

**United States Department of Energy**  
**Nuclear Criticality Safety Program**  
**Five-Year Execution Plan for the Mission and Vision**  
**FY2013 through FY2017**



**October 2012**

Department of Energy Nuclear Criticality Safety Program Five-Year Execution Plan for Fiscal Years 2013 through 2017, dated October 2012.

Approved:

A handwritten signature in black ink, reading "Jerry N. McKamy". The signature is written in a cursive style with a long horizontal flourish extending to the right.

Dr. Jerry N. McKamy  
Manager  
Nuclear Criticality Safety Program

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## ACRONYMS AND DEFINITIONS

3D	3-dimensional
AM	Analytical Methods
AMPX	Nuclear cross-section processing code
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ARH	Atlantic Richfield Hanford
AWE	Atomic Weapons Establishment
BNL	Brookhaven National Laboratory
BUC	Burn-up Credit
CAAS	Criticality Accident Alarm System
CE	Continuous energies
CEA	Commissariat à l'Énergie Atomique
COG <sup>1</sup>	Lawrence Livermore National Laboratory Monte Carlo Computer Code
CritView	A plotting and interpolation software program designed to display criticality data from the ARH-600 Criticality Handbook
CSCT	Criticality Safety Coordinating Team
CSE	Criticality Safety Evaluation
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)
ESN	Enterprise Secure Network
FY	Fiscal Year
GANDER	Code system to derive covariances from experimental data
GELINA	Linear Accelerator in Geel, Belgium
GForge	Web-based collaborative development environment
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
$k_{\text{eff}}$	The mean number of fission neutrons produced by a neutron during its life within the system
KENO <sup>2</sup>	Monte Carlo Criticality Computer Code
LA	Los Alamos (report)
LANL	Los Alamos National Laboratory
LINAC	Linear Accelerator
LLNL	Lawrence Livermore National Laboratory
MCNP	Monte Carlo N Particle (N currently equals 3) Computer Code
MG	Multi-group energies

MIDAS	Moyens d'Irradiation et d'expérimentations Dédiés à l'Analyse de Sûreté – criticité (Irradiation devices and experimental facilities devoted to the criticality safety assessment)
MIRTE	Matériaux Interaction Réflexion Toutes Epaisseurs
NA00-50	Office of Facilities Operations
NCERC	National Criticality Experiments Research Center
NCS	Nuclear Criticality Safety
NCSET	Nuclear Criticality Safety Engineer Training
NCSP	Nuclear Criticality Safety Program
ND	Nuclear Data
NDAG	Nuclear Data Advisory Group
NJOY	Nuclear cross-section processing code
NNDC	National Nuclear Data Center
NNSA	National Nuclear Security Administration
NNSS	Nevada Nuclear Security Site
OECD/NEA	Organization for Economic Cooperation and Development/Nuclear Energy Agency
ORNL	Oak Ridge National Laboratory
POC	Point of Contact
PREPRO	Nuclear cross-section processing code
QPR	Quarterly Program Review
RPI	Rensselaer Polytechnic Institute
RSICC	Radiation Safety Information Computational Center
SAMMY <sup>3</sup>	A nuclear model computer code
SCALE <sup>4</sup>	A modular modeling and simulation system for nuclear safety analysis and design
SILÈNE	Commissariat à l'Énergie Atomique Uranium Solution Critical Assembly
SNL	Sandia National Laboratories
SQA	Software Quality Assurance
S/U	Sensitivity/Uncertainty
TACS	Training Assembly for Criticality Safety
TRG	Technical Review Group
TSUNAMI	Tool for Sensitivity and Uncertainty Analysis Methodology Implementation
TSURFER <sup>5</sup>	Tool for Sensitive and Uncertainty Analysis of Response Functionals Using Experimental Results
V&V	Verification and Validation
VIM	Argonne National Laboratory Monte Carlo neutron/proton transport code
WPEC	Working Party on International Nuclear Data Evaluation Corporation
WPNCs	Working Party on Nuclear Criticality Safety
ZPPR	Zero-Power Plutonium Reactor
ZPR	Zero-Power Reactor

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<sup>1</sup>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.

<sup>2</sup>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.

<sup>3</sup>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.

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

<sup>5</sup>TSURFER is a module of the SCALE code system that performs a generalized linear least squares adjustment of cross-section data to produce consistency between calculated and experimental results. When coupled with TSUNAMI sensitivity data for a criticality safety application, the adjusted cross-section data can be used to predict a computational bias and its uncertainty.

**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 2009-2018* (<http://ncsp.llnl.gov/NCSP-MV-COMPRESSED.pdf>), are:

The NCSP mission is to provide **sustainable expert** leadership, direction, and the technical infrastructure necessary to develop, maintain, and disseminate essential technical tools, training, and data required to support **safe, efficient** fissionable material **operations** within the United States (U.S.) Department of Energy (DOE).

The NCSP will be a **continually improving, adaptable, and transparent** program that **communicates** and **collaborates** globally to incorporate technology, practices, and programs to be **responsive** to the essential technical needs of those responsible for developing, implementing, and maintaining nuclear criticality safety.

The NCSP is funded by the National Nuclear Security Administration (NNSA). Dr. Jerry McKamy (NA00-50) is the NCSP Manager. He is supported by the Criticality Safety Support Group (CSSG) and the Nuclear Data Advisory Group (NDAG) regarding technical matters and by the Criticality Safety Coordinating Team (CSCT), consisting of Federal Criticality Safety Practitioners at the sites regarding DOE field criticality safety issues. Charters for the CSCT, CSSG, and the NDAG can be found on the NCSP website at: (<http://ncsp.llnl.gov/>). The NCSP Planning Calendar can also be found on the NCSP website at: (<http://ncsp.llnl.gov/>).

## **2.0 Technical Program Elements**

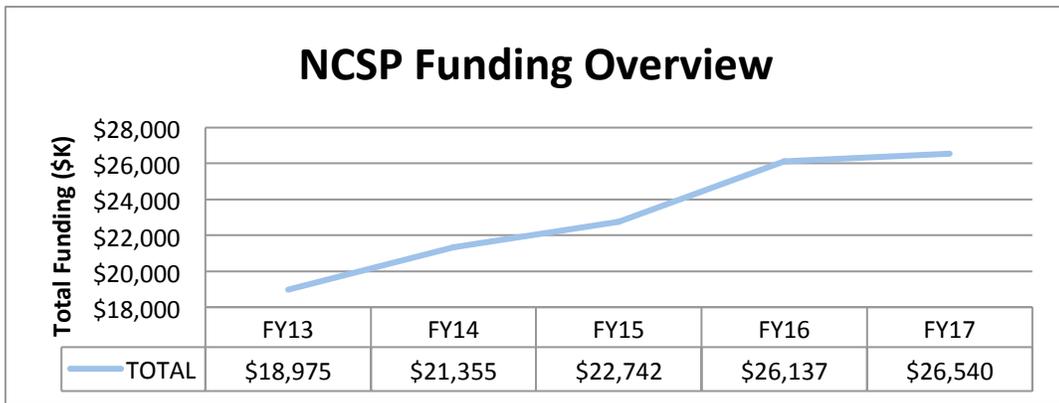
NCSP includes the following five technical program elements:

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

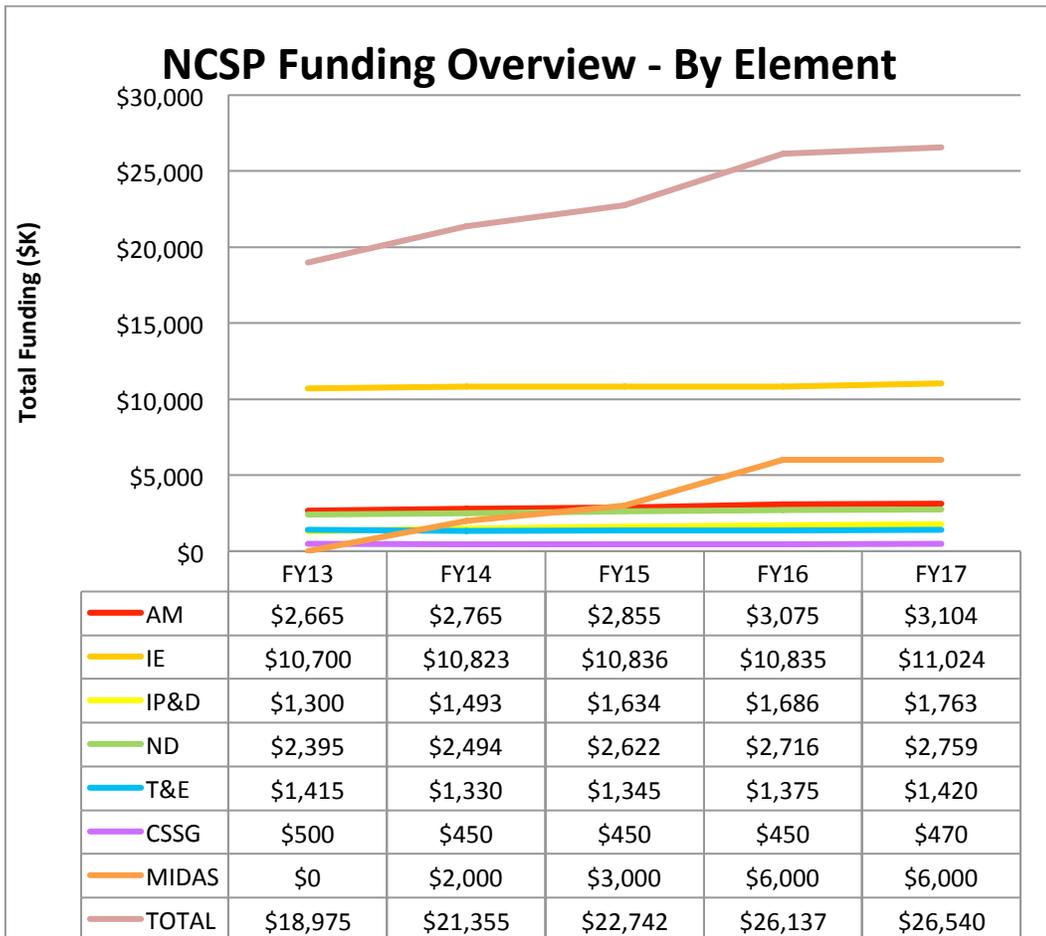
A description of how each of these elements contributes to the enhancement of criticality safety is contained in the NCSP Mission and Vision document. This Five-Year Execution Plan contains the road map for each of the five technical program elements, including a budget, tasks, and milestones for completing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

Funding for NCSP activities conducted in the United States, including programs in France are provided in Table 2.1, 2.2, and 2.3 (rounded to the nearest \$K).

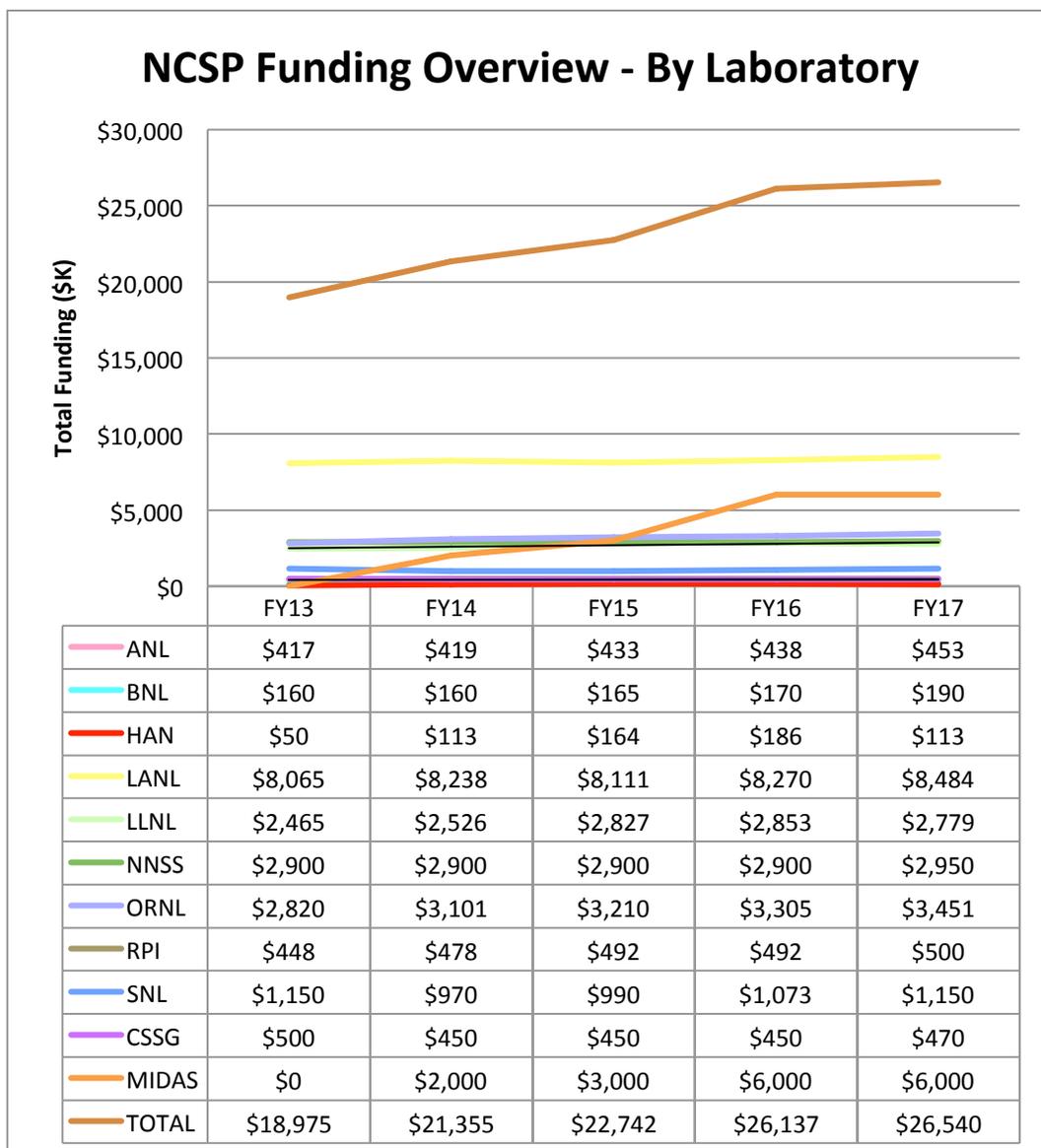
**Table 2.1 NCSP Funding Overview  
(United States Activities and Programs in France)**



**Table 2.2 NCSP Funding Overview – By Element  
(United States Activities and Programs in France)**



**Table 2.3 NCSP Funding Overview – By Laboratory  
(United States Activities and Programs in France)**



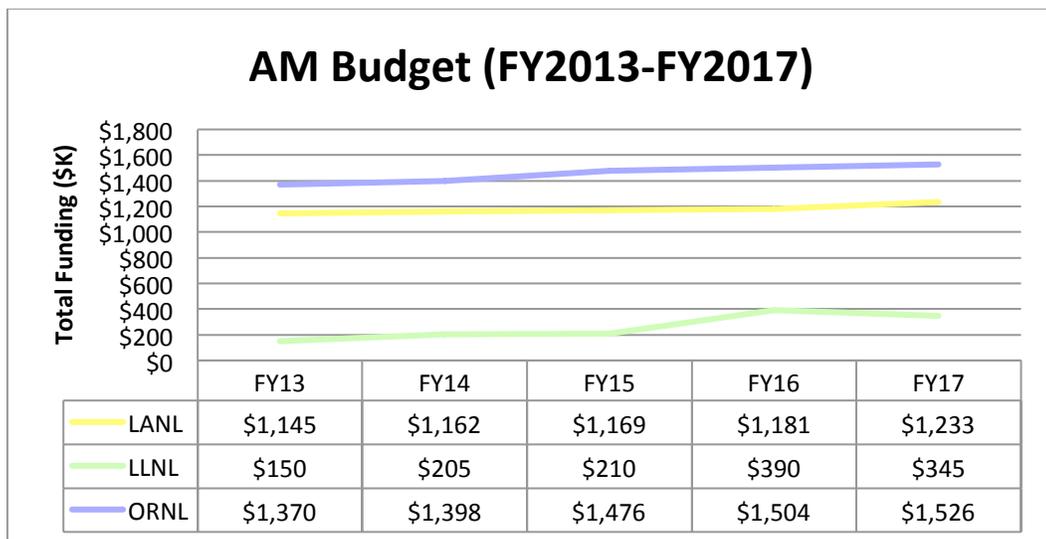
Finally, the goal of the NCSP is to provide “transparent responsiveness” for the DOE and Stakeholders. Therefore, this Plan and all accomplishments achieved under the auspices of the NCSP are posted in a timely manner on the NCSP website at: <http://ncsp.llnl.gov/>.

## 2.1 Analytical Methods (AM)

### 2.1.1 Program Element Description

The Analytical Methods (AM) program element provides development and maintenance of state-of-the-art analytical capability 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 this capability is the human expertise required to develop the analytical software, provide software configuration control, and train and assist the user community.

**Table 2.1-1 AM Budget (FY2013-FY2017)**



## **2.1.2 Approved Tasks**

### **2.1.2.1 Los Alamos National Laboratory (LANL)**

#### **LANL AM1 (\$795K)**

Maintenance of the basic capabilities for performing Nuclear Criticality Safety calculations with MCNP, including general code maintenance, user support, improved nuclear data libraries, Verification and Validation (V&V), documentation, user training, and implementation of limited new capabilities. For all tasks, LANL reports will be issued and posted on the MCNP website.

