Hafnium is a neutron poison used in reactor and fuel cycle applications. IRSN and ORNL will review the existing Hf RRR and URR evaluations and develop new evaluations if needed to improve agreement with the TEX HEU/Hf experiment.						
Iron (^{54,56,57}Fe)		ORNL	ORNL	ORNL			
		IRSN	IRSN	IRSN			
Basis	Although the effort on the Fe isotopes was planned as joint effort between ORNL and IRSN, IRSN mainly led the evaluation effort and it is unclear the status of this set of evaluations. The ORNL contribution to 56-Fe was the generation of a preliminary ENDF file solving the problem with the benchmark performance. However, a rigorous evaluation work is still needed for the three major isotopes mainly for the assessment of the inelastic scattering reaction channel. ORNL will revise the 54-Fe, 56-Fe, and 57-Fe resonance evaluations.						
Iron (^{56}Fe)	ORNL	ORNL	ORNL	ORNL			
	IRSN	IRSN	IRSN	IRSN			
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 above the evaluated resonance range, extending far above the threshold for the first inelastic state. Currently, the latest ^{56}Fe evaluation in the ENDF/B data files does not have detailed resonance parameters here; 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). BNL also participating under DOE-SC funding.						
Lanthanum (La)	ORNL	ORNL	ORNL				
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)	LANL						
Lead (^{204,206,207,208}Pb)		ORNL	ORNL	ORNL			
		RPI	RPI	RPI			
		BNL	BNL	BNL			
		NNL	NNL	NNL			
		IRSN	IRSN	IRSN			
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. ORNL proposed to revisit RRR to address angular distribution concerns. RPI/BNL/NNL/IRSN also have a NE funded collaboration to evaluate Pb at energies relevant to fast reactors.						

Nuclear Data Evaluations							
Materials	**Pre-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Lithium (^{6}Li)		LANL	LANL	LANL	LANL		
Basis	The Li-6 evaluation in ENDF/B-VIII.0 was based on a combination of EDA R-Matrix fits to all reactions open in the Li-7 system up to ~ 4 MeV, influenced by the standards GMA 2017 result for the (n,t) reaction, and ENDF/B-VII.1 values above ~4 MeV. Li-6 is important for a number of reasons, including as a detector (and reference) in experiments, for example, for Chi-Nu measurement of prompt fission neutron spectra. It is important to extend the R-Matrix analysis to the full 20 MeV range for better precision and more complete (covariance information) at the important lower energy scale of a few MeV. Supports need at Y-12 for the new electrorefining process.						
Molybdenum (^{95}Mo)				RPI	RPI	RPI	
				NNL	NNL	NNL	
				IRSN	IRSN	IRSN	
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)					ORNL	ORNL	
					LANL	LANL	
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%).						
Nitrogen (^{14}N)			ORNL	ORNL	ORNL		
	Nitrogen cross section are important in the reprocessing process and related analyses. Nitrogen was recently included as action item in the series of INDEN meetings for light nuclei evaluations. In the ENDF/B-VIII.0 library there are no resonance parameters for nitrogen.						
Plutonium (^{239}Pu)	LANL	LANL					
	ORNL	ORNL	ORNL	ORNL	ORNL		
		IRSN	IRSN	IRSN	IRSN		
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. ORNL and IRSN will collaborate on a review of existing RRR and URR evaluation data and prepare new RRR/URR evaluations that will improve agreement with TEX Pu experimental results.						
Plutonium (^{240}Pu)					ORNL	ORNL	
			LANL	LANL	LANL		
Basis	Pu-240 is a meaningful component of almost all Pu benchmark experiments, and a significant component in some. This isotope is the next major constituent of plutonium and can reach 20% or more enrichment in reactor fuel. Some changes were made in ENDF/B-VIII.0, but there have been no accurate prompt fission spectra measurements previously. Such experiments, and subsequent re-evaluation will benefit criticality safety analysis for MOX fuel reprocessing, fabrication and disposal.						

Nuclear Data Evaluations							
Materials	**Pre-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Rhodium (^{103}Rh)		ORNL	ORNL	ORNL			
		NNL	NNL	NNL			
		IRSN	IRSN	IRSN			
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 priority - elevated per IRSN request.						
Strontium (^{88}Sr)	ORNL	ORNL	ORNL				
Basis	Existing R-matrix analysis of ^{88}Sr in the RRR was performed from the fit of ORELA transmission and capture measurements but the evaluation work was never included in the ENDF/B-VIII.0 library. Strontium is a fission product typically found in spent fuel and in high level waste tanks at Hanford and Savanah River.						
Strontium (^{86,87}Sr)							ORNL
Basis	^{86,87}Sr RR evaluation based on transmission and capture measurements performed at GELINA to supplement existing ^{88}Sr ORNL measurements to support complete RR evaluation for natural strontium isotopes for ENDF/B. ^{86,87}Sr are minor isotopes representing about 18% of natural strontium.						
Tantalum (Ta)	ORNL	ORNL	ORNL				
	NNL	NNL	NNL				
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	ORNL	ORNL	ORNL	ORNL	ORNL		
			LANL	LANL	LANL		
		IRSN	IRSN	IRSN	IRSN		
Basis	^{233}U is a fissile nuclide of interest to criticality safety. The availability of ^{233}U is important to NCS applications mainly at Y-12, ORNL, and at NCERC. 1. The evaluation will include the newly evaluated thermal values from the standard evaluation including the updated fission prompt neutron spectrum. Reevaluate differential data to check the renormalization of ORNL fission data. A new fit for the fission cross sections to account for the Guber and n_TOF fission data, that agree within 2% from 10 eV to 100 keV and higher than the current ENDF/B-VIII.0 evaluated data. 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. Evaluation in the RRR is planned at ORNL and in the fast region at LANL. In the RRR the main goal of the new evaluation is to improve the negative bias in the benchmarks calculations.						
Uranium-234	LANL						
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.						

Nuclear Data Evaluations							
Materials	**Pre-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Uranium-235	LANL	LANL	LANL	LANL			
				ORNL			
				IRSN			
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. Includes ORNL revisiting ^{235}U URR evaluation.						
Uranium-236	LANL						
							ORNL
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. ORNL will evaluate ^{236}U high-resolution transmission measurements in the RRR to complement recent LANL fast energy evaluation. ^{236}U is a minor activation product present in HEU. Improved ^{236}U cross section evaluation supports all DOE programs using HEU.						
Uranium-238	LANL	LANL	LANL	LANL			
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)	ORNL	ORNL	ORNL	ORNL			
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.						

Nuclear Data Evaluations							
Materials	**Pre-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Zirconium (^{90,91,92,94,96}Zr)					ORNL	ORNL	ORNL
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)	LLNL/NCSU	LLNL/NCSU					
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)	LLNL/NCSU	LLNL/NCSU					
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)	LLNL/NCSU	LLNL/NCSU					
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.						
Uranium Metal (U)	LLNL/NCSU	LLNL/NCSU	LLNL/NCSU				
Basis	TSL evaluation. Requested by the RPI for use in U-235 resonance parameter analysis.						
Uranium Carbide (UC)		LLNL/NCSU	LLNL/NCSU	LLNL/NCSU			
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.						
Paraffin (C_nH_{2n+2})			LLNL/NCSU	LLNL/NCSU	LLNL/NCSU		
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)				LLNL/NCSU	LLNL/NCSU	LLNL/NCSU	
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.						

Nuclear Data Evaluations							
Materials	**Pre-FY2021**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**Post-FY2025**
Uranyl Fluoride (UO_2F_2)					LLNL/NCSU	LLNL/NCSU	LLNL/NCSU
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)						LLNL/NCSU	LLNL/NCSU
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.						
Plutonium Oxide (PuO_2)							LLNL/NCSU
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.						
Lithium-6 Hydride (^6LiH)	NNL	NNL					
Basis	TSL evaluation. Poison material planned to be used in TEX HEU/Li critical experiment. Evaluation funded by NR.						
Lithium-7 Hydride (^7LiH)	NNL	NNL					
Basis	TSL evaluation. Super-moderator for use in critical mass studies. Evaluation funded by NR.						
Lithium-7 Deuteride (^7LID)	NNL	NNL					
Basis	TSL evaluation. Super-moderator for use in critical mass studies. Evaluation funded by NR.						
Beryllium Hydride (BeH_2)	NNL	NNL					
Basis	TSL evaluation. Super-moderator for use in critical mass studies. Evaluation funded by NR.						
Plutonium Hydride (PuH_{2+x})						NNL	NNL
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. Evaluation funded by NR.						
Polystyrene $(C_8H_8)_n$	ORNL	ORNL	ORNL				
Basis	Polystyrene is a moderator material found in several thermal systems (PCT001, PCT02, MCT012, MCT013, MCT014, MCT016). Currently, polyethylene is used as a surrogate to represent thermal scattering in polystyrene in neutron transport simulations. This measurement and evaluation will determine the validity of this approximation, as well as inform future substitutions for other hydrocarbons found in benchmarks. RPI could perform sub-thermal transmission measurements to support this TSL evaluation.						

