



NUCLEAR CRITICALITY SAFETY PROGRAM (NCSP)

FY2019 4TH QUARTER REPORTS

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: LANL AM1, AM2, AM4, AM5, AM6 Task Title: see last page M&O Contractor Name: LANL Point of Contact Name: Brian Bluhm / Bob Little Point of Contact Phone: 505-667-2440 / 505-665-3487</p>	<p>Reference: B&R DP0909010 Date of Report: October 18, 2019</p>
<p align="center">BUDGET</p>	<p align="center">MAJOR ACCOMPLISHMENTS</p>
<p>The graph displays the budget and spending for the fiscal year 2019. The y-axis represents the amount in dollars, ranging from 0 to 1800. The x-axis shows the months from October to September. The 'Approved Budget' is a constant horizontal line at approximately \$1,601,000. 'Planned Spending' is shown as a red line with triangles, starting at about \$100 in October and rising to approximately \$1,450 by September. 'Actual Costs' is shown as a green line with squares, starting at about \$100 in October and rising to approximately \$1,650 by September, exceeding the planned spending.</p> <ol style="list-style-type: none"> 1. Carryover into FY 2019 = \$0 2. Approved FY 2019 Budget = \$1,601,000 (includes carryover) 3. Actual spending for 1st Quarter FY 2019 = \$283,516 4. Actual spending for 2nd Quarter FY 2019 = \$321,123 5. Actual spending for 3rd Quarter FY 2019 = \$493,582 6. Actual spending for 4rd Quarter FY 2019 = \$566,459 7. Projected carryover into FY 2020 = \$0 	<ul style="list-style-type: none"> • Education (AM1, TE4) <ul style="list-style-type: none"> - MCNP6 training courses at LANL - 1/2 -day sensitivity-uncertainty seminar for LANL NCS group - Monte Carlo class at UNM. Thesis advisor for UNM graduate student working in NCS area. • R&D Work, continued to investigate & develop (AM1) <ul style="list-style-type: none"> - Automated Acceleration and Convergence Testing for Monte Carlo Criticality Calculations. Merging mcnp6 code modifications into permanent mcnp6 git repository, for inclusion with next mcnp6 release. - Updating whisper to whisper-1.2, capabilities for multiple benchmark catalogs & new covariance data. Initial phase complete. Now have 2723 ICSBEP benchmarks. Converting new covariance data to ACE format. - Region-dependent sensitivity-uncertainty data for NCS validation - Machine learning studies to understand the bias in criticality calculations - Impact of correlated fission multiplicity models in criticality calculations - Studies into the validation for chlorine • MCNP Support & Maintenance (AM1) <ul style="list-style-type: none"> - Support MCNP6 users. MCNP Forum, email, direct interactions, etc. Milestone complete (AM1)

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	<ul style="list-style-type: none">- Code modernization effort - Efforts are in progress to improve SQA, implement some MCNP-2020 features, & upgrade portions of MCNP6. Includes more formal planning, design proposals, improved code review, SQA tools, and more. (Most of funding is non-NCSP.)• Comparison of Sensitivity-Uncertainty-based USL Methods (AM4)<ul style="list-style-type: none">- Comparison of results from LANL & ORNL is in progress. Awaiting results from IRSN.- Comparison of USLs found using LANL, SNL, & SRS benchmark suites, in progress.• Comparison of ICSBEP Benchmark Results (AM5)<ul style="list-style-type: none">- Preliminary results were obtained from LANL, LLNL, ORNL, SNL, IRSN. Detailed comparison of results will occur in 2019.- Detailed review of benchmark input files, with cooperation from NCS & Nuclear Data Team. Several candidate updates have been created.• Technical Data for the Pitzer Formulation of Solution Compositions (AM6)<ul style="list-style-type: none">- Participated in teleconference with ORNL and LLNL, transmitted density data for uranium sulfate, literature search progressing for additional density data.• Conferences, Reports, & Publications <u>ANS conference on Mathematics & Computation, MC-2019, Portland OR, August 2019</u> Attendees: M.E. Rising, C.J. Josey (LANL), P.A. Grechanuk (Oregon St), D.H. Timmons (UNM) Papers & talks:
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NCSP Quarterly Progress Report (FY-2019 Q4)

F.B. Brown, C.J. Josey, S.J. Henderson, W.R. Martin, “Automated Acceleration and Convergence Testing for Monte Carlo Criticality Calculations”

C.J. Josey, F.B. Brown, “Stabilizing the k- Alpha Iteration Algorithm in Very Subcritical Regimes”

C.J. Josey, F.B. Brown, “Computing Alpha Eigenvalues Using the Fission Matrix”

D.H. Timmons, M.E. Rising, C.M. Perfetti, “The Use of MCNP 6.2 KCODE for High Fidelity, Near Critical Benchmarks”

P. Grechanuk, M.E. Rising, T.S. Palmer, “Identifying Sources of Bias from Nuclear Data in MCNP6 Calculations Using Machine Learning Algorithms”

International Conference on Nuclear Criticality, ICNC-2019, Paris, FR, September 2019

Attendees: F.B. Brown, M.E. Rising, J.A. Alwin (LANL), P.A. Grechanuk (Oregon St)

Papers & talks:

F.B. Brown, C.J. Josey, S.Henderson, W.R. Martin, “Automated Acceleration and Convergence Testing for Monte Carlo NCS Calculations”

J.L. Alwin, J.B. Spencer, G. Failla, “Criticality Accident Alarm System Analysis Using MCNP6.2 Constructive Solid Geometry/Unstructured Mesh Hybrid”

M.E. Rising, “Evaluating Sensitivity-Based Similarity Metrics Between Applications And Benchmarks”

P.A. Grechanuk, M.E. Rising, “Comparing the Whisper Validation Methodology with Machine Learning Methods”

International Conference on Transport Theory, ICTT-26, Paris, FR, September 2019

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	<p>Attendees: F.B. Brown</p> <p>Papers & talks:</p> <p>F.B. Brown, C.J. Josey, S.Henderson, W.R. Martin, “Automated Acceleration and Convergence Testing for Monte Carlo NCS Calculations”</p> <p><u>OECD-NEA-WPNCS Meetings, Paris, FR, September 2019</u></p> <p>Attendees: F.B. Brown, M.E. Rising</p> <p>Papers & talks, for Subgroup-6:</p> <p>F.B. Brown, C.J. Josey, S.Henderson, W.R. Martin, “Automated Acceleration and Convergence Testing for Monte Carlo NCS Calculations”</p> <p>-</p> <ul style="list-style-type: none">• NJOY Development and Support (AM2)<ul style="list-style-type: none">- We have done a lot with regards to NJOY user support and maintenance. Six updates were made to NJOY2016 during FY2019, all released on GitHub. In addition, there were six updates to NJOY21 fixing bugs and adding features. A brief document summarizing all NJOY2016 updates during the FY has been prepared.- A paper was presented at ICNC on the resonance reconstruction work with R-Matrix Limited format; <i>Progress on the RECONR module for NJOY21</i>, W. Haeck, A. P. McCartney, J. L. Conlin, and A. J. Trainer.- Work on ENDFtk including parsing of MF=5, MF=4, and MF=12.- Work continues with ACEtk to enable the creation of ACE data for fast neutrons. This is virtually complete; just need to polish off a few issues.
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	<ul style="list-style-type: none">- Work has begun on modern ACER—which uses ACETk. We understand most of the processing steps that have to be implemented in a modern ACER to replicate what was done in Legacy NJOY. We intend to complete these steps in FY2020.- The algorithm for LEAPR has been completed, by our contract at MIT. Great documentation for this has also been created. The integration of this into NJOY21 will be completed in FY2020.
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NCSP Quarterly Progress Report (FY-2019 Q4)

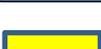
LANL AM Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Support MCNP6 users (AM1)		
	Support NJOY users (AM2)		
	Provide status reports on LANL participation in US and International analytical methods collaborations (AM1, AM2, AM4, AM5, and AM6)		
	Provide reports on summer intern work accomplished (AM1)		
Q2	Support MCNP6 users (AM1)		
	Support NJOY users (AM2)		
	Provide status reports on LANL participation in US and International analytical methods collaborations (AM1, AM2, AM4, AM5, and AM6)		
	Issue an MCNP V&V report, including ENDF/B-VIII.0 (AM1)		
	Provide MCNP6 Criticality training course (AM1)		
	Provide status of R&D and modernization efforts at the NCSP Technical Program Review (AM1)		

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	Implement the Doppler broadening capabilities into the NJOY21 framework (AM2)		Now scheduled for delivery in Q4.
Q3	Support MCNP6 users (AM1)		
	Support NJOY users (AM2)		
	Provide status reports on LANL participation in US and International analytical methods collaborations (AM1, AM2, AM4, AM5, and AM6)		
	Release initial version of MCNP6 with automatic convergence testing & under-sampling diagnostics to several NCSP early-adopters for testing, issue report (AM1)		
Q4	Support MCNP6 users (AM1)		
	Support NJOY users (AM2)		
	Provide status reports on LANL participation in US and International analytical methods collaborations (AM1, AM2, AM4, AM5, and AM6)		Note that trip report for ICNC and OECD-NEA-WPNCs is in progress, as trip occurred only near the end of the quarter.
	Implement ACER fast neutron capabilities into the NJOY21 framework (AM2)		Underway, but to be completed during FY20.
	Issue report on the Sensitivity-Uncertainty Comparison Study (AM4)		Multi-Lab report still in progress.
	Issue report on the ICSBEP Benchmark Comparison Study (AM5)		Multi-Lab report still in progress.
	Document and release beta versions of ENDF/B-VIII.1 evaluations in ACE format on LANL website (AM1)		

NCSP Quarterly Progress Report (FY-2019 Q4)

Task Title:

AM1 MCNP Maintenance and Support, Uncertainty Analysis Development, and Modernization

AM2 NJOY Development and Maintenance, Uncertainty Analysis Development, and Modernization

AM4 Sensitivity/Uncertainty Comparison Study with a Focus on Upper Subcritical Limits

AM5 Proposed Benchmark Intercomparison Study

AM6 Technical Data for the Pitzer Formulation of Solution Compositions to Include Uranium/Plutonium Solutions with Selected Admixed Absorbers

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtasks: AM2, 3, 5, 6, 7</p> <p>Task Titles:</p> <p>AM2 Multiphysics Methods for the Simulation of Criticality Accidents AM3 Slide Rule Application AM5 Proposed Benchmark Intercomparison Study AM6 Proposed 1-D Multipoint Analytical Benchmark Comparison AM7 Technical Data for the Pitzer Formulation of Solution Compositions</p> <p>M&O Contractor Name: Lawrence Livermore National Laboratory</p> <p>Point of Contact Name: David Heinrichs</p> <p>Point of Contact Phone: (925) 424-5679</p>	<p>Reference: B&R DP0909010</p> <p>Date of Report: October 18, 2019</p>						
<p style="text-align: center;">BUDGET</p> <p>1. Carryover into FY 2019 = \$45,203</p> <p>2. Approved FY 2019 Budget = \$326,203 (includes carryover)</p> <p>3. Actual spending for 1st Quarter FY 2019 = \$22,055</p> <p>4. Actual spending for 2nd Quarter FY 2019= \$27,204</p> <p>5. Actual spending for 3rd Quarter FY 2019 = \$28,026</p> <p>6. Actual spending for 4rd Quarter FY 2019 = \$105,049 (not including \$68,737 in liens).</p> <p>7. Projected carryover into FY 2020 = \$143,869 (44%) w/o liens; or \$75,132 (23%) with liens.</p>	<p style="text-align: center;">MAJOR ACCOMPLISHMENTS</p> <ol style="list-style-type: none"> LLNL multiphysics methods development continues with testing of delayed neutrons in the sub-prompt super-critical regime based on a mechanically simplified model of Flattop (AM2). Mathieu Duluc presented <i>Criticality Accidents Detection and Minimum Accident of Concern: Review and Discussions</i> at ICNC on September 18, 2019 (AM3). Provided additional high-precision COG benchmark results using ENDF/B-VII.1, ENDF/B-VIII.0 and JEFF-3.3 to Isabelle Duhamel (IRSN) for a total of 2,336 ICSBEP benchmark cases for inclusion in the Benchmark Intercomparison Study (AM5) as follows: <table style="margin-left: 40px;"> <tr> <td>PU: 650</td> <td>U233: 193</td> <td>MIX: 124</td> </tr> <tr> <td>HEU: 818</td> <td>IEU: 188</td> <td>LEU: 363</td> </tr> </table> Soon Kim presented <i>Results of a Newly Expanded COG Criticality Validation Suite</i> at ICNC on September 19, 2019 (AM5). Isabelle Duhamel presented <i>International Benchmarks Intercomparison Study for Code and Nuclear Data Validation</i> at ICNC on September 16, 2019. Shauntay Coleman presented <i>Validation of MCNP6.1 and MCNP 6.2 Using ENDF/B-VII.1 Nuclear Data for Criticality Safety Application to Plutonium and Highly Enriched Uranium Systems</i> at ICNC on September 17, 2019. Dave Heinrichs provided references, benchmark values, and COG11.3 results for 20 β_{eff} benchmarks to NNL (Bettis) and JSI (Slovenia) (AM5). Barry Ganapol (Arizona) and Dave Heinrichs presented <i>Precision Benchmark of the COG Monte Carlo Code</i> at ICTT on September 22-27, 2019 (AM6). 	PU: 650	U233: 193	MIX: 124	HEU: 818	IEU: 188	LEU: 363
PU: 650	U233: 193	MIX: 124					
HEU: 818	IEU: 188	LEU: 363					

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LLNL AM Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	COMMENTS
Q1	Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, AM5, AM6, AM7).		
Q2	Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, AM5, AM6, AM7).		
Q3	Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, AM5, AM6, AM7).		
Q4	Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, AM5, AM6, AM7).		

Task Titles:

AM2 Multi-Physics Methods for Simulation of Criticality Excursions

AM3 Slide Rule Application

AM5 Proposed Benchmark Intercomparison Study

AM6 Proposed 1-D Multipoint Analytical Benchmark Comparison

AM7 Technical Data for the Pitzer Formulation of Solution Compositions to Include Uranium/Plutonium Solutions with Selected Admixed Absorbers

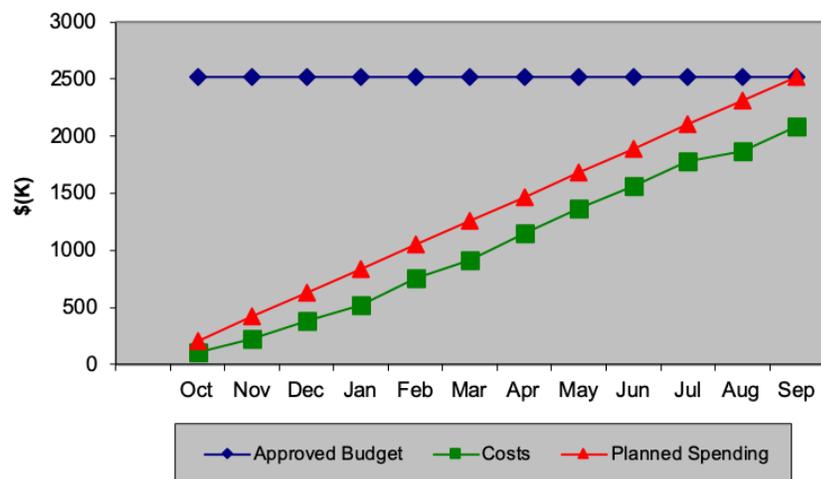
NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtask: ORNL – AM1, 2, 3, 6, 9, 10, 11, 13, 14, 15, 16
Task Titles: See last page
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP090010/ORNL
Date of Report: October 11, 2019

BUDGET

FY19 Analytical Methods



1. Carryover into FY19 = \$301K; FY20 = \$437K
2. Approved FY 2019 Budget = \$2521k (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$388K
4. Actual spending for 2nd Quarter FY 2019 = \$523K
5. Actual spending for 3rd Quarter FY 2019 = \$651K
6. Actual spending for 4rd Quarter FY 2019 = \$522K

MAJOR ACCOMPLISHMENTS

AM1 – Distribution of available and newly packaged software

- Distributed 820 software packages and updated 2 software packages.
- 174 SCALE, 335 MCNP®, and 0 COG packages distributed.
- RSICC quarterly report issued.

AM2 - SCALE/KENO/TSUNAMI Maintenance and Support/Cross-Section and Generation/Modernization

- Held annual SCALE Users' Group Workshop at ORNL.
 - The workshop included over 30 technical talks, six 2-hour tutorials involving both lecture and hands-on application using both SCALE 6.2 production version and 6.3 beta5 features, tours of the historical graphite reactor, irradiated fuels exam lab and liquid salt loop. In addition, an evening poster session highlighted many student's work. A closing session collected feedback on improvements in both process and capability from attendees.
 - The workshop attendees included industry, government and government contractors, and students from both the US and other countries.
- Attended ICNC conference and WPNCs meeting in Paris.
 - At WPNCs, ORNL proposed a new sub-group (SG-8) on "Preservation of Expert Knowledge and Judgement Applied to Criticality Benchmarks", to be led by Wieselquist.
 - SG-8 will create a system to record and maintain expert opinion on ICSBEP benchmarks, e.g. applicability for code validation or data adjustment.
- Deployed SCALE 6.3 beta5 release internally and externally
 - Infrastructure/Maintenance
 - Refactored some embedded dependencies in the repositories as git submodules, which allows for more controlled dependency management. This will be how parts of SCALE may be deployed as stand-alone, open-source "submodules" (e.g. AMPX or SAMMY) which are both available without need for export control and also configured at a particular version for use and deployment within export-controlled SCALE.

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- A reformatting of the SCALE manual was initiated based on Re-structured Text, able to create high-quality HTML and PDF formats.
- NCSP Code/Data enhancements
 - Additional support for error handling in deep hierarchical nesting in CSAS-Shift geometry.
 - Corrections to SCALE 6.1 to 6.2 MG library converters.
 - Support for reaction rate tallies on hexagonal domains.

AM3 - AMPX Maintenance and Modernization

- An error was discovered in the program ZEST, used to combine various 1-D cross section data files. This did not affect library creation. Our new staff member was tasked to fix the problem as a good introduction into the AMPX source code and the SCALE SQA procedure. The program was fixed and additional unit tests were added.
- Work started on adding code in preparation for a ENDF format clarification proposal regarding the external R-Matrix.

AM6 – SlideRule Application

- ORNL has finished the FY19 by waiting possible tasks that would be assigned by IRSN. There has been no major assignments other than project meetings in which ORNL contributed by providing expert views on the subjects. It is anticipated that ORNL will have similar responsibilities in the next FY.

AM9 - Sensitivity/Uncertainty Comparison Study with a Focus on Upper Subcritical Limits

- Still awaiting results from IRSN in order to begin comparisons between all participants
- Plans made to discuss available results and plan path forward at ANS meeting in November

AM10 - Proposed Benchmark Inter-Comparison Study

- ORNL provided initial beta ENDF/B-VIII.0 results to IRSN

AM11 – Proposed 1-D Multipoint Analytical Benchmark Inter-Comparison

- This task is pending information from LLNL to proceed.

AM13 - Nuclear Data and Cross Section Testing Using ENDF/B-VIII.0

- Contract has been cancelled.

NCSP Quarterly Progress Report (FY-2019 Q4)

AM14 - Development and Addition of Continuous-Energy Sensitivity Data Files to SCALE's VALID Library

- Contract is complete.

AM15 - The Effects of Temperature on the Propagation of Nuclear Data Uncertainty in Nuclear Criticality Safety Calculation

- Work on implementation of temperature dependent cross section covariance data in the resolved resonance region in AMPX code. Exploring demonstration on NCS applications.

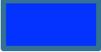
AM16 - Technical Data for the Pitzer Formulation of Solution Compositions to Include Uranium/Plutonium Solutions with Selected Admixed Absorbers

- Sufficient data have been located to implement models of the following actinide solutions:
 - UO₂F₂ in acid at or near 25°C
 - UO₂SO₄ in acid between 20 – 90°C
- These data are being regressed to obtain model parameters and will be reported for inclusion to the SCALE material input processor. We are preparing a draft report describing these systems, as well as other efforts during the year. This report will also identify gaps in current data and important systems for which density data are lacking.