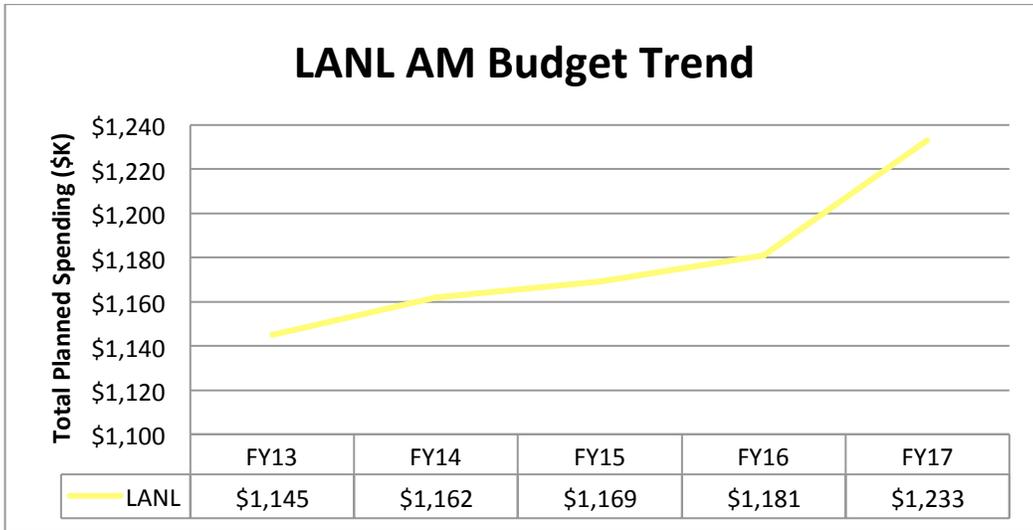
#### **LANL AM2 (\$100K)**

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. Base versions of the NJOY code system will continue to be distributed to the domestic user community through the Radiation Safety Information Computational Center (RSICC) and to the international user community through the Nuclear Energy Agency (NEA) Data Bank, with code updates distributed to all users through a LANL maintained website.

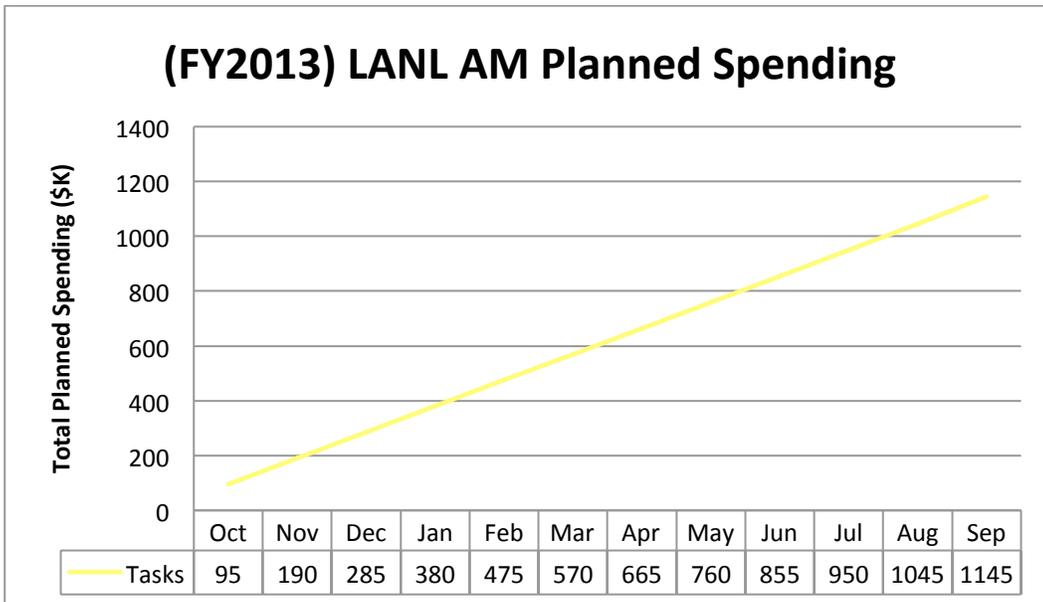
#### **LANL AM3 (\$250K)**

This task is to further MCNP development during FY13-15 with the goal to provide the capability to extract uncertainties in the k-eigenvalue from ENDF covariance data. The scope of the work is to: define an ACE format for covariance data, modify NJOY to process ENDF covariance data into the ACE format, provide ACE covariance data libraries using the most recent ENDF evaluations, develop a post-processing capability for the data in MCNP (a continuous-energy sensitivity capability already exists), and provide documentation, instructions, and verification reports released on the MCNP website.

**Table 2.1-2 LANL AM Budget Trend (FY2013-FY2017)**



**Table 2.1-3 LANL AM Planned Spending (FY2013)**



## **LANL AM Milestones:**

### **Quarter 2**

- Issue an MCNP V&V report (T1: Q2).
- Publish a user's guide on the MCNP website for generating k-eigenvalue sensitivity coefficients with MCNP (T3: Q2).
- Produce a publicly available document detailing the draft ACE extension format for covariance data, and send out e-mail on the MCNP mailing list informing users, asking for input (T3:Q2).

### **Quarter 3**

- Provide one on-site class at a DOE site on the theory and practice of Monte Carlo criticality calculations with MCNP (T1: Q3).

### **Quarter 4**

- Improve MCNP parallel processing capabilities for current computers (T1: Q4).
- Improve the MCNP capabilities for performing uncertainty quantification (T1: Q4).
- Issue a report on temperature dependence and new Doppler broadening methods (T1: Q4).
- Implement a new capability for performing subcritical calculations with MCNP (T1: Q4).
- Release an updated version of MCNP to RSICC (T1: Q4).
- Provide user guidance and support for migrating from MCNP5 to MCNP6 (T1: Q4).
- Release NJOY code updates required to process new ENDF-6 formats, as implemented in US and international general purpose and specialized nuclear data files (T2: Q4).
- Provide end-user consultation on code usage (T2: Q1-Q4).
- Into the MCNP CVS repository, check in modifications to MCNP making it capable of producing SCALE formats of sensitivity data files (T3: Q4).
- Create and publish, on the MCNP website, a progress report on NJOY and MCNP modifications for sensitivity/uncertainty analysis (T3: Q4).

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

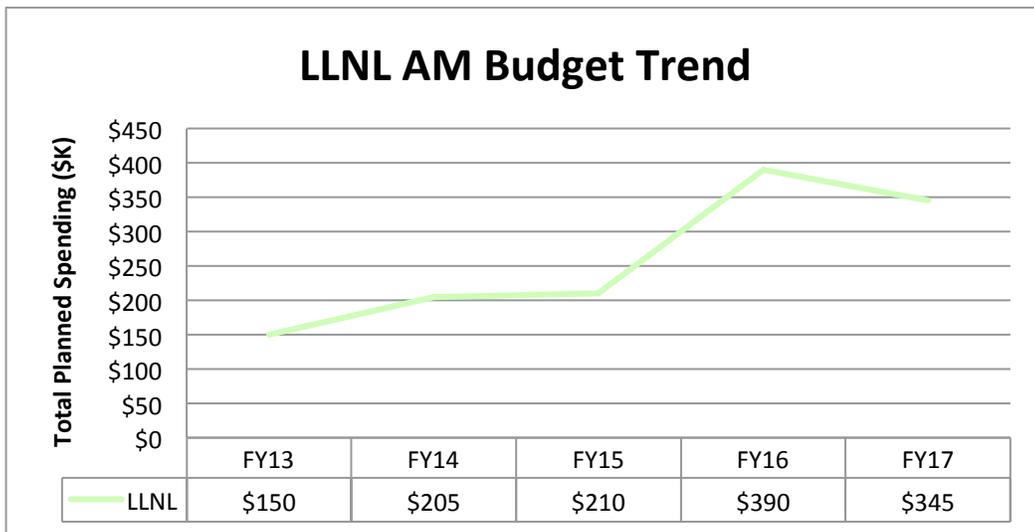
Very modest increases in out years to help mitigate increased cost of doing business.

## 2.1.2.2 Lawrence Livermore National Laboratory (LLNL)

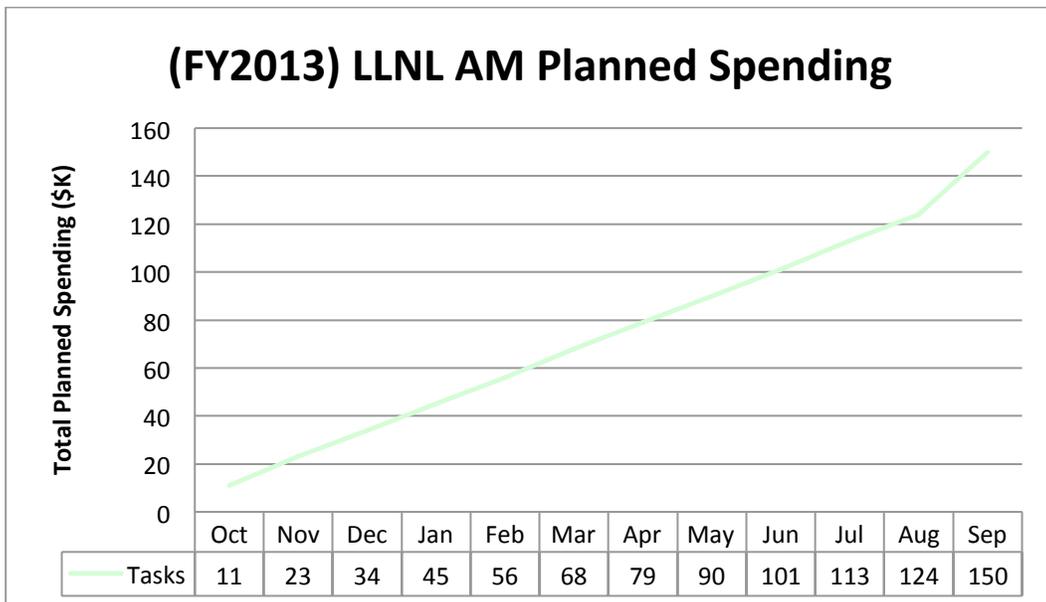
### LLNL AM1 (\$150K)

Ongoing approved activity to provide maintenance, user support and minor upgrades to existing LLNL analytical methods including nuclear data processing, geometry modeling and Monte-Carlo methods. This task also supports on-going LLNL assistance to the International Atomic Energy Agency (IAEA) in developing and maintaining the PREPRO nuclear data processing code system as needed to process and distribute new general-purpose nuclear data files in evolving ENDF-6 format. The task also supports participation in NCSP activities including the Cross Section Evaluation Working Group (CSEWG) and Nuclear Data Advisory Group (NDAG).

**Table 2.1-4 LLNL AM Budget Trend (FY2013-FY2017)**



**Table 2.1-5 LLNL AM Planned Spending (FY2013)**



## **LLNL AM Milestones:**

### **Quarter 3**

- Release COG supplemental library (or COG update, if required) with JEF-2.2 and JEFF-3.1.2 nuclear data libraries (T1: Q3).

### **Quarter 4**

- Use PREPRO to process and test ENDF/B-VII.2 preliminary data in support of the next release of the national nuclear data library (T1: Q4).

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

Due to budget constraints, several LLNL AM tasks have been deferred to FY2014 and beyond.

### **2.1.2.3 Oak Ridge National Laboratory (ORNL)**

#### **ORNL AM1 (\$380K)**

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

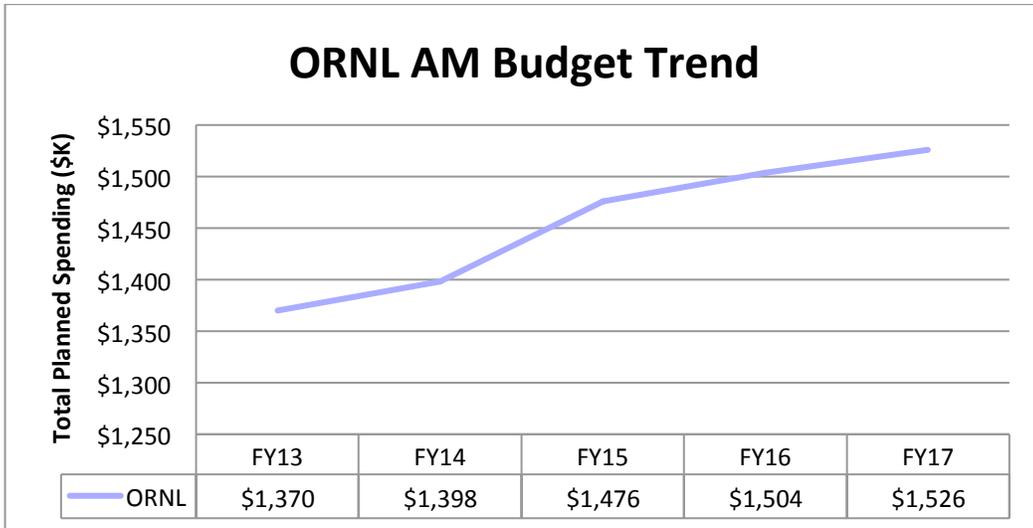
#### **ORNL AM2 (\$690K)**

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.

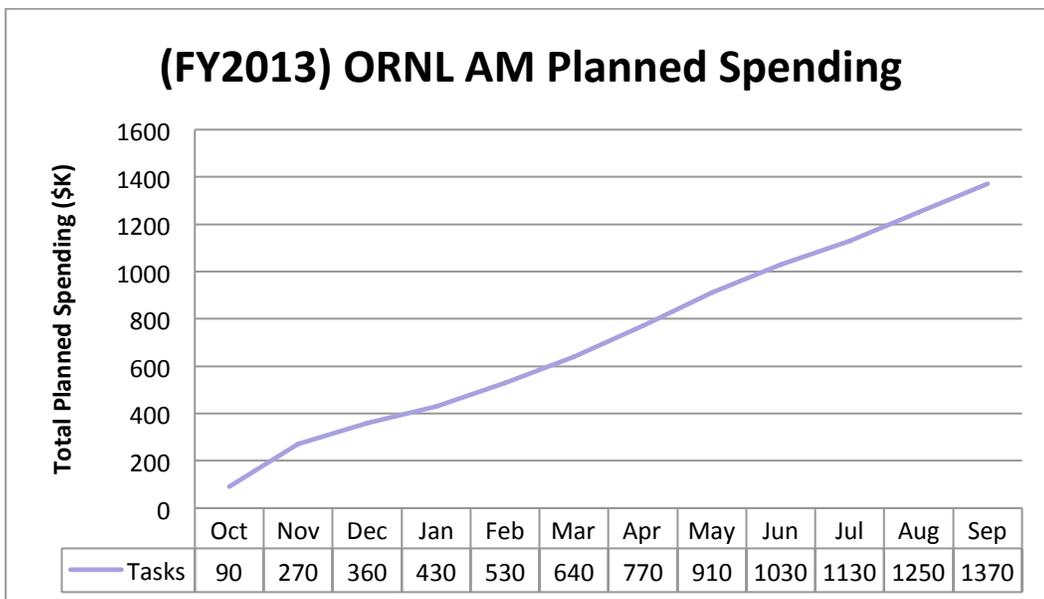
#### **ORNL AM3 (\$300K)**

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.

**Table 2.1-6 ORNL AM Budget Trend (FY2013-FY2017)**



**Table 2.1-7 ORNL AM Planned Spending (FY2013)**



## **ORNL AM Milestones:**

### **Occurs all 4 Quarters**

- Continue distribution of available and newly packaged software to the NCS community requesters (at no direct cost to them) and provide distribution totals quarterly (T1).

### **Quarter 1**

- Issue an annual SCALE maintenance report to the NCSP Manager (T2: Q1).

### **Quarter 2**

- Publish semiannual newsletters to users to communicate software updates, user notices, generic technical advice, and training course announcements (T2: Q2).
- Letter report to NCSP Manager documenting development and implementation of AMPX QAP (T3: Q2).

### **Quarter 4**

- Publish semiannual newsletters to users to communicate software updates, user notices, generic technical advice, and training course announcements (T2: Q4).
- Participate in Expert Groups related to analytical methods that are important to criticality safety, including the OECD/NEA expert groups on uncertainty analyses for criticality safety assessment. (T2: Q4).
- Document AMPX technical support for SCALE CE, multigroup, and covariance libraries and report status annually to the NCSP Manager (T3: Q4).
- Complete merger of AMPX configuration control and software build with SCALE (FY13: Q4).

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

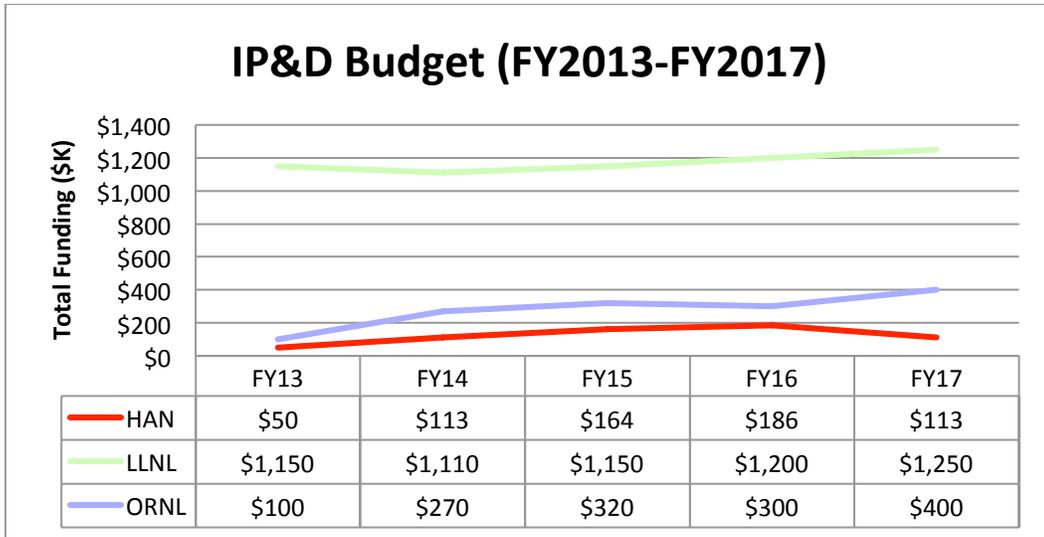
The ORNL AM budget includes incremental increases for inflation in the out years for RSICC and SCALE Maintenance tasks. An additional new subtask begins in FY15 and FY16 to develop a "handheld" NCS SlideRule App for deployment on a handheld device such as a smartphone or tablet PC (\$40K and \$80K in FY15 and FY16, respectively).