List Legend	ORNL	RPI	LANL	LLNL/NCSU	IRSN	NNL	BNL

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

- Beryllium (Be-9)
- Cerium (Ce)
- Chlorine (Cl-35)
- Chromium (Cr-50,53)
- Copper (^{nat}Cu)
- Fluorine (F-19)
- Hafnium (Hf-176,177,178,179,180)
- Iron (Fe-54,56,57)
- Lanthanum (La)
- Lead (Pb-208)
- Lead (Pb-204,206,207,208)
- Lithium (Li-6)
- Molybdenum (Mo-95)
- Neptunium (Np-237)
- Plutonium (Pu-239) (LANL plus ORNL/IRSN Collaboration)
- Plutonium (Pu-240)
- Strontium (Sr-88)
- Tantalum (Ta)
- Uranium-233 (U-233)
- Uranium-234 (U-234)
- Uranium-235 (U-235)
- Uranium-238 (U-238)
- Vanadium (V-51)
- Zirconium (Zr-90, 91, 92, 94, 96)

Completed Work

- Calcium (Ca)
- Cobalt (Co-59)
- Copper (Cu-63, 65)
- Copper (^{nat}Cu) - scattering angular distributions
- Dysprosium (Dy-161, 162, 163, 164)
- Gadolinium (Gd-155, 156, 157, 158, 160)
- Lead (Pb-208)
- Nickel (Ni-58, 60)
- Oxygen (O-16)
- Tungsten (W-182, 183, 184, 186)
- Uranium-234 (U-234)
- Uranium-236 (U-236)

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

Table B-1. Differential Measurements and Evaluations

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Beryllium (Be-9)	11/1/11	7/1/21		
Employ a new representation of the four-body (2n,2 alpha) breakup channel in the R-matrix analysis	11/15/19	4/15/20	LANL	
Finalize Evaluation and Deliver to NNDC	10/1/19	9/30/20	LANL	
Phase I Testing, Post to ENDF/A and Broadcast	10/1/20	2/1/21	BNL	
CSEWG Validation Testing	12/1/20	5/1/21	NDAG	
CSEWG Approval of Complete Evaluation	5/1/21	8/1/21	BNL	
Cerium (Ce-142)	11/01/11	10/30/20		
Transmission and Capture Measurements	11/15/19	12/30/20	ORNL (JRC-Geel)	Transmission and capture measurements were performed in FY19, however, additional transmission measurements for 142-Ce were needed to have better statistics.
Experimentalist Data Reduction and Testing	01/01/20	4/01/20	ORNL	
Resolved Resonance Region Evaluation	11/15/19	3/31/21	ORNL	
Assess Data for URR Evaluation and Complete URR Evaluation	6/01/19	3/31/21	ORNL	URR will be performed on the basis of available measured data if any
Finalize Resonance Evaluation and Deliver to NNDC	4/1/21	5/30/21	ORNL	
Phase I testing, Post to ENDF/A and Broadcast	6/1/21	6/15/21	BNL	
CSEWG Validation Testing	6/16/21	6/30/21	NDAG	
CSEWG Approval of Complete Evaluation	7/1/21	9/31/21	BNL	
Chlorine (Cl-35)	10/1/20	9/30/23		
Perform (n,p) Measurements	10/1/20	9/30/21	ORNL	Funding source: ORNL ND1
Complete Lujan measurements of Cl-35 (n,p), finalize report on LENZ analysis, and deliver final experimental cross-sections to evaluators	10/1/22	9/30/24	LANL	Currently Unfunded
Resolve Resonance Region Evaluation	10/01/21	9/30/23	ORNL	
Finalize isotopic Evaluation Resonance Region Evaluation and Deliver to NNDC	9/30/23	10/15/23	ORNL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Phase I testing, Post to ENDF/A and Broadcast	10/16/23	10/30/23	BNL	
CSEWG Validation Testing	11/01/23	11/15/23	NDAG	
CSEWG Approval of Complete Evaluation	11/16/23	12/30/23	BNL	
Chromium (Cr-50, 53)				The two links below describe the problem and motivation for the proposed work. In addition to ORNL plans to 1) to develop procedure to treat experimental effects such as neutron sensitivity and multiple scattering corrections with geometry different from cylindric. https://www.oecd-nea.org/dbdata/hprl/hprlview.pl?ID=518 and https://www.oecd-nea.org/dbdata/hprl/hprlview.pl?ID=519 . Measurements for both isotopes below 10 keV with diluted sample are needed to reduce or minimize the neutron sensitivity of the experimental set up and MS in the sample. Cr50 data over the whole energy ranges is needed.
Perform Capture Measurements	1/1/24	9/30/25	ORNL	
Perform SAMMY Analysis	1/1/24	9/30/26	ORNL	
Resolved Resonance Region Evaluation for Cr-50, 53				
Finalize isotopic Evaluation Resonance Region Evaluation and Deliver to NNDC				
Phase I testing, Post to ENDF/A and Broadcast	10/16/26	10/30/26	BNL	
CSEWG Validation Testing	11/1/26	11/15/26	NDAG	
CSEWG Approval of Complete Evaluation	11/16/26	12/30/26	BNL	
Cu (Cu-63,65)				A revised evaluation on copper isotopes is needed to improve the benchmark performance above 100 keV up to 300 keV. This will include a statistical analysis of the resonance parameters above 100 keV to quantify the impact of the missing resonances in the measured data as well as a guidance in the level spin assignment. Due to the importance of the copper being used in reactor applications as reflector, additional work on the angular distributions is needed.
Perform Capture Measurements	N/A	N/A	–	
Perform SAMMY Analysis	10/1/19	12/30/20	ORNL	
Resolved Resonance Region Evaluation for Cu-63,65				
Finalize isotopic Evaluation Resonance Region Evaluation and Deliver to NNDC				