NCSP Quarterly Progress Report (FY-2019 Q4)

ORNL AM Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Continue distribution of available and newly packaged software to the NCS community requesters (at no direct cost to them) and provide distribution totals quarterly. (AM1)		
	Provide status reports on ORNL participation in US and International Analytical Methods collaborations and provide brief trip summary report to NCSP Manager on items of NCSP interest. (AM2, AM3)		
	Provide status on ORNL AM activities in NCSP Quarterly Progress Reports. (AM1, AM2, AM3, AM6, AM9, AM10, AM11, AM13, AM14, AM15, AM16)		See above
Q2	Continue distribution of available and newly packaged software to the NCS community requesters (at no direct cost to them) and provide distribution totals quarterly. (AM1)		
	Provide status reports on ORNL participation in US and International Analytical Methods collaborations and provide brief trip summary report to NCSP Manager on items of NCSP interest. (AM2, AM3)		
	Provide status on ORNL AM activities in NCSP Quarterly Progress Reports. (AM1, AM2, AM3, AM6, AM9, AM10, AM11, AM13, AM14, AM15, AM16)		
	Issue an annual SCALE maintenance report to the NCSP Manager. (AM2)		Completed in Q4.
Q3	Continue distribution of available and newly packaged software to the NCS community requesters (at no direct cost to them) and provide distribution totals quarterly. (AM1)		

NCSP Quarterly Progress Report (FY-2019 Q4)

	Provide status reports on ORNL participation in US and International Analytical Methods collaborations and provide brief trip summary report to NCSP Manager on items of NCSP interest. (AM2, AM3)		
	Provide status on ORNL AM activities in NCSP Quarterly Progress Reports. (AM1, AM2, AM3, AM6, AM9, AM10, AM11, AM13, AM14, AM15, AM16)		
Q4	Continue distribution of available and newly packaged software to the NCS community requesters (at no direct cost to them) and provide distribution totals quarterly. (AM1)		
	Provide status reports on ORNL participation in US and International Analytical Methods collaborations and provide brief trip summary report to NCSP Manager on items of NCSP interest. (AM2, AM3)		
	Provide status on ORNL AM activities in NCSP Quarterly Progress Reports. (AM1, AM2, AM3, AM6, AM9, AM10, AM11, AM13, AM14, AM15, AM16)		
	Publish annual newsletter to users to communicate software updates, user notices, generic technical advice, and training course announcements. (AM2)		Not completed on schedule. In progress.
	Document AMPX modernization and technical support for SCALE CE, multigroup, and covariance libraries and report status annually to the NCSP Manager. (AM3)		

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Task Titles:

- AM1 Radiation Safety Information Computational Center (RSICC)
- AM2 SCALE/KENO/Tsunami Maintenance and Support/Cross-Section and Generation/Modernization
- AM3 AMPX Maintenance and Modernization
- AM6 Slide Rule Application
- AM9 Sensitivity/Uncertainty Comparison Study with a Focus on Upper Subcritical Limits
- AM10 Proposed Benchmark Intercomparison Study
- AM11 Proposed 1-D Multipoint Analytical Benchmark Intercomparison
- AM13 Nuclear Data and Cross Section Testing Using ENDF/B-VIII.0
- AM14 Development and Addition of Continuous-Energy Sensitivity Data Files to SCALE's VALID Library
- AM15 The Effects of Temperature on the Propagation of Nuclear Data Uncertainty in Nuclear Criticality Safety Calculations
- AM16 Technical Data for the Pitzer Formulation of Solution Compositions to Include Uranium/Plutonium Solutions with Selected Admixed Absorbers

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NCSP Element and Subtasks: IPD1, 2, 4

Task Titles:

- IPD1 Conduct ICSBEP for Benchmarks listed in Appendix C of the 5-Year Plan and publish annual revision to the Handbook
- IPD2 Maintain the NCSP Website and Systems
- IPD4 Benchmark Evaluation of Hot Box, LLNL Historical Critical Configurations at High Temperature

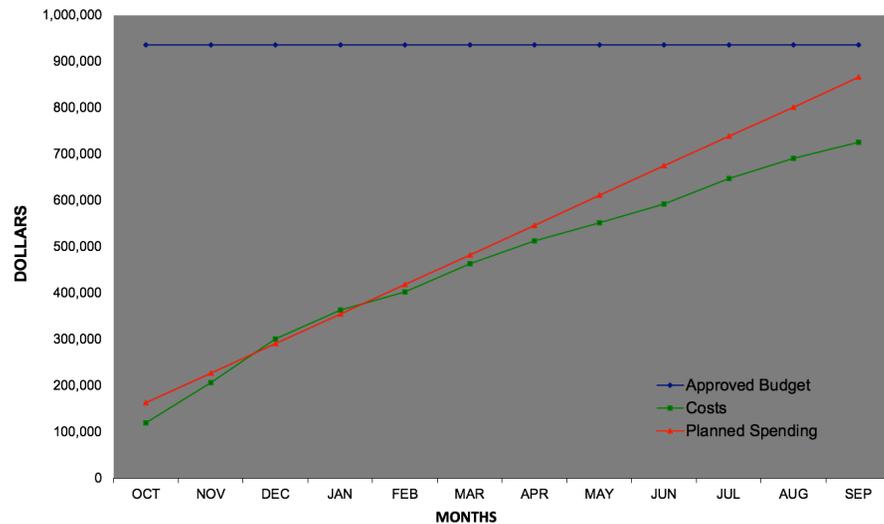
M&O Contractor Name: Lawrence Livermore National Laboratory

Point of Contact Name: David Heinrichs

Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010
Date of Report: October 18, 2019

BUDGET



1. Carryover into FY 2019 = \$102,907
2. Approved FY 2019 Budget = \$935,907 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$301,469
4. Actual spending for 2nd Quarter FY 2019= \$161,932
5. Actual spending for 3rd Quarter FY 2019 = \$128,720
6. Actual spending for 4rd Quarter FY 2019 = \$134,517 (w/o \$110,254 in liens)
7. Projected carryover into FY 2020 = \$209,269 (22%) w/o liens; \$99,015 (11%) with liens

MAJOR ACCOMPLISHMENTS

1. ICSBEP (IPD1).

Three NCSP evaluations have been submitted to the ICSBEP TRG meeting:

- **IER-209**, LCT101, 7uPCX, 0.855 cm pitch, variable water height (SNL)
- **IER-184**, TEX baseline experiments with PANN plates moderated by polyethylene (LLNL)
- **IER-299**, HMF101, KRUSTY cold/warm critical experiments (LANL)

Additionally, LLNL reviewed the following IRSN and JAEA evaluations:

- **LCT074**, MIRTE (Rev. 0) (IRSN)
- **LST013**, TRACY, 10% uranyl nitrate with B4C rod (JAEA) (with COG calculation for 1 case)
- **PST041**, Pu nitrate solution in annular cylinders (IRSN) (with COG calculations for 40 cases)

2. Website and Systems (IPD2).

- Provided NCSP website updates as requested by NCSP Management and developing new webpages for the NCSP TPR.
- Maintained and updated NTS-SLAN/NCERC classified network.
- Completed new 10 GB VPN router for LANL connectivity at A-1 improving network and ESNet data throughput significantly.
- Added 6 users and 2 new network scanners on NTS-SLAN in support of NCERC.
- Completed COMSEC annual inventory in support of all classified IT.
- Received and deployed 4 new U/C systems to NCERC control rooms.
- Installed new MF (U/C) printer for NCERC office.

Provided equipment inspections, certifications and data transfers (IPD2) supporting:

- IER-462: NCSP T&E Hands-On Training (LANL)
- IER-466: LANL IE1 – Provide NCERC Operational Support at the DAF
- IER-489: U-235 Unresolved Resonance Region (URR) Integral Experiment
- IER-494: Non-NCSP RTO TI Project September 2018
- IER-505: Non-NCSP NA-22 Consortium Weeks of 7/22 and 7/29/2019
- IER-509: Non-NCSP DTRA Support Activities
- IER-510: Non-NCSP LANL Student Tour August 8 Week
- IER-511: Non-NCSP Falcon DPF

3. Hot Box (IPD4).

Formal evaluation of “Hot Box” is in progress. Experiment overview (Section 1) is complete; evaluating experimental uncertainties (Section 2) commenced, and the benchmark model (Section 3) continues to be refined.

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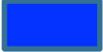
LLNL IP&D Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	COMMENTS
Q1	Manage all aspects of the DOE NCSP participation in the ICSBEP as required to ensure the finalizing and publishing ICSBEP evaluations per IE schedule. (IPD1)		
	Provide status reports on LLNL participation in US and International IPD collaborations (including ICSBEP) and provide brief summary report to NCSP Manager on items of NCSP interest. (IPD1)		
	Maintain, operate and modernize the NCSP website, databases, and provide user assistance as required. (IPD2)		
	Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. (IPD4)		
Q2	Manage all aspects of the DOE NCSP participation in the ICSBEP as required to ensure the finalizing and publishing ICSBEP evaluations per IE schedule. (IPD1)		
	Provide status reports on LLNL participation in US and International IPD collaborations (including ICSBEP) and provide brief summary report to NCSP Manager on items of NCSP interest. (IPD1)		
	Maintain, operate and modernize the NCSP website, databases, and provide user assistance as required. (IPD2)		
	Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. (IPD4)		
Q3	Manage all aspects of the DOE NCSP participation in the ICSBEP as required to ensure the finalizing and publishing ICSBEP evaluations per IE schedule. (IPD1)		
	Provide status reports on LLNL participation in US and International IPD collaborations (including ICSBEP) and provide brief summary report to NCSP Manager on items of NCSP interest. (IPD1)		
	Maintain, operate and modernize the NCSP website, databases, and provide user assistance as required. (IPD2)		
	Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. (IPD4)		

NCSP Quarterly Progress Report (FY-2019 Q4)

Q4	Manage all aspects of the DOE NCSP participation in the ICSBEP as required to ensure the finalizing and publishing ICSBEP evaluations per IE schedule. (IPD1)		Received 100 ICSBEP DVD copies and mailed to NCSP members in Oct 2019.
	Provide status reports on LLNL participation in US and International IPD collaborations (including ICSBEP) and provide brief summary report to NCSP Manager on items of NCSP interest. (IPD1)		ICSBEP report to be provided after meeting in Oct 2019.
	Maintain, operate and modernize the NCSP website, databases, and provide user assistance as required. (IPD2)		
	Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. (IPD4)		

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: ORNL – IPD5, 6</p> <p>Task Titles: IPD5-Oak Ridge Health Physics Research Reactor CAAS Benchmark Evaluation IPD6- Preservation and Dissemination of Unpublished Critical Experiments by Mihalcz</p> <p>M&O Contractor Name: ORNL</p> <p>Point of Contact Name: Doug Bowen</p> <p>Point of Contact Phone: (865) 576-0315</p>	<p style="text-align: right;">Reference: DP090010/ORNL</p> <p style="text-align: right;">Date of Report: October 11, 2019</p>																																																				
<p>BUDGET</p>	<p>MAJOR ACCOMPLISHMENTS</p>																																																				
<div data-bbox="107 431 951 987" data-label="Figure"> <table border="1"> <caption>FY19 Information Preservation and Dissemination Budget Data</caption> <thead> <tr> <th>Month</th> <th>Approved Budget (\$K)</th> <th>Costs (\$K)</th> <th>Planned Spending (\$K)</th> </tr> </thead> <tbody> <tr><td>Oct</td><td>115</td><td>0</td><td>0</td></tr> <tr><td>Nov</td><td>115</td><td>0</td><td>15</td></tr> <tr><td>Dec</td><td>115</td><td>0</td><td>25</td></tr> <tr><td>Jan</td><td>115</td><td>5</td><td>35</td></tr> <tr><td>Feb</td><td>115</td><td>5</td><td>45</td></tr> <tr><td>Mar</td><td>115</td><td>5</td><td>55</td></tr> <tr><td>Apr</td><td>115</td><td>15</td><td>65</td></tr> <tr><td>May</td><td>115</td><td>35</td><td>75</td></tr> <tr><td>Jun</td><td>115</td><td>35</td><td>85</td></tr> <tr><td>Jul</td><td>115</td><td>50</td><td>95</td></tr> <tr><td>Aug</td><td>115</td><td>70</td><td>105</td></tr> <tr><td>Sep</td><td>115</td><td>64</td><td>115</td></tr> </tbody> </table> </div> <div data-bbox="100 1036 751 1226" data-label="List-Group"> <ol style="list-style-type: none"> 1. Carryover into FY 2019 = \$0K; FY 2020 = \$5K 2. Approved FY 2019 Budget = \$115K (includes carryover) 3. Actual spending for 1st Quarter FY 2019 = \$0K 4. Actual spending for 2nd Quarter FY 2019 = \$5K 5. Actual spending for 3rd Quarter FY 2019 = \$31K 6. Actual spending for 4rd Quarter FY 2019 = \$64K </div>	Month	Approved Budget (\$K)	Costs (\$K)	Planned Spending (\$K)	Oct	115	0	0	Nov	115	0	15	Dec	115	0	25	Jan	115	5	35	Feb	115	5	45	Mar	115	5	55	Apr	115	15	65	May	115	35	75	Jun	115	35	85	Jul	115	50	95	Aug	115	70	105	Sep	115	64	115	<p>IPD5 – Oak Ridge Health Physics Research Reactor CAAS Benchmark Evaluation</p> <ul style="list-style-type: none"> ○ Task transferred to new individual ○ Reviewing/documenting collected information, identifying necessary missing information ○ Development of preliminary benchmark models begun <p>IPD6 – Preservation and Dissemination of Unpublished Critical Experiments by Mihalcz</p> <ul style="list-style-type: none"> ○ The task was complete in Q3 ○ John Mihalcz has written a historical report on his critical experiments which is currently in review.
Month	Approved Budget (\$K)	Costs (\$K)	Planned Spending (\$K)																																																		
Oct	115	0	0																																																		
Nov	115	0	15																																																		
Dec	115	0	25																																																		
Jan	115	5	35																																																		
Feb	115	5	45																																																		
Mar	115	5	55																																																		
Apr	115	15	65																																																		
May	115	35	75																																																		
Jun	115	35	85																																																		
Jul	115	50	95																																																		
Aug	115	70	105																																																		
Sep	115	64	115																																																		

NCSP Quarterly Progress Report (FY-2019 Q4)

ORNL IPD Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	NONE		
Q2	Complete documentation of data needed for an ICSBEP benchmark based on the ORNL HPRR (IPD5)		We are engaging HPRR facility management to obtain the data archives and logbooks. More progress was made in Q3.
Q3	Perform initial evaluation of HPRR data and determine if this task should continue (IPD5)		This project was started late in the year due to the departure of Thomas Miller. This task will be delayed into FY20. There were also some delays being able to access HPRR facilities to access logbooks and personnel.
Q4	Perform some initial benchmark simulations to evaluate the quality of the data collect in IPD5 and the ability to simulate the measured data (IPD5)		New individual catching up on what information has been collected and identifying necessary missing information, also progress hindered by loss of individual acting as liaison, current efforts focused on developing acceptable models.
	Report on progress made with the review of 25 critical experiments and their potential applicability and quality for generating ICSBEP evaluations in an FY20 NCSP proposal (IPD6)		

NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtask: SRS IPD1

Task Title: ARH-600 Reissue

M&O Contractor Name(s): SRNS

Point of Contact Name: David Erickson

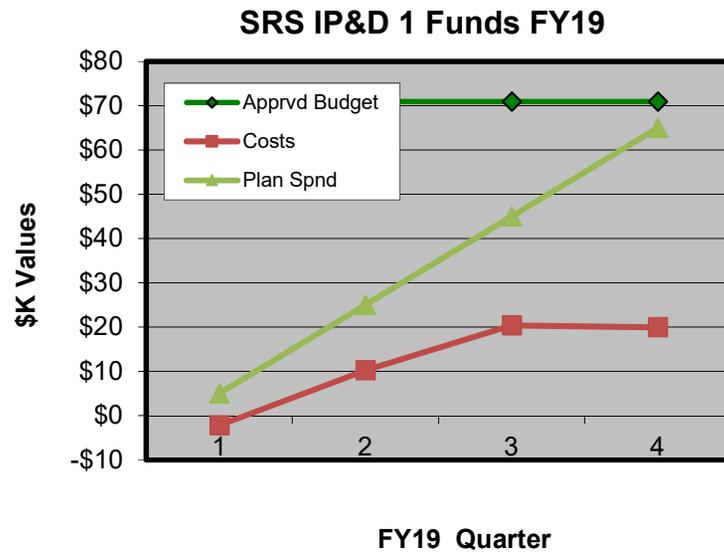
Point of Contact Phone: 803-557-9445

Reference: B&R DP 0909010

Date of Report: October 9, 2019

BUDGET

MAJOR ACCOMPLISHMENTS



The updated user manual, and local testing is complete. Working on approvals for export control/copyright release. The release is needed to post/distribute via the NCSP website.

1. Carryover into FY 2019 = \$1.9K
2. Approved FY 2019 Budget = \$ 70.9K (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = ~~\$-2.2K~~
4. Actual spending for 2nd Quarter FY 2019 = \$12.4K
5. Actual spending for 3rd Quarter FY 2019 = \$10.2K
6. Actual spending for 4rd Quarter FY 2019 = ~~\$-0.5K~~
7. Projected carryover into FY 2020 = \$51K

NCSP Quarterly Progress Report (FY-2019 Q4)

SRS IP&D Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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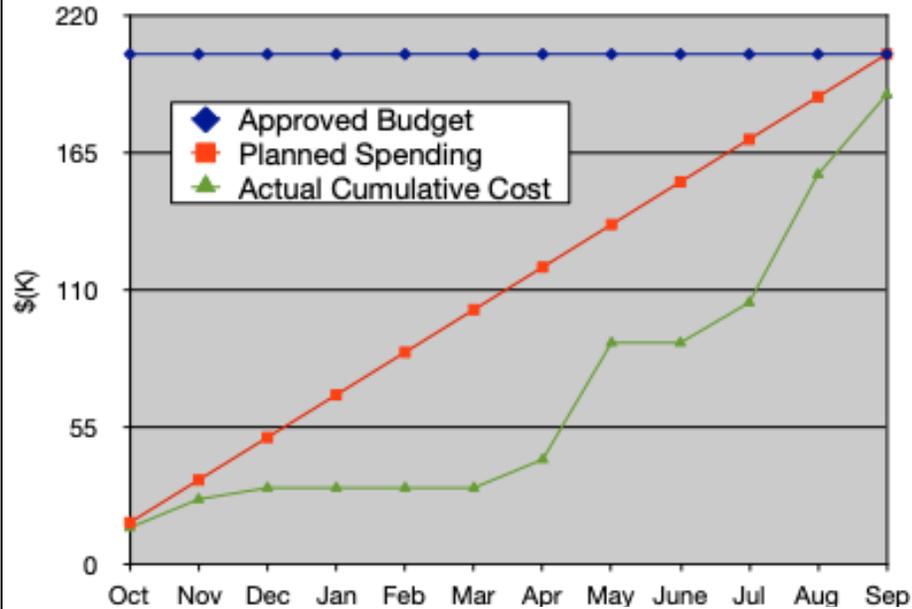
QUARTER	MILESTONE	STATUS	COMMENTS
Q1	Provide status reports on SRS progress. (IPD1)		
Q2	Provide status reports on SRS progress. (IPD1) Develop QA documents for current version to meet current SRS/DOE requirements. (IPD1)		
Q3	Provide status reports on SRS progress. (IPD1)		Local Export Control Release is moving very slowly.
Q4	Provide status reports on SRS progress. (IPD1)		Due to significant high priority site work, and office relocation, progress on the Export Control Release has been minimal.
	Issue Preliminary (updated) CritView version for internal testing. (IPD1)		The revised CritView has been released for testing at SRS. However, until the Export Control/Copyright issue is resolved, significant other distribution is on hold.
	Issue Preliminary User Guide to support internal testing. (IPD1)		

NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtask: Nuclear Data ND1
 Task Title: National Nuclear Data Center (NNDC) Support to the NCSP
 M&O Contractor Name: BNL
 Point of Contact Name: David Brown
 Point of Contact Phone: 631-344-2814

Reference: DP0909010
 Date of Report: Oct. 17, 2019

BUDGET



1. Carryover into FY 2019 = \$24,444
2. Approved FY 2019 Budget = \$224,444 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$31,019
4. Actual spending for 2nd Quarter FY 2019 = \$0
5. Actual spending for 3rd Quarter FY 2019 = \$58,172
6. Actual spending for 4th Quarter FY 2019 = \$99,564
7. Projected carryover into FY 2020 = \$35,689

MAJOR ACCOMPLISHMENTS

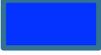
Resonance quality report, based on BNL's FY18 TS6 task, is now in production in ADVANCE. One can see an example report at https://www.nndc.bnl.gov/ndf/b7.dev/qa/neutrons/n-027_Co_059/n-027_Co_059.html (click on the "Resonances" tab).

BNL has extended offer to a senior nuclear engineer who will work 50% time on NSCP tasks including ADVANCE and validation and 50% time on reactor analysis for another group.

NCSP Quarterly Progress Report (FY-2019 Q4)

BNL ND Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Maintain and upgrade ADVANCE code system by performing data verification of new NCSP evaluations and performing quality assurance on the data as required and provide status reports on all nuclear data support activities to the NCSP Manager. (ND1)		Porting ADVANCE (and all of its dependencies) to Python3 is taking longer than anticipated. Also, actively interviewing for potential NCSP post-doc.
Q2	Maintain and upgrade ADVANCE code system by performing data verification of new NCSP evaluations and performing quality assurance on the data as required and provide status reports on all nuclear data support activities to the NCSP Manager. (ND1)		ADVANCE is ported to Python3 and Buildbot 2.1. Still interviewing for potential post-doc.
Q3	Maintain and upgrade ADVANCE code system by performing data verification of new NCSP evaluations and performing quality assurance on the data as required and provide status reports on all nuclear data support activities to the NCSP Manager. (ND1)		ADVANCE turned on and we have deployed the first build reports. ADVANCE is not yet operating autonomously.
	If mandated by CSEWG, release new ENDF library. (ND1)		n/a
Q4	Maintain and upgrade ADVANCE code system by performing data verification of new NCSP evaluations and performing quality assurance on the data as required and provide status reports on all nuclear data support activities to the NCSP Manager. (ND1)		ADVANCE is still not in autonomous mode as we are upgrading our GForge server to GitLab, which will require some minor modifications to ADVANCE.

NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtask: LANL ND1

Task Title: Nuclear Data Evaluation and Testing

M&O Contractor Name: LANL

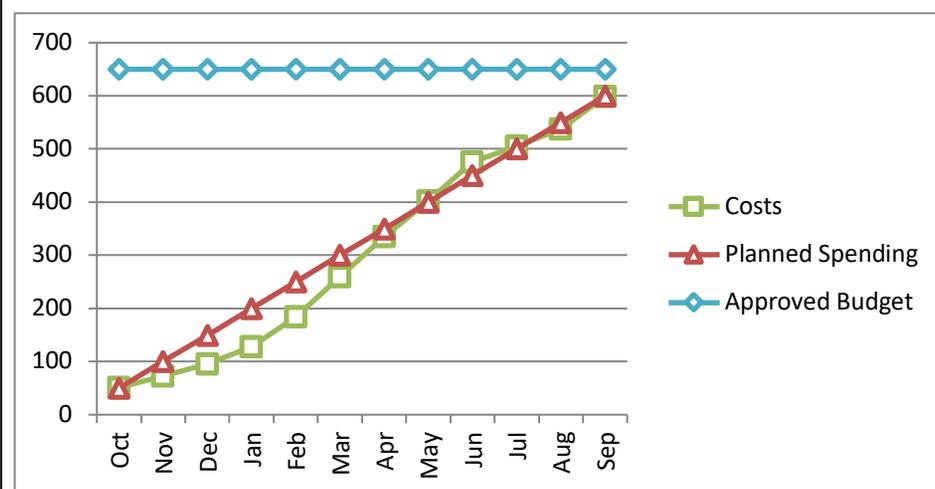
Point of Contact Name: Brian Bluhm / Bob Little

Point of Contact Phone: 505-667-2440 / 505-665-3487

Reference: DP0909010

Date of Report: October 18, 2019

BUDGET



1. Carryover into FY 2019 = \$0
2. Approved FY 2019 Budget = \$650,000 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$96,044
4. Actual spending for 2nd Quarter FY 2019 = \$163,795
5. Actual spending for 3rd Quarter FY 2019 = \$216,096
6. Actual spending for 4rd Quarter FY 2019 = \$122,914
7. Projected carryover into FY 2020 = \$0

MAJOR ACCOMPLISHMENTS

- We generated new evaluation for n+208Pb during Q3. Benchmark testing occurred during Q4, including two historical critical benchmarks and several configurations from recent JAEA experiments at NCERC (with LEU, HEU, and Pu). Results have been summarized in a brief memo.
- Tested and reformatted the evaluation files for $^{234,236}\text{U}$, which contain the new evaluations for fast neutrons in all the open channels.
- Performed benchmark calculations of selected **fast** benchmarks that have ^{236}U and/or ^{234}U , and could be sensitive to changes in the evaluated files for those isotopes. We have found that in general the new evaluation files produces k_{eff} results that are consistent with the previous calculations. This is not a surprise, since the changes are rather minor.
- We have continued to collaborate with G. Rusev, J. Ullmann and M. Jandel (U Mass Lowell), who have advanced in their analysis of the low-energy capture cross section for ^{234}U . Preliminary results show additional resonances than what is in the ENDF file, and they are working on making sure that these are indeed capture resonances and not background.
- Ionel Stetcu has participated in the 11th International Conference on Nuclear Criticality giving a talk in the Nuclear data session about the $^{234,236}\text{U}$ and ^{239}Pu evaluations. A paper detailing the contribution has been accepted to be published in the proceedings. A report of the trip is presented separately.