## 2.2 Information Preservation and Dissemination (IP&D)

### 2.2.1 Program Element Description

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

**Table 2.2-1 IP&D Budget (FY2013-FY2017)**



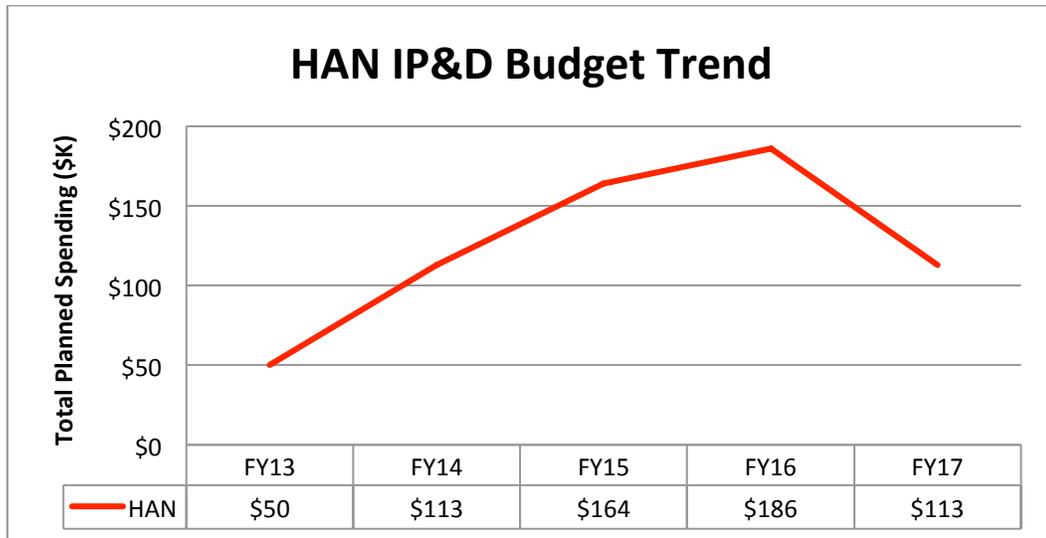
## 2.2.2 Approved Tasks

### 2.2.2.1 Hanford

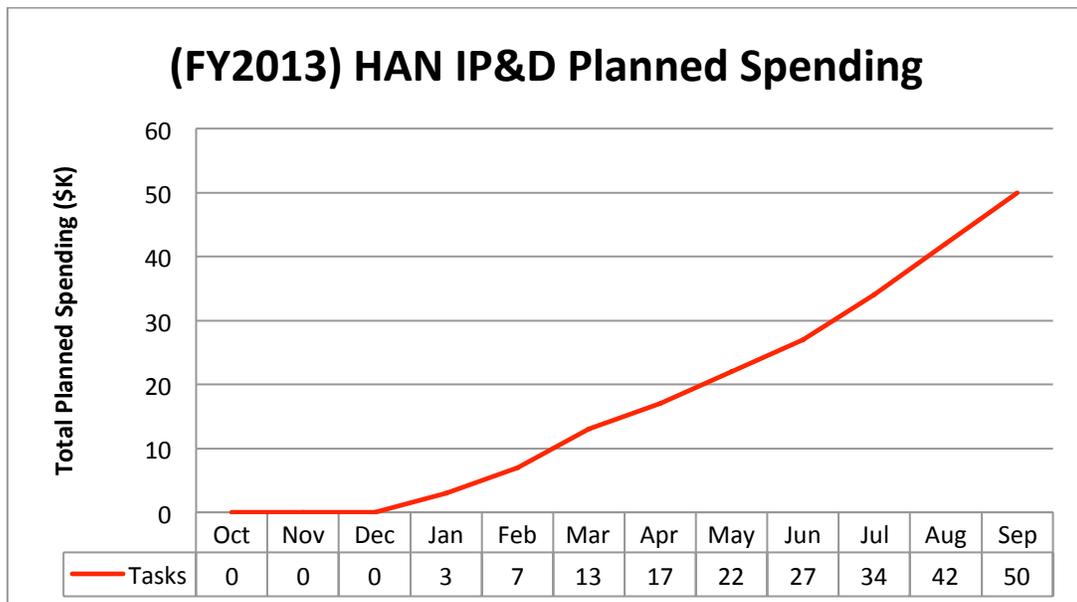
#### Hanford IP&D2 (\$50K)

Develop a method for obtaining integral cross sections for actinides from reactor operations and special test data. This task will also develop a data record matrix for isotopes and reactors and support data preservation for these archived data.

**Table 2.2-2 Hanford IP&D Budget Trend (FY2013-FY2017)**



**Table 2.2-3 Hanford IP&D Planned Spending (FY2013)**



## **Hanford IP&D Milestones:**

### **Quarter 2**

- Update existing compilation of data (reactor and special test), issue data compilation report, and provide report on NCSP website (T2: Q2).

### **Quarter 4**

- Issue letter report for Th-U Tree data and possible benchmark data for posting on NCSP website (T2: Q4).

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

Variances in out-year funding levels reflect funding changes to the continuing tasks (Hanford IP&D1 and Hanford IP&D2) and two new tasks. The ARH-600 task (Hanford IP&D1) is planned to restart in FY2014 at the \$43K funding level and increase to \$44K in FY2015. The ARH-600 task has an increase planned in FY16 and FY17 above the maintenance level funding to support a modification to the CritView code to handle data points such as from LA-10860 and make the code interface more user friendly. The Obtaining Integral Actinide Cross Sections from Reactor Operations and Special Test Data task (Hanford IP&D2) ends after FY15 and has approved funding of \$70K and \$40K for fiscal years FY14 and FY15. Both new tasks start in FY16. The Criticality Safety Documentation Preservation task (Hanford IP&D3) is currently funded at 30K and 35K for fiscal years FY16 and FY17, respectively. The Smartphone App for Dissemination of Criticality Safety Handbook Data in the Field task is currently a new task proposed in FY2012. The figure shows this task funded at \$60K for fiscal years FY16 and FY17.

### **2.2.2.2 Lawrence Livermore National Laboratory (LLNL)**

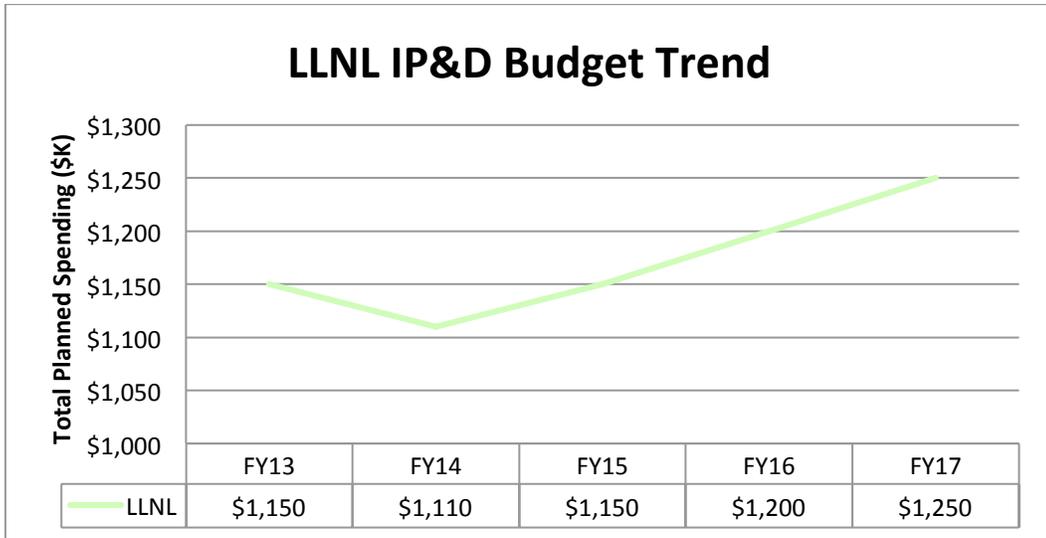
#### **LLNL IP&D1 (\$400K)**

Ongoing approved activity that provides independent and Technical Review Group (TRG) reviews for all newly completed NCSP funded experiments. Priority historical experiments will be evaluated and reviewed (internal, independent, and TRG) as resources allow. All NCSP funded experiments will be finalized and published on the NCSP website within two quarters of receipt of an Experiment Design Team reviewed and approved draft report (CED-4a). LLNL IP&D Subtask 1 will also provide leadership, coordination, and publication support for the OECD/NEA ICSBEP.

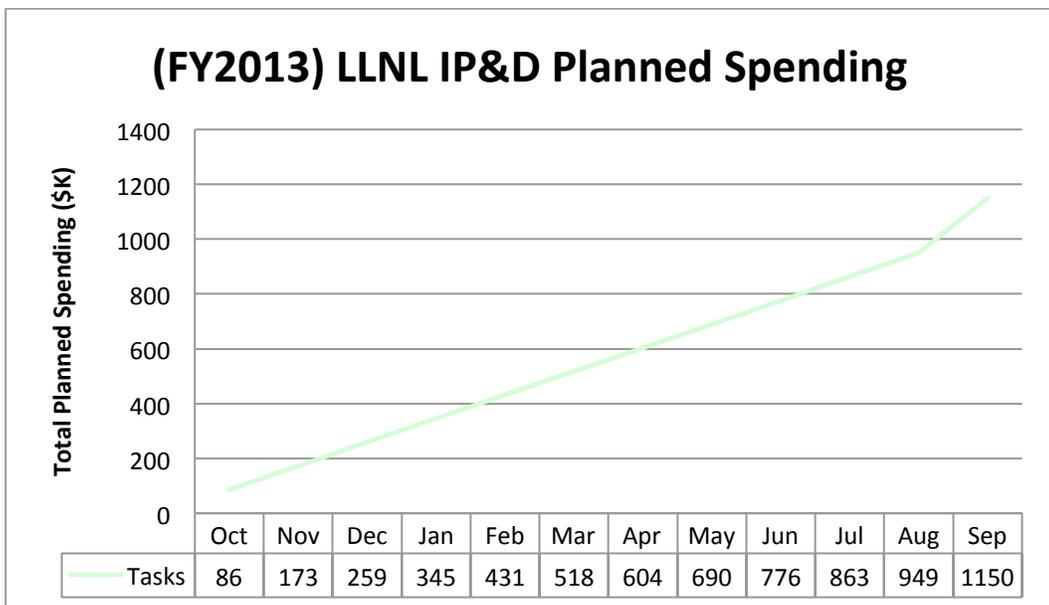
#### **LLNL IP&D2 (\$750K)**

Ongoing approved activities for operation and maintenance of both unclassified and classified NCSP websites. The NCSP websites are the central focal point for access to criticality safety information collected under the NCSP, and are the gateway to a comprehensive set of hyperlinks to other sites containing criticality safety information resources. This task also provides operations and maintenance for information technology supporting the NCERC (e.g., “Red” network).

**Table 2.2-4 LLNL IP&D Budget Trend (FY2013-FY2017)**



**Table 2.2-5 LLNL IP&D Planned Spending (FY2013)**



## **LLNL IP&D Milestones:**

### **Occurs all 4 Quarters**

- Provide external review and assist evaluators and their internal reviewers in finalizing and publishing ICSBEP evaluations per schedule specified in the Integral Experiments Section of the Five-Year Execution Plan, Appendix A, Integral Experiments GANTT Charts (T1).
- Coordinate with the OECD NEA for ICSBEP activities (T1).
- Maintain and develop ICSBEP web content (T1).
- Maintain, operate and develop both unclassified and classified NCSP websites, and “Red” network (T2).
- Maintain and develop both unclassified and classified Integral Experiment Request (IER) forms, and Nuclear Data request form (T2).
- Develop and deploy multimedia web-based training and videos as directed by the IP&D Manager (T2).
- Digitize and archive unclassified and classified hardcopy bibliography reports starting with the LLNL hardcopy report collections (T2).
- Maintain and develop the searchable LLNL, Hanford and CSE databases (T2).

### **Quarter 1**

- Deploy ICSBEP content received from OECD/NEA on the NCSP website (T1: Q1).
- Establish classified Enterprise Secure Network (ESN) connectivity from NNSA (formerly NTS) to classified NCSP website (T2: Q1).

### **Quarter 2**

- Establish classified ESN connectivity from DOE Germantown to classified NCSP website (T2: Q2).

### **Quarter 3**

- Hold annual ICSBEP TRG meeting (T1: Q3).
- Establish classified ESN connectivity from LANL to classified NCSP website (T2: Q3).

### **Quarter 4**

- Provide publication support to OECD/NEA as required to assist in completion, replication and distribution of the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (T1: Q4).
- Establish classified ESN connectivity from Y12 to classified NCSP website (T2: Q4).

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

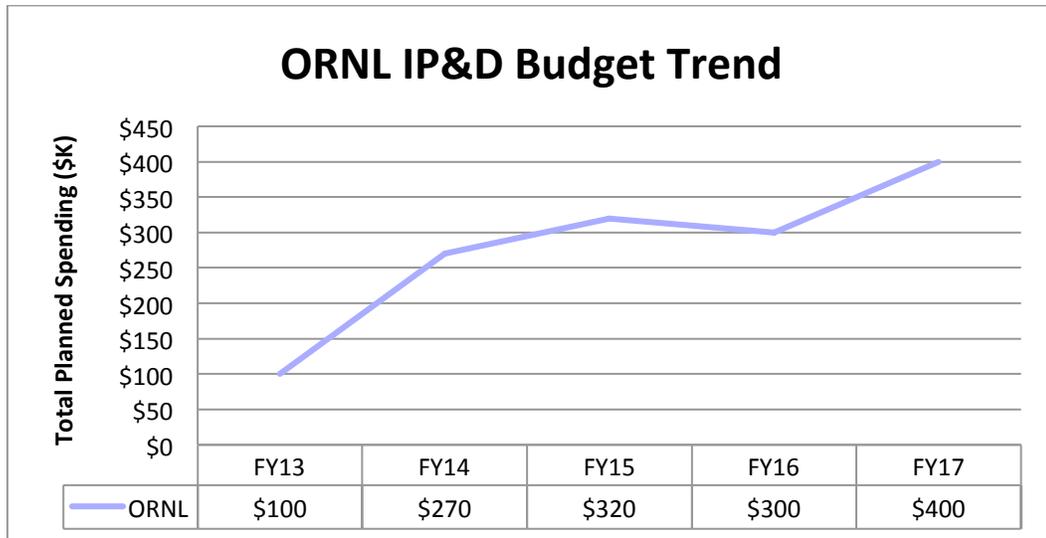
ESN connectivity to various NNSA sites will be completed in 2013, which accounts for the budget decrease in 2014.

### 2.2.2.3 Oak Ridge National Laboratory (ORNL)

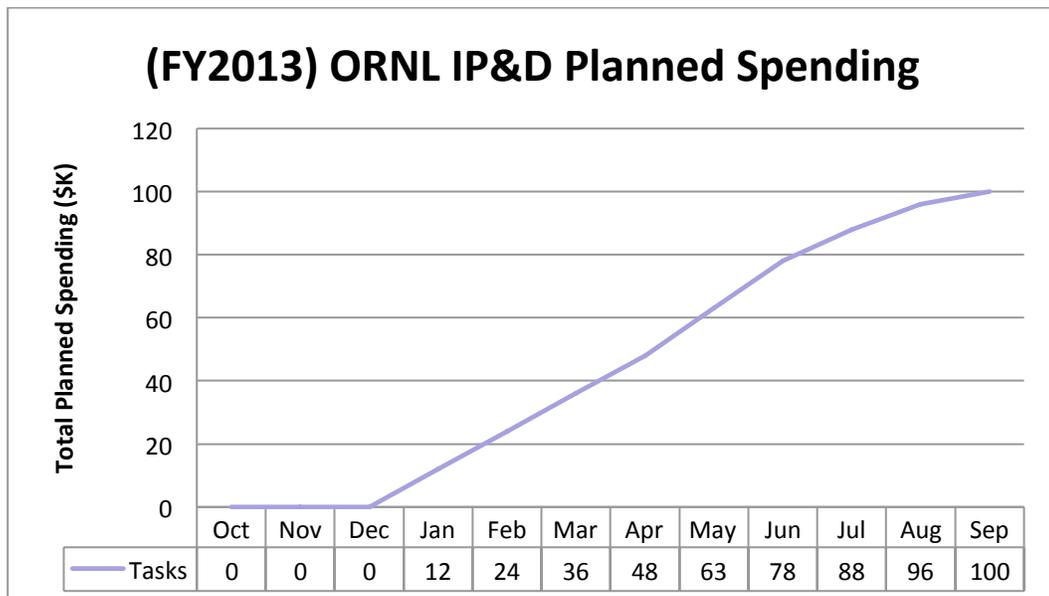
#### ORNL IP&D1 (\$100K)

Ongoing, approved work task to provide TSUNAMI-generated sensitivity data files and verified SCALE input files for new benchmark evaluations approved for distribution with the ICSBEP Handbook. In this task, all work will be conducted within the quality assurance framework established by the *SCALE Procedure for Verification and Configuration Management of Models and Derived Data*.