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Phase I testing, Post to ENDF/A and Broadcast	1/1/21	1/15/21	BNL	Moreover, since benchmark sensitivity extends above 300 keV, a careful analysis of the high energy cross sections might be needed.
CSEWG Validation Testing	1/16/21	1/31/21	NDAG	
CSEWG Approval of Complete Evaluation	2/1/21	3/30/21	BNL	
Fluorine (F-19)	1/1/24	9/30/26		F-19 might be the main cause bias in ^{233}U solution benchmarks. There are no resonance parameters in the ENDF/B-VIII.0 library because the RRR evaluation was converted to point wise cross sections. There are no high-resolution measured data for F-19 inelastic scattering reaction channel, e.g. (n,n'), (n,n0), (n,n1), that in the current evaluation seems to be underestimated. Analysis and evaluation on the angular distributions in RRR is required.
Perform Inelastic Measurements (IRMM)	1/1/24	12/30/24	ORNL	
Perform SAMMY Analysis	12/30/24	9/30/26	ORNL	
Resolve Resonance Region Evaluation for F-19				
Finalize isotopic Evaluation Resonance Region Evaluation and Deliver to NNDC				
Phase I testing, Post to ENDF/A and Broadcast	10/1/26	10/15/26	BNL	
CSEWG Validation Testing	10/15/26	11/1/26	NDAG	
CSEWG Approval of Complete Evaluation	11/1/26	12/31/26	BNL	
Hafnium (Hf-176,177,178,179,180)	10/1/19			Resolved and unresolved resonance evaluations for Hf isotopes have been carried out mainly to address issues on benchmark results in the thermal energy region. IRSN and LLNL will be working on the development of the TEX-Hf experiments focusing in the epithermal energy region. Indeed, MORET calculations of the benchmark sensitive to Hf in the epithermal energy region have demonstrated discrepancies calculated and experimental multiplication factors result. The intent of the proposal is to review and re-evaluate the Hf cross sections in the resolved and unresolved resonance regions with additional covariance and uncertainty information. (ORNL is waiting for IRSN feedback)
Perform assessment of the available Hf evaluation in the resolved and unresolved resonance regions in the JEFF, ENDF and JENDL libraries; Perform detail study of the sensitivity of Hf cross sections in the calculations using the TEX-Hf benchmarks; Examine the results from different cross section libraries; Initiate resonance parameter evaluation in the resolved and unresolved resonance regions.	10/1/19	9/30/20	ORNL/IRSN	
Continue tasks initiated in previous year; Incorporate experimental differential data in the evaluation process as they become available; Continue evaluation	10/1/20	9/30/21	ORNL/IRSN	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
using computer evaluation tool.				
Complete the resolved resonance and resonance parameter covariance evaluation; Use the evaluation for testing in benchmark calculation; Work with ORNL on the benchmark validation; Submit the evaluation to JEFF and ENDF for further testing;	10/1/21	9/30/22	ORNL/IRSN	
Initiate the unresolved resonance region evaluation; Incorporate experimental differential data in the evaluation process as they become available; Continue evaluation using computer evaluation tool;	10/1/22	9/30/23	ORNL/IRSN	
Complete the unresolved resonance and cross section covariance evaluation; Use the evaluation for testing in benchmark calculation; Work with ORNL on the benchmark validation; Submit the evaluation to JEFF and ENDF for further testing.	10/1/23	9/30/24	ORNL/IRSN	
CSEWG Approval of Complete Evaluations				
Fe (Fe-54, 56, 57)	1/1/13	12/31/23		Although the effort on the Fe isotopes was planned as joint effort between ORNL and IRSN, IRSN mainly led the evaluation effort and it is unclear the status of this set of evaluations. The ORNL contribution to 56-Fe was the generation of a preliminary ENDF file solving the problem with the benchmark performance. However, a rigorous evaluation work is still needed for the three major isotopes mainly for the assessment of the inelastic scattering reaction channel.
Perform Capture Measurements for Fe-54	10/1/21	9/30/22	RPI	
Perform SAMMY Analysis Finalize isotopic Evaluation Resonance Region Evaluation and Deliver to NNDC	1/1/21	9/30/23	ORNL	
Phase I testing, Post to ENDF/A and Broadcast	10/1/23	10/15/23	BNL	
CSEWG Validation Testing	10/16/23	11/1/23	NDAG	
CSEWG Approval of Complete Evaluation	11/1/23	12/31/23	BNL	
Lanthanum (La)				Updated from FY2019
Transmission and Capture Measurements	10/1/17	6/1/18	ORNL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Experimentalist Data Reduction and Testing	6/1/18	9/30/19	ORNL	
Resolved Resonance Region Evaluation	10/1/21	6/30/22	ORNL	
Finalize Resonance Evaluation and Deliver to NNDC	7/1/22	9/30/22	ORNL	
Phase I Testing, Post to ENDF/A and Broadcast	10/1/22	10/15/22	BNL	
CSEWG Validation Testing	10/15/22	11/1/22	NDAG	
CSEWG Approval of Complete Evaluation	11/1/22	12/31/22	BNL	
Lead (Pb-208)	10/1/15	12/31/17		Changes consistent with discussion at August BEM Meeting and text in basis statement
Update High-Energy Neutron Angular Distributions	10/1/17	3/31/19	LANL	
Test New Scattering Data Using Semi-Integral Experiment and Recommend Path Forward	4/1/19	9/30/19	LANL	
Phase I Testing, Post to ENDF/A and Broadcast	10/1/19	10/14/19	BNL	
CSEWG Validation Testing	10/15/19	10/31/19	NDAG	
CSEWG Approval of Complete Evaluation	11/1/19	12/31/19	BNL	
Lead (Pb-204,206,207,208)	10/1/21	12/31/23		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. ORNL proposed to revisit RRR to address angular distribution concerns
Resolved Resonance Region Evaluation	4/1/21	9/30/23	ORNL	
Phase I Testing, Post to ENDF/A and Broadcast	10/1/23	10/14/23	BNL	
CSEWG Validation Testing	10/15/23	10/31/23	NDAG	
CSEWG Approval of Complete Evaluation	11/1/23	12/31/23	BNL	
Lithium (Li-6)	10/1/21	8/1/25		
Perform data compilation and add EDA code capabilities to support new R-	10/1/20	9/30/22	LANL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Matrix evaluation up to 20 MeV				
Deliver new evaluation using R-Matrix analysis to 20 MeV	10/1/22	9/30/24	LANL	
Phase I Testing, Post to ENDF/A and Broadcast	10/1/24	2/1/25	BNL	
CSEWG Validation Testing	12/1/24	5/1/25	NDAG	
CSEWG Approval of Complete Evaluation	5/1/25	8/1/25	BNL	
Molybdenum (Mo-95)	10/1/20	>FY24		
Reduce prior ORELA transmission and capture measurement data and submit to EXFOR	10/1/20	9/30/21	LANL	
Transmission and Capture Measurements	10/1/22	>FY24	RPI	
Experimentalist Data Reduction and Testing	TBD	TBD	RPI	
Resolved Resonance Region Evaluation	TBD	TBD	RPI/NNL	IRSN will collaborate on evaluation.
Finalize Resonance Evaluation and Deliver to NNDC	TBD	TBD	RPI/NNL	
Phase I Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	>FY24	BNL	
Neptunium (Np-237)	10/1/20	>FY25		
Assess needs for new Np-237 differential experiments at LANSCE	10/1/20	9/30/21	LANL	
Finalize Np-237 fission measurement at LANSCE	10/1/21	9/30/24	LANL	Currently Unfunded
Transmission, Fission, and Capture Measurements (LANL)	10/1/21	9/30/23	ORNL/LANL	Extended to allow more time for measurements to be completed.
Finalize Fast Region Evaluation and Deliver to NNDC	10/1/23	9/30/25	LANL	
Fast Region Evaluation	TBD	TBD	ORNL	
Finalize Resonance Evaluation and Deliver to NNDC	TBD	TBD		
Phase I Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	>FY25	BNL	
Nitrogen (N-14)	12/30/20	9/30/23		Nitrogen cross section are important in the reprocessing process and related analyses. Nitrogen was recently included as action item in the series of INDEN meetings for light nuclei evaluations. In the ENDF/B-VIII.0 library there are no resonance parameters for nitrogen.
Transmission and Capture Measurements	–	–		
Experimentalist Data Reduction and Testing	–	–		
Resolved Resonance Region Evaluation	12/30/22	9/30/24	ORNL	
Assess Data for URR Evaluation and Complete URR Evaluation				
Phase I Testing, Post to ENDF/A and Broadcast	10/1/24	10/15/24	BNL	
CSEWG Validation Testing	10/15/24	11/1/24	NDAG	
CSEWG Approval of Complete Evaluation	11/1/24	12/30/24	BNL	
Oxygen (O-16)	10/1/13	12/31/21		To be discussed by NDAG in FY2021. Not in App. B tables.
Update evaluation as part of Cielo Project	<FY19	6/30/21	ORNL	This milestones is based on the availability of the (n,a) measured at LANL. After several years, this data should be ready for release and put some light on the magnitude of the (n,a) reaction channel. Moreover, the quality of this evaluation is also linked to the updates in the SAMMY code regarding the multiple incident channel option.
Finalize Evaluation and Deliver to NNDC	7/1/21	9/30/21	ORNL	
Phase I testing, Post to ENDF/A and Broadcast	10/1/21	10/15/21	BNL	Define post evaluation process
CSEWG Validation Testing	10/15/21	11/1/21	NDAG	
CSEWG Approval of Complete Evaluation(s)	11/1/21	12/31/21	BNL	
Rhodium (Rh-103)	6/30/25	1/1/27		Reprioritized to FY21-FY23.
Assess data for Resolved Resonance Region Evaluation	6/30/25	9/30/27	ORNL	NNL & IRSN will collaborate
Finalize Resonance Evaluation and Deliver to NNDC			ORNL	
Phase I Testing, Post to ENDF/A and Broadcast	10/1/27	10/15/27	BNL	Define post process evaluation
CSEWG Validation Testing	10/15/27	11/1/27	NDAG	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
CSEWG Approval of Complete Evaluation(s)	11/1/27	12/31/27	BNL	
Plutonium (Pu-239)	10/1/10	9/30/24		IRSN to collaborate with ORNL evaluation work.
Deliver p(nu) Data in ENDF/B format	10/1/12	9/30/13	LANL	
Update Prompt Fission Neutron Spectra Based on LANSCE Low-Energy Emission Data	10/1/18	3/31/20	LANL	
Deliver Multiplicity-Dependent Fission Spectra	10/1/13	9/30/14	LANL	
Deliver Prompt Fission Gamma Spectra	10/1/14	3/31/16	LANL	
Update Prompt Fission Neutron Spectra Based on LANSCE High-Energy Emission Data	10/1/18	3/31/20	LANL	
WPEC SG34 Improved Resonance Evaluation	<FY19	TBD	ORNL	
URR Evaluation using Hwang-Leal Methodology	TBD	TBD	ORNL	
Finalize Resonance Region Evaluation and Deliver to NNDC	TBD	9/30/24	ORNL	
Phase I testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	TBD	BNL	
Finalize a report assessing our methodology to evaluate PFNS and multiplicity consistently, including angular information about prompt neutrons	4/1/19	9/30/20	LANL	
Evaluate PFNS and multiplicity consistently, including angular information about prompt neutrons	10/1/19	9/30/21	LANL	
Update Fission Cross-Section Based on TPC Results (based on Pu239/U235 ratio data)	10/1/19	9/30/21	LANL	
Update Evaluation Based on LANL Updates and CSEWG & WPEC Testing	10/1/20	>FY24	ORNL	
Complete LANCE / DICER low-energy transmission measurements, finalize report on analysis, and	10/1/22	9/30/24	LANL	Currently Unfunded