NCSP Quarterly Progress Report (FY-2019 Q4)

	<ul style="list-style-type: none">• A paper detailing the prompt fission gamma evaluations included in ENDF/B-VIII.0 was also accepted to be published in the January issue of the Nuclear Data Sheets.• Extensive experimental information about $n+{}^9\text{Be}$ differential cross sections and polarizations was added to the measured data set at energies up to about 3 MeV. We are in the process of analyzing these data along with the integrated cross sections that were already well fit.• A paper titled “Enhancing Nuclear Data Validation Analysis by Using Machine Learning” by D. Neudecker et al. was submitted to Nuclear Data Sheets (LA-UR-19-29472).
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NCSP Quarterly Progress Report (FY-2019 Q4)

LANL ND Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on LANL participation in US and International Nuclear Data collaborations. (ND1)		
	Conduct CSEWG Data Evaluation Committee session. (ND1)		
	Report data testing results with ENDF/B-VIII.0 and additional beta release cross sections. (ND1)		
Q2	Provide status reports on LANL participation in US and International Nuclear Data collaborations. (ND1)		
Q3	Provide status reports on LANL participation in US and International Nuclear Data collaborations. (ND1)		
Q4	Provide status reports on LANL participation in US and International Nuclear Data collaborations. (ND1)		
	Report on development of machine learning tools, in particular decision trees, for criticality-safety applications and sensitivity to nuclear data. (ND1)		
	Deliver nuclear data evaluations as indicated in Appendix B of this document. (ND1)		Note that we had previously pushed a couple of Appendix B FY19 milestones into FY20 due to experimental data delivery being later than anticipated.

NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtask: ND1, 2, 3, 5, 6

Task Titles: See last page for full task titles

- ND1 Delayed fission gammas
- ND2 Generation and testing of thermal scattering laws
- ND3 FLASSH (modern code)
- ND5 Advanced Doppler Broadening
- ND6 Cadmium radiative capture gammas

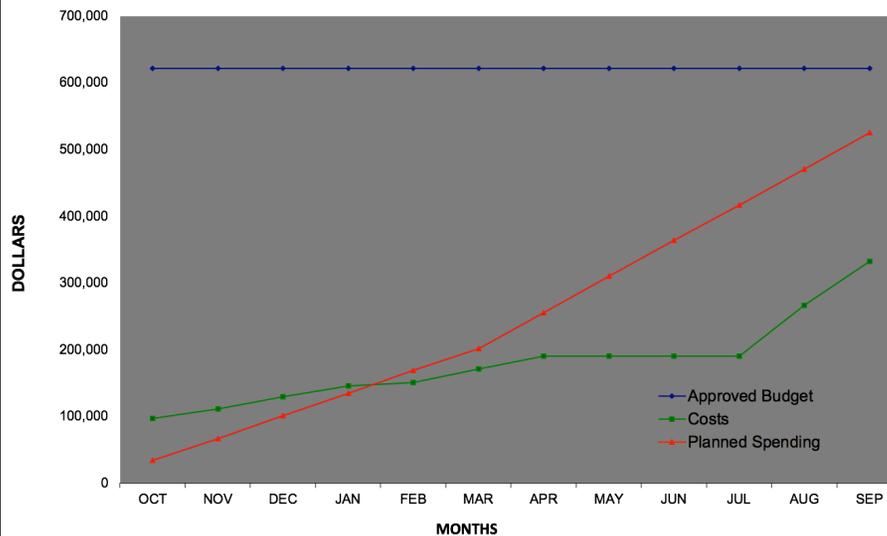
M&O Contractor Name: Lawrence Livermore National Laboratory

Point of Contact Name: David Heinrichs

Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010
Date of Report: October 18, 2019

BUDGET



1. Carryover into FY 2019 = \$181,360
2. Approved FY 2019 Budget = \$621,360 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$130,142
4. Actual spending for 2nd Quarter FY 2019 = \$ 41,306
5. Actual spending for 3rd Quarter FY 2019 = \$ 18,885
6. Actual spending for 4rd Quarter FY 2019 = \$142,468*
7. Projected carryover into FY 2020 = \$332,801 (54%) w/o \$163,421 in liens; \$253,359 (27%) with liens.

*This amount reflects actual invoices received by LLNL to date.

MAJOR ACCOMPLISHMENTS

1. Provided recipe for how to account for prompt and delayed photons in calculating β_{eff} and the in-hour period-reactivity equation in **HMF101** [KRUSTY]. (ND1)
2. NCSU completed a LAMMPS classical molecular dynamics model (1000 molecules, NPT ensemble) of hydrofluoric acid (**HF**). The model is based on the use of an LJ potential with a Coulomb component for inter-molecular interactions and a harmonic component for intra-molecular interactions. Parametrization of this potential is on-going based on information derived from both literature data and ICSBEP benchmark reports. As part of the parameterization, model predictions of temperature dependent density and species diffusivity is compared to experimental data and results of previous calculations. Current results are reasonable but further development and testing is underway. (ND2)
3. NCSU continued work on updating the *FLASSH* code to use improved methods and models. This includes modifying and testing the internal construction of the fine beta convolution grid. The new methods are more flexible, more concise, and demonstrably more accurate. Potential additional liquid models have been identified for future implementation. The liquid physics code is now incorporated into the *FLASSH* code structure. In the elastic routine, modifications are underway to the Bragg edge calculation to relax current limitations. *FLASSH* is being modified to include the generalized TSL methodology with applicability in Doppler broadening. Work has been completed for integration of FUDGE with *FLASSH*. (ND3)
4. NCSU continued development of algorithms to use the TSL in Doppler analysis. The formulism of $S(\alpha, \beta)$ has been revisited to eliminate the assumption of cubic symmetry. Furthermore, the developed treatment removes the atom site approximation. This generalized self-scattering law was implemented into the *FLASSH* code using the phonon expansion method. From *FLASSH*, a generalized $S(\alpha, \beta)$ is calculated and utilized in Doppler broadening for UO_2 . NCSU models published for the ENDF/B-VIII UO_2 TSL evaluation were used to generate the required inputs. To test the methodology, the SAMMY 8.1.0 code has been modified to read in the generalized $S(\alpha, \beta)$ from *FLASSH*, and to reconstruct the resonances from the ENDF file by convolution with the *FLASSH* TSL. This represents a first step that allows for consistent application of the TSL in both thermal scattering and Doppler evaluations. (ND5)
5. Tamás Belgya (Center for Energy Research, Budapest, Hungary) completed prompt gamma radiative capture measurements for cadmium using a natural cadmium metal sample and an enriched ^{113}Cd powder sample in 2017. Preliminary results for the ^{113}Cd (n,g) gamma emission spectra shows good agreement between the unfolded experimental spectrum and calculated spectrum. LLNL is attempting to get the data directly from the author and will discuss this request at CSEWG in the context of EXFOR. (ND6)

NCSP Quarterly Progress Report (FY-2019 Q4)

LLNL ND Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	COMMENTS
Q1	Provide status on LLNL/NCSU nuclear data activities to NCSP Manager (ND1 {subtask 1 and 2}, ND2, ND3, ND5, ND6).		
Q2	Provide status on LLNL/NCSU nuclear data activities to NCSP Manager (ND1 {subtask 1 and 2}, ND2, ND3, ND5, ND6).		
Q3	Provide status on LLNL/NCSU nuclear data activities to NCSP Manager (ND1 {subtask 1 and 2}, ND2, ND3, ND5, ND6).		
Q4	Provide status on LLNL/NCSU nuclear data activities to NCSP Manager (ND1 {subtask 1 and 2}, ND2, ND3, ND5, ND6).		
	Deliver thermal neutron scattering data evaluations as indicated in Appendix B of the 5-Year Plan. (ND2)		Evaluations completed one or more years in advance of schedule.

Task Titles:

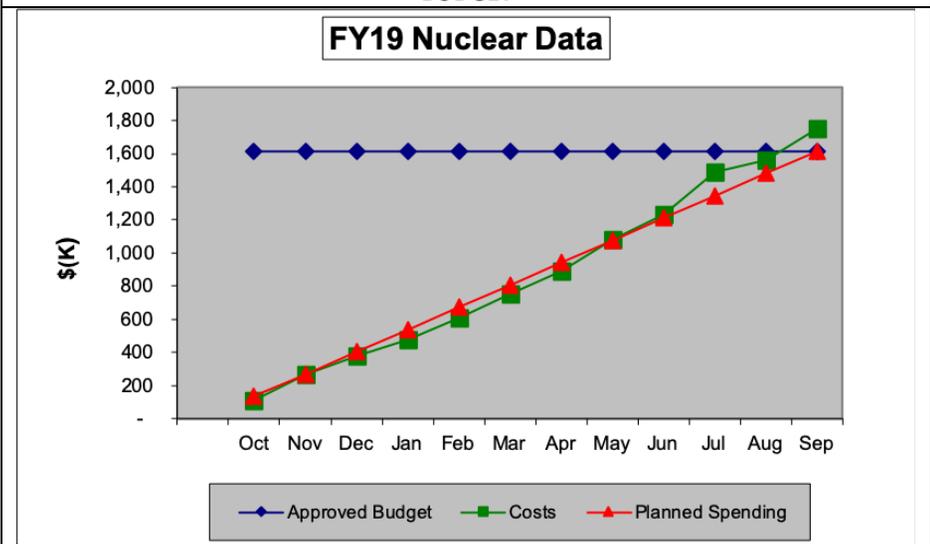
- ND1 Subtask 1 – Delayed Fission Gamma Multiplicity and Spectra – Data testing
- ND1 Subtask 2 – Delayed Fission Gamma Multiplicity and Spectra – Document the technical basis of the method and data testing results
- ND2 Generation and Benchmarking of Thermal Neutron Scattering Cross Sections in Support of Advanced Nuclear Reactor Concepts
- ND3 Development and Implementation of an Advanced and Rigorous Computational Platform for Thermal Neutron Scattering Analysis
- ND5 Development and Implementation of a Modern Doppler Broadening Approach Including Atomic Binding Effects
- ND6 Evaluate Neutron Radiative Capture Gamma Production in Cadmium

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: ORNL – ND1, 3, 6, 7, 10 Task Title: see last page M&O Contractor Name: ORNL Point of Contact Name: Doug Bowen Point of Contact Phone: (865) 576-0315</p>	<p align="right">Reference: DP090010/ORNL Date of Report: October 11, 2019</p>
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BUDGET

MAJOR ACCOMPLISHMENTS



1. Carryover into FY 2019 = \$124K; FY 2020 = \$0K
2. Approved FY 2019 Budget = \$1,615K (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$379K
4. Actual spending for 2nd Quarter FY 2019 = \$374K
5. Actual spending for 3rd Quarter FY 2019 = \$479K
6. Actual spending for 4rd Quarter FY 2019Y = \$521K

ND1 – Evaluations and Measurements

- Status report on all nuclear data support activities.**
- Gd-156,158,160 evaluations finalized.
 - Support of post-doc for Ce data analysis.
 - Support of post-doc for V data analysis.
 - Mentor new staff member for the NCSP.
 - Cerium Evaluation: Evaluation work on 140,142-Ce is progressing. Presented progress of nat-Ce evaluation at ICNC19 conference. Waiting on reduction of 142-Ce data before continuing.
 - Vanadium Evaluation: Evaluation work on 51V is in early stages. Work was paused while issue below 10 keV was identified. Evaluation work will proceed now that issue has been identified.
 - 239Pu evaluation in the Resolved Resonance Region (RRR) is in progress. Effort to evaluate fluctuating cross sections above the RRR was also performed
 - 233U evaluation is also progressing. The fit of the measured data is completed and work on extending the RRR evaluation in the fluctuating neutron energy region is in progress
 - Work on updating the Appendix B and coordinating the task for ORNL measurements and related evaluations
 - There was the work on the assessment of the titanium cross section and related letter report (RES ID 131196)

- Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B of the 5-year plan.**
- Travel to JRC-Geel to finalized Ce-142 capture experiments (green)
 - Finalized data sorting at JRC-Geel for Ce-142 capture experiments. The list mode data are sorted into TOF spectra. (green)
 - Enriched Zr experiments are delayed, due to previous problems obtaining samples for lease. (behind schedule). However, this issue seems to be resolved. Path forward: After finalizing the Ce-142 experiments, enriched Zr neutron capture experiments will be started in Fall.

Y12 ND1 – GELINA depleted Uranium target cost estimate and construction

- No action. Target is in procurement process for outside production at MSC Inc.

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: ORNL – ND1, 3, 6, 7, 10 Task Title: see last page M&O Contractor Name: ORNL Point of Contact Name: Doug Bowen Point of Contact Phone: (865) 576-0315</p>	<p style="text-align: right;">Reference: DP090010/ORNL Date of Report: October 11, 2019</p>
<p>BUDGET</p>	<p>MAJOR ACCOMPLISHMENTS</p>
	<p>ND3 – Isotopic Sample Lease to Support ND1 ND Measurements</p> <ul style="list-style-type: none"> ○ Ce-142 sample lease will be extended for additional experiments at JRC. (green) ○ Started prelease of Zr samples: Experiments of ORNL isotopes to produce metal sample ○ Activation calculation for Zr isotopes using SCALE/ORIGEN. ○ Completed activation calculation to support enriched Zr isotope leasing for ND measurements ○ Zr sample preparation is in progress by the National Isotope Development Center <p>ND6 - Sammy Modernization</p> <ul style="list-style-type: none"> ○ In order to be able to share code between AMPX and SAMMY, resonance parameters information needs to be stored in-memory in a structure accessible by both codes. Last reporting period we changed SAMMY to use the number of spin groups and isotope information from the C++ in-memory structure. This reporting period the work continued to include the resonance parameters and channel information. This includes shifting the reading of the input and parameters files from Fortran to C++. The reading and some of the output has been changed to use the C++ structure. For the resonance parameter SAMMY exclusively uses the C++ in-memory structure, for channel data this process is not yet finished. For each of these changes, the merge request for the code were reviewed by two staff member, so as to give our new staff exposure to the code. ○ Work on the removal of the container array continued, but due to additional overstepped bounds in the original code, we continue to investigate the impact on results. ○ The SAMMY and AMPX annual report has been finished and should provide additional information. ○ Fixed a production error where the resonances that are not included in the fit were not printed in the reduced width parameter output file. This causes problems if that file is used in subsequent SAMMY runs. <p>ND7 - Nuclear Data Evaluation and Testing for Nuclear Criticality Safety Applications</p> <ul style="list-style-type: none"> ○ Student finished work at ORNL for the summer, and produced KENO inputs for 29 benchmark evaluations that cover 129 unique experiments.

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: ORNL – ND1, 3, 6, 7, 10 Task Title: see last page M&O Contractor Name: ORNL Point of Contact Name: Doug Bowen Point of Contact Phone: (865) 576-0315</p>	<p style="text-align: right;">Reference: DP090010/ORNL Date of Report: October 11, 2019</p>
BUDGET	MAJOR ACCOMPLISHMENTS
	<ul style="list-style-type: none"> ○ Submitted full paper of Cu-63/65 ENDF-8 integral benchmark performance to the PHYSOR 2020 conference. ○ Student vetted with the VALID procedure, produced data and re-report for the HEU-MET-FAST-001 "Godiva" entry, which is to be reviewed by the VALID maintainer. ○ Student began work on creating MCNP models from the KENO models completed over the last year. <p>ND10 - Monte Carlo Evaluation of Differential and Integral Data</p> <ul style="list-style-type: none"> ○ During Q4, we have created 1,000 sets of randomly perturbed U-233 resonance parameters by randomly sampling from the current ENDF/B-VIII.0 ("ENDF") U-233 resonance parameter covariance matrix (RPCM), and have used it to prototype ORNL's new Monte Carlo (MC) evaluation framework of differential and integral data. ○ We have verified consistency of the said 1,000 sets with ENDF U-233 RPCM by writing a computer program that compares the variance of each resonance parameter computed from the 1,000 sets to the corresponding variance in the ENDF U-233 RPCM. ○ For each of the 1,000 resonance parameter sets we have created a corresponding SCALE nuclear data library using AMPX. ○ For each of the 1,000 nuclear data libraries thus created, we have performed a KENO neutron transport simulation of the U233-SOL-INTER-001 benchmark, and have computed the corresponding 1,000 k_{eff}'s. ○ Our results indicate that spread of k_{eff}'s computed from the 1,000 MC sets is nearly 8 times larger than the k_{eff} uncertainty computed by linear approximation implemented in SCALE. ○ To pinpoint the onset of non-linear effects, we have repeated these calculations using the ENDF U-233 RPCM divided by 4 and 8, respectively, and have found that the agreement between the ORNL's new MC evaluation framework and the TSUNAMI linear method is achieved after dividing the ENDF U-233 RPCM by 8. ○ Inconsistencies of this magnitude make U-233 a strong candidate for re-evaluation of its resolved resonance range, as uncovered while prototyping ORNL's new MC evaluation framework.

NCSP Quarterly Progress Report (FY-2019 Q4)

ORNL ND Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND3, ND6, ND7, ND10).		
	Provide status reports on ORNL participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND1).		
	Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B (ND1).		
Q2	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND3, ND6, ND7, ND10).		
	Provide status reports on ORNL participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND1).		
	Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B (ND1).		
Q3	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND3, ND6, ND7, ND10).		
	Provide status reports on ORNL participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND1).		

NCSP Quarterly Progress Report (FY-2019 Q4)

	Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B (ND1).		
Q4	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND3, ND6, ND7, ND10).		
	Provide status reports on ORNL participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND1).		
	Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B (ND1).		
	Document SAMMY modernization progress and report status annually to the NCSP Manager (ND6).		

Task Titles:

ND1 Nuclear Data Measurement and Evaluation

ND3 Isotopic Sample Leases to Support ND1 ND Measurements

ND6 SAMMY Nuclear Data Evaluation Code Modernization

ND7 Nuclear Data Evaluation and Testing for Nuclear Criticality Safety Applications

ND10 Monte Carlo Evaluation of Differential and Integral Data

NCSP Management Report Completion of Gadolinium-156,158,160 Evaluations

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INTRODUCTION

A reevaluation of the resonance regions of the five most abundant isotopes of gadolinium had been undertaken as a collaboration between the nuclear data group at Oak Ridge National Laboratory (ORNL) under funding from the Nuclear Criticality Safety Program (NCSP) and the Institut de Radioprotection et de Sûreté Nucléaire (IRSN) under a memorandum of understanding between the US Department of Energy (DOE) NCSP and IRSN.

ORNL has partnered with IRSN to perform an evaluation of a wide body of available experimental data and to seek to resolve discrepancies between several independent experimental measurements to produce a new set of resonance evaluations for gadolinium. The new gadolinium evaluations benefit the NCSP by significantly improving the predictive power of radiation transport calculations for systems involving gadolinium in the DOE Complex. The new evaluations also provide evaluated covariance data to support sensitivity/ uncertainty analyses.

The benefit of this collaboration to the NCSP is a direct cost savings due to the shared responsibilities between the evaluators at IRSN and ORNL. Furthermore, the quality of the evaluation is increased due to the collaborative nature of the work and cross-checking between the two laboratories. Vladimir Sobes, at ORNL, is responsible for delivering the evaluations of isotopes 156, 158 and 160, while Luiz Leal, at IRSN, is working on isotopes 155 and 157. As neutron cross sections are usually measured based on samples where all isotopes are present, even if the sample is isotopically enriched, it is tremendously important that all of the major isotopes of a natural element be evaluated together. This will be demonstrated in several figures below.

BACKGROUND

Gadolinium-157 has the largest thermal-neutron cross section of all naturally occurring isotopes. Gadolinium is used as an emergency shutdown measure in some nuclear reactors, as a burnable reactor poison, particularly in nuclear marine propulsion systems, and for tumor treatment in neutron therapy. The naturally occurring abundance for the isotopes of gadolinium is shown in Table I along with the thermal capture cross section as reported in the *Atlas of Neutron Resonances* [1].

A new set of resonance evaluations for gadolinium is warranted because of the significant role that gadolinium plays in the nuclear industry and because new experimental cross-section measurements made at the RPI Gaertner LINAC Center [2,3] suggest discrepancies of up to 9% in the thermal cross-section values with respect to the current ENDF/B-VIII.0 evaluation. Further, simulations of integral experiments with varying sensitivities to gadolinium, such as in Ref. 4, suggest that the thermal cross section in the ENDF/B-VIII.0 evaluation may be over-predicted. The resonance evaluations for gadolinium in ENDF/B-VIII.0 were propagated from ENDF/B-VII.1. The completed new evaluation will be proposed for inclusion in the next release after ENDF/B-VIII.0.

Table I. Naturally occurring abundances for the isotopes of gadolinium and thermal capture cross-section values from Ref. 1.