**Table 2.2-6 ORNL IP&D Budget Trend (FY2013-FY2017)**



**Table 2.2-7 ORNL IP&D Planned Spending (FY2013)**



## **ORNL IP&D Milestones:**

### **Quarter 4**

- Provide TSUNAMI sensitivity data files and inputs for all new evaluations to the ICSBEP for distribution. (T1: Q4).

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

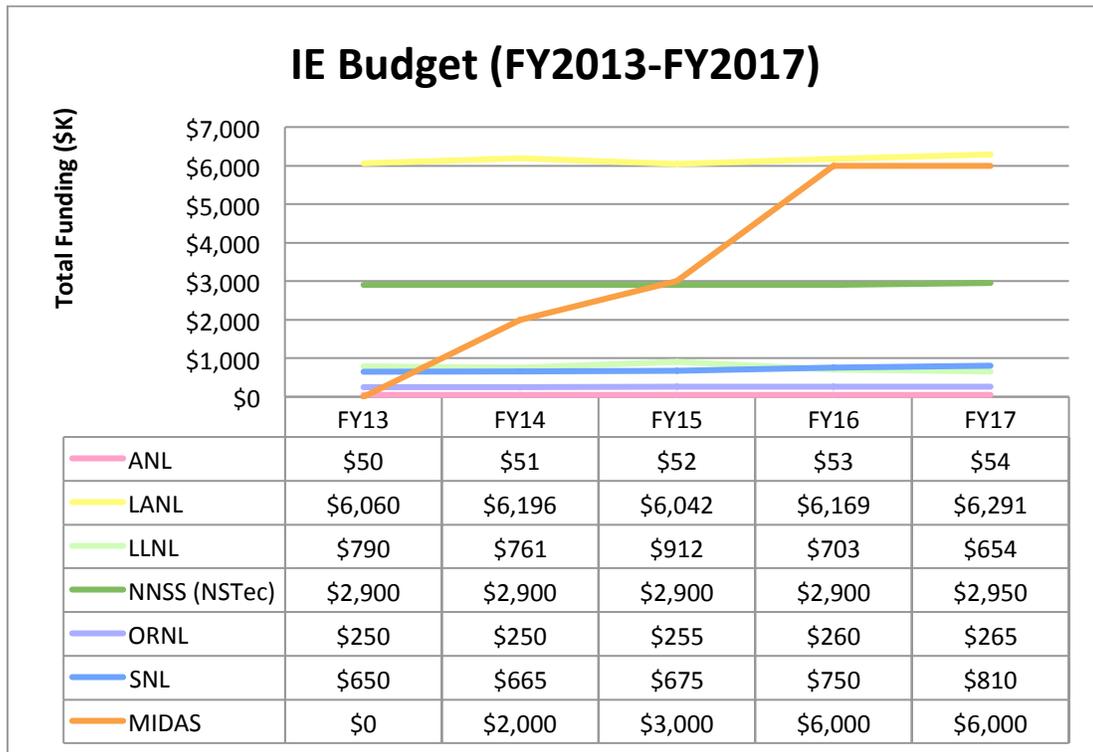
The ORNL FY13 IP&D budget only includes funding for generating sensitivity profiles for new ICSBEP benchmarks and does not include funding for the "historical-looking" task to generate sensitivity profiles for benchmark experiments already in the handbook. Funding to generate sensitivity profiles for existing ICSBEP benchmarks is restored in FY14 thereby explaining the increase in the budget profile relative to FY13. Beginning in FY15, the task to develop algorithms to generate experimental uncertainty correlation data resumes thereby accounting for the increase relative to FY14. In FY17, the task to utilize the experimental correlation algorithms to provide experimental uncertainty correlations for select ICSBEP benchmark experiments is initiated and accounts for an additional increase in budget relative to the previous year.

## 2.3 Integral Experiments (IE)

### 2.3.1 Program Element Description

The Integral Experiments (IE) 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 specific-site needs on a prioritized basis. 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.

**Table 2.3-1 IE Budget (FY2013-FY2017)**



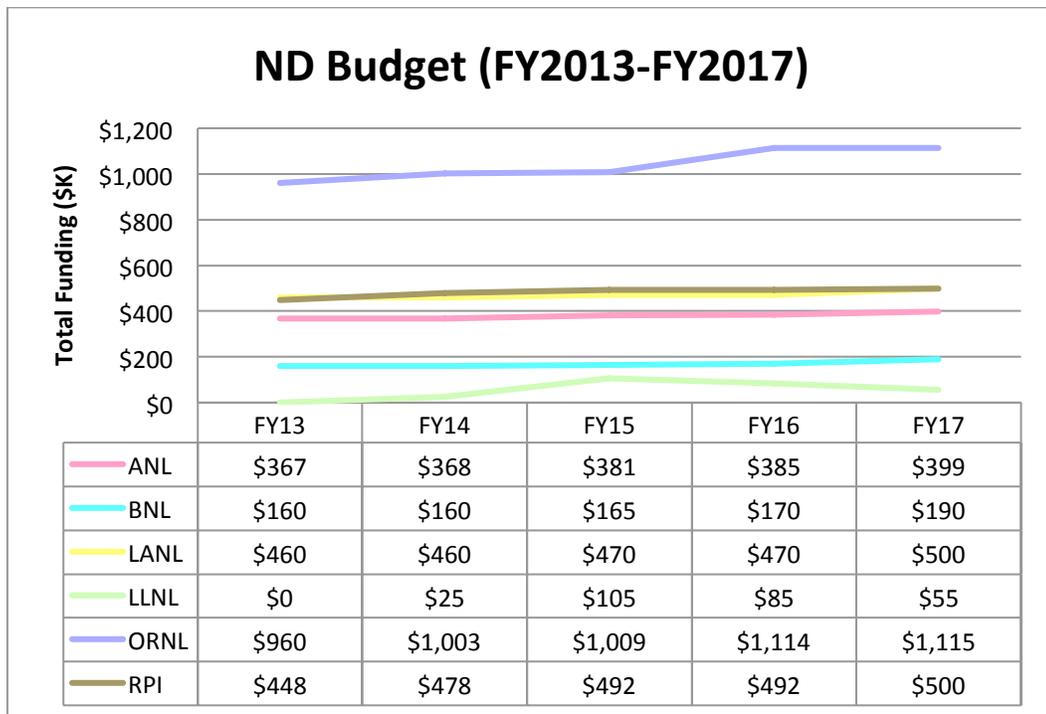
*All Integral Experiment tasks and milestones are published as standalone documents. Contact the NSCP Program Manager, Dr. Jerry McKamy, if you have a 'Need-to-Know.'*

## 2.4 Nuclear Data (ND)

### 2.4.1 Program Element Description

The Nuclear Data (ND) 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 FY2013 through FY2017 schedule, milestones, and deliverables associated with specific nuclear data measurement, evaluation, and publication. Milestones not contained in Appendix B are delineated below.

**Table 2.4-1 ND Budget (FY2013-FY2017)**



## 2.4.2 Approved Tasks

### 2.4.2.1 Argonne National Laboratory (ANL)

#### ANL ND1 Subtask 1(\$240K)

Perform on-going data testing in support of the data validation effort for ENDF/B-VII and new evaluated nuclear data that are of interest to the criticality safety community. Emphasis is on testing and reporting performance of priority evaluations identified by the NDAG. Support the NCSP website initiatives for addressing differential nuclear data needs. Participate and provide leadership roles in nuclear data international expert groups and working groups.

#### ANL ND1 Subtask 2(\$42K)

Support on-going development of advanced nuclear data covariance methodologies (e.g., material-to-material covariance, application of GANDER to assess nuclear data requirements, etc.), formats, and quality assurance. Emphasis is to assure development of high-quality covariance files required for NCSP S/U methods. This effort is lead by nuclear data experts Doug Muir and Donald Smith (Argonne special term appointees), including the chairman of the CSEWG Covariance Committee.

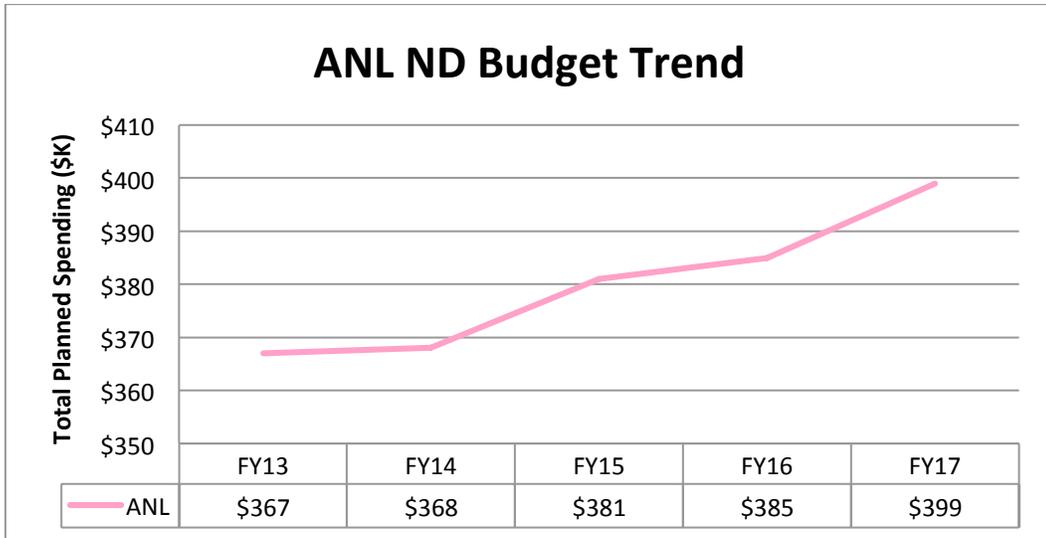
#### ANL ND1 Subtask 3(\$60K)

Generate integral experiment covariance data in on-going support of S/U methods, Uncertainty Quantification and nuclear data adjustment methods. Develop evaluation methodology for these covariance data and apply to the ANL Zero Power Reactor (ZPR) and Zero Power Plutonium Reactor (ZPPR) experiments available in the ICSBEP Handbook. Covariance data for new ANL benchmark experiments will be integrated (correlated) with existing data and added to the DICE database. On-going support will apply the methodology to produce covariance files for priority integral data for the NCSP.

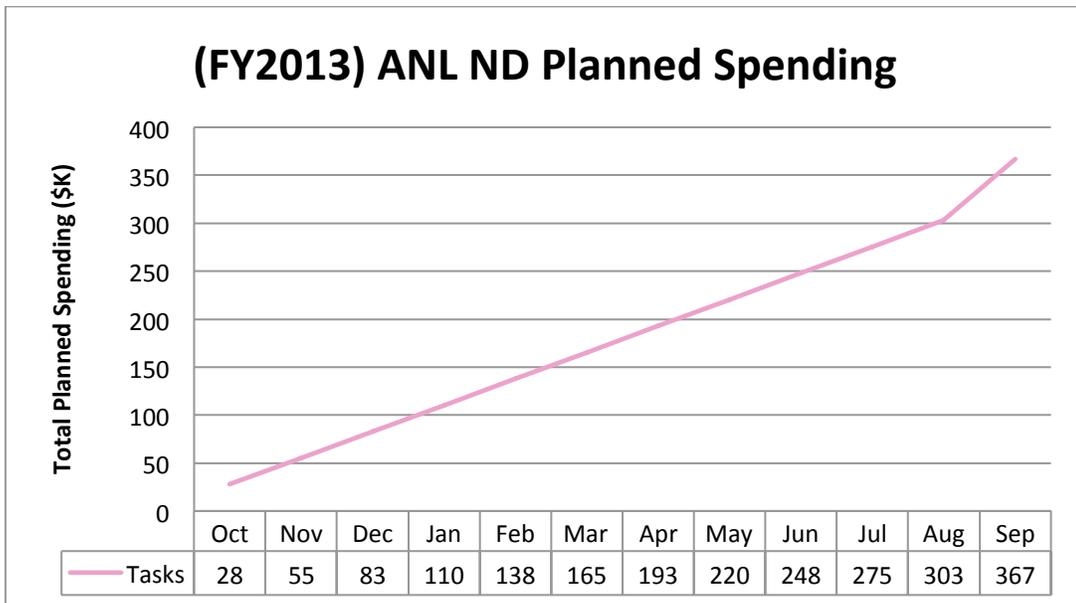
#### ANL ND2 (\$25K)

The NDAG, through making recommendations to the NCSP Manager, enhances the coordination of the NCSP ND element work program with current and future DOE needs and promotes the integration of this work program with other elements of the NCSP. The NDAG Chair provides timely reviews and input to all Integral Experiment Requests (IERs) and all Nuclear Data Requests (NDRs). The NDAG Chair receives funding (\$25K) to support his management of the NDAG.

**Table 2.4-2 ANL ND Budget Trend (FY2013-FY2017)**



**Table 2.4-3 ANL ND Planned Spending (FY2013)**



## **ANL ND Milestones:**

### **Occurs all 4 Quarters**

- Provide NCSP NDAG Chairperson support including timely review of all IERs and NDRs (T4).

### **Quarter 1**

- Provide reports to NDAG and CSEWG documenting results of NCSP data testing and validation (T1: Q1, Q3).
- Chair meetings of the CSEWG Covariance Committee and report contributions through NDAG and CSEWG (T2: Q1, Q3).

### **Quarter 2**

- Report progress on evaluation methodology and preliminary results (T3: Q2).

### **Quarter 3**

- Provide reports to NDAG and CSEWG documenting results of NCSP data testing and validation (T1: Q1, Q3).
- Chair meetings of the CSEWG Covariance Committee and report contributions through NDAG and CSEWG (T2: Q1, Q3).
- Participate as ENDF representative in the OECD/NEA Working Party on International Nuclear Data Evaluation Corporation (WPEC) annual meeting and various subgroup activities, including the High-Priority Request List (T1: Q3).

### **Quarter 4**

- Participate as NCSP representative to the OECD/NEA Working Party on NCS Working Party on Nuclear Criticality Safety (T1: Q4).
- Participate in Expert Groups related to nuclear data that are important to criticality safety, including the OECD/NEA expert groups on uncertainty analyses for criticality safety assessment, Assay Data for Spent Nuclear Fuel for Burn-Up Credit (BUC), expert group on BUC, and WPEC SG33 on methods and issues for the combined use of integral experiments and covariance data (T1: Q4).
- Document additional capability to produce quality covariance evaluations for ENDF (T2: Q4).
- Deliver completed covariance evaluations to ICSBEP project (T3: Q4).

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

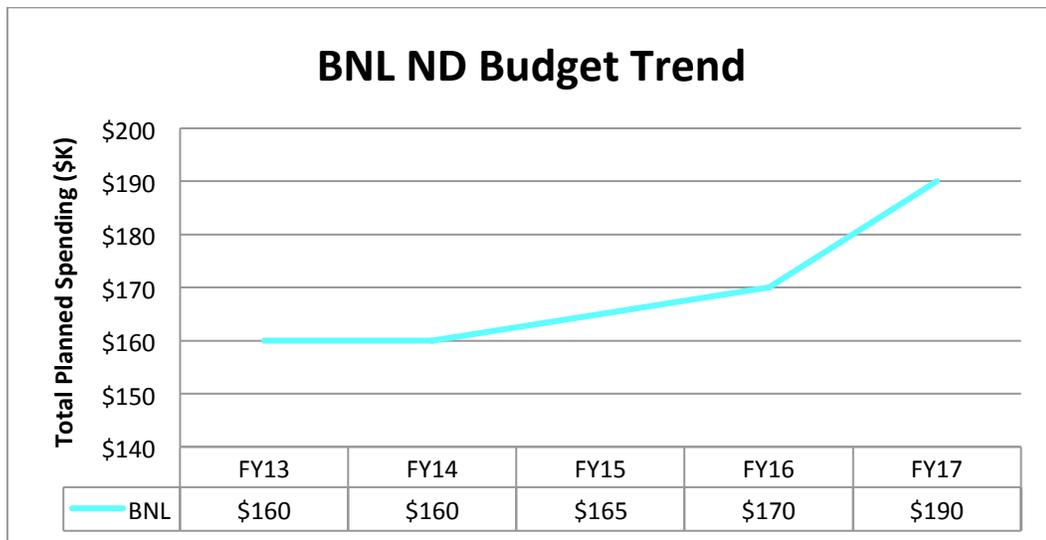
Very modest increases in out years to help mitigate increased cost of doing business.

## 2.4.2.2 Brookhaven National Laboratory (BNL)

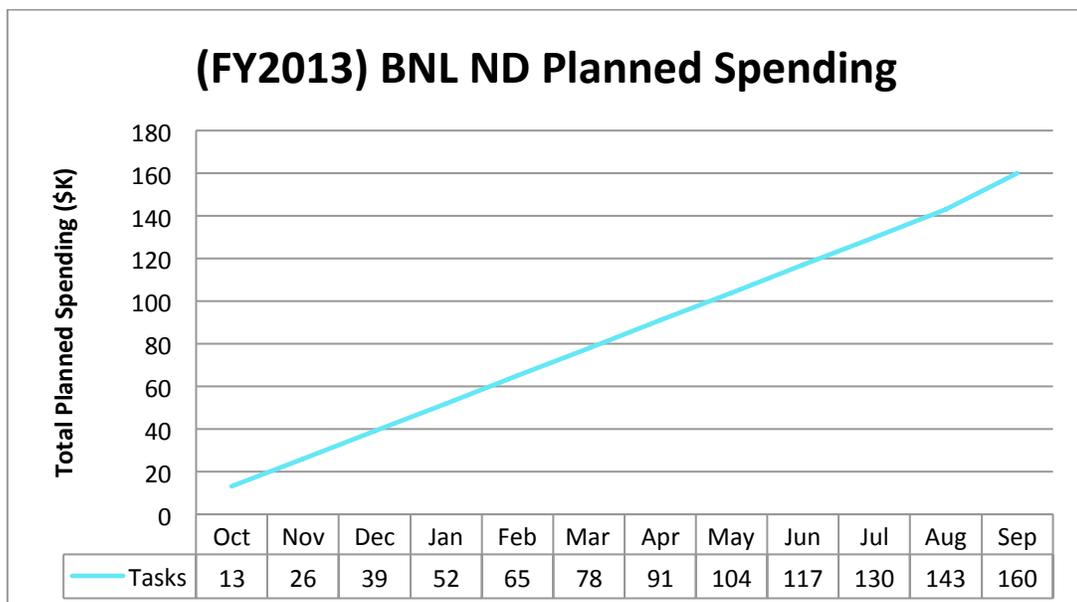
### BNL ND1 (160K)

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

**Table 2.4-4 BNL ND Budget Trend (FY2013-FY2017)**



**Table 2.4-5 BNL ND Planned Spending (FY2013)**



## **BNL ND Milestones:**

### **Occurs all 4 Quarters**

- Perform data verification of new NCSP evaluations and store them in the GForge server (T1).