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
deliver final experimental data to evaluators				
Plutonium-240 (Pu-240)	10/1/19	8/1/25		
Procure a Pu-240 target for PFNS measurements	10/1/19	9/30/20	LANL	
Fabricate, assemble, and test the Pu-240 PPAC target and fission detector components	6/1/20	3/31/21	LANL	
Obtain final experimental results for Pu-240 PFNS at LANSCE, finalize data analysis, and deliver data to evaluators	4/1/21	9/30/22	LANL	
Update evaluation to include new LANSCE / Chi-Nu prompt fission neutron spectra	3/30/22	3/30/24	LANL	
Resolved Resonance Region Evaluation	10/1/22	9/30/24	ORNL	
Phase I Testing, Post to ENDF/A and Broadcast	10/1/24	2/1/25	BNL	
CSEWG Validation Testing	12/1/24	5/1/25	NDAG	
CSEWG Approval of Complete Evaluation(s)	5/1/25	8/1/25	BNL	
Strontium (Sr-88)	10/1/21	12/31/22		
Resolved Resonance Region Evaluation	10/1/21	9/30/22	ORNL	
Assess Data for URR Evaluation and Complete URR Evaluation	10/1/22	9/30/22	ORNL	
Finalize Resonance Evaluation and Deliver to NNDC	10/1/22	10/15/22	ORNL	
Phase I Testing, Post to ENDF/A and Broadcast	10/16/22	10/30/22	BNL	
CSEWG Validation Testing	11/1/22	11/15/22	NDAG	
CSEWG Approval of Complete Evaluation	11/16/22	12/30/22	BNL	
Strontium (Sr-86,87)	10/1/25	12/30/28		
Transmission and Capture Measurements (Geel)	10/1/25	9/30/27	ORNL	
Experimentalist Data Reduction and Testing	10/1/27	3/30/28	ORNL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Resolved Resonance Region Evaluation	4/1/26	9/30/28	ORNL	
Finalize Resonance Evaluation and Deliver to NNDC	10/1/28	10/15/28	ORNL	
Phase I Testing, Post to ENDF/A and Broadcast	10/16/28	10/30/28	BNL	
CSEWG Validation Testing	11/1/28	11/15/28	NDAG	
CSEWG Approval of Complete Evaluation	11/16/28	12/30/28	BNL	
Tantalum (Ta)	10/1/15	12/31/20		ORNL is/was not part of the measurement campaign. However, ORNL is working with NNL to generate an evaluation in the RRR.
Transmission and Capture Measurements	10/1/15	9/30/21	RPI	
Experimentalist Data Reduction and Testing	10/1/21	9/30/22	RPI	
Resolved Resonance Region Evaluation	10/1/18	9/30/22	NNL/ORNL	
Assess Data for URR Evaluation and Complete URR Evaluation			NNL/ORNL	
Finalize Resonance Evaluation and Deliver to NNDC			NNL/ORNL	
Phase I Testing, Post to ENDF/A and Broadcast	10/1/22	10/15/22	BNL	
CSEWG Validation Testing	10/15/22	11/1/22	NDAG	
CSEWG Approval of Complete Evaluation	11/1/22	1/1/23	BNL	
Uranium (U-233)	10/1/2019	8/1/25		
Complete review of previous “thin” target U233 measurements and finalize specifications for new “thick” U233 target	10/1/2019	6/30/20	LANL	The measurements will be performed on the basis of the cross section evaluation and the performance with the benchmarks
Complete fabrication of new “thick” U-233 target	7/1/20	6/30/21	LANL	
Finalize acquisition of U-233 thick target capture data, finalize data analysis, and deliver data to evaluators	7/1/21	9/30/22	LANL	
Resolved Resonance Region Evaluation	4/1/20	9/30/23	ORNL	IRSN will collaborate
Assess data for Unresolved Resonance Region Evaluation	10/1/23	9/30/24	ORNL	
Finalize Fast Region Evaluation, including new DANCE capture	10/1/22	9/30/24	LANL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
data, and Deliver to NNDC				
Phase I testing, Post to ENDF/A and Broadcast	10/1/24	2/1/25	BNL	
CSEWG Validation Testing	12/1/24	5/1/25	NDAG	
CSEWG Approval of Complete Evaluations	5/1/25	12/30/248/1/25	BNL	
Uranium (U-234)	10/1/11	8/1/21		
Finalize Resonance Evaluation and Deliver to NNDC	10/1/11	9/30/14	ORNL	
Phase I testing, Post to ENDF/A and Broadcast	10/1/14	9/30/17	BNL	
CSEWG Validation Testing	10/1/17	12/31/17	NDAG	
CSEWG Approval of Complete Evaluations	10/1/15	12/31/16	BNL	
Revisit capture cross section and covariance based on new DANCE data	4/1/18	3/31/20	LANL	
Update U-234 evaluation based on new capture cross section and deliver to NNDC	10/1/19	9/30/20	LANL	
Phase I testing, Post to ENDF/A and Broadcast	10/1/20	2/1/21	BNL	
CSEWG Validation Testing	12/1/20	5/1/21	NDAG	
CSEWG Approval of Complete Evaluations	5/1/21	8/1/21	BNL	
Uranium (U-235)	10/1/11	9/30/23		
Deliver p(nu) Data in ENDF/B Format	10/2/12	9/30/13	LANL	
Deliver Multiplicity-Dependent Fission Spectra	10/2/13	9/30/14	LANL	
Deliver Prompt Fission Gamma Spectra	10/1/14	3/31/16	LANL	
Review the evaluation of U-235 capture and fission cross sections based on new measurements at LANSCE	4/1/16	9/30/17	LANL	
Resolved Resonance Capture Evaluation Per WPEC SG29 Recommendations	10/1/11	9/30/14	ORNL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
CSEWG Validation Testing	10/1/14	9/30/17	NDAG	
CSEWG Approval of Complete Evaluation(s)	10/1/17	12/31/17	BNL	
Update Prompt Fission Neutron Spectra Based on LANSCE Low-Energy Emission Data	10/1/15	9/30/18	LANL	
Finalize prompt fission neutron spectra based on LANSCE high-energy emission data from Chi-Nu	10/1/20	9/30/21	LANL	
Finalize a report assessing our methodology to evaluate PFNS and multiplicity consistently, including angular information about prompt neutrons	4/1/19	9/30/20	LANL	
Evaluate PFNS and multiplicity consistently, including angular information about prompt neutrons	10/1/19	9/30/21	LANL	
Update fission cross section and covariance evaluation based on new TPC results (from U235/U238 ratio data)	10/1/18	9/30/19	LANL	
Update fission cross section based on TPC Results (from Pu-239/U-235 ratio data)	10/1/20	9/30/21	LANL	
Develop consistent evaluation of fission yields, neutron multiplicity, and spectra from thermal to 20 MeV	10/1/19	9/30/21	LANL	
Revisit elastic and inelastic cross sections based on planned LANSCE experiments using Chi-Nu	10/1/21	9/30/23	LANL	
Uranium (U-236)	10/1/11	2/1/20		
Transmission measurements at LANL or GELINA	>2025		ORNL	
Resonance evaluation	>2025		ORNL	
Revisit capture cross section and covariance based on new DANCE data	4/1/17	9/30/18	LANL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Update U-236 evaluation based on new capture cross section and deliver to NNDC	10/1/18	3/31/19	LANL	
Phase I testing, Post to ENDF/A and Broadcast	4/1/19	8/1/19	BNL	
CSEWG Validation Testing	6/1/19	11/1/19	NDAG	
CSEWG Approval of Complete Evaluations	11/1/19	2/1/20	BNL	
Uranium (U-238)	10/1/12	3/31/23		
Unresolved Resonance Region Evaluation Using the Hwang-Leal Methodology	10/1/13	12/31/15	ORNL	
Finalize URR Evaluation and Deliver to NNDC	1/1/16	1/1/16	ORNL	
Deliver p(nu) Data in ENDF/B Format	10/1/12	9/30/13	LANL	
Deliver Multiplicity-Dependent Fission Spectra	10/1/13	9/30/14	LANL	
Deliver Prompt Fission Gamma Spectra	10/1/14	3/31/16	LANL	
Phase I Testing, Post to ENDF/A and Broadcast	1/1/16	1/15/16	BNL	
CSEWG Validation Testing	1/16/16	12/31/16	NDAG	
CSEWG Approval of Complete Evaluation(s)	1/1/17	2/28/17	BNL	
Revisit fission cross section and covariance evaluation based on new TPC data (based on U238/U235 ratio data)	10/1/17	9/30/19	LANL	
Finalize Prompt Fission Neutron Spectra Based on LANSCE Chi-Nu Data	10/1/21	3/31/23	LANL	
Finalize a report assessing our methodology to evaluate PFNS and multiplicity consistently, including angular information about prompt neutrons	4/1/19	9/30/20	LANL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Evaluate PFNS and multiplicity consistently, including angular information about prompt neutrons	10/1/20	9/30/22	LANL	
Vanadium (V-51)	10/1/14	12/31/23		Additional task for measurement was described above
Complete Resonance Region Capture Measurements (Geel)	12/30/21	9/30/22	ORNL	Due to enhanced neutron scattering and MS of the thin V sample, experiments with a diluted sample are needed for the energy region below 10 keV.
Perform SAMMY Analysis	12/30/21	9/30/23	ORNL	The evaluation work should be started on the basis on the additional needed measurements
Finalize Resonance Evaluation and Deliver to NNDC	9/30/23	9/30/23	ORNL	
Phase I Testing, Post to ENDF/A and Broadcast	10/1/23	10/15/23	BNL	
CSEWG Validation Testing	10/16/23	10/31/23	NDAG	
CSEWG Approval of Complete Evaluation(s)	11/1/23	12/31/23	BNL	
Zirconium (Zr-90,91,92,94,96)	9/30/14	12/30/24		Capture and transmission Experiments with different nat-Zr samples have been performed
Deliver Updated High-Energy Evaluation of Zr-90	10/1/14	9/30/15	LANL	
Phase I Testing, Post to ENDF/A and Broadeast	10/1/15	10/15/15	BNL	
CSEWG Validation Testing	10/16/15	10/31/16	NDAG	
CSEWG Approval of Complete Evaluations	11/1/16	12/31/16	BNL	
Transmission and Capture Measurements	3/30/20	3/30/25	ORNL	Delay due to COVID-19
Experimentalist Data Reduction and Testing			ORNL	
Resolved Resonance Region Evaluation	3/30/21	6/30/26	ORNL	
Assess Data for URR Evaluation and Complete URR Evaluation	TBD	TBD	ORNL	
Finalize Resonance Evaluation and Deliver to NNDC	TBD	TBD	ORNL	