Isotope	Abundance (%)	Thermal Capture Cross Section (b)
¹⁵² Gd	0.20	735 +/- 20
¹⁵⁴ Gd	2.18	85 +/- 12
¹⁵⁵ Gd	14.80	60 900 +/- 500
¹⁵⁶ Gd	20.47	1.8 +/- 0.7
¹⁵⁷ Gd	15.65	254 000 +/- 815
¹⁵⁸ Gd	24.84	2.2 +/- 0.2
¹⁶⁰ Gd	21.86	1.4 +/- 0.3

The resolved resonance region evaluations for isotopes of gadolinium currently in the ENDF/B-VIII.0 library come from the compilation in Ref. 1. The work done on the gadolinium isotopes was part of the WPEC: NEA Working Party on Evaluation Cooperation Subgroup-23 on the International Library of Fission Product Evaluations in 2004 and 2005 [5].

Table II presents and compares the upper energy limits for the resolved resonance region evaluations for ENDF/B-VIII.0, JENDL-4.0, and JEFF-3.2. Of physical significance to the evaluation of the experimental data in the resolved resonance region, the normalized penetrability ($P_1(E)/P_0(E)$) is reported at the energy of the end of the resolved resonance region for the ENDF/B-VIII.0 evaluations. The physical significance of the normalized penetrability is that, among other factors, it can be used to judge the importance of p-wave resonances to the angle-integrated cross section. Consequently, no p-wave resonances are reported for gadolinium isotopes ^{155}Gd or ^{157}Gd ; however, for the other isotopes, p-wave resonances need to be considered and are observed in the experimental data.

Table II. Gadolinium Isotope Upper Energy Limits for the Resolved Resonance Region Evaluations for ENDF/B-VIII.0, JEFF-3.2 and JENDL-4.0

	ENDF-VIII.0	JEFF-3.2	JENDL-4.0	P_1/P_0
^{155}Gd	183.3	181.8	181.8	0.00057
^{156}Gd	2227	1580	2214	0.0069
^{157}Gd	306.6	215	303.7	0.00096
^{158}Gd	9980	6037.6	6580	0.030
^{160}Gd	9663	2883.7	4224	0.029

RESULTS

The figures in this section show some snapshots of the new resonance evaluations done in this work. Figure 1 focuses on showing how the resonance data for all of the isotopes must be evaluated together in order to reconstruct the cross section for the natural element. Figures 2 and 3 focus on showing two regions of significant improvements over current ENDF/B-VIII.0 evaluations.

Figure 1 shows the fit in this work on top of capture cross section experimental measurements using a natural sample of gadolinium. The energy region 20 to 40 eV has resonances present from isotopes of Gd-155 and Gd-157 evaluated at IRSN and Gd-156 and Gd-158 evaluated at ORNL. The resonances of the ORNL evaluations and the IRSN evaluations are present in the reconstruction of the capture cross section of the natural sample. Therefore, close collaboration was necessary between the two laboratories to ensure a good fit of the data and to correctly assign the resonances to the corresponding isotopes.

Figure 2 shows an improved fit of the experimental data measured on an isotopically enriched Gd-158 target. A good fit to the experimental data can be determined by the residual between the experimental data and the fit of this work in the bottom panel of the top plot in Figure 2. The middle and bottom plots show the theoretical cross section for this energy region for Gd-157 and Gd-158. Even though the top plot shows experimental data measured on an isotopically enriched sample, it is evident that the resonance parameters of Gd-157, evaluated at IRSN, are necessary to fit the Gd-158 experimental data.

Figure 3 shows clear improvement over the ENDF/B-VIII.0 evaluation of the fit to the experimental data for isotopes Gd-156, Gd-158 and Gd-160 evaluated at ORNL. A good fit of the experimental data is observed in the plotted residual between the updated evaluation and the experimental data. Furthermore, Figure 3 shows how several erroneous resonances in ENDF/B-VIII.0 were removed in isotopes Gd-156 and Gd-160.

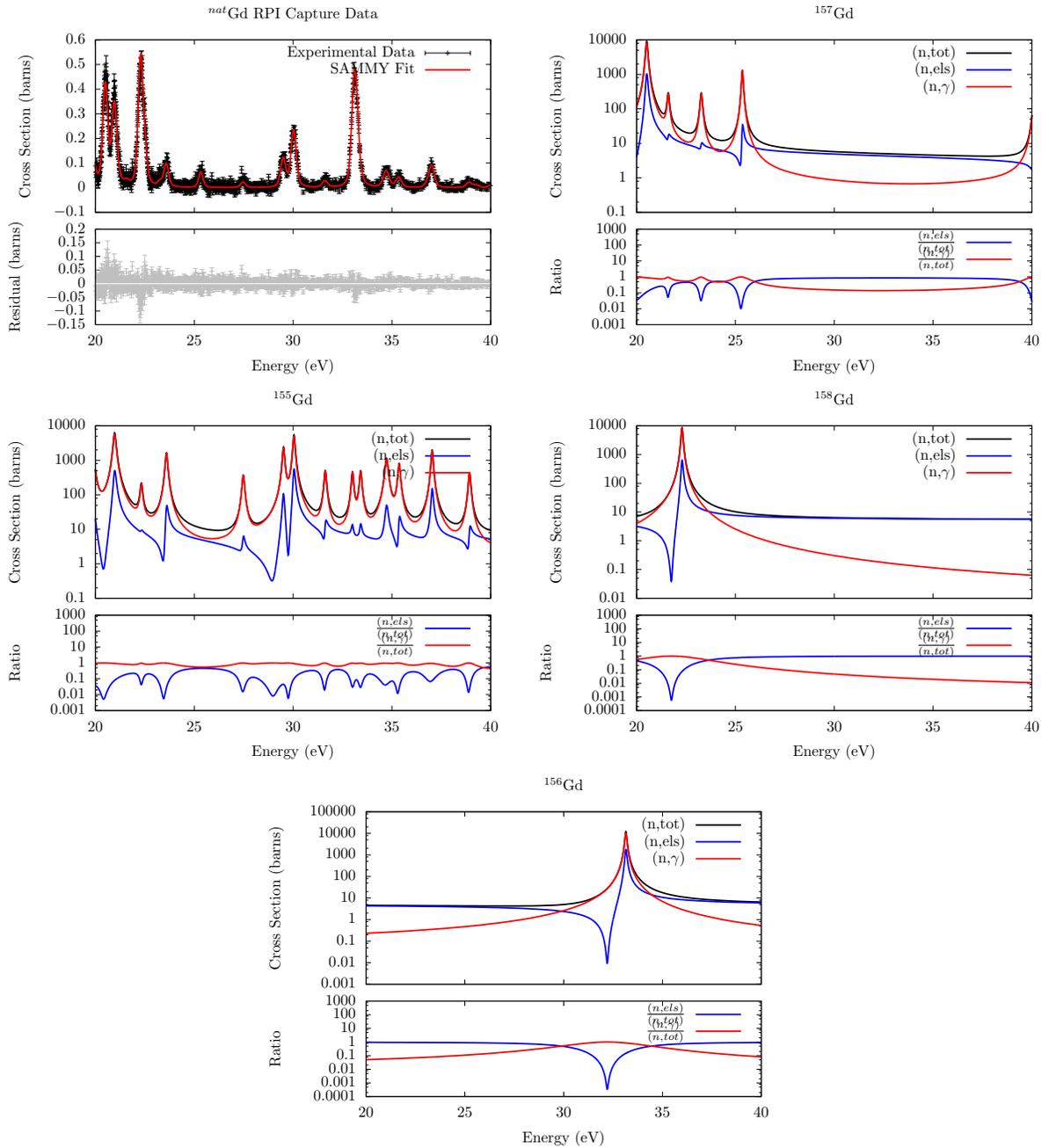


Figure 1: The top left plot shows how the resonance evaluation of this work fits capture data measured from a natural sample of gadolinium. The other four plots break down the cross-section contribution for the natural element into the isotopic components. Gd-155 and Gd-157 were evaluated at IRSN and Gd-156 and Gd-158 were evaluated at ORNL.

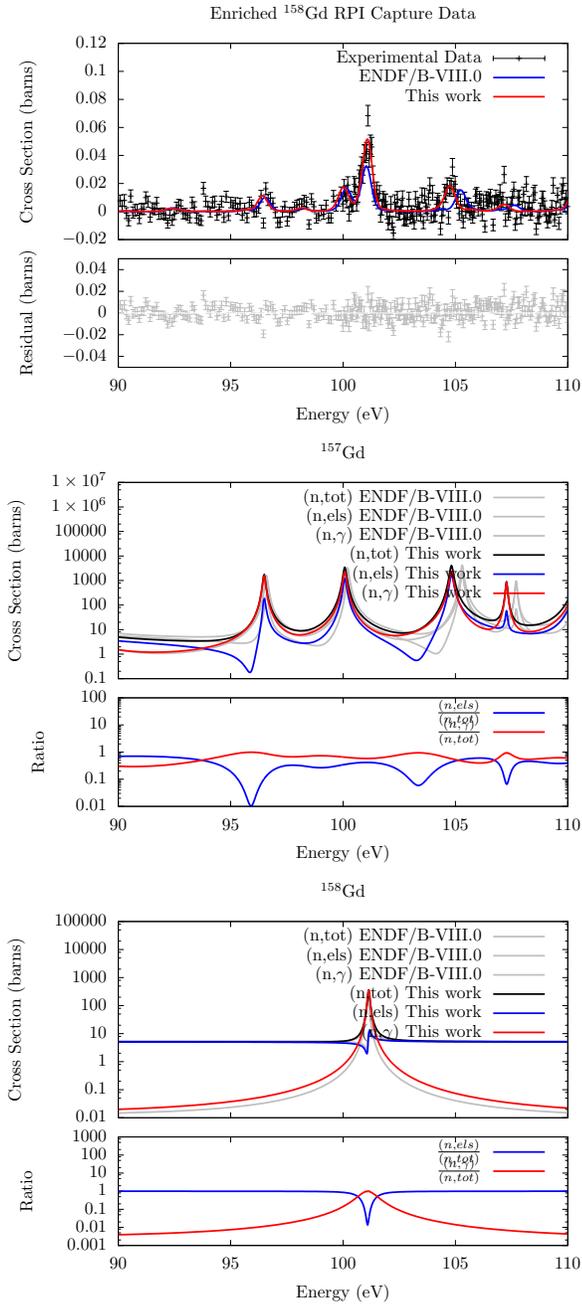


Figure 2: The top plot shows the improved fitting of capture cross section measurement on the enriched Gd-156 target done in this work and compared to ENDF/B-VIII.0. The residual between the experimental data and the evaluation of this work is shown in the bottom panel of the top plot. The middle and bottom plot break out the isotopic cross section contributions and show the changes in the theoretical cross section compared to ENDF/B-VIII.0.

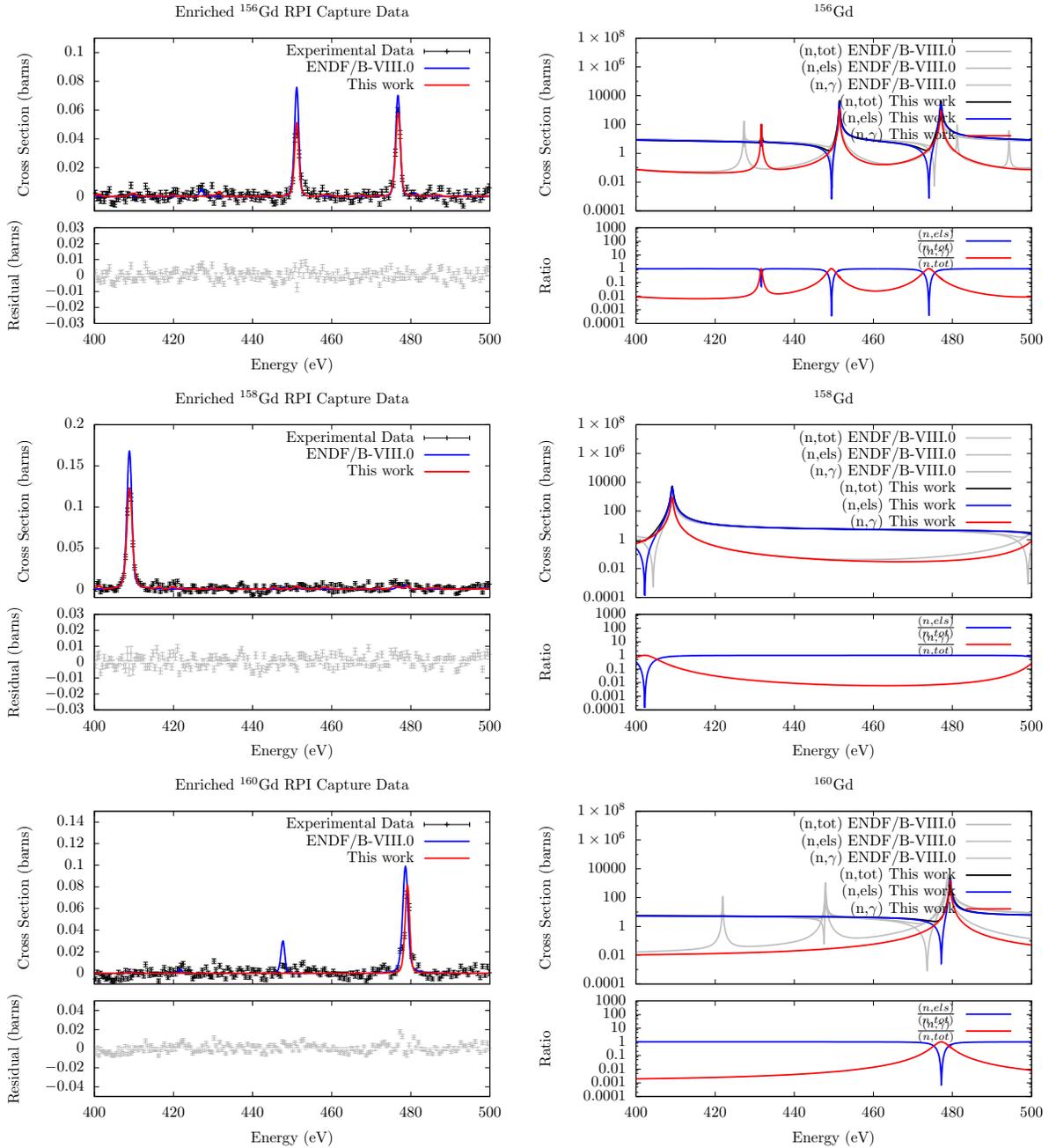


Figure 3: The three plots on the left show an improved fitting in this work compared to ENDF/B-VIII.0 of the isotopically enriched sample data. The bottom panel of each plot on the left shows the residual between the experimental data and the fit of this work. The three plots on the right show how the theoretical cross section changed from ENDF/B-VIII.0.

CONCLUSIONS

A reevaluation of the resonance region of the five most abundant isotopes of gadolinium has been a collaboration between ORNL and IRSN in support of the NCSP nuclear data request. The ORNL resonance evaluations of Gd-156, Gd-158 and Gd-160 are complete. In combination with the IRSN evaluations of Gd-155 and Gd-157, the new set of 5 isotopes will significantly improve the predictive power of radiation transport calculations for systems involving gadolinium in the DOE Complex.

ACKNOWLEDGMENTS

This work was supported by the US Department of Energy (DOE) Nuclear Criticality Safety Program, funded and managed by the National Nuclear Security Administration for DOE.

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Activation Study of Isotopically Enriched Samples During Neutron Time-of-Flight Measurements



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August 2019

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Reactor and Nuclear Systems Division

**ACTIVATION STUDY OF ISOTOPICALLY ENRICHED SAMPLES DURING
NEUTRON TIME-OF-FLIGHT MEASUREMENTS**

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ACRONYMS

ORNL	Oak Ridge National Laboratory
TOF	Time Of Flight
GELINA	GEel LINear electron Accelerator
FP	Flight Path
ENDF	Evaluated Nuclear Data File
NIDC	National Isotope Development Center
DOE	Department Of Energy

ABSTRACT

Over the course of a time-of-flight neutron cross section measurement, the sample isotope(s) of interest are irradiated by neutrons and photons. Ideally, the enriched sample will not have any additional radioactivity after the measurement as compared to the baseline detectable radioactivity (0.6 Bq/g) established prior to acquisition of the sample. This document presents the process for estimating the activation of a stable enriched isotope exposed to a mixed photon and neutron source using tools from the SCALE code system developed at Oak Ridge National Laboratory. The report also presents the activation analysis for the isotopes of current interest: $^{90,91,92,94}\text{Zr}$. This information is provided for two sets of Zr samples: one set of ZrO_2 samples, and one set of metal Zr samples. It was determined that, following measurements at the GELINA linear accelerator facility, all of the enriched Zr samples would contain less than 0.6 Bq/g of radioactivity within 183 days after irradiation.

1. INTRODUCTION

The physical models of neutron-nucleus reactions are semi-empirical, meaning that they rely on measured nuclear data to be complete. Due to this reliance, computational tools which model behavior of nuclear systems such as power reactors require nuclear data as input. The accuracy of these computational tools is limited by the accuracy of the input nuclear data. For this reason, nuclear data are carefully evaluated and maintained in nuclear data libraries such as ENDF/B-VII.1 [1], JEFF-3.3 [2], and JENDL-4.0 [3]. The cross sections of many nuclides have been measured, but a significant number of these measurements have various deficiencies. To remedy this, new cross section measurements must be made to reduce uncertainty in existing cross section data and to provide more detailed and accurate cross section data where none previously existed.

The time-of-flight (TOF) method is one of the most accurate methods for measuring cross section as a function of energy. The TOF method typically involves accelerating charged particles to collide with a target consisting of heavy atoms such as Ta or U. When the charged particles interact with these atoms, Bremsstrahlung radiation of varying energies is produced, and Bremsstrahlung photons produce neutrons through (γ, n) reactions in the heavy target nuclei. The charged particles are accelerated in a pulsed fashion, and the time at which a burst of neutrons is released from the target can be recorded for each pulse. The time required for the neutrons to fly from the neutron producing target to the sample of interest (typically meters away from the target) is referred to as the *TOF*. Once the TOF of the neutrons has been determined, the energy of the neutrons can be calculated, and neutron interactions with the sample of interest can be recorded as a function of energy.

Often, samples of interest are isotopically enriched to isolate the observed neutron interactions to a single unique nucleus. Since the enrichment process requires a great deal of time and energy, enriched samples can be quite expensive to fabricate, and experimentalists must exercise caution when using them. Enriched samples can be purchased from the National Isotope Development Center (NIDC), but the cost is often prohibitive. Instead, a researcher may lease the sample for a fraction of the cost.

One of the caveats for the lease is that the sample must have no measurable activity added to it, which has been defined in this case as 0.6 Bq/g. During the lease process, before the TOF measurement is made, approximately 30 mg of the sample will be removed and tested to establish a baseline for the pre-lease activity of the sample. Following the TOF measurement, another 30 mg of the sample will be removed and

measured again to ensure that the sample has had no radioactivity added during the lease. Since the pre- and post-lease measurements are of a destructive nature, the 60 mg portion of the sample must be purchased by the lessee. As TOF measurements require placing an enriched sample of interest in a beam of neutrons and photons, activation of a given sample may become a concern. To predict how a TOF measurement may affect a given sample, the experiment can be modeled with tools from the SCALE code system [4] developed at Oak Ridge National Laboratory (ORNL). This will ensure that when the sample is returned it contains less than 0.6 Bq/g of radioactivity.

1.1 PLANNED EXPERIMENTAL PARAMETERS

Only a handful of pulsed-source linear accelerators are available to perform cross section measurements, one of which is the Geel linear electron accelerator (GELINA)[5]. Most of these accelerators produce neutron beams in a similar manner. In this case, the GELINA facility will be used for the planned cross section measurements. GELINA is currently operated with an average electron current of approximately 60 μA , with energies as high as 150 MeV. Pulses of electrons are accelerated linearly to a U target, producing short, intense bursts of neutrons and photons. The neutrons and photons are collimated down a beam path toward the sample of interest; in this case, samples of $^{90,91,92,94}\text{Zr}$ will be considered. As in-beam photons only add to the unwanted background signal of a measurement, a large brick of Pb (called a *shadow bar*) is placed next to the U target in the direction of the beam path. This significantly reduces the photon flux in the beam path but still allows sufficient neutron flux. The neutron and photon flux spectra for GELINA as calculated by a Monte Carlo N-Particle (MCNP) [6] model are shown in Fig. 1. These fluxes are calculated for a 60 m flight path (FP) and a 60 μA average electron beam current for both the photon and neutron fluxes. To make the activity calculation more conservative, the fluxes were modeled without a neutron overlap filter. The overlap filter is typically a sample of B or Cd placed in the beam to remove low energy neutrons left over from previous neutron bursts that would interfere with the measured TOF count rates (e.g. if we produce bursts at a rate of 400 Hz we must remove any slow-moving low-energy neutrons in the beam which take longer than 2.5 ms to travel the FP, otherwise those slow neutron interactions would be recorded at an arbitrary TOF during the next burst). By excluding these filters in the calculation, the flux spectrum includes more low energy neutrons that have an opportunity to create a larger number of radioactive products.

The quantity of interest for upcoming measurements is the capture cross section of $^{90,91,92,94}\text{Zr}$. To measure this quantity the samples will be placed at 60 m where one of the neutron capture detector setups currently resides at GELINA. As neutrons strike the sample, some are captured by the Zr nuclei. The excited nuclei following the capture will de-excite, emitting a cascade of photons which can be measured by the capture detector and recorded. The capture cross sections of the Zr isotopes are quite small, in particular for the even-even isotopes of $^{90,92,94}\text{Zr}$. In fact ^{90}Zr has a closed neutron shell, making it especially resistant to neutron capture. As a result, a sufficient amount (~ 20 g) of the samples must reside in the neutron beam for an adequate amount of time to produce a statistically significant number of capture events to be recorded by the detector: typically on the order of 480 hours. However, for this study, a conservative estimate will be made, and it will be assumed that the measurement campaign will last for 960 hours for each sample. The measurement parameters are summarized below in Table 1.