### **Quarter 2**

- Perform quality assurance of covariance data in new NCSP evaluations (T1: Q2).

### **Quarter 4**

- Perform quality assurance of covariance data in new NCSP evaluations (T1: Q4).

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

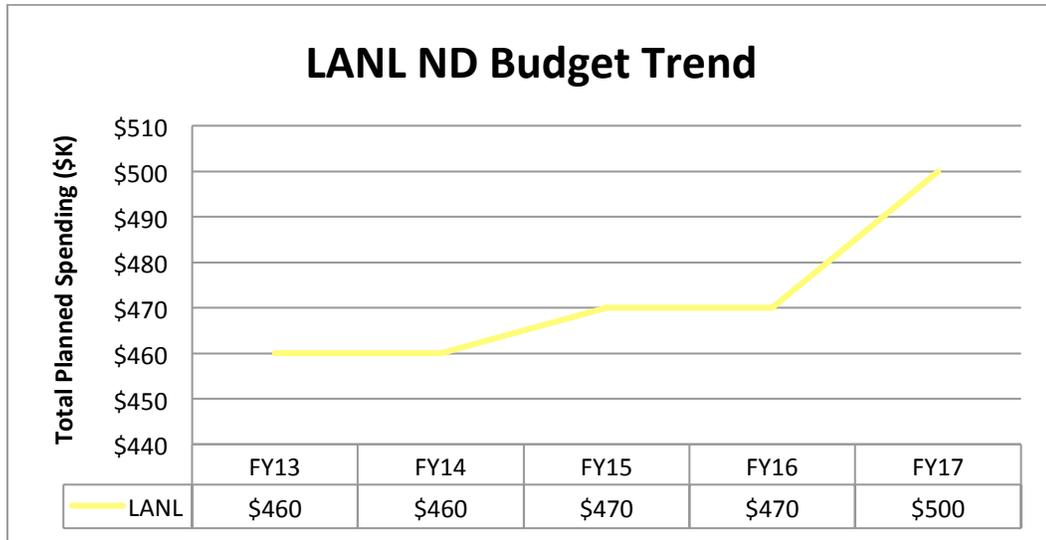
Very modest increases in out years to help mitigate increased cost of doing business.

### 2.4.2.3 Los Alamos National Laboratory (LANL)

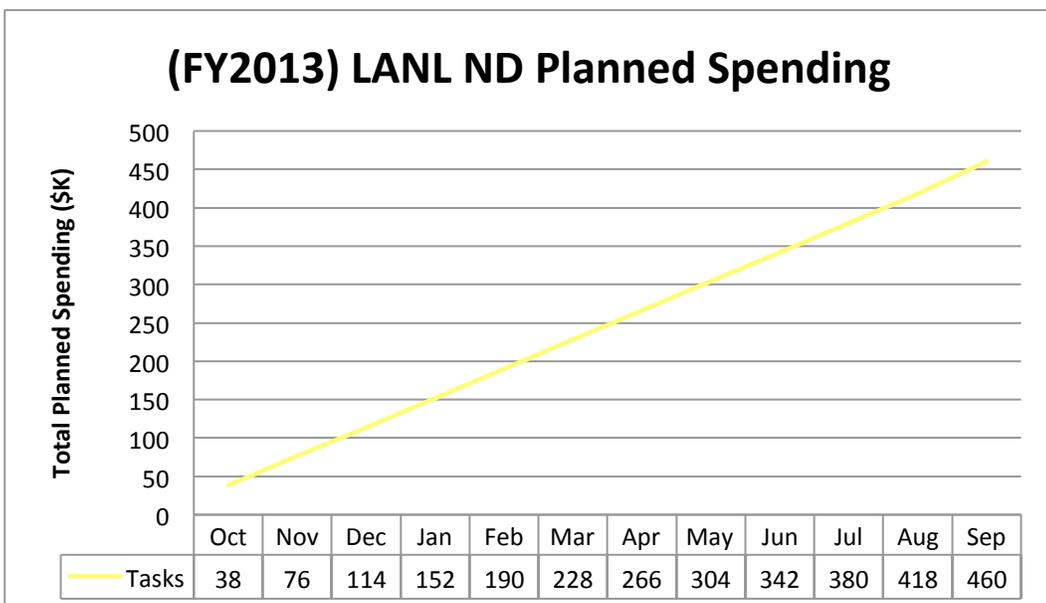
#### LANL ND1 (\$460K)

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.

**Table 2.4-6 LANL ND Budget Trend (FY2013-FY2017)**



**Table 2.4-7 LANL ND Planned Spending (FY2013)**



## **LANL ND Milestones:**

### **Occurs all 4 Quarters**

- Provide status reports on all nuclear data activities in NCSP Quarterly Progress Reports (T1).

### **Quarter 4**

- Deliver updated high-energy evaluations for Ni-58 and Ni-60 to NNDC (T1: Q2).
- Deliver p(nu) data in ENDF format for U-235, U-238, and Pu-239 to NNDC. (T1: Q4).
- Establish the capability (physics, statistical Bayesian analyses, computational infrastructure) to re-evaluate the prompt fission neutron spectrum (PFNS) of neutron-induced fission on  $^{239}\text{Pu}$ , as well as  $^{235,238}\text{U}$  if possible, for neutron incident energies from thermal up to 20 MeV. (T1: Q4).

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

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

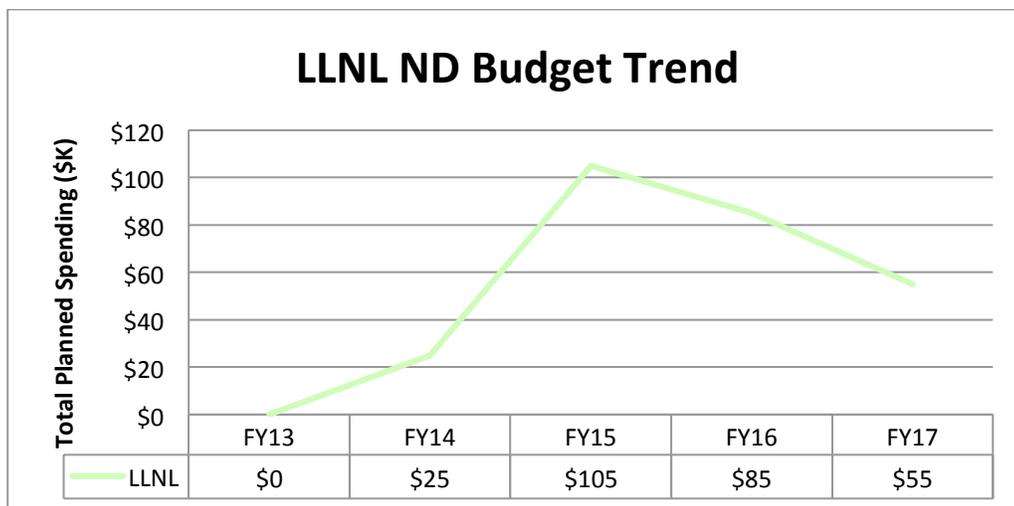
## 2.4.2.4 Lawrence Livermore National Laboratory (LLNL)

### LLNL ND1 (\$0K)

Ongoing approved activity to develop a first principles analytic method to determine the equilibrium and time-dependent emission of delayed gammas based on event-by-event modeling of the fission process and subsequent fission product decay. Generation of this data for all available nuclides was completed in FY2012. Completion and issuance of a comprehensive final report documenting the technical basis of the method and data testing results have been deferred to FY2014 and beyond.

In FY2014 and beyond, this task supports continued data testing as new experimental data becomes available from foil activation measurements and dosimetry testing using Godiva, Flattop and Comet.

**Table 2.4-8 LLNL ND Budget Trend (FY2013-FY2017)**



**Table 2.4-9 LLNL ND Planned Spending (FY2013)**



**LLNL ND Milestones:**

N/A

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

All LLNL ND tasks are deferred to FY2014 and beyond.

#### **2.4.2.5 Oak Ridge National Laboratory (ORNL)**

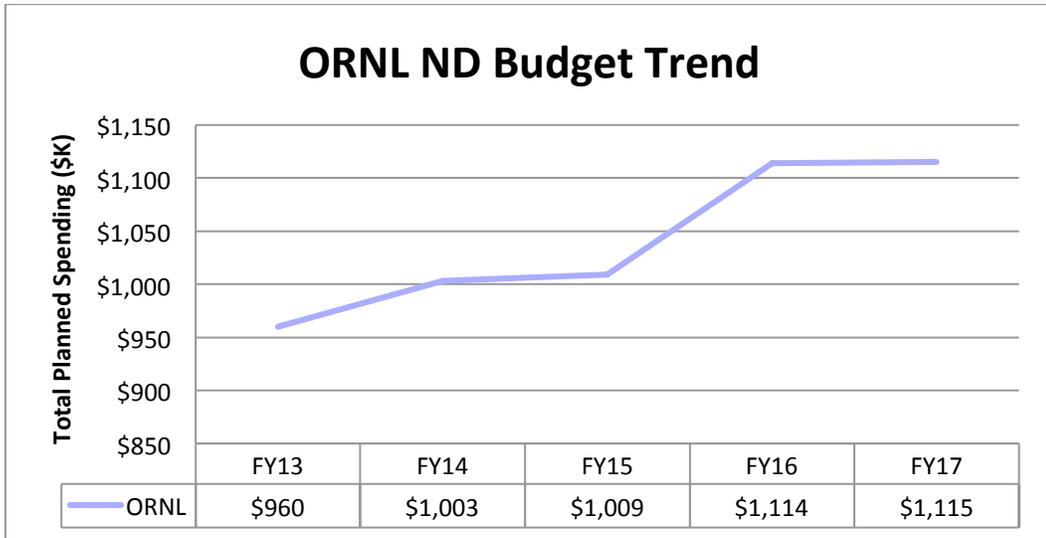
##### **ORNL ND1 (\$890K)**

Ongoing task to conduct nuclear data measurement and evaluation activities in support of the NCSP. This subtask continues to primarily focus on the resonance-region and includes cross-section measurements and the production of new cross-section evaluations with covariance data. The ORNL nuclear data measurements and evaluations are performed in accordance with the milestone schedule in Appendix B.

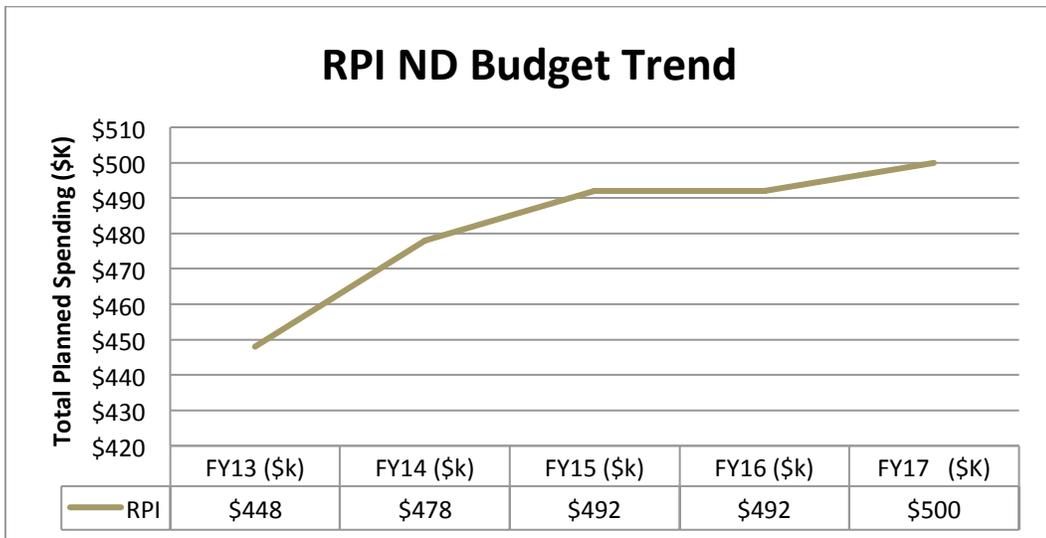
##### **ORNL ND2 (\$70K to ORNL; \$448K to RPI through Naval Reactors: RPI ND Subtask 1 = \$318K and RPI ND Subtask 2 = \$130K)**

This is a new task for ORNL to support RPI efforts to perform thermal scattering measurements at the SNS and/or LANSCE for thermal moderators of priority for the NCSP. In this task, ORNL will initiate efforts to develop data analysis capability that will enable the parameterization of the measured thermal moderator scattering data that are obtained by RPI measurements.

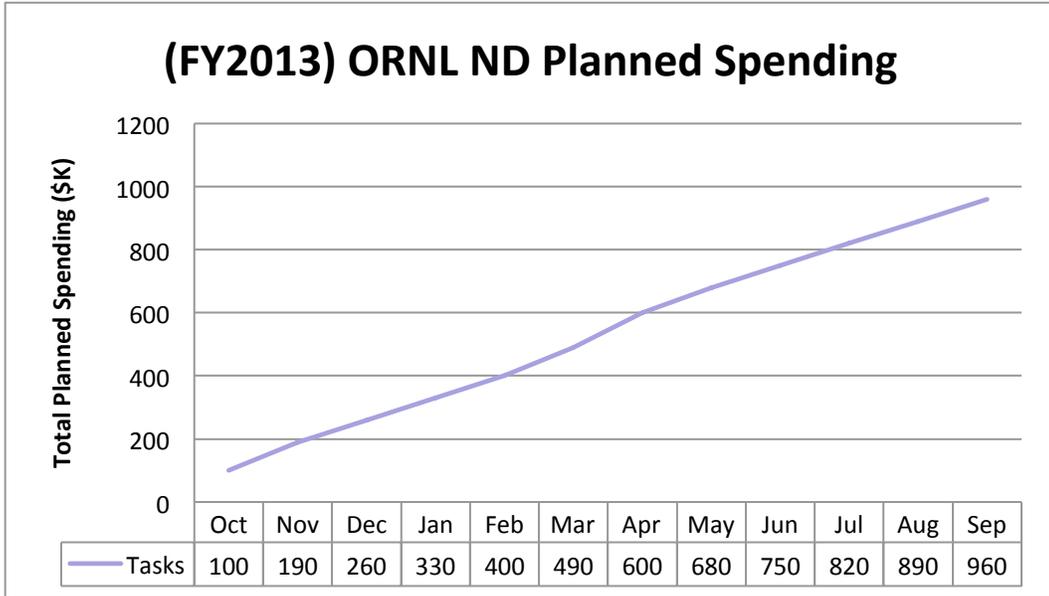
**Table 2.4-10 ORNL ND Budget Trend (FY2013-FY2017)**



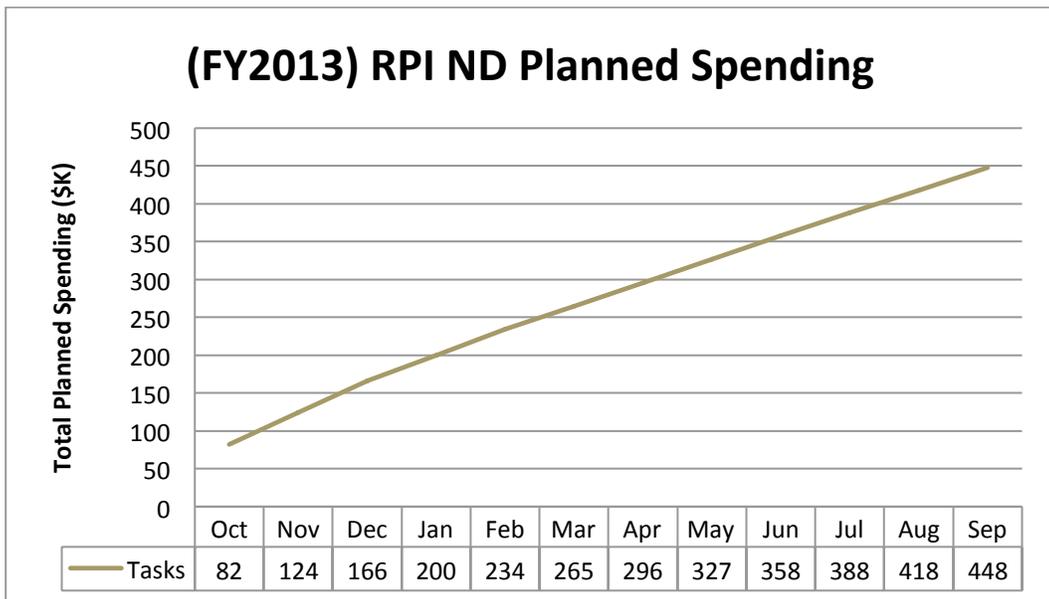
**Table 2.4-11 RPI ND Budget Trend (FY2013-FY2017)**



**Table 2.4-12 ORNL ND Planned Spending (FY2013)**



**Table 2.4-13 RPI ND Planned Spending (FY2013)**



## **ORNL ND Milestones:**

### **Occurs all 4 Quarters**

- Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (T1, T2).
- Provide status reports on all ORNL/RPI nuclear data support activities in NCSP Quarterly Progress Reports (T2).