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

- Hydrofluoric Acid (HF)
- Paraffin (C_nH_{2n+2})
- Plutonium Oxide **(**PuO_2)
- Polyethylene $(C_2H_4)_n$ – subthermal transmission
- Polystyrene $(C_8H_8)_n$
- Uranium Metal (U)
- Uranium Carbide (UC)
- Uranyl Fluoride (UO_2F_2)
- Uranium Hexafluoride (UF_6)
- Triuranium Octoxide (U_3O_8)
- Uranium Silicide (U_3Si_2)
- 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
- Uranium Hydride (UH_3) – evaluate by NNL

Table B-2. Thermal Scattering Measurements and Evaluations - Compounds

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Water (H_2O)	10/1/17	12/31/20		
Thermal Scattering Evaluation	10/1/17	9/30/20	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	9/30/20	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/20	BNL	
Hydrofluoric Acid (HF)	10/1/18	12/31/20		
Thermal Scattering Evaluation	10/1/18	9/30/20	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	9/30/20	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/20	BNL	
Uranium Hexafluoride (UF_6)	10/1/18	12/31/20		
Thermal Scattering Evaluation	10/1/18	9/30/20	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	9/30/20	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/20	BNL	
Uranium Metal (U)	10/1/19	12/31/21		Replaced hydraulic fluid.
Thermal Scattering Evaluation	TBD	TBD	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	TBD	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/21	BNL	
Uranium Carbide (UC)	10/1/20	12/31/22		
Thermal Scattering Evaluation	TBD	TBD	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	TBD	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/22	BNL	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
Paraffin (C_nH_{n+2})	10/1/21	12/31/23		
Thermal Transmission Measurements	TBD	TBD	RPI	
Thermal Scattering Evaluation	TBD	TBD	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	TBD	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/23	BNL	
Triuranium Octoxide (U_3O_8)	10/1/22	12/31/24		
Thermal Transmission Measurements	TBD	TBD	RPI	
Thermal Scattering Evaluation	TBD	TBD	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	TBD	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/24	BNL	
Uranyl Fluoride (UO_2F_2)	10/1/23	12/31/25		
Thermal Transmission Measurements	TBD	TBD	RPI	
Thermal Scattering Evaluation	TBD	TBD	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	TBD	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/25	BNL	
Uranium Silicide (U_3Si_2)	10/1/24	12/31/26		
Thermal Transmission Measurements	TBD	TBD	RPI	
Thermal Scattering Evaluation	TBD	TBD	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	TBD	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/26	BNL	
Plutonium Oxide (PuO_2)	10/1/25	12/31/27		.
Thermal Scattering Measurements	TBD	TBD	NCSU	
Thermal Scattering Evaluation	TBD	TBD	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	TBD	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	

Isotope(s)	Start Date	End Date	Responsible Laboratory	Comments
CSEWG Approval of Complete Evaluation	TBD	12/31/27	BNL	
Uranium Silicide (U_3Si_2)	10/1/24	12/31/26		
Thermal Transmission Measurements	TBD	TBD	RPI	
Thermal Scattering Evaluation	TBD	TBD	NCSU	
Finalize and Deliver Evaluation to NNDC	TBD	TBD	NCSU	
Phase 1 Testing, Post to ENDF/A and Broadcast	TBD	TBD	BNL	
CSEWG Validation Testing	TBD	TBD	NDAG	
CSEWG Approval of Complete Evaluation	TBD	12/31/26	BNL	
Polystyrene $(C_8H_8)_n$	10/1/19	9/30/22		
Procure Samples	10/1/19	6/30/20	ORNL	
Write Proposal for Beamtime	3/30/20	3/30/20	ORNL	
Experiment Preparations	6/30/20	6/30/20	ORNL	
Differential Thermal Scattering Measurements at SNS	7/1/20	12/31/20	ORNL	Experiments may be delayed due to COVID-19
Data Reduction & Analysis of SNS Data	7/1/20	2/28/21	ORNL	
Sub thermal Transmission Measurements at RPI	1/1/21	4/1/21	ORNL/RPI	Dependent on progress of sub thermal moderator at RPI, which is experiencing COVID-19 related delays.
Data Reduction & Analysis of RPI Data	1/1/21	5/1/21	ORNL/RPI	
Prepare Experimental Data for Submission to EXFOR	5/1/21	7/31/21	ORNL	
Submit Experimental Data to EXFOR	7/31/21	7/31/21	ORNL	
Perform Thermal Scattering Evaluation	6/1/20	7/1/22	ORNL	
Finalize and Deliver Evaluation to NNDC	7/15/22	7/31/22	ORNL	
Phase 1 Testing, Post to ENDF/A and Broadcast	8/1/22	8/14/22	BNL	
CSEWG Validation Testing	8/15/22	8/30/22	NDAG	
CSEWG Approval of Complete Evaluation	9/1/22	9/30/22	BNL	
Polyethylene $(C_2H_4)_n$	10/1/20	9/30/21		
Sub-thermal transmission measurements at RPI	10/1/20	9/30/21	RPI	
Data reduction and analysis	10/1/20	9/30/21	RPI	
Submit Experimental data to EXFOR	9/1/21	9/30/21	RPI	

APPENDIX C: Fiscal Year 2021 Projected Foreign Travel

Lab and Participant(s)	Destination	Date	Count	Costs ($)	Conference/Meeting Title	Task	Milestone	Justification
LLNL Heinrichs, Norris, Percher	OECD/NEA Paris, France	Oct-20	3	0 (Virtual)	ICSBEP, IRPhE, and SINBAD Technical Review Meetings	IE, IPD, TS	Provide brief trip summary report to NCSP Manager (Q1).	ICSBEP, IRPhE, and SINBAD Technical Review Meetings.
LLNL Godfree, Mattoon	IAEA NDS Vienna, Austria	Oct-20	2	12,000	IAEA Technical Meeting on Nuclear Data Processing	AM	Provide brief trip summary report to NCSP Manager (Q1)	Technical meeting of international experts on nuclear data processing methods and codes.
LLNL Coleman, Percher	Brussels, Belgium	Nov-20	2	12,000	Nuclear Education and Training NESTet 2021 International Conference	TE	Provide brief trip summary report to NCSP Manager (Q1)	Premier conference on nuclear education and training.
LLNL Norris, Siefman	OECD/NEA Paris, France	Nov-20	2	12,000	OECD NEA Training Course on FISPACT-II	AM, IE, IPD, ND, TS	Provide brief trip summary report to NCSP Manager (Q1)	Unique training opportunity on UKAEA's enhanced multiphysics, inventory, and source term code system.
LLNL Heckmaier, Mattoon	IAEA NDS Vienna, Austria	Dec-20	2	12,000	IAEA Technical Workshop on Compilation of Experimental Nuclear Reaction Data (EXFOR)	ND, TS	Provide brief trip summary report to NCSP Manager (Q1)	Technical meeting of international experts on nuclear data compilation essential for nuclear data evaluation.
LLNL Chidambaram, Stone	Lausanne, Switzerland	May-21	2	12,000	International Symposium on Reactor Dosimetry ISRD 2021	AM, IE, IPD	Provide brief trip summary report to NCSP Manager (Q3)	Premier conference on experimental techniques, databases, and standards for neutron metrology.
LLNL Mattoon, Percher, Siefman	OECD/NEA Paris, France	May-21	3	18,000	WPEC Annual Meeting and associated subgroup meetings	AM, IE, ND, TS	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).
LLNL Siefman	Giardini Naxos, Sicily, Italy	May-21	1	6,000	Best Estimate Plus Uncertainty (BEPU) 2020 International Conference	IE, IP&D	Provide brief trip summary report to NCSP Manager (Q1)	Premiere conference on best estimate and uncertainty methodologies. (https://www.nineeng.com/bepu2020/)