The ZrO_2 samples described in Table 1 are easier to obtain for a measurement, so while they are a more cost-friendly option, the oxygen content is undesirable for a neutron cross section measurement, as it introduces greater experimental uncertainty and additional complexity for the cross section evaluator. If it is not prohibitively expensive, another option is to obtain metalized samples, which would provide a

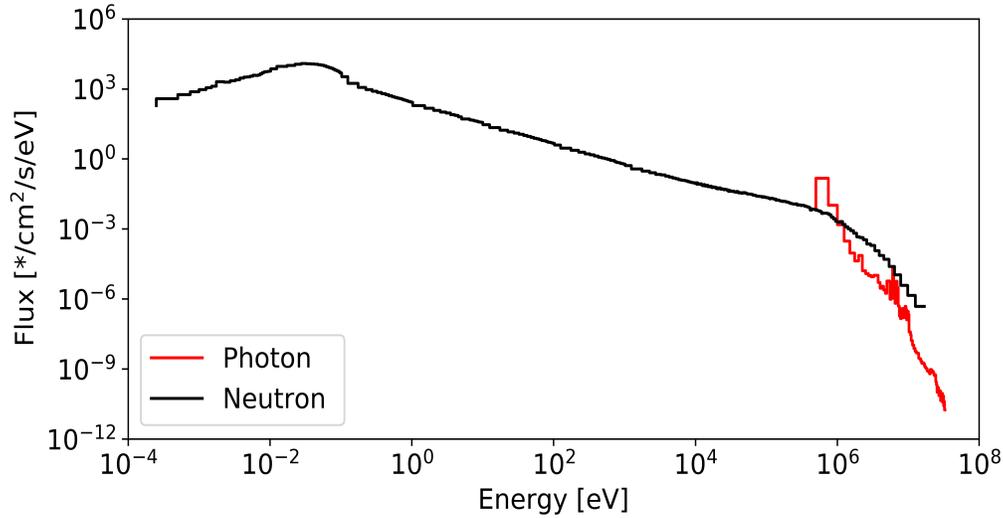


Figure 1. Neutron and photon fluxes at GELINA. Fluxes are shown at a 60 m flight path and an operating current of $60 \mu\text{A}$ without the overlap filters which are typically placed along the flight path to absorb low energy neutrons.

Table 1. Summary of experimental parameters planned for capture cross section measurement of oxide and metal samples for isotopes $^{90,91,92,94}\text{Zr}$

Isotope	Batch No.	Oxide/Metal	Enrichment	Duration	Current	FP	Meas. Type	Mass
^{90}Zr	157493	Oxide	96.93%	960 hours	$60 \mu\text{A}$	60 m	σ_γ	20 g
^{91}Zr	157591	Oxide	89.31%	960 hours	$60 \mu\text{A}$	60 m	σ_γ	20 g
^{92}Zr	189001	Oxide	98.06%	960 hours	$60 \mu\text{A}$	60 m	σ_γ	20 g
^{94}Zr	189191	Oxide	98.48%	960 hours	$60 \mu\text{A}$	60 m	σ_γ	20 g
^{90}Zr	157441	Metal	97.65%	960 hours	$60 \mu\text{A}$	60 m	σ_γ	20 g
^{91}Zr	157570	Metal	89.11%	960 hours	$60 \mu\text{A}$	60 m	σ_γ	20 g
^{92}Zr	157672	Metal	95.17%	960 hours	$60 \mu\text{A}$	60 m	σ_γ	20 g
^{94}Zr	157740	Metal	96.07%	960 hours	$60 \mu\text{A}$	60 m	σ_γ	20 g

significantly more chemically pure composition. To prepare for both options, an analysis was performed for each.

1.2 ANALYSIS

Neutron activation of materials has been studied extensively. The SCALE program includes a module called ORIGEN which, given a user-specified flux and material specifications, can predict the activity of an irradiated material. To obtain an accurate estimate of the activity of a sample after irradiation, as much detail as possible should be included in the ORIGEN program. The user should specify a flux distribution over energy (seen in Fig. 1), as well as the mass content of every nuclide present in the sample, which is specific to the batch numbers given in Table 1.

For this effort, an MCNP model of the GELINA neutron production target was used to predict the energy

profile of the neutron and photon fluxes. The MCNP-simulated neutron flux was then used as input to the program MAVRIC, a Monte Carlo transport module in SCALE, to calculate the energy-dependent flux averaged over the sample. The step with MAVRIC is necessary to ensure that scattered neutrons within the sample are incorporated into the total average neutron flux within the volume of the sample. Once the energy-group averaged neutron fluxes are known, they can be input to COUPLE, which creates a library for ORIGIN to determine the activation of the sample.

As previously mentioned, ORIGIN also requires the sample composition. The enrichment and impurity contents of the samples stored by NIDC are catalogued in detail. This information can be used to select the sample most appropriate for a given experiment. The samples for this study were selected based on criteria of high enrichment and minimal impurities. NIDC designates batch numbers for each enriched sample material. The batches selected for this study are listed in Table 1; the batch numbers can be used to obtain the impurity content.

To run the activation calculation, ORIGIN also requires the cross sections for the relevant nuclides and nuclear reactions. Default group averaged cross sections are distributed as part of the SCALE package and have been calculated and formed into libraries for the SCALE program environment based on the ENDF/B-VII.1 library. These are the neutron cross sections used for the current analysis, as they have been validated by other SCALE modules and benchmark experiments. The input flow for ORIGIN is illustrated in Fig. 2.

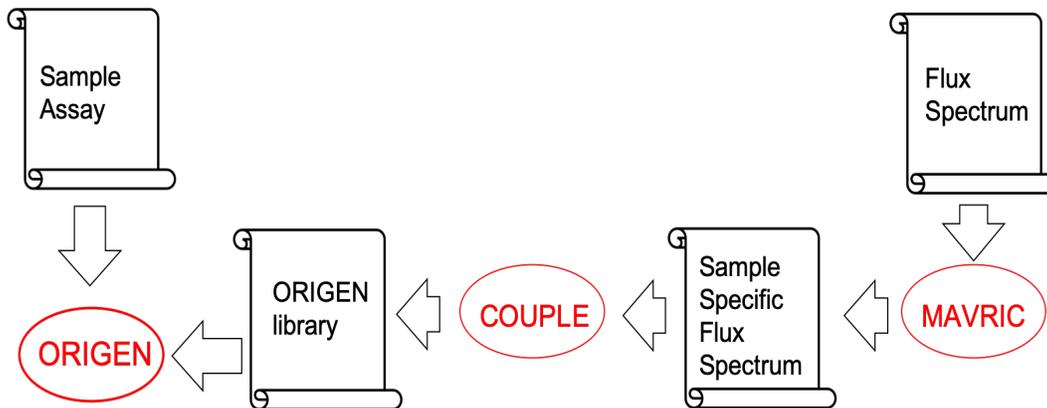


Figure 2. Information flow for a typical sample activation calculation using ORIGIN. The programs used are in red: MAVRIC, COUPLE, and ORIGIN. The sample assay sheet specifies all nuclides present in the sample before beginning irradiation, and the ORIGIN library contains energy-grouped cross sections. MAVRIC is used to calculate the average flux within the volume of each sample, and COUPLE uses the flux and cross section to create a reaction library for ORIGIN.

In its normal operation, ORIGIN calculates neutron activation but does not calculate photon activation. This is largely because photonuclear cross sections are poorly known, and photonuclear reactions have arguably limited applicability to reactors. However, photonuclear reactions may be of importance in the low-level activation of isotopically enriched samples. To overcome this limitation, the TENDL-2017 photonuclear library [7] was used as a source of photonuclear reaction cross sections. Since the ORIGIN program expects a neutron flux, we change the MT numbers of the photon reaction cross sections to analogous reaction MT numbers with incident neutrons and an additional outgoing neutron. In this way we obtain the desired resulting nuclides from the reaction cross sections. The specific reactions used in this

analysis have been listed in Table 2 where the photon and neutron reactions are described next to one another. It should be noted that the TENDL-2017 library is based on the TALYS [8] program, which gives theoretical predictions of cross sections.

Table 2. Photonuclear reactions for which the TENDL-2017 library was used as a source of cross sections

Photon reaction	MT	Corresponding neutron reaction	MT
(γ, n)	4	$(n, 2n)$	16
$(\gamma, 2n)$	16	$(n, 3n)$	17
(γ, p)	103	(n, pn)	28
(γ, α)	107	$(n, \alpha n)$	22
(γ, d)	104	(n, dn)	32
(γ, t)	105	(n, tn)	33
(γ, np)	28	$(n, 2np)$	41
$(\gamma, n\alpha)$	22	$(n, 2n\alpha)$	24

The cross sections from the TENDL-2017 photonuclear library can be used to compose an ORIGEN library with tools from AMPX, which is part of the SCALE environment. This process is illustrated in Fig. 3. The process for creating an ORIGEN library is repeated for each evaluated nuclear data file (ENDF) in the TENDL-2017 photonuclear library. The POLIDENT module reads the ENDF file and produces pointwise cross sections, in this case from file 3 of the ENDF. Subsequently, the module ZEST reads these pointwise cross sections and returns the user-selected reactions (with modified MT numbers), which are input to the PRILOSEC module. PRILOSEC requires an energy differential flux shape to calculate energy-grouped cross sections; the user's flux shape can be converted to a readable format by the CHARMIN module. Finally, using PRELL, the group structure for the resulting cross section library can be specified and formatted properly for PRILOSEC. PRILOSEC takes all of these inputs and produces a cross section library for each nuclide. The AJAX module is then used to combine all of the nuclides and reactions into a single final cross section library. This cross section library is used by COUPLE, along with the default SCALE decay library, to create an ORIGEN library.

2. RESULTS

Once all of the inputs for ORIGEN were defined, the program determined the concentrations of activated products due to neutron and photon interactions. The program also tracked the activity of the isotopes present before the experiment. For example, a 500 ppm impurity of Rb resides in the ^{91}Zr oxide sample which was selected for this study. Approximately 27% of naturally occurring Rb is the isotope ^{87}Rb , which decays at a rate of ≈ 8.8 Bq for a sample of 20 g. The calculated activities of the separate photon activation and neutron activation are summed together, with the exception of pre-existing radioactive nuclides such as the ^{87}Rb . This was done for two sets of samples: a set of ZrO_2 samples and a set of metalized Zr samples.

2.1 SAMPLE ACTIVATION

The ZrO_2 samples selected for these measurements tended to have a greater number of impurities than the metal samples. In terms of the 0.6 Bq/g limit, these impurities can be a relatively large source of activity in a sample, both before and after irradiation. The isotope ^{87}Rb is an impurity in the ^{91}Zr oxide sample which by itself maintains the sample activity at a minimum of 0.44 Bq/g. This is uncomfortably close to the 0.6

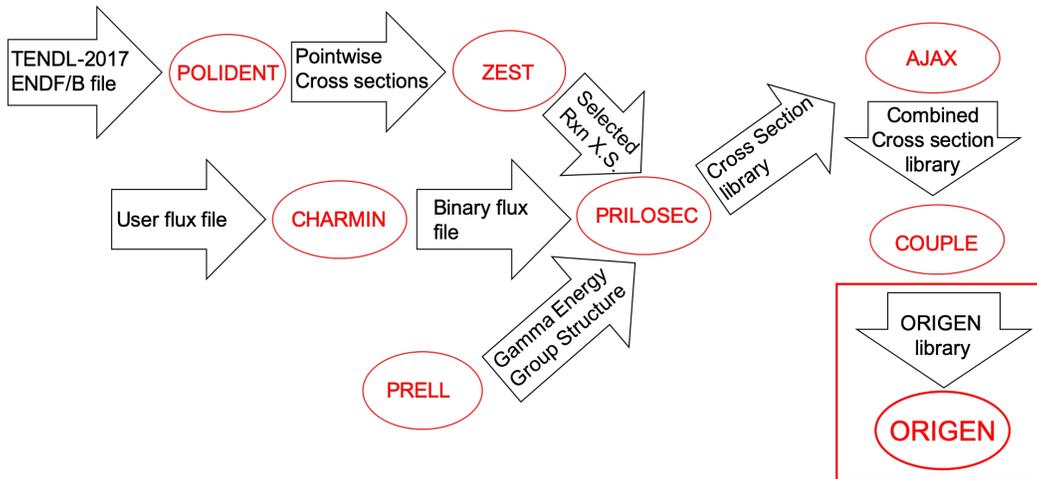


Figure 3. The process for creating an ORIGEN library from the TENDL-2017 photonuclear library. Modules used from the AMPX code are in red. Data inputs to the modules are included in the arrow shapes. For this study, the process up to the PRILOSEC step was repeated for all nuclides (>2000) and then combined using the AJAX module before being input to COUPLE.

Bq/g limit. The total anticipated activity for the set of ZrO₂ samples considered for this analysis is shown in Fig. 4.

Figure 4 shows that all of the oxide samples are predicted to decay to below the 0.6 Bq/g limit within 107 days following a capture cross section measurement at GELINA. The ⁹⁴Zr sample had the longest lived products, primarily due to the neutron capture reaction on the main isotope: ⁹⁴Zr(n,γ)⁹⁵Zr. The ⁹⁵Zr isotope then decays to ⁹⁵Nb through beta decay. These radioactive isotopes play the dominant role in extending the activity (above 0.6 Bq/g) of the sample to 107 days. It should be noted that photon interactions were predicted to introduce a trivial amount of radioactive products for all of the samples in this study.

For isotopically enriched Zr samples in metal form, it is assumed again that the sample mass is 20 g. In general, the metal Zr samples contain fewer impurities, and those impurities contribute less to the overall sample mass. Measuring the cross section using metal Zr samples would reduce experimental uncertainty as compared to the ZrO₂ samples, as there will be less oxygen from which to scatter. Neutron scattering from the sample will already be significant considering the small capture cross section of the Zr isotopes. Neutron scattering is problematic, as it increases the probability for *false capture*. False capture is the process in which a neutron scatters from a nucleus in the sample and subsequently captures in a nearby material, producing photons which can be falsely attributed to sample capture. One example of false capture is a neutron scattering from the sample and then capturing in the sample holder material.

Another advantage of measuring metal samples instead of ZrO₂ samples is reduced evaluation complexity and uncertainty. During evaluation of Zr capture cross section data obtained with oxide samples, oxygen content must be taken into account, and the evaluated Zr and O cross sections must be correlated. To prepare for the possibility that metal samples are chosen for the planned measurement, the anticipated activities of those samples have been calculated and plotted in Fig. 5.

The two largest contributors to the overall activity of each of the oxide and metal samples following the TOF measurements are shown in Table 3. Photon activation is trivial for all of the Zr samples. It should be

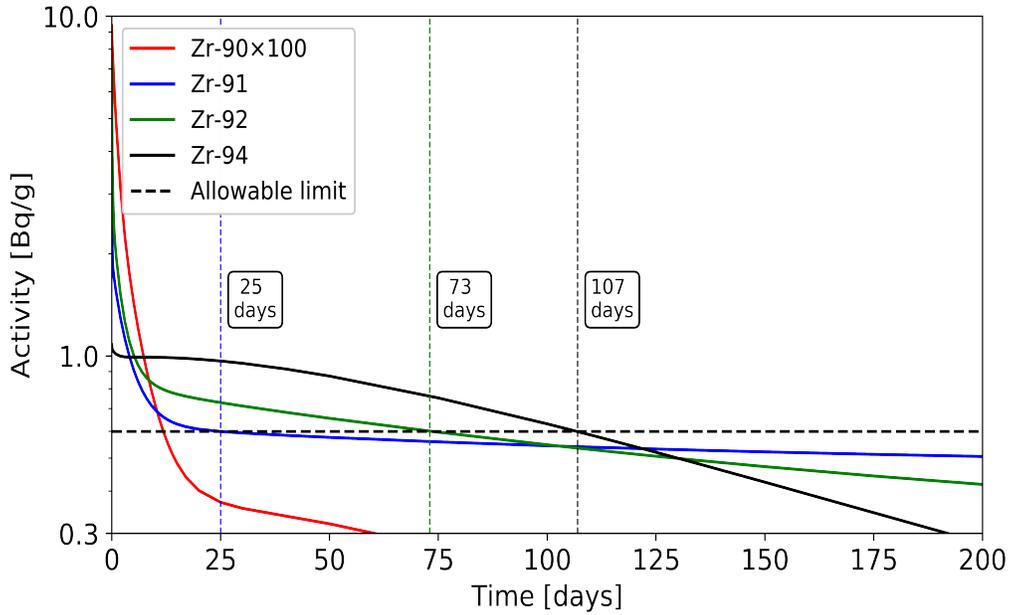


Figure 4. Total specific activities (Bq/g) for oxide samples for the isotopes $^{90,91,92,94}\text{Zr}$ following irradiation in a TOF measurement. Vertical dashed lines represent the points at which the samples—indicated by matching line colors—decay below the 0.6 Bq/g limit. The horizontal dashed line represents the limit of activation. Since the activity predicted for the ^{90}Zr sample was well below the limit, it was multiplied by a factor of 100 for this plot to show the activation.

noted that ^{87}Rb is a leading contributor on two of the oxide samples. For most of the metal samples, it can be seen that ^{97}Zr and ^{97}Nb are the leading contributors to activity. This is due to ^{96}Zr neutron capture, which occurs in all of the samples, and it results in activity which is orders of magnitude less than the 0.6 Bq/g limit. The dominant reaction which produces the most significant activity is ^{94}Zr neutron capture, in which ^{94}Zr is the main constituent of the sample.

Table 3. The top two largest contributors to radioactivity of each sample following irradiation following a TOF measurement at GELINA

Batch	Isotope	1 st	Reaction	2 nd	Reaction
157493	^{90}Zr	^{97}Zr	$^{96}\text{Zr}(n, \gamma)$	^{97}Nb	$^{97}\text{Zr} \beta^-$
157591	^{91}Zr	^{87}Rb	pre-existing	^{182}Ta	$^{181}\text{Ta}(n, \gamma)$
189001	^{92}Zr	^{170}Tm	$^{169}\text{Tm}(n, \gamma)$	^{87}Rb	pre-existing
189191	^{94}Zr	^{95}Zr	$^{94}\text{Zr}(n, \gamma)$	^{95}Nb	$^{95}\text{Zr} \beta^-$
157441	^{90}Zr	^{97}Zr	$^{96}\text{Zr}(n, \gamma)$	^{97}Nb	$^{97}\text{Zr} \beta^-$
157570	^{91}Zr	^{97}Zr	$^{96}\text{Zr}(n, \gamma)$	^{97}Nb	$^{97}\text{Zr} \beta^-$
157672	^{92}Zr	^{97}Zr	$^{96}\text{Zr}(n, \gamma)$	^{97}Nb	$^{97}\text{Zr} \beta^-$
157740	^{94}Zr	^{95}Zr	$^{94}\text{Zr}(n, \gamma)$	^{95}Nb	$^{95}\text{Zr} \beta^-$

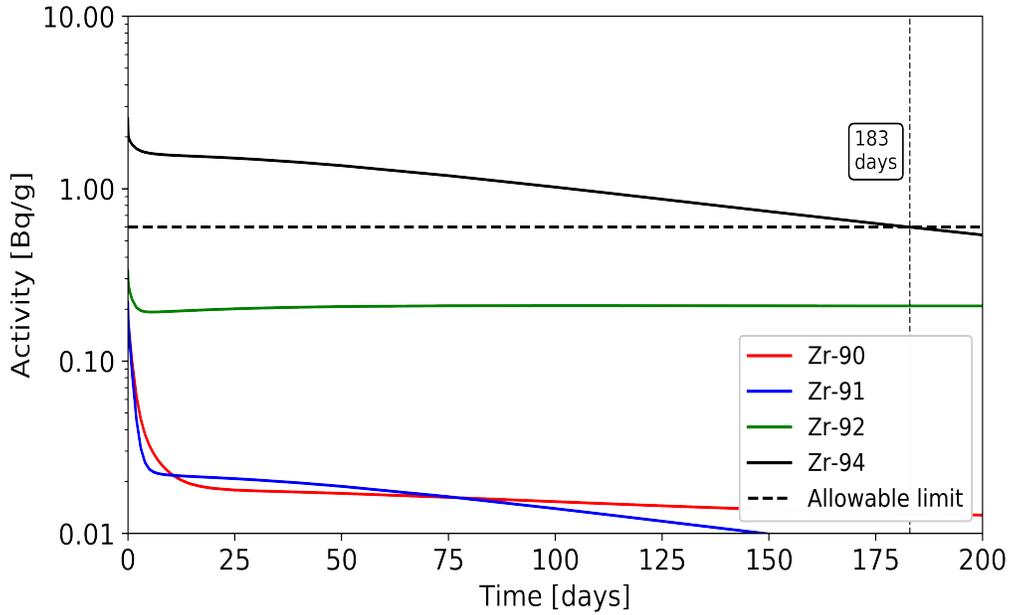


Figure 5. Total specific activities (Bq/g) for metal samples of the isotopes $^{90,91,92,94}\text{Zr}$. The vertical dashed line represents the point at which the ^{94}Zr sample—indicated by matching black line color—decays below the 0.6 Bq/g limit. The horizontal dashed line represents the limit of activation. Only ^{94}Zr was found to be activated beyond the 0.6 Bq/g limit for any significant amount of time.

3. CONCLUSIONS

Two main conclusions were drawn from this study. The first conclusion is that the activity of an enriched sample exposed to a mixed photon and neutron source can be estimated using tools from AMPX/SCALE. The outline in this report provides a reproducible method that can be applied to any sample. The second conclusion is that the proposed samples for the current measurement would not be activated beyond 183 days in the worst case. To comply with the lease from NIDC, the samples should be maintained for the duration of the typical 1-year lease and returned without any measurable radioactivity added.

4. REFERENCES

References

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- [4] B. T. Rearden and M. A. Jessee, “Scale Code System,” Oak Ridge National Laboratory, Oak Ridge, TN, Tech. Rep. ORNL/TM-2005/39, 2018, available from Radiation Safety Information Computational Center as CCC-834.
- [5] W. Mondelaers and P. Schillebeeckx, “GELINA, a neutron time-of-flight facility for high-resolution neutron data measurements,” *Notizario*, vol. 11, no. 2, pp. 19–25, Jul. 2006.
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- [7] D. Rochman, A. J. Koning, J. C. Sublet, M. Fleming *et al.*, “The TENDL library: hope, reality and future,” in *Proc. of the International Conference on Nuclear Data for Science and Technology*, Bruges, Belgium, Sept. 11–16, 2016.
- [8] A. Koning and D. Rochman, “Modern nuclear data evaluation with the talys code system,” *Nuclear Data Sheets*, vol. 113, no. 12, pp. 2841–2934, 2012, special issue on Nuclear Reaction Data. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0090375212000889>

ACKNOWLEDGMENTS

The authors would like to acknowledge the expert advice from Ian Gauld on the use of the ORIGEN program. This work was supported by the US Department of Energy (DOE) Nuclear Criticality Safety Program, funded and managed by the National Nuclear Security Administration for DOE.