### **Quarter 3**

- Capability development: Complete RPI capture detection system and perform testing. (T2: Q2).

### **Quarter 4**

- Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B (T1: Q4).
- Participate in NDAG, CSEWG, and WPEC meetings (T1, T2: Q4).
- Measurements: Initiate capture measurements using new RPI capture detection system to supplement ORNL measurements planned at IRMM (T2: Q4).
- Perform thermal neutron scattering measurements of water at elevated temperatures from room temperature up to 550K and SiO<sub>2</sub> (glass) at room temperature (as an example of other moderators) (T2: Q4).
- Submit status report to NCSP manager of thermal neutron scattering measurements and analysis of initial measurements (T2: Q4).

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

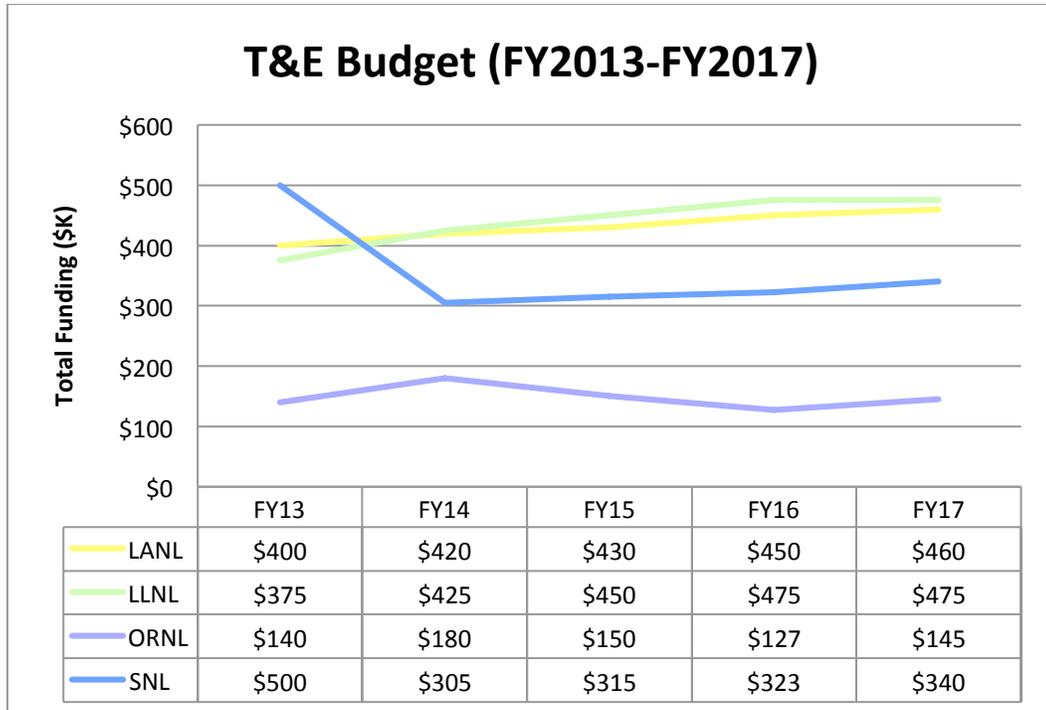
The ORNL ND budget includes incremental increases for inflation in the out years. Beginning in FY16, a new subtask will be initiated to help quantify NCSP differential data target accuracies needed to address target integral experiment/application accuracies. This new nuclear data subtask will utilize SCALE inverse sensitivity/uncertainty analysis tools that are currently being developed to quantify the differential data target accuracies and facilitate prioritization of NCSP nuclear data work efforts.

## 2.5 Training and Education (T&E)

### 2.5.1 Program Element Description

The Training and Education (T&E) program element will continue to offer hands-on training courses as needed by DOE and identify and develop training needs and resources in areas where no suitable materials exist. The primary purpose of the T&E element is to maintain the technical capabilities of criticality safety professionals and provide for the training and education of people entering the criticality safety discipline from related scientific fields.

**Table 2.5-1 T&E Budget (FY2013-FY2017)**



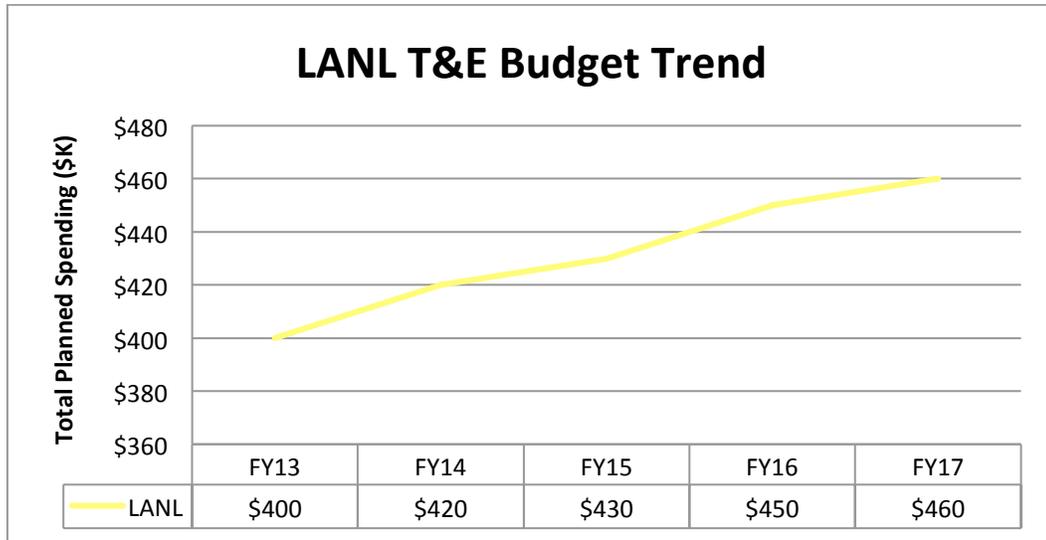
## 2.5.2 Approved Tasks

### 2.5.2.1 Los Alamos National Laboratory (LANL)

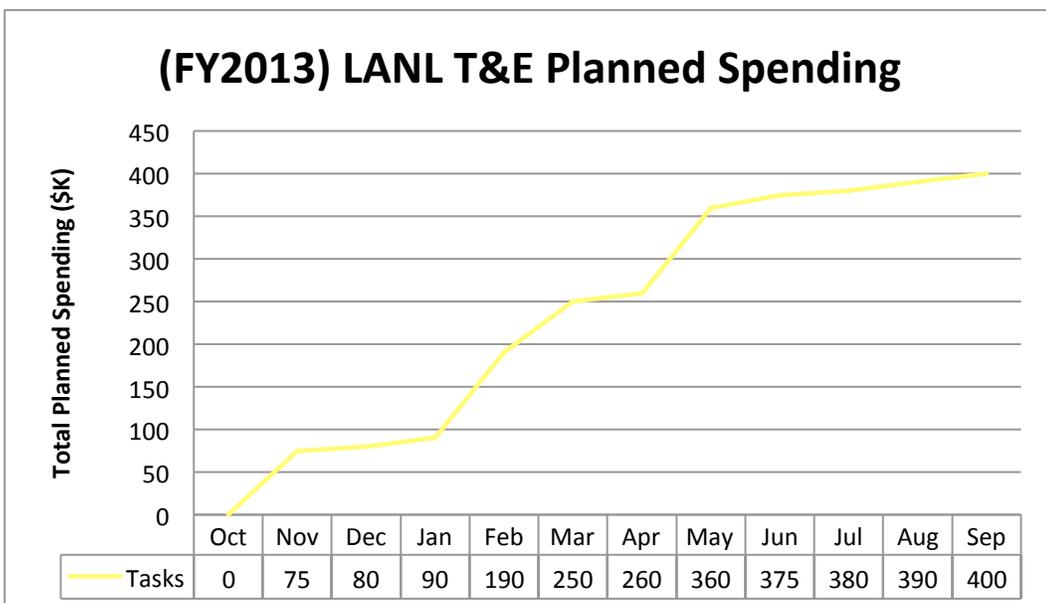
#### LANL T&E1 (400K)

Conduct combined criticality safety classroom and hands-on training at LANL and NCERC according to an integrated schedule developed by ORNL and approved by the NCSP Manager.

**Table 2.5-2 LANL T&E Budget Trend (FY2013-FY2017)**



**Table 2.5-3 LANL T&E Planned Spending (FY2013)**



**LANL T&E Milestones:**

**Occurs all 4 Quarters**

- Provide class room and hands-on training at LANL and at NCERC in accordance with the approved schedule and provide status reports on all training activities in the NCSP Quarterly Progress Reports (T1).

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

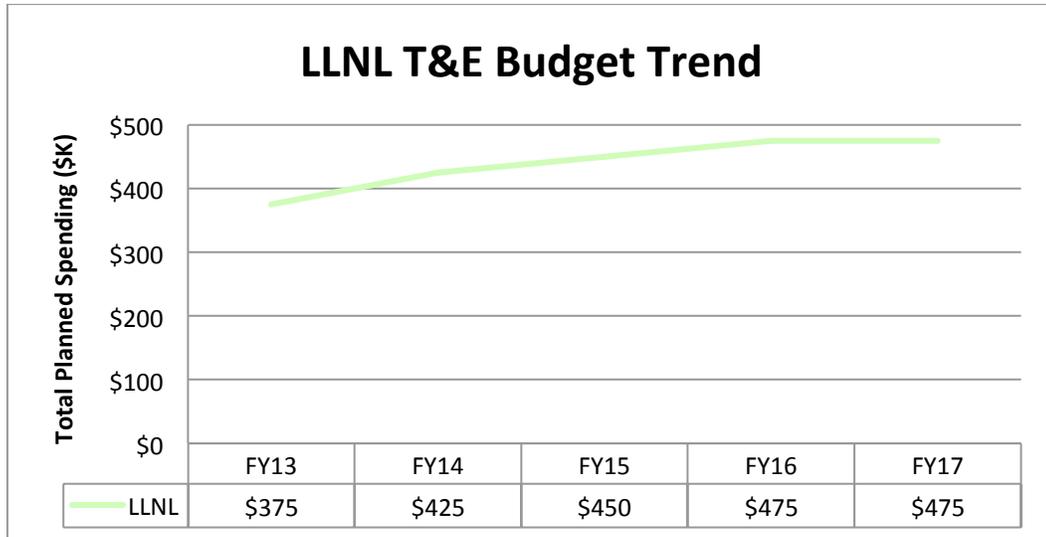
Very modest increases in out years to help mitigate increased cost of doing business.

## 2.5.2.2 Lawrence Livermore National Laboratory (LLNL)

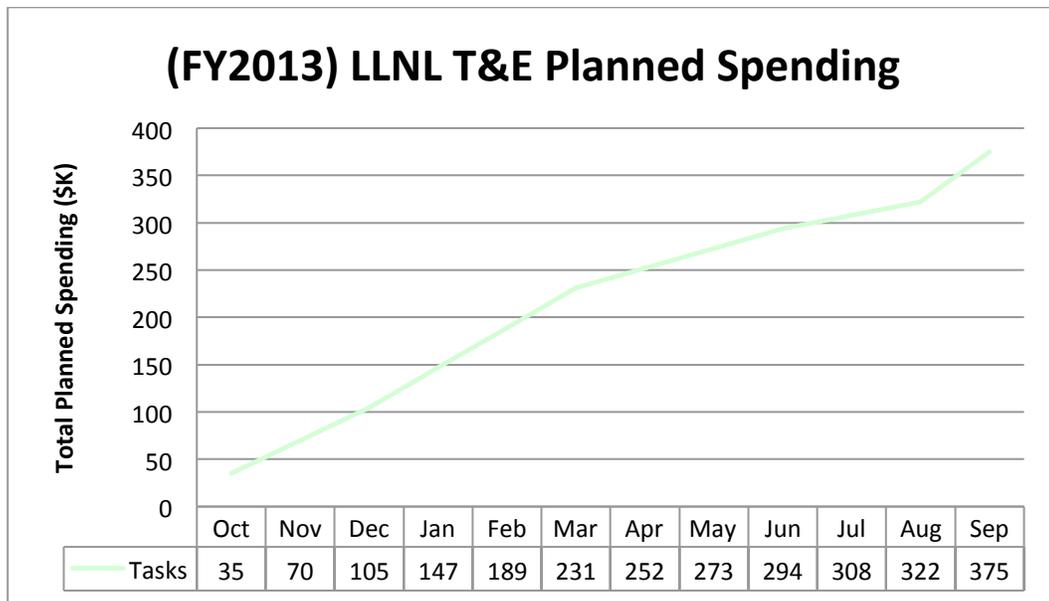
### LLNL T&E1 (\$375K)

Ongoing approved activity to provide unique “hands-on” training at the Device Assembly Facility (DAF) using the Training Assembly for Criticality Safety (TACS). Specifically, the task provides for LLNL support for four classes at NCERC in FY2013, and three classes in FY2014 and beyond. This task also supports continued LLNL coordination of the course registration process for all courses at LANL, NCERC and SNL and continued LLNL participation in the T&E planning activities.

**Table 2.5-4 LLNL T&E Budget Trend (FY2013-FY2017)**



**Table 2.5-5 LLNL T&E Planned Spending (FY2013)**



**LLNL T&E Milestones:**

**Occurs all 4 Quarters**

Update, maintain and support the registration process and provide “hands on” TACS training in accordance with the schedule approved by the NCSP Manager (T1).

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

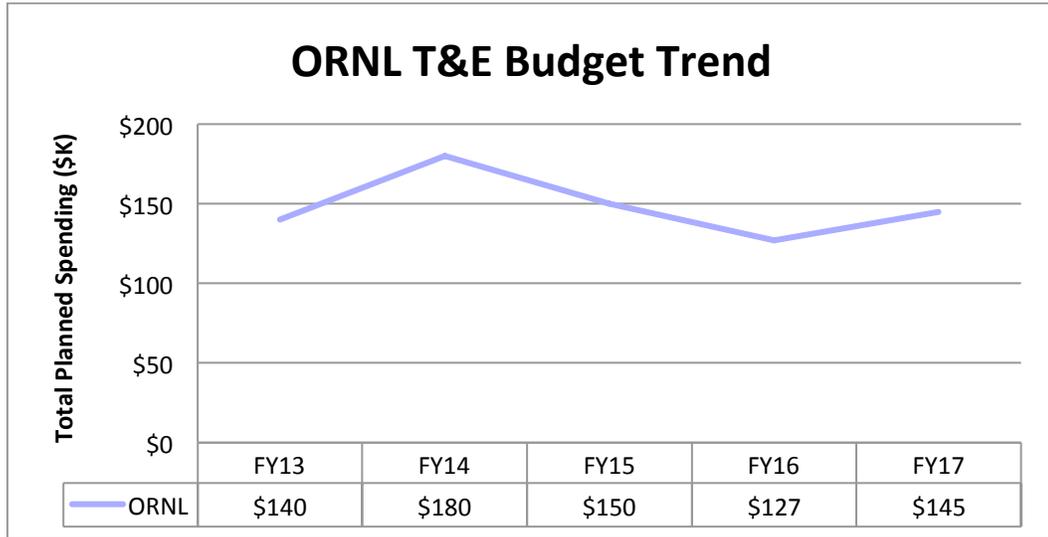
Up in FY14 for conversion of another NCET Module to multi-media format. After FY14, flat line budget for out years.

### 2.5.2.3 Oak Ridge National Laboratory (ORNL)

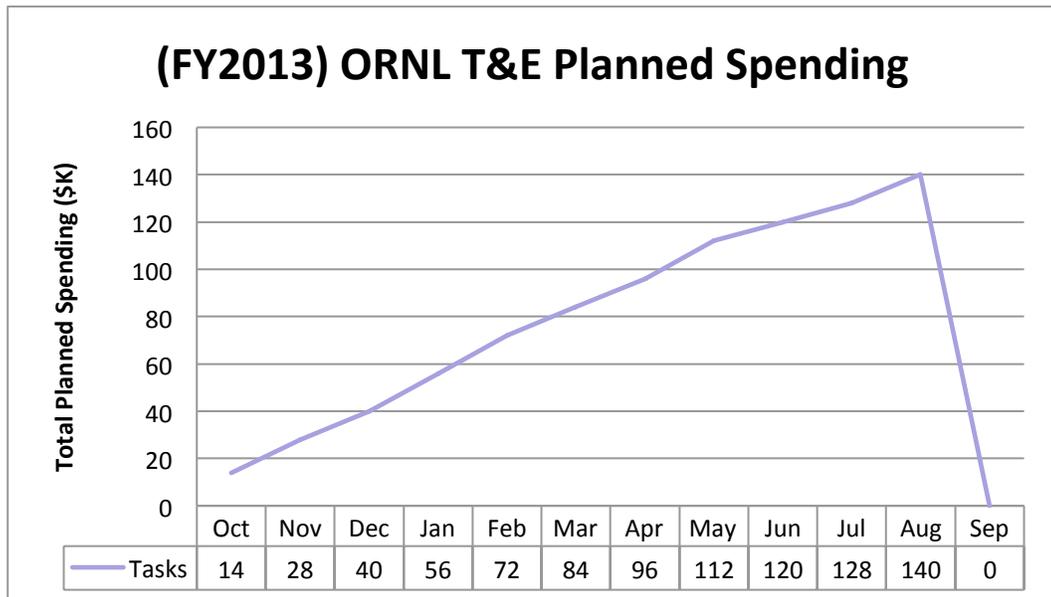
#### ORNL T&E1 (\$140K)

Ongoing ORNL task to manage the collaborative multi-laboratory development, designing, and scheduling of the multi-faceted and phased NCSP training program and oversee the execution of the program.