Lab and Participant(s)	Destination	Date	Count	Costs ($)	Conference/Meeting Title	Task	Milestone	Justification
LLNL Coleman	Japan	Jun-21	1	6,000	World Nuclear University	TS	Provide brief trip summary report to NCSP Manager (Q3).	Unique nuclear educational and training opportunity for emerging leaders and SMEs in nuclear technology.
LLNL Percher, Zywiec	OECD/NEA Paris, France	Sep-21	2	12,000	WPNCS Meeting	AM, IE, IPD, TS	Provide brief trip summary report to NCSP Manager (Q4).	Participate in activities of the Working Party on Nuclear Criticality Safety and expert group meetings on IE S/U, MC methods, criticality accidents, and experimental needs.
LLNL Mattoon, Siefman	Tokyo, Japan	Sep-21	2	12,000	Fifth International Workshop on Nuclear Data Covariances CW2020	AM, ND, TS	Provide brief trip summary report to NCSP Manager (Q4).	Premier workshop on covariances and S/U methods.
LLNL Coleman, Yamanaka, Zywiec	Aldermaston, United Kingdom	TBD-2021	3	18,000	JOWOG29/30 Meetings	AM, IE, IPD, ND, TE, TS	Provide brief trip summary report to NCSP Manager (Q4).	Coordinate joint AWE-LLNL work as described in Appendix F of the Five-Year Execution Plan.
LLNL Heinrichs, Percher, Siefman	Paris, France	TBD-2021	3	18,000	Coordinate International Collaboration Efforts with IRSN	AM, IE, IPD, 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.
LLNL Zywiec	Toronto, Canada	Jun-21	1	6,000	Deep Learning Summit	IE	Provide brief trip summary report to NCSP Manager (Q3).	International conference focusing on deep learning methodology, current research areas and practical applications.
NNL NDAG Chair (Zerkle)	OECD/NEA Paris, France	Oct-20	1	0 (Virtual)	ICSBEP, SINBAD, and IRPhE Technical Review Meetings	ND	Provide brief trip summary report to NCSP Manager (Q1).	Provide oversight of NCSP IE tasks as ICSBEP, SINBAD, and IRPhEP tasks are the end product of the NCSP IE process. May be held online due to COVID-19.
NNL NDAG Chair (Zerkle)	OECD/NEA Paris, France	May-21	1	6,000	WPEC Annual Meeting and associated subgroup meetings	ND	Provide brief trip summary report to NCSP Manager (Q3).	As NDAG Chair, participate in WPEC.
NNL NDAG Chair (Zerkle)	OECD/NEA Paris, France	Sep-21	1	6,000	WPNCS Meeting	ND	Provide brief trip summary report to NCSP Manager (Q4).	As NDAG Chair, participate in SG8 on criticality benchmark expert knowledge.
RPI Danon	OECD/NEA Paris, France	May-21	1	6,000	WPEC Annual Meeting and associated subgroup meetings.	ND	Provide brief trip summary report to NCSP Manager (Q3).	As CSEWG US Measurements Chair, participate and present in the WPEC meeting, subgroup SG-C (high priority list), and other subgroups. Also actively participate in SG-48 (Advances in Thermal Scattering Law Analysis).

Lab and Participant(s)	Destination	Date	Count	Costs ($)	Conference/Meeting Title	Task	Milestone	Justification
LANL Hutchinson, Amundson, McKenzie, McSpaden, Kristin Smith, Favorite	OECD/NEA Paris, France	Oct-20	6	0 (Virtual)	ICSBEP, IRPhE, and SINBAD Technical Review Meetings	IE, TS	Provide brief trip summary report to NCSP Manager (Q1).	Authors or reviewers for KRUSTY and JAEA evaluations for ICSBEP. Also attend IRPhE, and SINBAD Technical Review Meetings.
LANL Paris, Herman, Colin, Haeck, Thompson, Cutler	OECD/NEA Paris, France	May-21	6	36,000	WPEC Annual Meeting and associated subgroup meetings	ND, AM, IE	Provide brief trip summary report to NCSP Manager (Q3).	Contributor and co-leads of multiple sub-groups and expert groups, including SG45 "Validation of Nuclear Data Libraries (VaNDaL) Project," SG46 ""Efficient and Effective Use of Integral Experiments for Nuclear Data Validation," SG49 "Reproducibility in Nuclear Data Evaluation," and SG38 "Beyond the ENDF format: A modern nuclear database structure." All of these groups are focused on activities that overlap with NCSP priorities.
LANL Brown, Rising	OECD/NEA Paris, France	Jun-21	2	12,000	OECD Expert Group Meetings for NCSP, collaboration with IRSN on NCS	AM	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.
LANL Hayes, Thompson	OECD/NEA Paris, France	Sep-21	2	12,000	WPNCS Meeting	IPD, TS	Provide brief trip summary report to NCSP Manager (Q4).	Participate in activities of the Working Party on Nuclear Criticality Safety and expert group meetings. Related to NCSP priorities.
ORNL Bowen, Marshall	OECD/NEA Paris, France	Oct.-20	2	0 (Virtual)	ICSBEP, IRPhE, and SINBAD Technical Review Meetings	TS, IE, AM2	Provide brief trip summary report to NCSP Manager (Q1).	Provide oversight of NCSP IE tasks as ICSBEP tasks are the end product of the NCSP IE process.
ORNL Wiarda, McDonnell	IAEA NDS Vienna, Austria	Oct-20	2	12,000	IAEA Technical Meeting on Nuclear Data Processing	AM	Provide brief trip summary report to NCSP Manager (Q1)	Technical meeting of international experts on nuclear data processing methods and codes.

Lab and Participant(s)	Destination	Date	Count	Costs ($)	Conference/Meeting Title	Task	Milestone	Justification
ORNL Bowen	London, UK or Paris, FR	Nov-20	1	6,000	ISO TC85/SC5 Plenary and WG8 Nuclear Criticality Safety Meetings	TS	Provide brief trip summary report to NCSP Manager (Q4).	Continue to provide US leadership with ISO Nuclear Criticality Safety Standards (Rescheduled 2020 meeting)
ORNL Pigni, Chapman	IAEA NDS Vienna, Austria	Dec-20	2	12,000	IAEA Technical Workshop on Compilation of Experimental Nuclear Reaction Data (EXFOR)	ND, TS	Provide brief trip summary report to NCSP Manager (Q1)	Technical meeting of international experts on nuclear data compilation essential for nuclear data evaluation.
ORNL Guber, Brown	IRMM Mol, Belgium	Jan-21	6	20,000	Resonance region nuclear data measurements using GELINA facility at IRMM	ND, TS	Provide brief trip summary report to NCSP Manager (Q2).	Continues cross-section measurements to support the production of new cross-section evaluations per the schedule in Appendix B of the Five-Year Plan. Jesse Brown to support half of the visits to supporting succession planning.
ORNL Guber, Brown	IRMM Mol, Belgium	Apr-21	6	90,000	Resonance region nuclear data measurements using GELINA facility at IRMM	ND, TS	Provide brief trip summary report to NCSP Manager (Q3).	Continues cross-section measurements to support the production of new cross-section evaluations per the schedule in Appendix B of the Five-Year Plan. Jesse Brown to support half of the visits to supporting succession planning.
ORNL Pigni, Wiarda	OECD/NEA Paris, France	May-21	2	12,000	WPEC Annual Meeting and associated subgroup meetings	ND, TS	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)
ORNL Bowen	Tokyo, JP	May-21	1	7,500	ISO TC85/SC5 Plenary and WG8 Nuclear Criticality Safety Meetings	TS	Provide brief trip summary report to NCSP Manager (Q3).	Continue to provide US leadership with ISO Nuclear Criticality Safety Standards (Annual Meeting)
ORNL Guber	IRMM Mol, Belgium	Jun-21	6	10,000	Resonance region nuclear data measurements using GELINA facility at IRMM	ND, TS	Provide brief trip summary report to NCSP Manager (Q3).	Continues cross-section measurements to support the production of new cross-section evaluations per the schedule in Appendix B of the Five-Year Plan. Jesse Brown to support half of the visits to supporting succession planning.