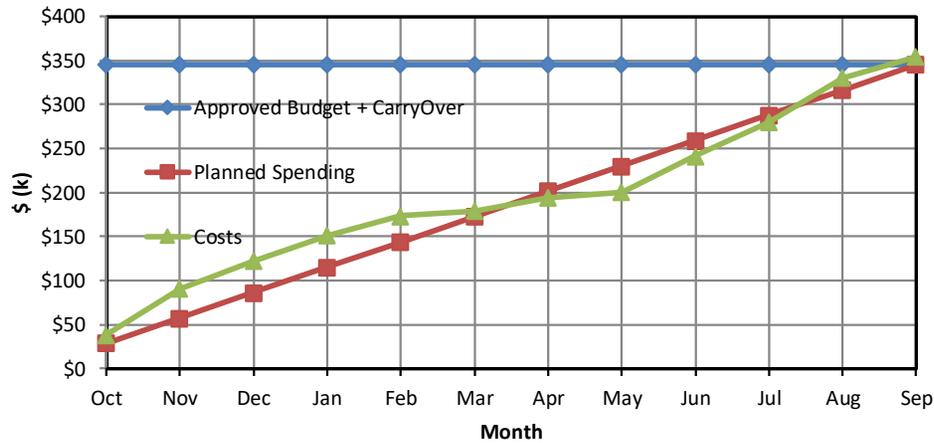
NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtask: ND1
Task Title: Resonance Region Nuclear Data Measurement Capability at RPI
M&O Contractor Name: RPI
Point of Contact Name: Yaron Danon
Point of Contact Phone: 518-276-4008

Reference: BNR Code 0909010
 Date of Report: 10,3, 2019

BUDGET

MAJOR ACCOMPLISHMENTS



- Started fabrication of a new design for the C₆D₆ capture detector incorporating 3 additional detectors for a total of 7 detectors.
- Completed keV scattering experiment for Cu
- Analysis of Cu scattering data started.
- Performed activation analysis of a Fe-54 sample and started the lease process with the isotopes center.

1. Carryover into FY 2019 = \$ 5,733
2. Approved FY 2019 Budget = \$345,733 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$122,637
4. Actual spending for 2nd Quarter FY 2019 = \$56,636
5. Actual spending for 3rd Quarter FY 2019 = \$62,488
6. Actual spending for 4rd Quarter FY 2019 = \$112,884
7. Projected carryover into FY 2020 = \$-8,913

NCSP Quarterly Progress Report (FY-2019 Q4)

RPI ND1 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND1)		
	Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest. (ND1)		
	Complete analysis of measurement from FY18. (ND1)		
Q2	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND1)		
	Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest. (ND1)		
Q3	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND1)		
	Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest. (ND1)		
	Complete transmission measurement per the nuclear data schedule in Appendix B. (ND1)		Cu scattering
	Complete capture measurement per the nuclear data schedule in Appendix B. (ND1)		Cu scattering
Q4	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND1)		

NCSP Quarterly Progress Report (FY-2019 Q4)

	Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest. (ND1)		
	Complete data analysis for transmission and capture measurements and provide the data to ORNL as needed to support the evaluation effort per the nuclear data schedule in Appendix B (ND1)		Completed for Ta, delivered data and the researcher to ORNL

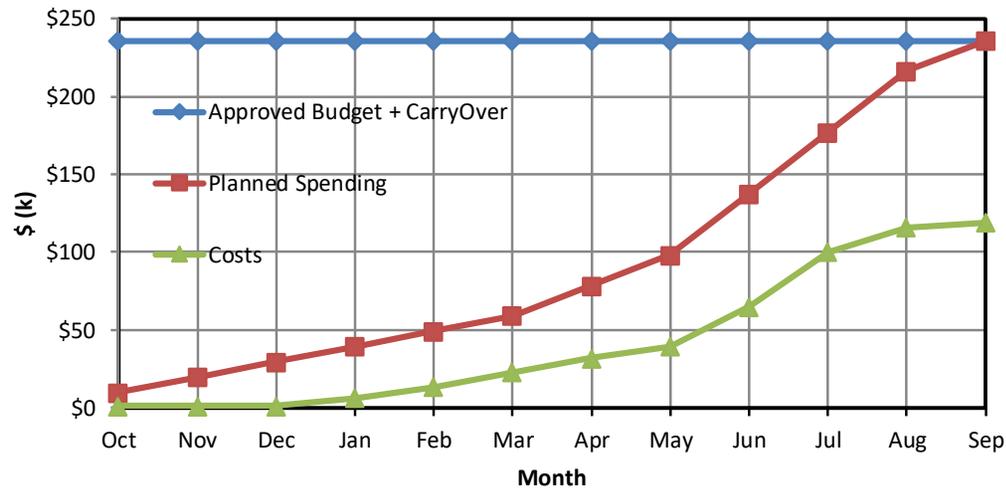
NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtask: ND2
Task Title: Thermal Neutron Scattering Measurement for Improvement of Criticality Calculations and Propagation of Scattering Kernel Uncertainties
M&O Contractor Name: RPI
Point of Contact Name: Yaron Danon
Point of Contact Phone: 518-276-4008

Reference: BNR Code 0909010
 Date of Report: 10/3, 2019

BUDGET

MAJOR ACCOMPLISHMENTS



1. Carryover into FY 2019 = \$35,974
2. Approved FY 2019 Budget = \$235,974 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$1,190
4. Actual spending for 2nd Quarter FY 2019 = \$21,684
5. Actual spending for 3rd Quarter FY 2019 = \$42,254
6. Actual spending for 4rd Quarter FY 2019 = \$53,957
7. Projected carryover into FY 2020 = \$116,888 (submitted equipment order of \$91,555)

- Finalized design drawings for manufacturing the cold moderator system.
- Selected vendor for procurement (JANIS) and submitted a PO.

NCSP Quarterly Progress Report (FY-2019 Q4)

RPI ND2 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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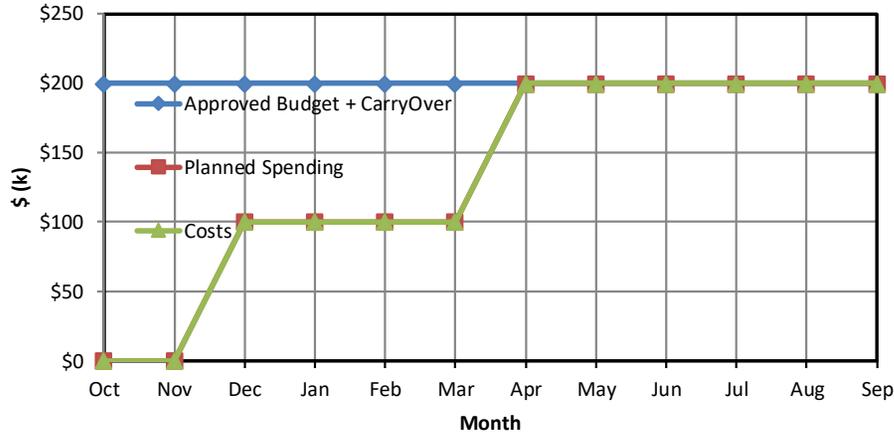
QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND2)		
	Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND2)		
Q2	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND2)		
	Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND2)		
	Complete cold moderator preliminary design phase (ND2)		
Q3	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND2)		
	Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND2)		
Q4	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND2)		
	Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (ND2)		
	Complete cold moderator design (ND2)		A PO was sent to vendor

NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtask: ND3
Task Title: RPI/ORNL: LINAC 2020 Nuclear Data Capabilities Maintenance Plan
M&O Contractor Name: RPI
Point of Contact Name: Yaron Danon
Point of Contact Phone: 518-276-4008

Reference: BNR Code 0909010
 Date of Report: 10, 3, 2019

BUDGET



1. Carryover into FY 2019 = \$0
2. Approved FY 2019 Budget = \$200K (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$100K
4. Actual spending for 2nd Quarter FY 2019 = \$0
5. Actual spending for 3rd Quarter FY 2019 = \$100K
6. Actual spending for 4rd Quarter FY 2019 = \$0
7. Projected carryover into FY 2020 = \$0

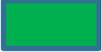
MAJOR ACCOMPLISHMENTS

- Modulator 1 is now at RPI
- Two klystron arrived at RPI
- Completed modulator electricity and water connections.
- Completed test of RF loads.

NCSP Quarterly Progress Report (FY-2019 Q4)

RPI ND3 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND3)		
	Factory acceptance tests of RF Modulators 2 and 3 (ND3)		
Q2	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND3)		
	Delivery of RF Modulator 1 and Klystron 1 (ND3)		
	Factory acceptance tests of RF Modulators 4 and 5 (ND3)		Factory delay to FY20 Q1 and Q2
Q3	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND3)		
	Factory Acceptance test for Tapered Phase Velocity and Speed of Light #1 Accelerator Sections (ND3)		Factory delay to FY20 Q2
Q4	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports. (ND3)		
	Delivery and of TPV and SOL1 Accelerator Sections (ND3)		Factory delay to FY20 Q3

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtasks: ND1 Task Title: Fabrication of New Uranium Target for IRMM/GELINA for Cross-section Measurements M&O Contractor Name: Y12 Point of Contact Name: Kevin Reynolds Point of Contact Phone: (865) 241-9067</p>	<p style="text-align: right;">Reference: B&R DP0909010 Date of Report: October 25, 2019</p>
<p>BUDGET</p>	<p>MAJOR ACCOMPLISHMENTS</p>
<div style="text-align: center;"> <p>Y-12 Budget/Incurred Costs</p> <p>Dollars</p> <p>Month</p> <p>— FY19 Budget + Carryover — Planned Spending — Actual Costs</p> </div> <ol style="list-style-type: none"> 1. Carryover into FY 2019 = \$97,968 2. Approved FY 2019 Budget = \$347,968 (includes carryover) 3. Actual spending for 1st Quarter FY 2019 = \$22,487 4. Actual spending for 2nd Quarter FY 2019 = \$9,167.78 5. Actual spending for 3rd Quarter FY 2019 = \$6,266.15 6. Actual spending for 4rd Quarter FY 2019 = +\$556.59 7. Projected carryover into FY 2020 = \$310,604.02 	<ul style="list-style-type: none"> • Q1: Complete set of fabrication drawings complete in Q1. Coordinated with US and Belgium. It was determined that MSC could manufacture the part more economically than Y-12 and so we are pursuing a Purchase Requisition to contract with MSC for the Manufacture of the target. • Q2: For the 2nd quarter we were able to get the purchase order documents drafted (Statement of Work, sole source form, etc.) and had the drawings updated again to reflect some minor clarifications between the proposed supplier and the GELINA technical staff. We also had the supplier prepare an estimate for shipping the target directly to Belgium and incorporated this requirement into the SOW during one of several iterations required to make everyone happy. We have now gotten all of the documentation through DC Review. • Q3: The Purchase Requisition is with Y-12 Procurement. There have been several requests for additional information from MSC but to date no contract has been awarded. • Q4: Contract placement with MSC has been delayed but should happen soon (next couple of weeks). Once that has been completed a true delivery schedule can be determined. The current estimate for delivery is Q1 of Calendar Year 2020.

NCSP Quarterly Progress Report (FY-2019 Q4)

Y12 ND Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	COMMENTS
Q1	Provide a status report of the fabrication of a depleted uranium/molybdenum target per IRMM/GELINA specifications to the NCSP Manager. (ND1)		Fabrication of part to commence in Q2
Q2	Provide a status report of the fabrication of a depleted uranium/molybdenum target per IRMM/GELINA specifications to the NCSP Manager. (ND1)		Fabrication of part is behind schedule. Will not complete this FY – tracking for end of Calendar 2019 at the moment.
Q3	Provide a status report of the fabrication of a depleted uranium/molybdenum target per IRMM/GELINA specifications to the NCSP Manager. (ND1)	TRENDING RED	PR not placed. Part manufacture delayed.
Q4	Provide a status report of the fabrication of a depleted uranium/molybdenum target per IRMM/GELINA specifications to the NCSP Manager. (ND1)		PR not placed. Part Manufacture delayed until Q1 of Calendar 2020 (earliest).

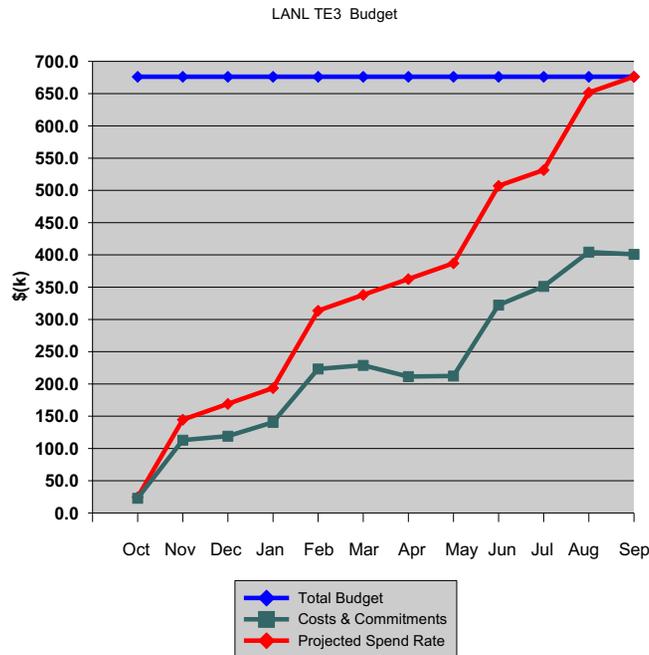
NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element: LANL TE3
Task Title: Conduct Hands-On Criticality Safety Training Course at NCERC
M&O Contractor Name: Los Alamos National Laboratory (LANL)
Point of Contact Name: Brian Bluhm
Point of Contact Phone: (505) 667-2440

Reference: DP0909010
 Date of Report: October 16, 2019

BUDGET

MAJOR ACCOMPLISHMENTS



- Supported the NCERC “hands on” Criticality safety training for the two week Criticality Safety practitioner’s course that occurred in Q4.

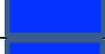
1. Carryover into FY 2019 = \$300K
2. Approved FY 2019 Budget = \$ 676K
3. Actual spending for 1st Quarter FY 2019 = \$118.9K
4. Actual spending for 2nd Quarter FY 2019 = \$109.8K
5. Actual spending for 3rd Quarter FY 2019 = \$93.4K
6. Actual spending for 4th Quarter FY 2019 = \$78.7K
7. Projected carryover into FY 2020 = \$

NCSP Quarterly Progress Report (FY-2019 Q4)

LANL TE3 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all training activities to the NCSP Manager. (TE3)		
	Provide training in accordance with the approved schedule. (TE3)		
Q2	Provide status reports on all training activities to the NCSP Manager. (TE3)		
	Provide training in accordance with the approved schedule. (TE3)		
Q3	Provide status reports on all training activities to the NCSP Manager. (TE3)		
	Provide training in accordance with the approved schedule. (TE3)		
Q4	Provide status reports on all training activities to the NCSP Manager. (TE3)		
	Provide training in accordance with the approved schedule. (TE3)		

NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element: LANL TE4

Task Title: On-Site Introductory Training for the NCS Practitioner on Modern Approaches to Validation using Sensitivity and Uncertainty Analysis Tools

M&O Contractor Name: Los Alamos National Laboratory (LANL)

Point of Contact Name: Brian Bluhm / Bob Little

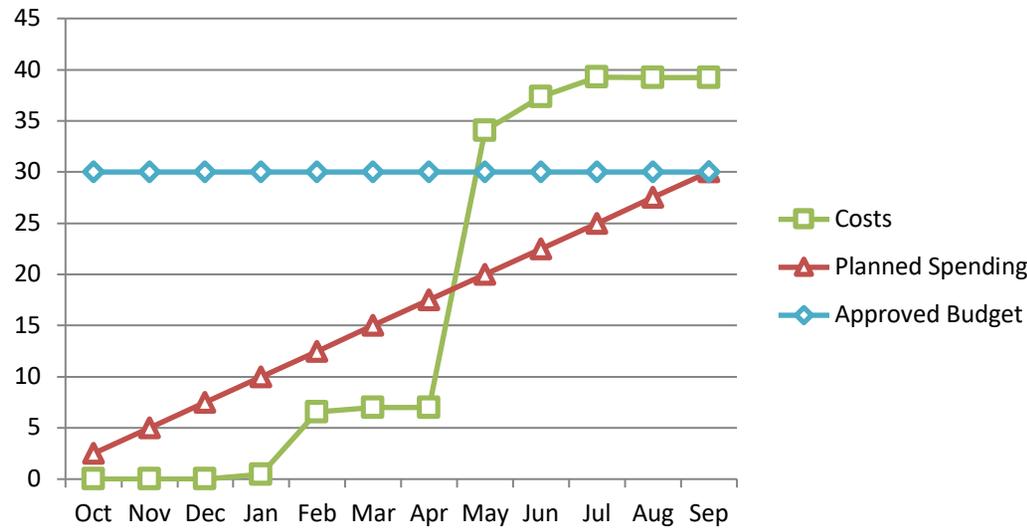
Point of Contact Phone: (505) 667-2440 / (505) 665-3487

Reference: B&R DP0909010

Date of Report: October 18, 2019

BUDGET

MAJOR ACCOMPLISHMENTS



- Milestone was accomplished in Q3. No additional work during Q4.

1. Carryover into FY 2019 = \$0
2. Approved FY 2019 Budget = \$30,000 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$0
4. Actual spending for 2nd Quarter FY 2019 = \$7,013
5. Actual spending for 3rd Quarter FY 2019 = \$30,364
6. Actual spending for 4th Quarter FY 2019 = \$1,832
7. Projected carryover into FY 2020 = \$0

NCSP Quarterly Progress Report (FY-2019 Q4)

LANL TE4 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

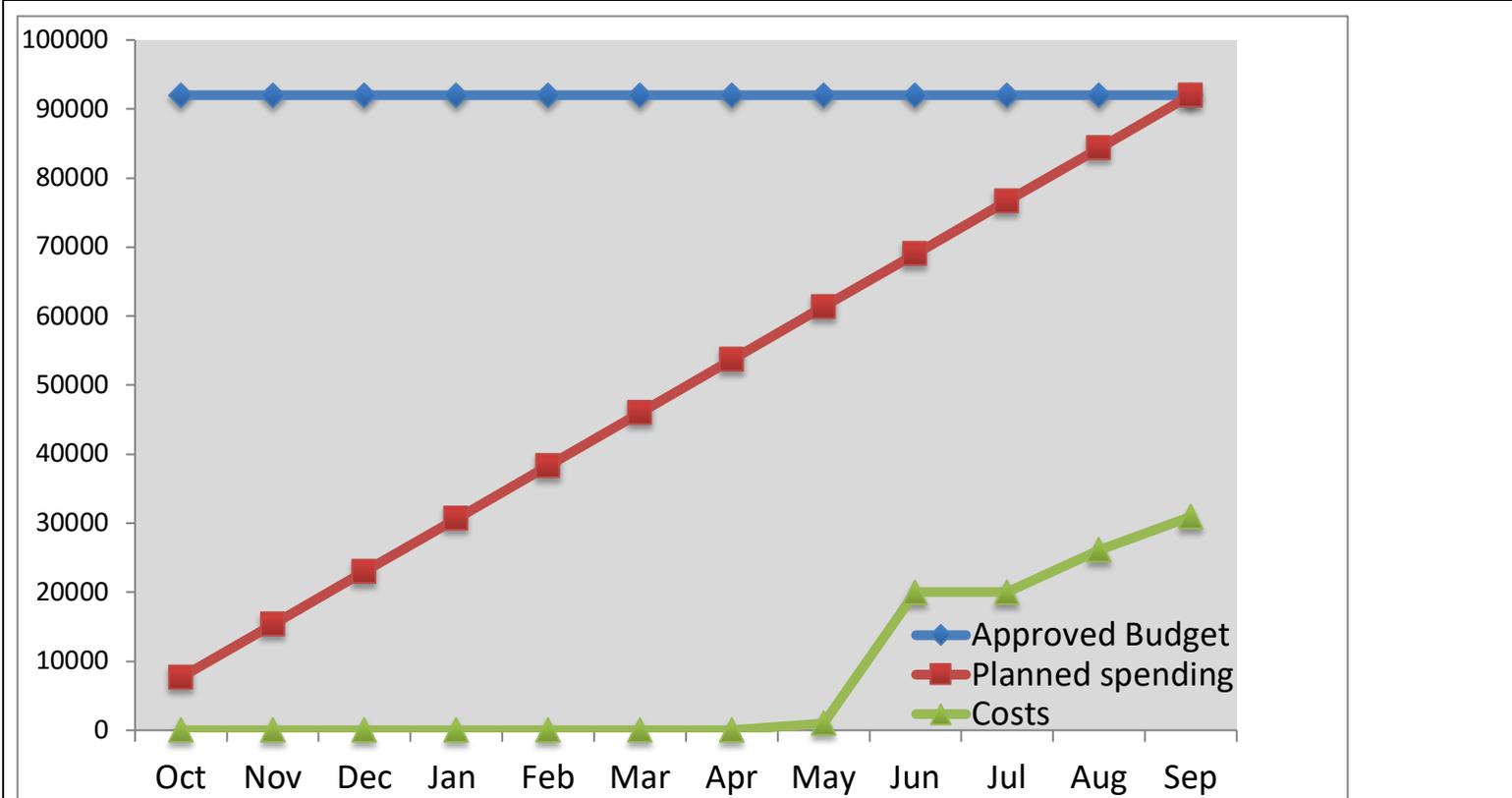
Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	NONE		
Q2	NONE		
Q3	NONE		
Q4	In collaboration with ORNL, provide introductory 1-day S/U workshop training to one or more DOE sites in FY19. (TE4)		

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element: LANL TE6 Task Title: Development of University Pipeline for Criticality Safety Professionals M&O Contractor Name: Los Alamos National Laboratory (LANL) Point of Contact Name: Brian K. Bluhm Point of Contact Phone: (505) 667-2440</p>	<p>Reference: B&R DP0909010 Date of Report: October 18, 2019</p>
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BUDGET	MAJOR ACCOMPLISHMENTS
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MAJOR ACCOMPLISHMENTS

- Some support to recruiting efforts and pipeline sustainment.