**Table 2.5-6 ORNL T&E Budget Trend (FY2013-FY2017)**



**Table 2.5-7 ORNL T&E Planned Spending (FY2013)**



## **ORNL T&E Milestones:**

### **Occurs all 4 Quarters**

- Provide status reports in NCSP Quarterly Progress Reports on implementation of the NCS training program (T1).
- Provide status reports in NCSP Quarterly Progress Reports on improvements/modifications to baseline NCS course training materials based on self-evaluation and feedback from reviewers, observers, trainers, and the NCSP manager (T1).

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

The ORNL T&E budget includes a planned decrease in funding beginning in FY15 as the training courses reach steady-state operation thereby requiring less oversight and monitoring.

#### **2.5.2.4 Sandia National Laboratories (SNL)**

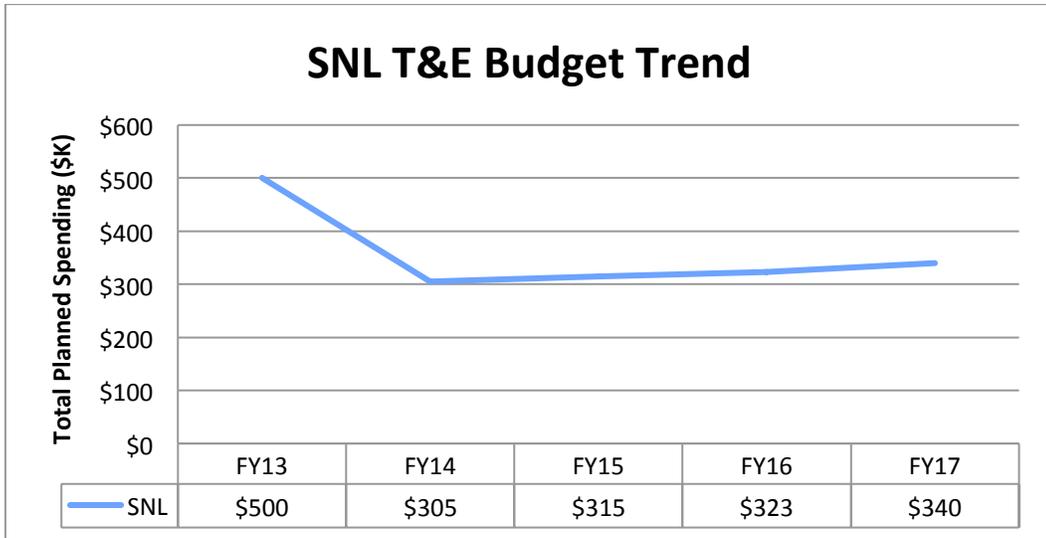
##### **SNL T&E1 (\$300K)**

Conduct criticality safety training classes at SNL according to an integrated schedule developed by ORNL and approved by the NCSP Manager. Provide Human Factors and Equipment Reliability module support to the training class at LANL. Four classes will be provided in FY13. The number of classes in FY14 through FY17 will be as directed by the NCSP Manager.

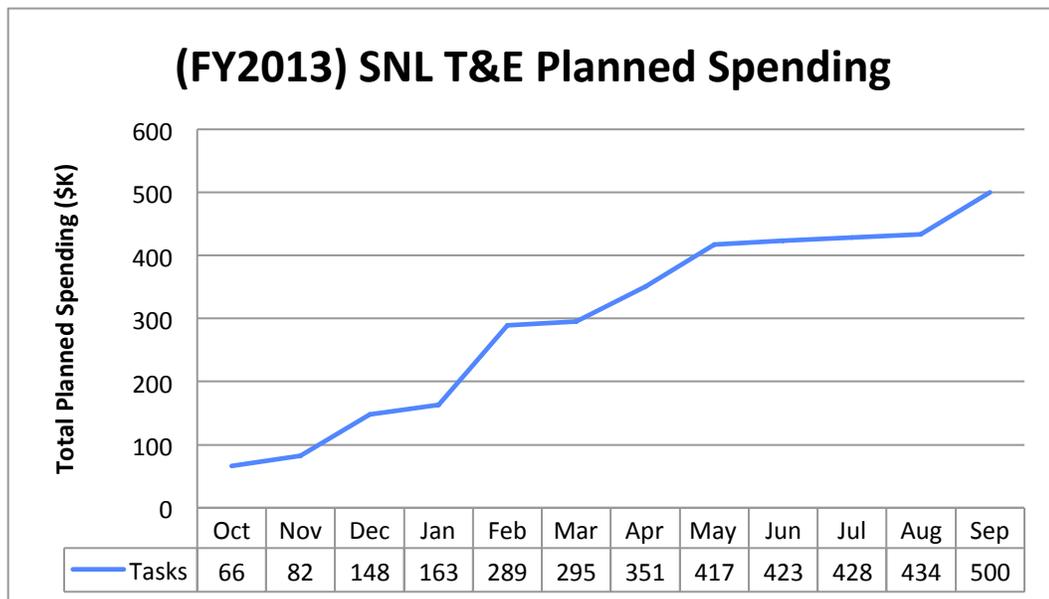
##### **SNL T&E2 (\$200K)**

Upgrade the classroom facilities associated with the Sandia critical experiments training course. Modifications to be considered include: installation of flooring in the classroom area, installation of acoustic modifications in the classroom, reconfiguration of the lighting in the classroom area, HVAC modifications to reduce the acoustic impact of the room air handler, upgrades to the sanitary facilities associated with the classroom, and other modifications as deemed appropriate within the budget.

**Table 2.5-8 SNL T&E Budget Trend (FY2013-FY2017)**



**Table 2.5-9 SNL T&E Planned Spending (FY2013)**



## **SNL T&E Milestones:**

### **Quarter 4**

- Conduct hands-on training classes at Sandia in accordance with the approved schedule (T&E1: Q4).
- Provide Human Factors and Equipment Reliability module support to the LANL training classes in accordance with the approved schedule (T&E1: Q4).
- Upgrade the classroom facilities associated with the Sandia critical experiments training course (T&E2: Q4).

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

The drop in the SNL T&E budget from FY13 to FY14 is due to the one-time FY13 investment in the classroom facilities at the Sandia critical experiment facility.



**Appendix A**  
**Work Authorization Statements for**  
**Nuclear Criticality Safety Program Funding for Execution Year FY2013**  
**Provided to the NA-10 Budget Office in September 2012**

**Argonne National Laboratory (ANL): \$467K**

***Tasks: Integral Experiments, Nuclear Data, Nuclear Data Advisory Group, and the Criticality Safety Support Group***

Reflects funds to continue supporting integral experiments and nuclear data activities, including chairing the Nuclear Data Advisory Group, as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan dated October 2012, or as directed by the NCSP Manager; 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.

ANL POC: Richard McKnight (630-252-6088), [rdmcknight@anl.gov](mailto:rdmcknight@anl.gov)  
DOE POC: Jerry McKamy, NNSA (301-903-7980)

**Brookhaven National Laboratory (BNL): \$160K**

***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 and subsequent publication of these data in the United States Evaluated Nuclear Data File (ENDF) as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan dated October 2012, or as directed by the NCSP Manager.

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

**Hanford: \$50K**

***Task: Information Preservation and Dissemination***

Reflects funds for obtaining integral cross sections for actinides from reactor operations and special test data.

Hanford POC: Raymond Puigh (509-376-3766), [Raymond.Puigh@rl.gov](mailto:Raymond.Puigh@rl.gov)  
DOE POC: Jerry McKamy, NNSA (301-903-7980)

**Los Alamos National Laboratory (LANL): \$8,165K**

***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) Five-Year Plan dated October 2012, or as directed by the NCSP Manager; and for participation in the Criticality Safety Support Group (CSSG) as it provides technical support to the NCSP Manager regarding planning and execution of the NCSP.

LANL POC: Robert Margevicius (505-665-8965), [margevicius@lanl.gov](mailto:margevicius@lanl.gov)  
DOE POC: Jerry McKamy, NNSA (301-903-7980)

**Lawrence Livermore National Laboratory (LLNL): \$2,665K**

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

Reflects funds to continue support for analytical methods; information preservation and dissemination; integral experiments; training and education, as delineated in the NCSP Five-Year Plan dated October 2012, or as directed by the NCSP Manager; 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](mailto:heinrichs1@llnl.gov)  
DOE POC: Jerry McKamy, NNSA (301-903-7980)

**Nuclear Security Technologies (NSTec): \$2900K**

***Task: Integral Experiments***

Reflects funds to continue support for integral experiments, as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan dated October 2012, or as directed by the NCSP Manager.

NNSA POC: Rashelle Will (702-295-4777), [willrd@nv.doe.gov](mailto:willrd@nv.doe.gov)  
DOE POC: Jerry McKamy, NNSA (301-903-7980)

**Oak Ridge National Laboratory (ORNL): \$2,870K**

***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; and training and education as delineated in the NCSP Five-Year Plan dated October 2012, or as directed by the NCSP Manager; 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.

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

**Pacific Northwest National Laboratory (PNNL): \$50K**

***Task: Criticality Safety Support Group***

Reflects funds 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.

PNNL POC: Michaele Brady Raap (509-588-3511), [MikeyBrady@aol.com](mailto:MikeyBrady@aol.com)  
DOE POC: Jerry McKamy, NNSA (301-903-7980)

**Rensselaer Polytechnic Institute (RPI): \$448K**

***Task: Nuclear Data***

Reflects funds to conduct differential nuclear data measurements and data evaluations as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Execution Plan dated October 2012, or as directed by the NCSP Manager.

RPI POC: Yaron Danon (518-276-4008), [danony@rpi.edu](mailto:danony@rpi.edu)  
DOE POC: Jerry McKamy, NNSA (301-903-7980)

**Sandia National Laboratories (SNL): \$1,150K**

***Tasks: Integral Experiments, Training and Education***

Reflects funds to continue support for integral experiments and training and education as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Execution Plan dated October 2012, or as directed by the NCSP Manager.

SNL POC: Gary Harms (505-845-3244), [gaharms@sandia.gov](mailto:gaharms@sandia.gov)

DOE POC: Jerry McKamy, NNSA (301-903-7980)

**Y-12: \$50K**

***Task: Criticality Safety Support Group***

Reflects funds 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.

Y-12 POC: Kevin Kimball (865-576-6675), [kimball@y12.doe.gov](mailto:kimball@y12.doe.gov)

DOE POC: Jerry McKamy, NNSA (301-903-7980)

## Appendix B Nuclear Data

Priority Needs / Additional Needs		Thermal scattering (BeO, HF, D <sub>2</sub> O, SiO <sub>2</sub> , CH <sub>2</sub> , C <sub>2</sub> F <sub>4</sub> , C <sub>5</sub> O <sub>2</sub> H <sub>8</sub> , etc.), <sup>239</sup> Pu, Cr, <sup>237</sup> Np, Pb, W, <sup>55</sup> Mn, Ti, <sup>240</sup> Pu, Fe, <sup>58</sup> Ni, <sup>60</sup> Ni, <sup>63</sup> Cu, <sup>65</sup> Cu / <sup>233</sup> U, Th, Be, <sup>51</sup> V, Zr, F, K, Ca, Mo, Na, La								
Completed Evaluations (FY)		SiO <sub>2</sub> (12), <sup>55</sup> Mn (12), <sup>180,128,183,184,186</sup> W (10), <sup>239</sup> Pu (09), <sup>52,52</sup> Cr (09), <sup>58,60</sup> Ni (09), <sup>55</sup> Mn (09), <sup>39,41</sup> K (09), <sup>19</sup> F (09)								
	Materials	Pre-FY2012	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	Post-FY2018
Measurements	Calcium (Ca)									
	Cerium (Ce)									
	Copper (Cu)									
	Dysprosium (Dy)									
	Gadolinium (Gd)									
	Iron (Fe)									
	Strontium (Sr)									
	Tungsten (W)									
	Vanadium (V)									
	Zirconium (Zr)									
	Polyethylene (CH <sub>2</sub> )					H <sub>2</sub> O / CH <sub>2</sub>				
		Materials	Pre-FY2012	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
Complete Evaluations	Calcium (Ca)									
	Cerium (Ce)									
	Chromium (Cr)									
	Copper (Cu)									
	Dysprosium (Dy)									
	Gadolinium (Gd)									
	Iron (Fe)									
	Lead (Pb)									
	Minor Actinides									
	Nickel (Ni)									
	Plutonium-239									
	Strontium (Sr)									
	Tungsten (W)									
	Uranium-235									
	Uranium-238									
	Vanadium (V)									
Zirconium (Zr)										
Polyethylene (CH <sub>2</sub> )										
		ORNL		RPI		LANL				
<ul style="list-style-type: none"> <li>• Requests for additional IE measurements: Ni, Mo, Cr (Fe-Cr alloys), Mn in intermediate energy range (VNIITF, NCERC).</li> <li>• Request for measurements and evaluation of angular distributions at high energy for Cu.</li> <li>• Continuing need for thermal scattering data.</li> </ul>										

## **B-1 Differential Measurements and Evaluations – Elements**

B-1.1 Calcium (Ca)

B-1.2 Cerium (Ce)

B-1.3 Copper (Cu-63, 65)

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

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

B-1.6 Iron (Fe-56)

B-1.7 Lead (Pb-208)

B-1.8 Minor Actinides

B-1.9 Nickel (Ni-58, 60)

B-1.10 Plutonium (Pu-239)

B-1.11 Strontium (Sr)

B-1.12 Tungsten (W-182,183,184,186)

B-1.13 Uranium (U-235)

B-1.14 Uranium (U-238)

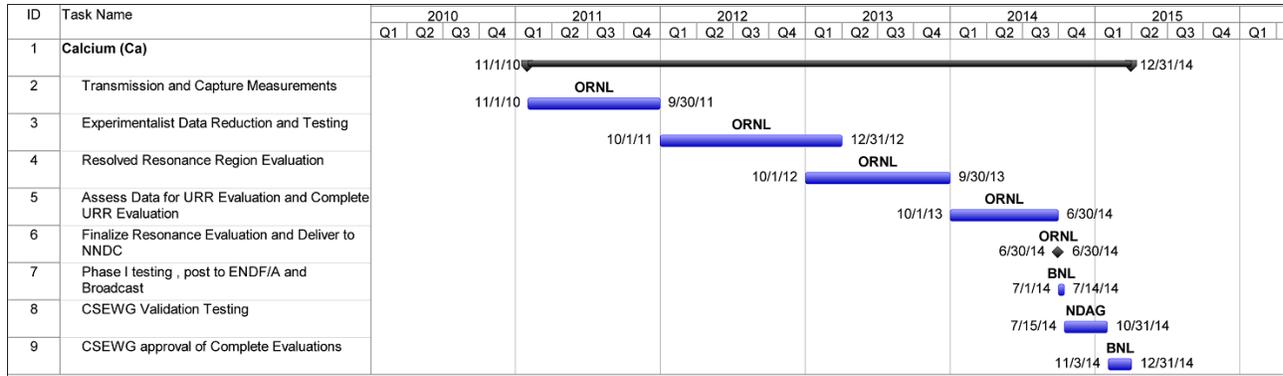
B-1.15 Vanadium (V-51)

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

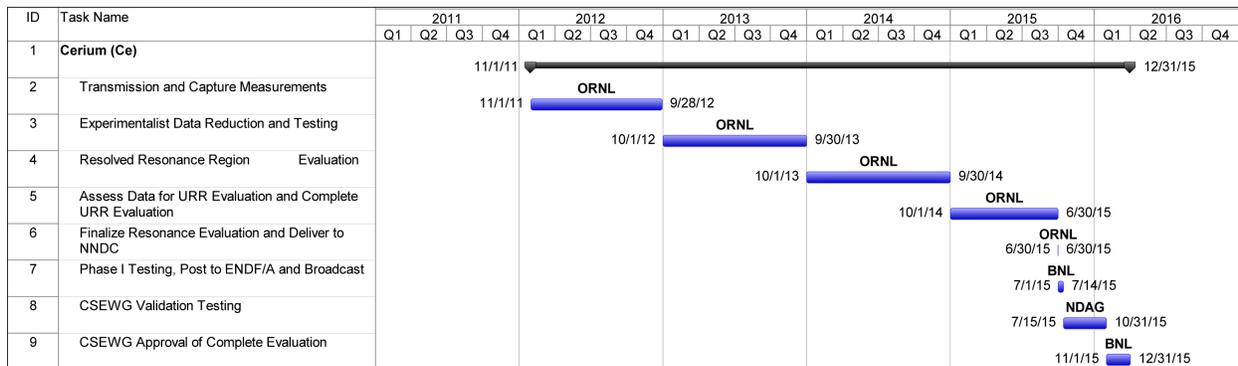
## **B-2 Differential Measurements and Evaluations – Compounds**

B-2.1 Polyethylene (CH<sub>2</sub>)