Lab and Participant(s)	Destination	Date	Count	Costs ($)	Conference/Meeting Title	Task	Milestone	Justification
ORNL Holcomb, Arbanas, or Pigni	Tokyo, JP	Sep-21	2	12,000	5th International Conference on Nuclear Data Covariances	ND, TS	Provide brief trip summary report to NCSP Manager (Q4).	This conference is within the mission of ORNL ND work and aligned with the NCSP Mission and Vision.
ORNL Guber, Brown	IRMM Mol, Belgium	Sep-21	6	20,000	Resonance region nuclear data measurements using GELINA facility at IRMM	ND, TS	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. Jesse Brown to support half of the visits to supporting succession planning.
ORNL Marshall, Bowen, Clarity, Wieselquist, Hart	OECD/NEA Paris, France	Sep-21	5	30,000	WPNCS Meeting	TS, IE, AM	Provide brief trip summary report to NCSP Manager (Q4).	AM collaboration; provide relationship between IAEA and ISO with respect to NCS standards.
ORNL Bowen	Aldermaston, United Kingdom	TBD-21	1	6,000	JOWOG29/30 Meetings	TS	Provide brief trip summary report to NCSP Manager (Q4).	Coordinate NCSP work as described in Appendix F of the Five Year Execution Plan. Bowen invited to participate.
ORNL Pigni	Vienna, Austria	TBD-21	1	6,000	IAEA International Nuclear Data Evaluation Network (INDEN)	ND	Provide brief trip summary report to NCSP Manager (Q3).	IAEA International Nuclear Data Evaluation Network (INDEN), Vienna, 1 week. International nuclear data evaluation collaboration. Represent NCSP and ORNL interests in international nuclear data evaluation.
ORNL Wiarda, Holcomb, McDonnell	Paris, France	TBD-21	3	18,000	IRSN Meetings	AM, IE, IPD, ND, TS	Provide brief trip summary report to NCSP Manager (Q3).	Coordinate joint IRSN-ORNL work per 5YP such as the Pu SlideRule; Collaborate with IRSN on the resonance evaluation of the isotopes for the NCSP.
ORNL Arbanas, Wiarda, Brown	Tokyo, Japan	Sep-21	3	18,000	5th International Conference on Nuclear Data Covariances	ND	Provide brief trip summary report to NCSP Manager (Q4).	This conference is within the mission of ORNL ND work and aligned with the NCSP Mission and Vision.
SNL Ames, Harms, Lutz	OECD/NEA Paris, France	Oct-20	3	0 (Virtual Meeting)	ICSBEP, IRPhE, and SINBAD Technical Review Meetings	IE, TS	Provide brief trip summary report to NCSP Manager (Q2).	ICSBEP, IRPhE, and SINBAD Technical Review Meetings.

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 FY2021-FY2023

Baseline Budget Needs for Execution Year FY2021

Baseline budget need for the FY2021 Nuclear Criticality Safety Program (NCSP) is $29,126K with 95% of funding supporting NCSP FTE's, equating to approximately 58 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. Also, development of updated Criticality SlideRule capability. ~9.3 FTEs supported. International collaborations: SCALE, NJOY, MCNP, AMPX work with AWE and IRSN.
- Information Preservation and Dissemination
    - NCSP website upgrade and maintenance. Four new ICSBEP evaluations and publications (OECD collaboration). Provide experimental uncertainty correlations. ~1.9 FTEs supported.
- Integral Experiments
    - Execution of ~29 critical/subcritical experiment and 6 critical/subcritical experiment evaluations published (NCERC and SNL). ~29.3 FTEs supported. Permanent party staff supported. Control System upgrades needed. International collaborations: TEX experiments with IRSN and AWE, CAAS experiment design and execution for Y-12 with AWE and IRSN involvement.
    - The NCSP will complete benchmark 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 FY2021 are shown in Appendix B. RPI refurbishment (NR collaboration) continues despite some cost overruns for ancillary equipment. Produce new scattering law data (NCSU and RPI collaboration). Modernization of SAMMY resonance analysis software. ~9.8 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 2-week course at Y-12/NCERC may be necessary to support new NCS staff undergoing training and qualification.
    - One 1-week managers course at Sandia. This course will be used to pilot new Criticality Safety Officer (CSO) training material.
    - One 1-week managers course at NCERC. This course will be used to pilot new training material.
    - ~3.2 FTEs supported.
- NCSP Technical Support: CSSG. NDAG. Succession planning for key areas of NCSP expertise, including CSSG. ORNL management support. ~4.8 FTEs supported.

The approved Over target budget for FY2022 NCSP is $0.35M that would support one high priority task to address key Mission and Vision goals not addressed within the current budget target:

- Radiation Safety Information Computational Center (RSICC) to support code package distribution costs for university students ($350K)

Baseline Budget Needs for Execution Year FY2022

Baseline budget need for the FY2022 Nuclear Criticality Safety Program (NCSP) is $29,648K with 95% of funding supporting NCSP FTE's, equating to ~59.3 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 FY2022:

- 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. ~10 FTEs supported. International collaborations: SCALE, NJOY, MCNP, AMPX work with AWE and IRSN.
- Information Preservation and Dissemination
    - NCSP website upgrade and maintenance. ~2.1 FTEs supported. Three ICSBEP evaluations and publications (OECD collaboration). Provide experimental uncertainty correlations.
- Integral Experiments
    - Execution of ~20 critical/subcritical experiment and 6 critical/subcritical experiment evaluations published (NCERC and SNL). Approximately 32.4 FTEs supported. 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 FY2022 are shown in Appendix B. RPI refurbishment (NR collaboration). Produce new scattering law data (NCSU and RPI collaboration). Modernization of SAMMY resonance analysis software. ~8.8 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/criticality safety officer course at Sandia.
    - One 1-week managers/criticality safety officer course at NCERC.
    - ~3.3 FTE supported.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~3.2 FTEs supported.

The approved Over target budget for FY2022 NCSP is $2.648M that would support high priority tasks to address key Mission and Vision goals not addressed within the current budget target:

- Complete tasks in the NCSP 5-year plan ($898K)
- Additional funding to support a minimum of two 2-week hands-on NCSP courses ($500K)
- Additional RSICC funding ($700K)
- RPI accelerator refurbishment ($150K)
- Subcritical assembly at ORNL for Use with CSO/FMH Courses ($400K)

Baseline Budget Needs for Execution Year FY2023

Baseline budget need for the FY2023 Nuclear Criticality Safety Program (NCSP) is $29,926K with 95% of funding supporting NCSP FTE's, equating to approximately 60.0 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 FY2023:

- 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. ~9.9 FTEs supported. International collaborations: SCALE, NJOY, MCNP, AMPX work with AWE and IRSN.
- Information Preservation and Dissemination
    - NCSP website upgrade and maintenance. Several new ICSBEP evaluations and publications (OECD collaboration) possible. ~2 FTEs supported. Provide experimental uncertainty correlations.
- Integral Experiments
    - Execution of ~18 critical/subcritical experiment and 9 critical/subcritical experiment evaluations published (NCERC and SNL). ~33.6 FTEs supported. 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 FY2023 are shown in Appendix B. RPI refurbishment (NR collaboration). Produce new scattering law data (NCSU and RPI collaboration). Modernization of SAMMY resonance analysis software ~7.5 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 CSO/Manager course at Sandia.
    - One 1-week CSO/Manager course at NCERC.
- NCSP Technical Support: CSSG. NDAG. Succession Planning for key areas of NCSP expertise. ORNL management support. ~3.2 FTEs supported.