1. Carryover into FY 2019 = \$ 0
2. Approved FY 2019 Budget = \$ 92K
3. Actual spending for 1st Quarter FY 2019 = \$ 0
4. Actual spending for 2nd Quarter FY 2019 = \$ 0
5. Actual spending for 3rd Quarter FY 2019 = \$20K
6. Actual spending for 4rd Quarter FY 2019 = \$10K
7. Projected carryover into FY 2020 = \$

NCSP Quarterly Progress Report (FY-2019 Q4)

LANL TE6 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

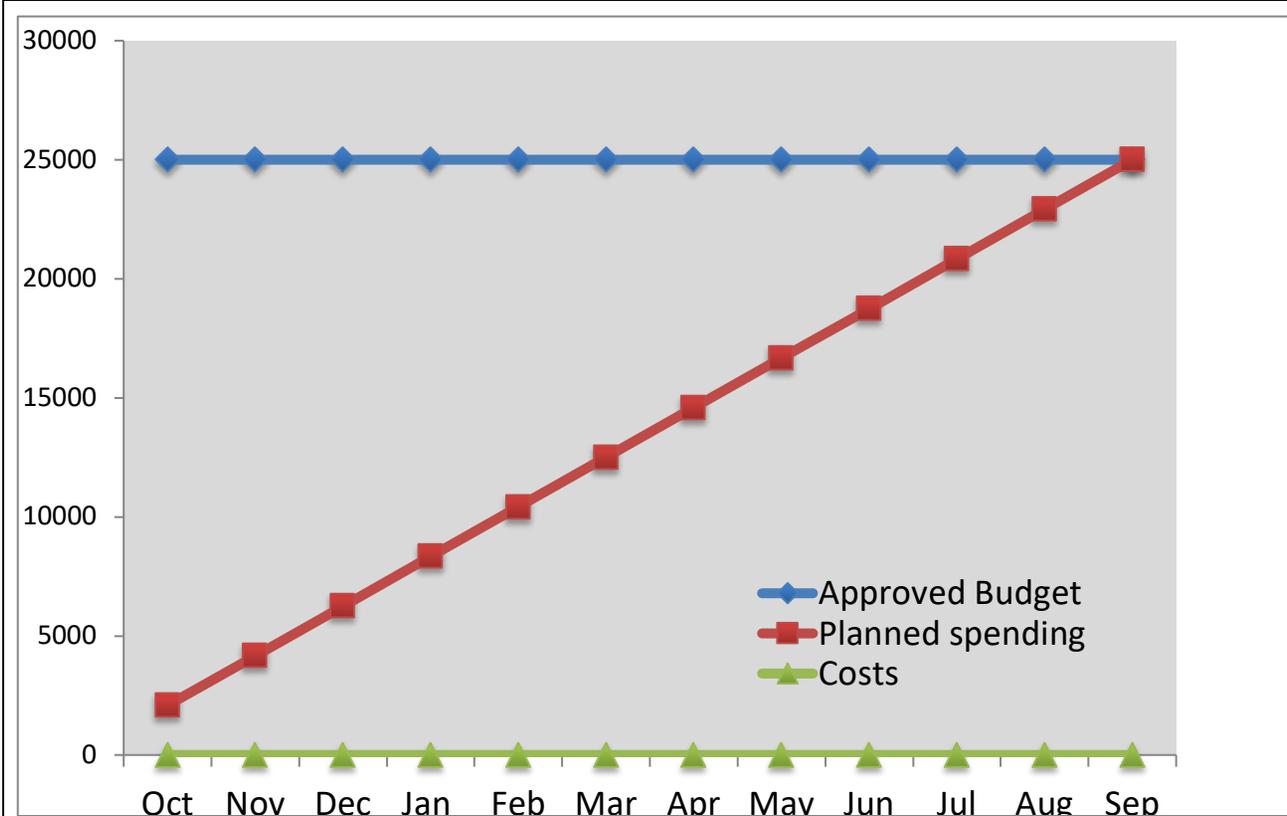
Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all training activities to the NCSP Manager. (TE6)	NO REPORT	
Q2	Provide status reports on all training activities to the NCSP Manager. (TE6)	NO REPORT	Will work with NCS D to develop plan for students
Q3	Provide status reports on all training activities to the NCSP Manager. (TE6)		NCS D reduced student population for this year to make more meaningful for the students they brought in.
Q4	Provide status reports on all training activities to the NCSP Manager. (TE6)		NCS D was able to get some student work going and begin recruiting for next year.
	Provide end of year progress report. (TE6)		

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element: LANL TE7 Task Title: Design and Develop a New NCSP T&E Course Criticality Safety Officers at DOE/NNSA Nuclear Facilities M&O Contractor Name: Los Alamos National Laboratory (LANL) Point of Contact Name: Brian K. Bluhm Point of Contact Phone: (505) 667-2440</p>	<p>Reference: B&R DP0909010 Date of Report: October 18, 2019</p>
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BUDGET	MAJOR ACCOMPLISHMENTS
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• Input was provided using LANL overhead.

1. Carryover into FY 2019 = \$ 0
2. Approved FY 2019 Budget = \$ 25K
3. Actual spending for 1st Quarter FY 2019 = \$ 0
4. Actual spending for 2nd Quarter FY 2019 = \$ 0
5. Actual spending for 3rd Quarter FY 2019 = \$ 0
6. Actual spending for 4rd Quarter FY 2019 = \$ 0
7. Projected carryover into FY 2020 = \$ 0

NCSP Quarterly Progress Report (FY-2019 Q4)

LANL TE7 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all training activities to the NCSP Manager. (TE7)	NO REPORT	
Q2	Provide status reports on all training activities to the NCSP Manager. (TE7)	NO REPORT	
Q3	Provide status reports on all training activities to the NCSP Manager. (TE7)	NO REPORT	
Q4	Provide status reports on all training activities to the NCSP Manager. (TE7)		
	Provide end of year progress report. (TE7)		

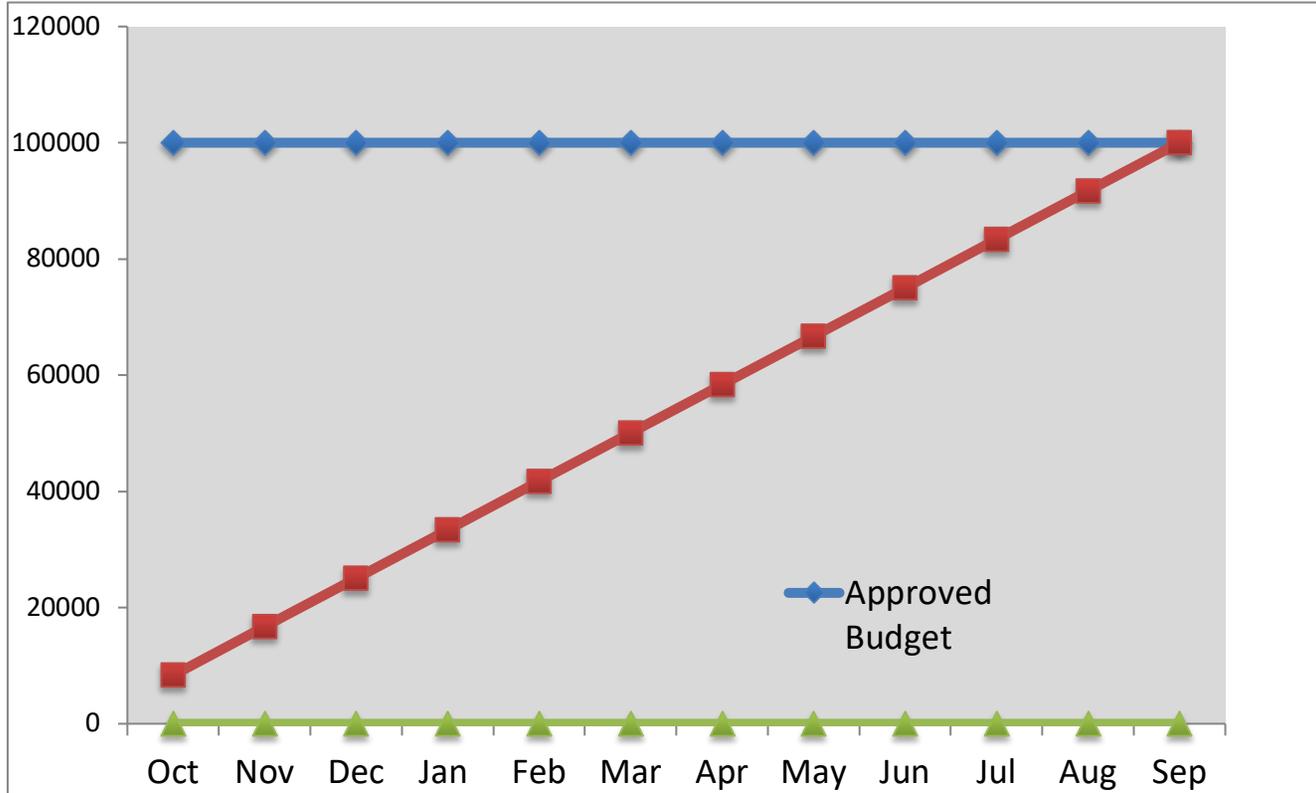
NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element: LANL TE8
Task Title: Reactivity Simulation Aids
M&O Contractor Name: Los Alamos National Laboratory (LANL)
Point of Contact Name: Brian K. Bluhm
Point of Contact Phone: (505) 667-2440

Reference: B&R DP0909010
Date of Report: October 18, 2019

BUDGET

MAJOR ACCOMPLISHMENTS



• No Progress in FY19, working to get this accomplished in FY20

1. Carryover into FY 2019 = \$ 0
2. Approved FY 2019 Budget = \$ 100K
3. Actual spending for 1st Quarter FY 2019 = \$ 0
4. Actual spending for 2nd Quarter FY 2019 = \$ 0
5. Actual spending for 3rd Quarter FY 2019 = \$0
6. Actual spending for 4th Quarter FY 2019 = \$0
7. Projected carryover into FY 2020 = \$ 0

NCSP Quarterly Progress Report (FY-2019 Q4)

LANL TE8 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all training activities to the NCSP Manager. (TE8)	NO REPORT	Will get work planned
Q2	Provide status reports on all training activities to the NCSP Manager. (TE8)	NO REPORT	Will get work planned
Q3	Provide status reports on all training activities to the NCSP Manager. (TE8)	NO REPORT	Will get work planned for early FY20
Q4	Provide status reports on all training activities to the NCSP Manager. (TE8)	NO REPORT	Work will begin in FY20
	Provide end of year progress report. (TE8)		

NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtasks: TE1, 3, 8, 9

Task Titles:

- TE1 Conduct Hands-on Training at the DAF (TACS)
- TE3 Classroom Criticality Safety Training
- TE8 Incorporate Superior Reflectors into TACS “Hands On” Training
- TE9 Design and Develop a New NCSP T&E Course for Criticality Safety Officers

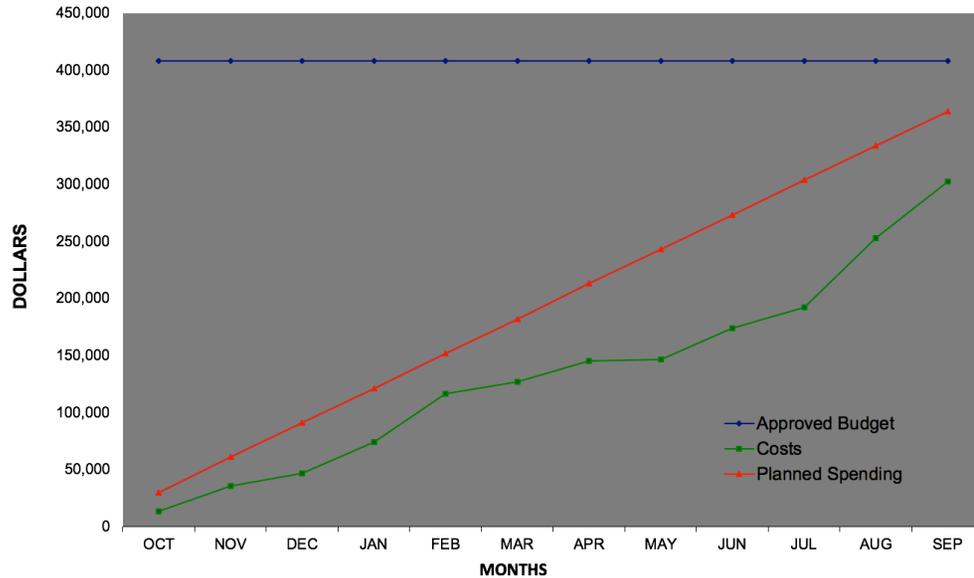
M&O Contractor Name: Lawrence Livermore National Laboratory

Point of Contact Name: David Heinrichs

Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010
Date of Report: October 18, 2019

BUDGET



1. Carryover into FY 2019 = \$12,541
2. Approved FY 2019 Budget = \$408,541 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$47,065
4. Actual spending for 2nd Quarter FY 2019= \$80,195
5. Actual spending for 3rd Quarter FY 2019 = \$46,825
6. Actual spending for 4rd Quarter FY 2019 = \$128,388
7. Projected carryover into FY 2020 = \$106,068 (26%)

MAJOR ACCOMPLISHMENTS

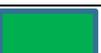
1. Provided registration and logistics support (TE1, TE3) for:
 - 2-week CSE course on Aug 12-23, 2019 at NATM & NCERC/SNL
 - 2-week CSE course on Jan 27-Feb 7, 2020 at NATM & NCERC/SNL
 - 1 week Managers course on March 30-April 3, 2020 at SNL
 - 1 week Managers course on June 15-19, 2020 at NCERC
 - 2-week CSE course on Aug 10-21, 2020 at NATM & NCERC/SNL
2. Provided academic and hands-on instruction for the two-week Criticality Safety Engineer course at NATM and NCERC on August 12-23, 2019 including the following modules:
 - NCS Fundamentals
 - NCS Evaluation
 - Introduction to Experimental Methods
 - TACS
 - CSE Workshop
 - Emergency Response
3. Participated in all T&E teleconferences (TE1, TE3).
4. CSE and work planning and control (WP&C) documents for the TACS were completed and are undergoing facility review to authorize use of the beryllium shells. First use of the shells scheduled for next quarter (TE8).
5. Updated and tailored the NCSE Module for the CSO/Managers Course (TE9).

NCSP Quarterly Progress Report (FY-2019 Q4)

LLNL T&E Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

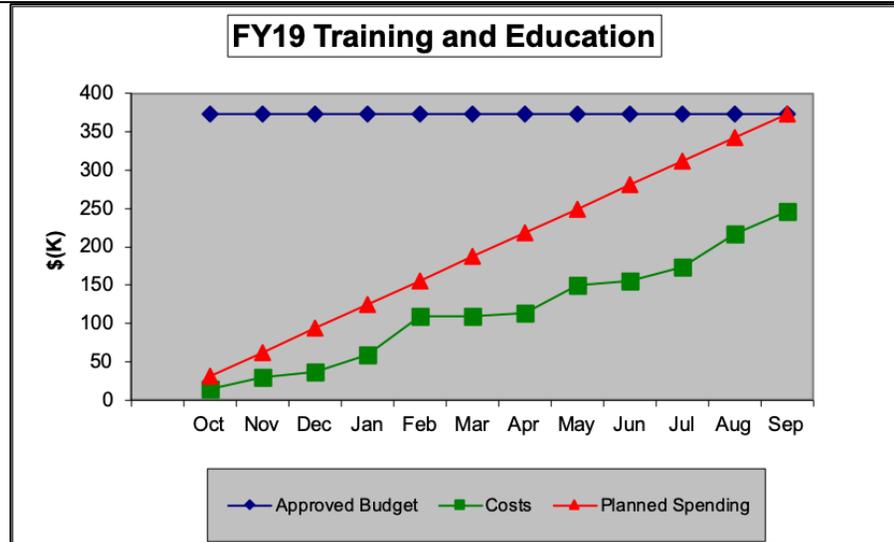
Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	COMMENTS
Q1	Update, maintain and support the registration process and provide classroom and "hands on" TACS training in accordance with the schedule approved by the NCSP Manager (TE1, TE3).		
	Conduct subcritical measurements using beryllium shells and finalize training materials addressing the concept of superior reflection. (TE8)		
	Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)		
Q2	Update, maintain and support the registration process and provide classroom and "hands on" TACS training in accordance with the schedule approved by the NCSP Manager (TE1, TE3).		
	Conduct subcritical measurements using beryllium shells and finalize training materials addressing the concept of superior reflection. (TE8)		
	Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)		
Q3	Update, maintain and support the registration process and provide classroom and "hands on" TACS training in accordance with the schedule approved by the NCSP Manager (TE1, TE3).		
	Conduct subcritical measurements using beryllium shells and finalize training materials addressing the concept of superior reflection. (TE8)		
	Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)		
Q4	Update, maintain and support the registration process and provide classroom and "hands on" TACS training in accordance with the schedule approved by the NCSP Manager (TE1, TE3).		
	Conduct subcritical measurements using beryllium shells and finalize training materials addressing the concept of superior reflection. (TE8)		CSE and work planning & control documents completed and in facility review.
	Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)		

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: TE1, 5, 9, 10 Task Title: See last page M&O Contractor Name: ORNL Point of Contact Name: Doug Bowen Point of Contact Phone: (865) 576-0315</p>	<p>Reference: DP0901010/ORNL Date of Report: October 11, 2019</p>
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BUDGET



1. Carryover into FY 2019 = \$40K; FY 2020 = \$128K
2. Approved FY 2019 Budget = \$374K (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$37K
4. Actual spending for 2nd Quarter FY 2019 = \$73K
5. Actual spending for 3rd Quarter FY 2019 = \$46K
6. Actual spending for 4rd Quarter FY 2019 = \$90K

MAJOR ACCOMPLISHMENTS

- TE1 - Manage and Provide Instruction for the DOE Nuclear Criticality Safety Training & Education Program**
- Archived June 2019 NCERC manager course exams, course materials and student evaluations.
 - Conducted telecons to prepare for the 2-week hands-on course at Sandia, NCERC and the National Atomic Testing Museum. Successfully executed the course according to 5YP and T&E procedures. NCERC portion was at risk due to nuclear facility issues at DAF. The NCERC portion of the class was ultimately completed as planned.
- TE5 - On-Site Introductory Training for the NCS Practitioner on Modern Approaches to Validation using Sensitivity and Uncertainty Analysis Tools**
- No activity in Q4 other than working to plan the next course offerings.
- TE9 - Design and Develop a New NCSP T&E Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities**
- Participated in the development of the CSSG 2018-01 tasking for the CSO course baseline content. Compiled a plan to revise the NCSP Manager course to add recommended content for the CSO course from the CSSG tasking. SNL, LLNL, LANL, ORNL, and Y12 were all part of the team. The course materials were completed on schedule (end of Q4) and course binders for the updated Managers courses for both NCERC and Sandia were created and provided to the NCSP manager.
- TE10 - Design of a Subcritical Assembly at ORNL for use with the CSO/FMH Courses**
- ORNL completed design computations for AGN 201M reactor components with various reflector materials. Y-12 worked to provide information about the availability of AGN-201M reactor components (fuel) to ORNL for use with the design computations to determine if sufficient fuel material is available to perform practical hands-on measurements. Engagement by Y-12 personnel has been slow and data for the core materials will not be delivered until FY20 Q1. A feasibility study report will be generated, along with

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: TE1, 5, 9, 10 Task Title: See last page M&O Contractor Name: ORNL Point of Contact Name: Doug Bowen Point of Contact Phone: (865) 576-0315</p>	<p>Reference: DP0901010/ORNL Date of Report: October 11, 2019</p>
	<p>an NCSP proposal for FY21, for the actual fabrication of a subcritical/critical assembly and a location at ORNL for the assembly will be located.</p>

NCSP Quarterly Progress Report (FY-2019 Q4)

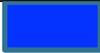
ORNL TE Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide a status report in NCSP Quarterly Progress Reports on implementation of the NCS training program and resolution of CSSG comments from CSSG tasking 2016-01. (TE1)		
	Provide status reports in NCSP Quarterly Progress Reports on improvements/modifications to baseline NCS course training materials based on CSSG assessment report 2016-01, self-evaluation, and feedback from reviewers, observers, trainers, and the NCSP manager. (TE1)		
	Provide a status report in NCSP Quarterly Progress Reports on the progress of 1-day onsite introductory validation training conducted at one or more DOE sites. (TE5)		
	Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)		
Q2	Provide a status report in NCSP Quarterly Progress Reports on implementation of the NCS training program and resolution of CSSG comments from CSSG tasking 2016-01. (TE1)		
	Provide status reports in NCSP Quarterly Progress Reports on improvements/modifications to baseline NCS course training materials based on CSSG assessment report 2016-01, self-evaluation, and feedback from reviewers, observers, trainers, and the NCSP manager. (TE1)		
	Provide a status report in NCSP Quarterly Progress Reports on the progress of 1-day onsite introductory validation training conducted at one or more DOE sites. (TE5)		
	Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)		

NCSP Quarterly Progress Report (FY-2019 Q4)

Q3	Provide a status report in NCSP Quarterly Progress Reports on implementation of the NCS training program and resolution of CSSG comments from CSSG tasking 2016-01. (TE1)		
	Provide status reports in NCSP Quarterly Progress Reports on improvements/modifications to baseline NCS course training materials based on CSSG assessment report 2016-01, self-evaluation, and feedback from reviewers, observers, trainers, and the NCSP manager. (TE1)		
	Provide a status report in NCSP Quarterly Progress Reports on the progress of 1-day onsite introductory validation training conducted at one or more DOE sites. (TE5)		
	Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)		Although still on track, the CSSG tasking report for 2018-01 was not issued until the end of FY19Q3 (June 20 th).
Q4	Provide a status report in NCSP Quarterly Progress Reports on implementation of the NCS training program and resolution of CSSG comments from CSSG tasking 2016-01. (TE1)		This task is complete
	Provide status reports in NCSP Quarterly Progress Reports on improvements/modifications to baseline NCS course training materials based on CSSG assessment report 2016-01, self-evaluation, and feedback from reviewers, observers, trainers, and the NCSP manager. (TE1)		
	Provide a status report in NCSP Quarterly Progress Reports on the progress of 1-day onsite introductory validation training conducted at one or more DOE sites. (TE5)		
	Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)		This task was completed on schedule
	Develop a feasibility report to the NCSP manager for the design and installation of a subcritical assembly at ORNL using existing resources at Y-12. If the concept is feasible, submit a proposal for consideration for FY20. (TE10)		Delayed to lack of engagement from Y-12 staff due to other priorities. Data to be provided to ORNL in FY20 Q1 sometime.