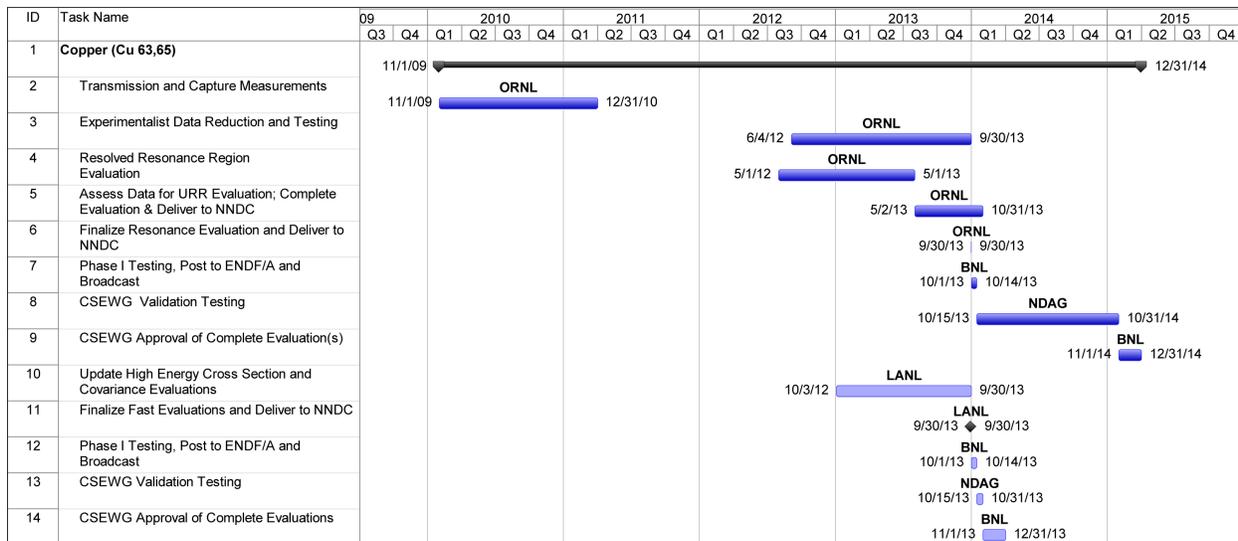
## B-1.1 Calcium (Ca)



## B-1.2 Cerium (Ce)



## B-1.3 Copper (Cu-63, 65)



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

ID	Task Name	2009				2010				2011				2012				2013				2014				2015			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	<b>Dysprosium (Dy-161,162,163,164)</b>	4/1/09 → 12/31/14																											
2	Perform Capture Measurements	4/1/09 → 3/30/10 (RPI)																											
3	Perform SAMMY Analysis	4/1/10 → 9/30/11 (RPI)																											
4	Resolve Resonance Region Evaluation for Dy-161,162,163,164	10/1/13 → 9/30/14 (ORNL)																											
5	Finalize isotopic Evaluation Resonance Region Evaluation and Deliver to NNDC	9/30/14 → 9/30/14 (ORNL)																											
6	Phase I testing, Post to ENDF/A and Broadcast	10/1/14 → 10/14/14 (BNL)																											
7	CSEWG Validation Testing	10/15/14 → 10/31/14 (NDAG)																											
8	CSEWG Approval of Complete Evaluation	11/1/14 → 12/31/14 (BNL)																											

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

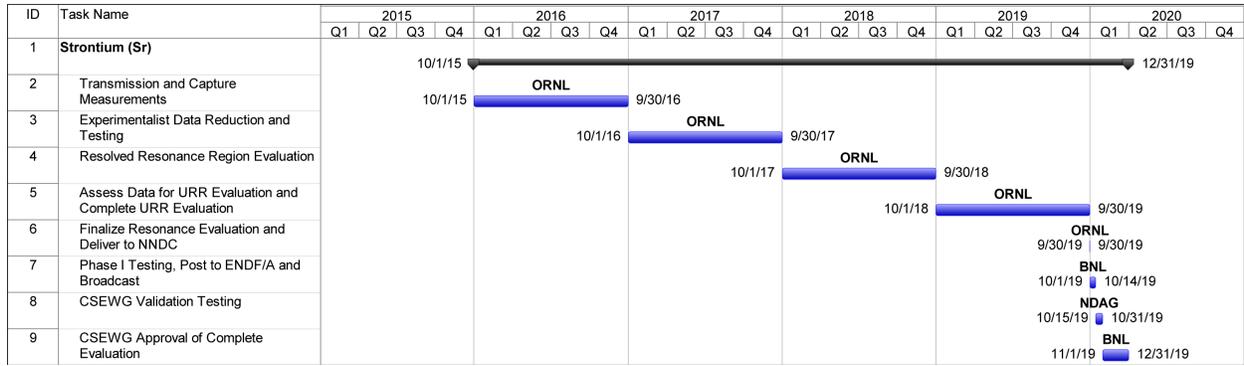
ID	Task Name	2008				2009				2010				2011				2012				2013				2014				2015				2016			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4				
1	<b>Gadolinium (Gd-155,156,157,158,160)</b>	4/1/08 → 12/30/15																																			
2	Perform Capture Measurements	4/1/08 → 3/30/10 (RPI)																																			
3	Perform SAMMY Analysis	4/1/10 → 9/30/11 (RPI)																																			
4	Resolve Resonance Region Evaluation for Gd-155,156,157,158,160	10/1/14 → 9/30/15 (ORNL)																																			
5	Finalize Resonance Region Evaluation and Deliver to NNDC	9/30/15 → 9/30/15 (ORNL)																																			
6	Phase I Testing, Post to ENDF/A and Broadcast	10/2/15 → 10/12/15 (BNL)																																			
7	CSEWG Validation Testing	10/13/15 → 11/1/15 (NDAG)																																			
8	CSEWG Approval of Complete Evaluations	11/1/15 → 12/30/15 (BNL)																																			

### B-1.6 Iron (Fe-56)

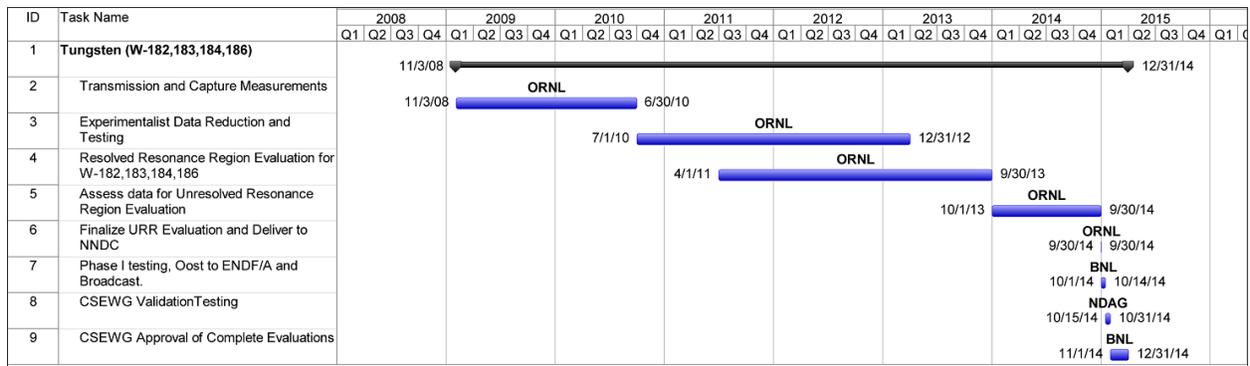
ID	Task Name	2011				2012				2013				2014				2015				2016							
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
1	<b>Iron (Fe-56)</b>	1/3/11 → 12/31/15																											
2	Scattering Measurements	10/1/11 → 9/30/13 (RPI)																											
3	Re-evaluation of Resonance Region for Fe-56	1/3/11 → 9/30/13 (ORNL)																											
4	Finalize Resonance Region Evaluation and Deliver to NNDC	9/30/13 → 9/30/13 (ORNL)																											
5	Phase I Testing; Post to ENDF/A and Broadcast	9/30/13 → 10/14/13 (BNL)																											
6	CSEWG Validation Testing	10/16/13 → 10/14/13 (NDAG)																											
7	CSEWG Approval of Completed Evaluation	11/1/14 → 12/30/14 (BNL)																											
8	Update High Energy Cross Section and Covariance Evaluations	10/4/13 → 3/31/15 (LANL)																											
9	Finalize Fast Evaluations and Deliver to NNDC	4/1/15 → 4/1/15 (LANL)																											
10	Phase I Testing, Post to ENDF/A and Broadcast	4/1/15 → 4/14/15 (BNL)																											
11	CSEWG Validation Testing	4/15/15 → 11/1/15 (NDAG)																											
12	CSEWG Approval of Complete Evaluations	11/1/15 → 12/31/15 (BNL)																											



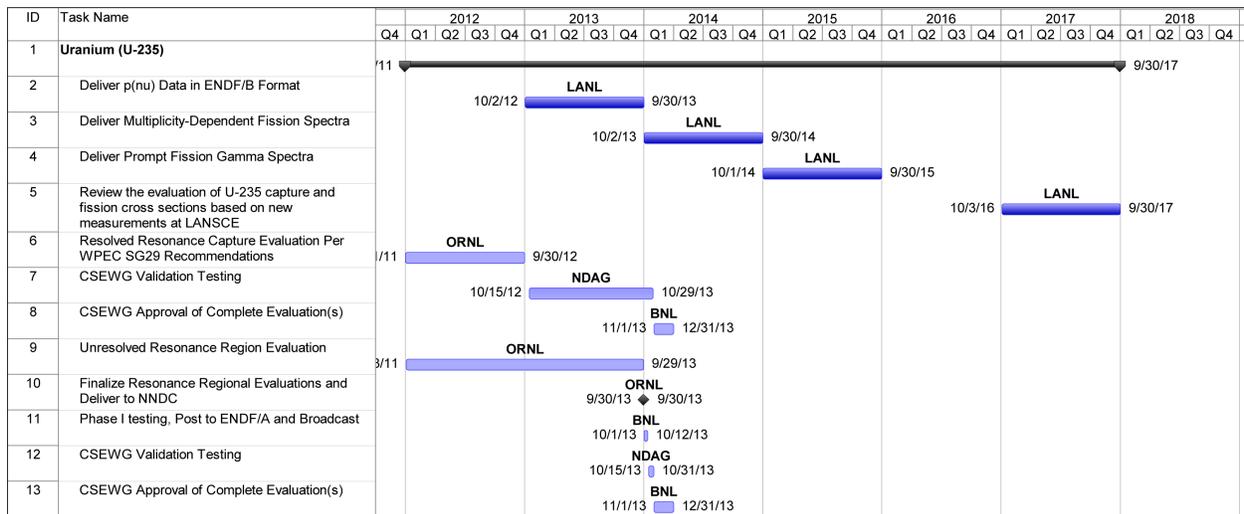
### B-1.11 Strontium (Sr)



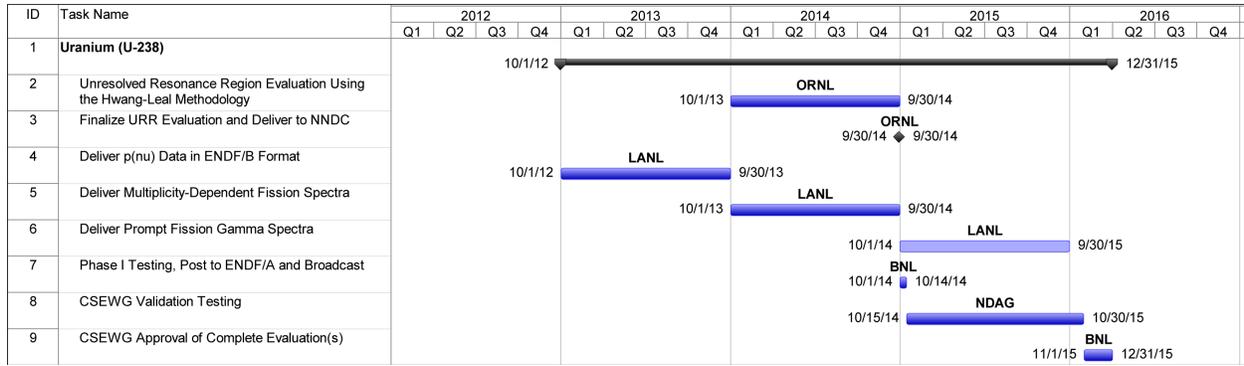
### B-1.12 Tungsten (W-182,183,184,186)



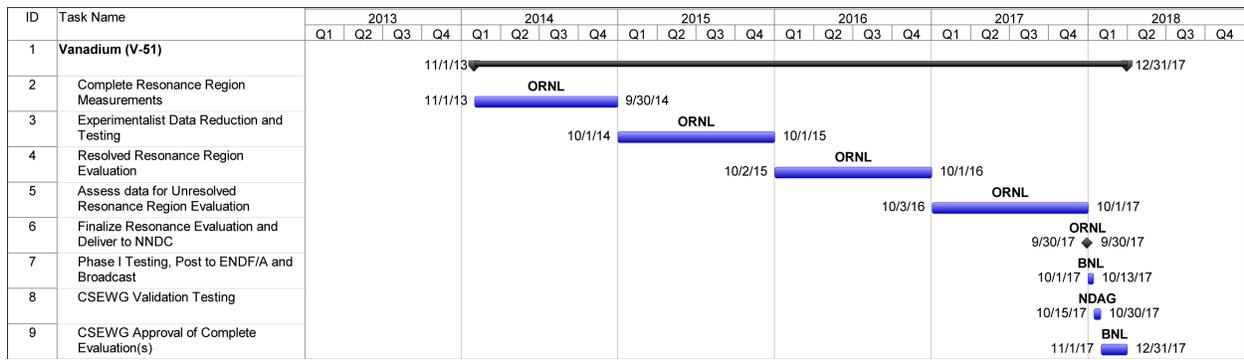
### B-1.13 Uranium (U-235)



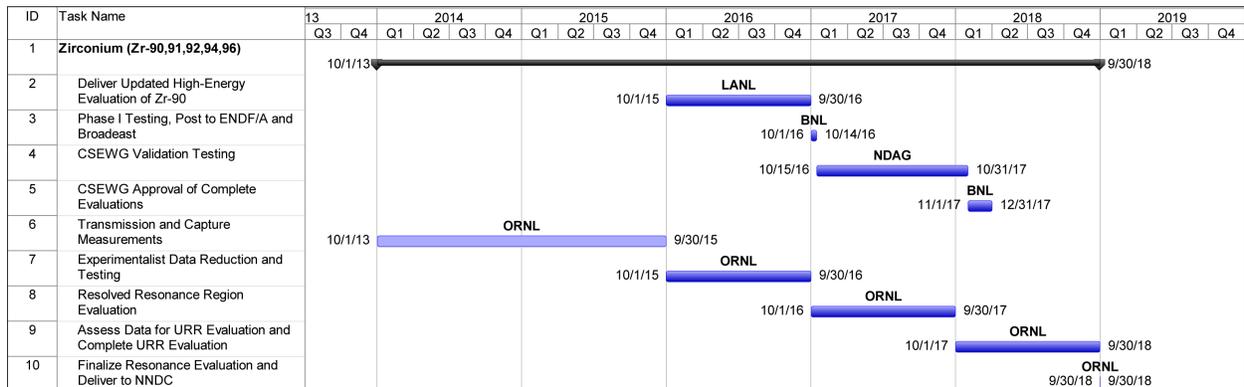
### B-1.14 Uranium (U-238)



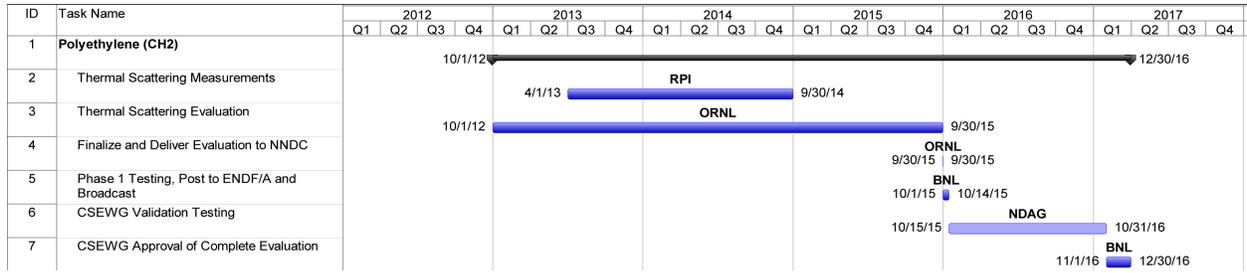
### B-1.15 Vanadium (V-51)



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



## B-2.1 Polyethylene (CH<sub>2</sub>)



## Appendix C

### Fiscal Year 2013 Projected Foreign Travel

Destination	Date	Labs	Count	Costs (\$)	One Sentence Justification
OECD/NEA ICSBEP Paris, France	5/2013	LANL LLNL SNL	4	30,000	Participate in the annual ICSBEP Technical Meeting (Favorite, Harms, Heinrichs, Hutchinson, Scorby)
IRMM Mol, Belgium	11/2012 3/2013 6/2013 9/2013	ORNL	1	60,000	Perform resonance region nuclear data measurements using the GELINA facility at IRMM (Guber)
NEA WPEC Paris, France	5/2013	ANL LANL ORNL RPI	5	23,000	Participate in annual OECD/NEA Working Party for Evaluation Cooperation (WPEC) meeting and associated working group meetings (Danon, Dunn, Kahler, Leal, McKnight)
CEA Provence, France	4/2013	ORNL	1	17,500	Work with CEA nuclear data evaluation team to complete a new <sup>235</sup> U resonance region capture evaluation (Leal)—plan to combine travel with WPEC meeting in 5/2013 in order to reduce airfare cost.
NEA WPNCs Paris, France	9/2013	ANL LLNL ORNL	4	25,000	Participate in OECD/NEA Working Party on Nuclear Criticality Safety (WPNCs) (Heinrichs, McKnight, Parks, Scorby)
NEA WPNCs Paris, France	9/2013	ORNL	1	5,000	Participate in WPNCs Expert Group meeting on Uncertainty Analyses for Criticality Safety Assessment (Perfetti)
NEA WPEC Paris, France	11/2012 5/2013	ORNL ANL	3	25,000	Participate in OECD WPEC Subgroup 33 Meeting (McKnight, Perfetti, Rearden)

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