APPENDIX E: International Collaboration with the Institut de Radioprotection et de Sûreté Nucléaire (IRSN) for FY2021

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 2021 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
ANALYTICAL METHODS						
IRSN-AM1	Validation and qualification methods	ORNL-AM2 ORNL-IPD4	Determination of the experimental correlations of Valduc experiments. To be discussed with ORNL.	N. LECLAIRE	B.J. MARSHAL	ORNL
IRSN-AM5	Update of the slide rule	ORNL-AM6 LLNL-AM3 AWE-AM1	Contribution to doses computation benchmarks, comparison with COG and SCALE results	M. DULUC	D. BOWEN D. HEINRICHS R. JONES	ORNL LLNL AWE
IRSN-AM8	Analytical Methods Working Group	NCSP-TS2	IRSN participation to NCSP analytical methods Working Group, NDAG meeting, and TPR meeting	S. PIGNET	F. BROWN D. BOWEN D. HEINRICHS	NCSP
IRSN-AM9	Cross sections processing validation	ORNL-AM3	AMPX training - Development of an interface between GAIA and AMPX and test interface capabilities.	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. MIX, U233 and SPEC systems will be included in FY 2021.	N. LECLAIRE	D. HEINRICHS D. BOWEN F. BROWN	LLNL ORNL LANL
IRSN-AM14	Sensitivity/Uncertainty comparison study with a focus on Upper Subcritical Limits	ORNL-AM9 LANL-AM4	Definition of test cases Calculations and intercomparison Technical report	A. BARDELAY	F. BROWN D. BOWEN	LANL ORNL
IRSN-AM15	MCNP Maintenance and Support / Uncertainty Analysis Development / Modernization / etc.	LANL-AM1	Interest for uncertainty analysis, source convergence development and modernization strategy	W. MONANGE	F. BROWN	LANL
INTEGRAL EXPERIMENTS						
IRSN-IE6 **IER 306**	Rh experiment	SNL-IE1	CED-2 report	N. LECLAIRE	G. HARMS	SNL
IRSN-IE7 **IER 305**	Mo experiment	SNL-IE1	Leading the CED-3a report; Supplying the Mo rods for the experiment. Participation to the experiments	N. LECLAIRE	G. HARMS	SNL
IRSN-IE11 **IER 297**	TEX - Hf baseline experiments (HEU)	LLNL-IE4	Contribution to ICSBEP evaluation of the baselines experiments	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE11 **IER 532**	TEX-Hf experiments	LLNL-IE4	Participation to experiments and analysis of results	M. BROVCHENKO	C. PERCHER	LLNL
IRSN-IE27 **IER 498**	GODIVA CAAS benchmark	ORNL-IE4	Participation in the design (CED2 FY2021) Provide IRSN materials for irradiation	F. TROMPIER	D. BOWEN	ORNL

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2021 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
IRSN-IE28 **IER 406**	Cf-252 CAAS benchmark	LLNL-IE1	Participation to the experiments. Provide IRSN materials for irradiation	F. TROMPIER	D. HEINRICHS	LLNL
IRSN-IE30	Full dosimetry exercise around GODIVA	LLNL-IE1	Participation in the design. Provide IRSN materials for irradiation, analysis of results	F. TROMPIER	D. HEINRICHS	LLNL AWE
IRSN-IE34 **IER 488**	MUSIC (HEU) critical and Subcritical measurements.	LANL-IE23	Participation to the experiments, analysis of results	W. MONANGE	J. HUTCHINSON	LANL
IRSN-IE36 **IER 514**	ICSBEP/SINBAD Shielding benchmarks for shipping containers	LLNL-IE1 AWE-IE8	Participation in the design and to the experiments	M. BROVCHENKO	D. HEINRICHS R. JONES	LLNL AWE
IRSN-IE41 **IER 499**	Thermal/Epithermal Experiments (TEX) with Chlorine and Lithium	LLNL-IE23	Participation in experiments design and CED reports.	M. BROVCHENKO	D. HEINRICHS	LLNL
IRSN-IE42 **IER 121**	Neptunium Subcritical Observations (NeSO) experiment	LANL-IE3	Independent review of the ICSBEP evaluation.	W. MONANGE	J. HUTCHINSON	LANL
IRSN-IE45 **IER 517**	Integral Experiments for Validation of Molybdenum Neutron Cross Sections on the whole energy spectrum	LANL-IE3	Participation in experiments design and CED reports.	N. LECLAIRE	D. HAYES T. CUTLER	LANL
IRSN-IE46 **IER 518**	High Multiplication Subcritical (Multiplicity) Benchmark Experiments	LLNL-IE1 SNL-IE1 LANL-IE3	Participation in experiments. IRSN will provide detectors for comparison.	W. MONANGE	D. HEINRICHS G. HARMS J. HUTCHINSON	LLNL SNL LANL
IRSN-IE47	Copper Critical Experiment	LANL-IE3	Participation in experiments design and CED reports. IRSN interest to understand results of various experiments (ZEUS experimental results and IRSN-IE48)	J-B. CLAVEL	J. HUTCHINSON	LANL
IRSN-IE49	Iron/Steel/Chromium Critical Experiment Series	LANL-IE3	Participation in experiments design and CED reports. High interest for IRSN.	J-B. CLAVEL	J. HUTCHINSON	LANL
INFORMATION PRESERVATION AND DISSEMINATION						
IRSN-IPD1	ICSBEP reviewing	LLNL-IPD1	IRSN ICSBEP reviewing tasks are reported in the IE tasks	S. PIGNET	D. HEINRICHS	LLNL
NUCLEAR DATA						
IRSN-ND1	Contribution to new evaluations	ORNL-ND1 NNL-ND1 RPI	Contribution to new evaluations and validation in accordance with the milestone schedule in Appendix B	L. LEAL	D. BOWEN T. TRUMBULL	ORNL NNL RPI

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2021 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
IRSN-ND2	Nuclear data Evaluation and Testing	LANL-ND1 LANL-ND2	Contribution to new evaluations and validation in accordance with the milestone schedule in Appendix B Contribution to Prompt Fission Neutron Spectra (PFNS) Measurement of Plutonium-240	L. LEAL	B. LITTLE N. THOMPSON	LANL
IRSN-ND3	Nuclear data Evaluation and Testing	LLNL-ND8 ORNL-ND1	Resonance evaluation of ^{233}U	L. LEAL	D. HEINRICHS D. BOWEN	LLNL ORNL
IRSN-ND4	Delayed fission gamma multiplicity and spectra	LLNL-ND1 (a and b)	Data testing as new experimental data becomes available from foil activation measurements and dosimetry testing using GODIVA, FLATTOP, and other assemblies	M. BROVCHENKO	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. PIGNET	D. BOWEN	NCSP

APPENDIX F : International Collaboration with the Atomic Weapons Establishment (AWE) for FY2021

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**	**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	S. PIGNET (IRSN) D. BOWEN D. HEINRICHS	ORNL LLNL
INTEGRAL EXPERIMENTS						
AWE-IE1	Inaugural international inter-comparison of nuclear accident dosimetry using Flattop	LLNL-IE1 IRSN-IE15	Co-author final report (CED-4b)	P. ANGUS	D. STONE	LLNL
AWE-IE2	Development of Passive Neutron Spectrometer (PNS)	LLNL-IE1	Fully commission TLD version of the PNS; Perform validation irradiations at NPL; develop unfolding tools for directionality	P. ANGUS	D. STONE	LLNL
AWE-IE3 **IER 406**	Cf-252 CAAS benchmark	LLNL-IE1 IRSN-IE28	Perform/support PNS(TLD) measurements with a shadow cone	P. ANGUS	D. HEINRICHS	LLNL
AWE-IE4 **IER 498**	Godiva-IV CAAS benchmark	ORNL-IE1 IRSN-IE27	Review of experiment design. Provide measurement capability as required	T. BIRKETT	D. BOWEN R. CUMBERLAND	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)	P. ANGUS	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. AWE to do some preliminary design	P. ANGUS	S. KIM	LLNL
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	P. ANGUS	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 IER 500	(Neutron multiplicity experiments) AWE/LLNL NCT 5-year measurement campaign	LLNL-IE1	Participate in experiment design, measurements and reporting	N. KELSALL	D. HEINRICHS	LLNL

Reference			AWE Contributions and POCs			
AWE Reference	**Task Description**	**NCSP Reference**	**AWE Contribution**	**AWE Technical POC**	**Collaborator POC**	**DOE Lab**
AWE-IE10	Enhanced methods of criticality accident dosimetry.	LLNL-IE1 IRSN-IE30 Naval Dosimetry Center	Develop prototypes, participate in design, execution and reporting of dosimetry experiments	P. ANGUS	F. TROMPIER	LLNL
AWE-IE11	International inter-comparison 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	P. ANGUS	D. STONE	LLNL
AWE-IE12	CIDAAS testing	–	Deploy AWE CIDAAS for test irradiation. Repeat 2 - 3 years	T. BIRKETT	J. SCORBY C. PERCHER	LLNL
AWE-IE13	Characterization of AFRRI TRIGA reactor radiation field AWE will provide onsite measurement	LLNL-IE18 SNL-IE4	Provide support to experiment design (Currently pending AFRRI NRC License)	P. ANGUS	A. ROMANYUKHA	LLNL
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	R. JONES	D. HEINRICHS	LLNL
TRAINING AND EDUCATION						
AWE-TE1	Hands-on criticality safety training	ORNL-TE1 LANL-TE1 LLNL-TE1 SNL-TE1 IRSN-TE1	AWE personnel to attend training course	R. JONES	D. BOWEN (Course Coordinator) J. GODA D. HEINRICHS G. HARMS S. PIGNET (IRSN)	ORNL

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