NCSP Quarterly Progress Report (FY-2019 Q4)

Task Title:

- TE1 Manage and Provide Instruction for the DOE Nuclear Criticality Safety Training & Education Program

- TE5 On-Site Introductory Training for the NCS Practitioner on Modern Approaches to Validation using Sensitivity and Uncertainty Analysis Tools

- TE9 Design and Develop a New NCSP T&E Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities

- TE10 Design of a Subcritical Assembly at ORNL for use with the CSO/FMH Courses

NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element: SNL TE1, 2

Task Titles:

TE1 Prepare for and Conduct Hands-on Criticality Safety Training at SNL
 TE2 Design and Develop a New NCSP T&E Course Criticality Safety Officers at DOE/NNSA Nuclear Facilities

M&O Contractor Name: Sandia National Laboratories (SNL)

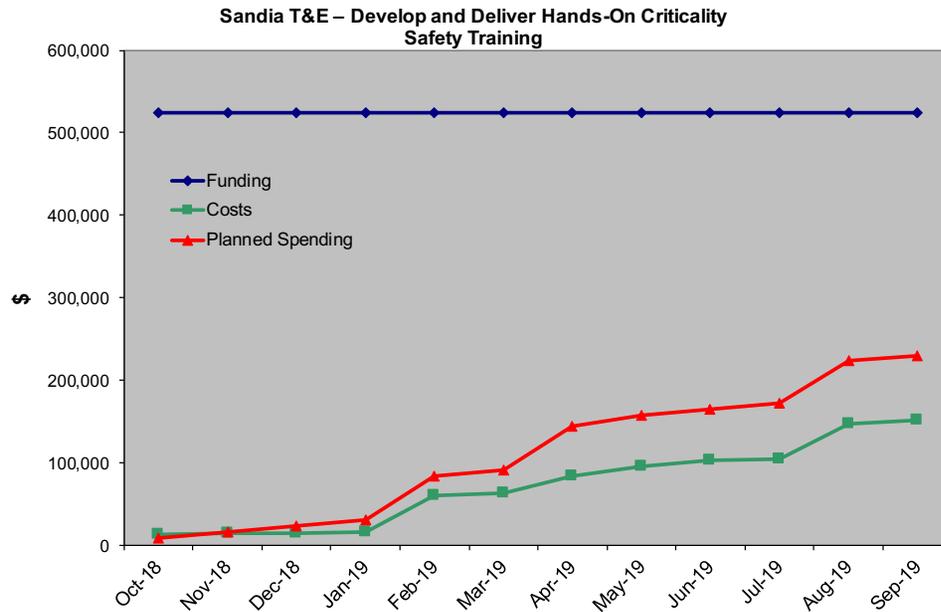
Point of Contact Name: Gary A. Harms

Point of Contact Phone: (505)845-3244

Reference: B&R DP 0909010
Date of Report: September 30, 2019

BUDGET

MAJOR ACCOMPLISHMENTS



- We delivered the Sandia portion of a Hands-On criticality safety course for NCSEs in August 2019.
- We completed the development of the Sandia portion of a Hands-On criticality safety course for Criticality Safety Officers in September.

1. Carryover into FY 2019 = \$295,351
2. Approved FY 2019 Budget = \$229,000 (new) + \$295,351 (carryover) = \$524,351
3. Actual spending for 1st Quarter FY 2019 = \$13,447
4. Actual spending for 2nd Quarter FY 2019 = \$48,948
5. Actual spending for 3rd Quarter FY 2019 = \$39,547
6. Actual spending for 4th Quarter FY 2019 = \$48,457
7. Projected carryover into FY 2020 = \$373,952

NCSP Quarterly Progress Report (FY-2019 Q4)

SNL T&E Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Conduct hands-on training classes at Sandia and provide Human Factors and Equipment Reliability module support to the LANL training classes in accordance with the approved schedule. (TE1)		
	Work with LLNL, ORNL, LANL to develop and deploy a 1-week hands-on NCSP T&E course for fissile material handlers and criticality safety officer. (TE2)		
Q2	Conduct hands-on training classes at Sandia and provide Human Factors and Equipment Reliability module support to the LANL training classes in accordance with the approved schedule. (TE1)		
	Work with LLNL, ORNL, LANL to develop and deploy a 1-week hands-on NCSP T&E course for fissile material handlers and criticality safety officer. (TE2)		
Q3	Conduct hands-on training classes at Sandia and provide Human Factors and Equipment Reliability module support to the LANL training classes in accordance with the approved schedule. (TE1)		
	Work with LLNL, ORNL, LANL to develop and deploy a 1-week hands-on NCSP T&E course for fissile material handlers and criticality safety officer. (TE2)		
Q4	Conduct hands-on training classes at Sandia and provide Human Factors and Equipment Reliability module support to the LANL training classes in accordance with the approved schedule. (TE1)		
	Work with LLNL, ORNL, LANL to develop and deploy a 1-week hands-on NCSP T&E course for fissile material handlers and criticality safety officer. (TE2)		

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtasks: Y12 TE1, 3, 4</p> <p>Task Title: TE1 Conduct Hands-On Criticality Safety Training Course (Lecture support week 1 of 2-week hands-on course and course material development) TE3 Design of a Subcritical Assembly at ORNL for use with the CSO Courses TE4 Design and Develop a New NCSP T&E Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities</p> <p>M&O Contractor Name: Y12</p> <p>Point of Contact Name: Kevin Reynolds</p> <p>Point of Contact Phone: (865) 241-9067</p>	<p style="text-align: right;">Reference: B&R DP0909010</p> <p style="text-align: right;">Date of Report: October 25, 2019</p>
<p style="text-align: center;">BUDGET</p>	<p style="text-align: center;">MAJOR ACCOMPLISHMENTS</p>
<div style="text-align: center;"> <p>Y-12 Budget/Incurred Costs</p> <p>Dollars</p> <p>Month</p> <p>— FY19 Budget + Carryover — Planned Spending — Actual Costs</p> </div> <ol style="list-style-type: none"> 1. Carryover into FY 2019 = \$0 2. Approved FY 2019 Budget = \$134k (includes carryover) 3. Actual spending for 1st Quarter FY 2019 = \$5394.30 4. Actual spending for 2nd Quarter FY 2019 = \$24,750.20 5. Actual spending for 3rd Quarter FY 2019 = \$0.00 6. Actual spending for 4rd Quarter FY 2019 = \$20,632.31 7. Projected carryover into FY 2020 = \$83,223.19 	<ul style="list-style-type: none"> • TE1 is Chris Haught’s time to teach at Hands On Courses. Minimal effort in Q1 – mostly prep for short course teaching which is to occur in Q2. • TE3 and TE4 are ORNL tasks we fund as requested and so far no effort from us on these items has occurred. • Q2 for TE1: Teaching prep for short course. • Q2 for TE3 and TE4 are zero effort to date. • Q3: TE3 – meeting held with Y-12 (Lloyd Jollay, Chris Haught and Kevin Reynolds) and ORNL (Ellen Saylor) to discuss initial planning. Y-12 (Lloyd Jollay) took and action to research inventory to determine what holdings we have that would be appropriate for ORNL’s purposes (AGN-201 plates). • Q3: TE1 and TE4 are zero effort for the quarter. • Q4: TE1 – Chris was at the courses as planned. TE3 – AGN core data delivered to ORNL. TE4 – No activity. This quarter we managed to back out the inappropriate charges as a result of our charge code being misappropriated. We are still \$29k short but that will come back in FY20.

NCSP Quarterly Progress Report (FY-2019 Q4)

Y12 TE Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

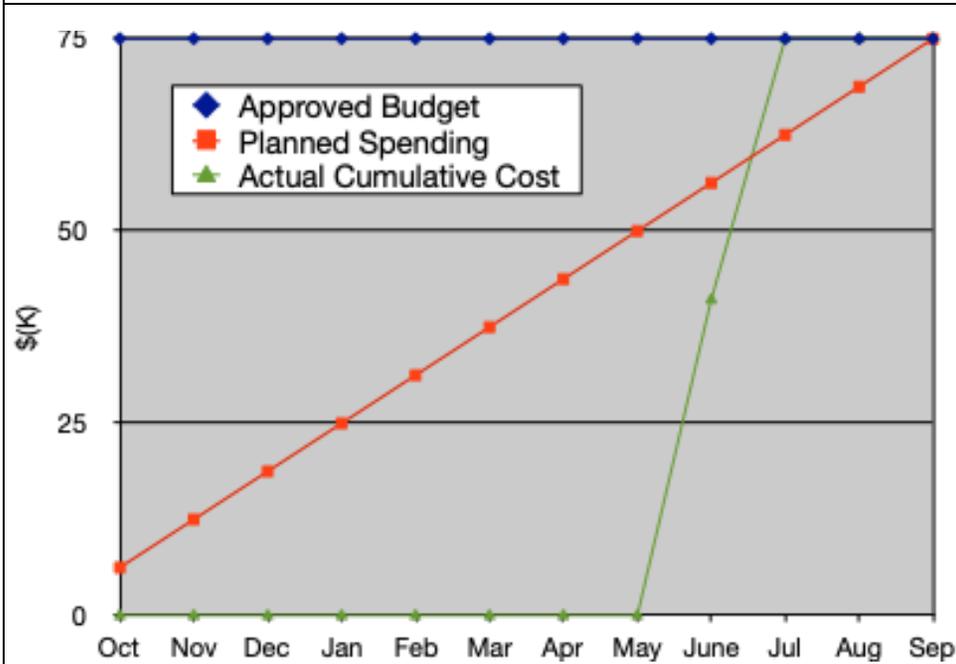
Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	COMMENTS
Q1	Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1, TE3, TE4)		
Q2	Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1, TE3, TE4)		
Q3	Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1, TE3, TE4)		
Q4	Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1, TE3, TE4)		

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: NCSP Technical Support TS6 Task Title: ND Succession Planning M&O Contractor Name: BNL Point of Contact Name: David Brown Point of Contact Phone: 631-344-2814</p>	<p>Reference: DP0909010 Date of Report: Oct. 17, 2019</p>
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BUDGET



ACCOMPLISHMENTS

I have taken over the electronic files from which the *Atlas of Neutron Resonances* is generated. With the collaboration of a summer student (G. Sayers) I documented the format for the electronic files and wrote the start of an API for the Atlas files. The format is described in a lab report (BNL-212201-2019-INRE).

We also have begun cross comparing the bibliography of the Atlas with EXFOR in an effort to determine the provenance of all values in the Atlas.

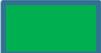
1. Carryover into FY 2019 = \$ 0
2. Approved FY 2019 Budget = \$75 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$0
4. Actual spending for 2nd Quarter FY 2019 = \$0
5. Actual spending for 3rd Quarter FY 2019 = \$41,060
6. Actual spending for 4rd Quarter FY 2019 = \$33,940
7. Projected carryover into FY 2020 = \$0

NCSP Quarterly Progress Report (FY-2019 Q4)

BNL TS6 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

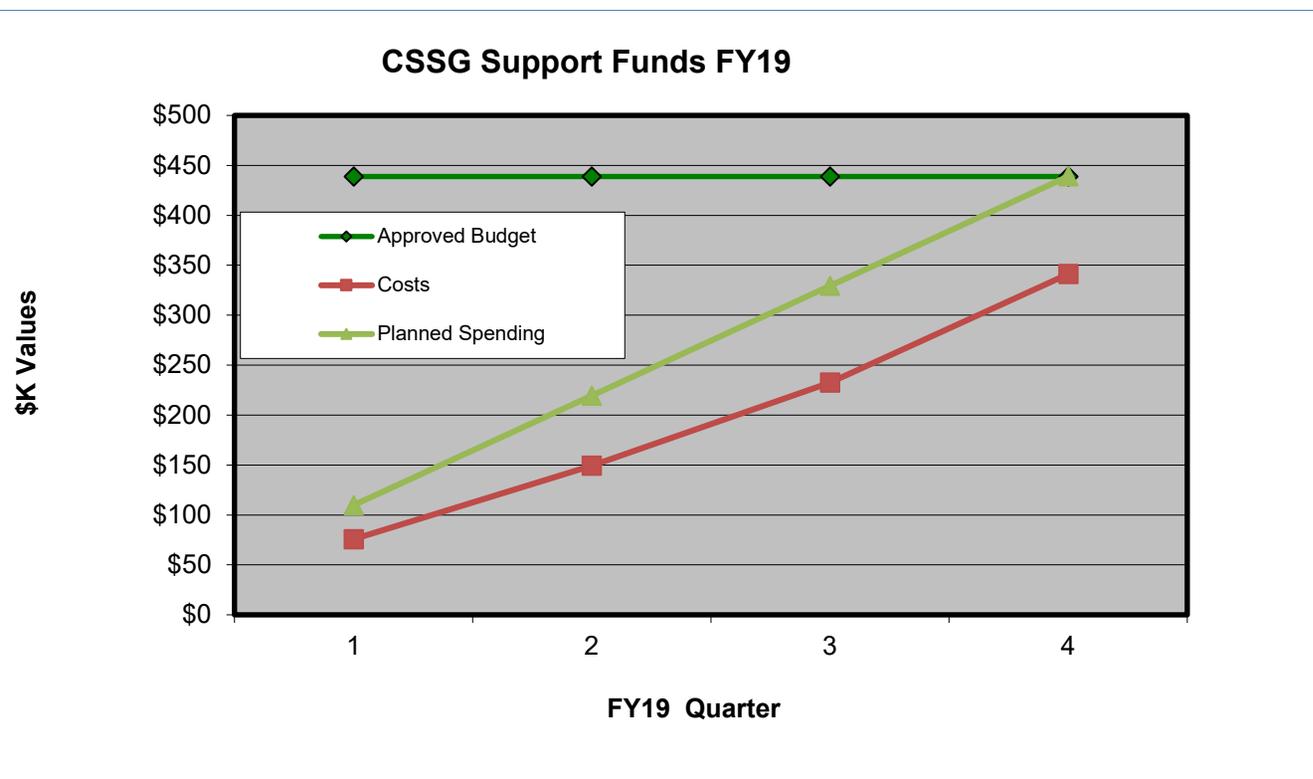
Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	NONE		n/a
Q2	NONE		n/a
Q3	NONE		Summer student has arrived, work on rewriting the Atlas analysis codes has begun!
Q4	Provide NCSP Manager annual report of succession planning efforts.		Atlas electronic files have significant number of errors and typos. With our API we have identified many of them. We are considering whether to issue an erratum for the Atlas.

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: TS1 Task Title: CSSG Support M&O Contractor Name(s): AECOM, ANL, LANL, LLNL, PNNL, SRNS, Y-12 Point of Contact Name: David Hayes (CSSG Deputy Chair) Point of Contact Phone: 505-667-4523</p>	<p>Reference: B&R DP 0909010 Date of Report: October 18, 2019</p>
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BUDGET	MAJOR ACCOMPLISHMENTS
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- Support of NPO Assessment
- Regular CSSG Telecons

1. Carryover into FY 2019 = \$k 48.8
2. Approved FY 2019 Budget = \$k 468.8 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$k 76
4. Actual spending for 2nd Quarter FY 2019 = \$k 74
5. Actual spending for 3rd Quarter FY 2019 = \$k 83
6. Actual spending for 4rd Quarter FY 2019 = \$k 109
7. Projected carryover into FY 2020 = \$k 98

NCSP Quarterly Progress Report (FY-2019 Q4)

CSSG TS Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide the NCSP manager with a summary of CSSG activities, meetings, and tasks. (TS1)		
Q2	Provide the NCSP manager with a summary of CSSG activities, meetings, and tasks. (TS1)		
Q3	Provide the NCSP manager with a summary of CSSG activities, meetings, and tasks. (TS1)		
Q4	Provide the NCSP manager with a summary of CSSG activities, meetings, and tasks. (TS1)		 Tasking 2019-01 input provided on FY20 proposals. Need to close the task

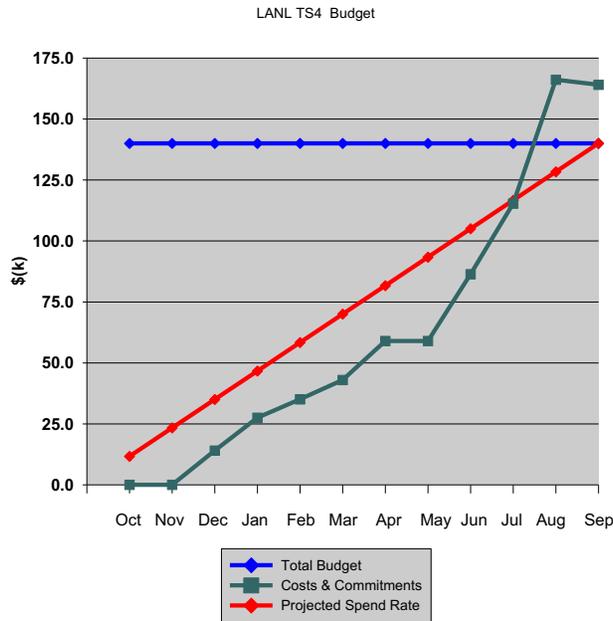
NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element: LANL TS4
Task Title: AM, IE, ND Succession Planning
M&O Contractor Name: Los Alamos National Laboratory (LANL)
Point of Contact Name: Brian Bluhm
Point of Contact Phone: (505) 667-2440

Reference: B&R DP0909010
 Date of Report: October 16, 2019

BUDGET

MAJOR ACCOMPLISHMENTS



- Completed Report of Succession Planning Efforts for FY19.

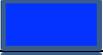
- Carryover into FY 2019 = \$ 0
- Approved FY 2019 Budget = \$ 140K
- Actual spending for 1st Quarter FY 2019 = \$14.0K
- Actual spending for 2nd Quarter FY 2019 = \$29.0K
- Actual spending for 3rd Quarter FY 2019 = \$43.2K
- Actual spending for 4th Quarter FY 2019 = \$77.2K
- Projected carryover into FY 2020 = \$

NCSP Quarterly Progress Report (FY-2019 Q4)

LANL TS4 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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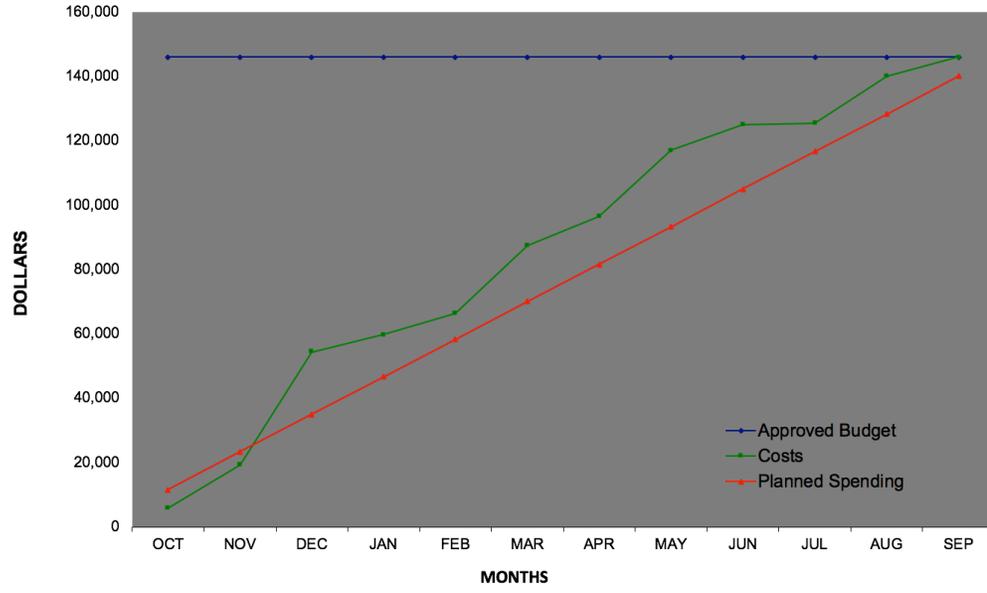
QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	NONE		
Q2	NONE		
Q3	NONE		
Q4	Provide NCSP Task Manager annual report of succession planning efforts.		

NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element and Subtasks: TS5
Task Title: LLNL Succession Planning
M&O Contractor Name: Lawrence Livermore National Laboratory
Point of Contact Name: David Heinrichs
Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010
Date of Report: October 18, 2019

BUDGET



1. Carryover into FY 2019 = \$6,086
2. Approved FY 2019 Budget = \$146,086 (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$54,353
4. Actual spending for 2nd Quarter FY 2019= \$33,114
5. Actual spending for 3rd Quarter FY 2019 = \$37,533
6. Actual spending for 4rd Quarter FY 2019 = \$21,086
7. Projected carryover into FY 2020 = \$0 (0%)

MAJOR ACCOMPLISHMENTS

1. Shauntay Coleman attended ICNC in Paris, France, on September 15-20, 2019, and presented *Validation of MCNP6.1 and MCNP6.2 Using ENDF/B-VII.1 Nuclear Data for Criticality Safety Application to Plutonium and Highly Enriched Uranium Systems*. (AM)
2. Jesse Norris attended ICNC in Paris, France, on September 15-20, 2019, and presented *Critical Experiment Design Using Optimus*. (AM, IE)
3. Daniel Siefman (PhD, École Polytechnique Fédérale de Lausanne, Switzerland) has accepted a Postdoc position within the LLNL Nuclear Criticality Safety Division starting October 14, 2019. (IE, ND)
4. Will Zywiec provided ‘university pipeline’ instruction in criticality safety at the University of California, Berkeley, Nuclear Engineering Department in September 2019. (T&E)
5. Jesse Norris attended the “hands-on” portion of the two-week CSE course at NCERC in August 19-23, 2019. (T&E)
6. LLNL posted open PD, TSS.1, and TSS.2/3 positions on <https://jobs.llnl.gov>.

NCSP Quarterly Progress Report (FY-2019 Q4)

LLNL TS5 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	NONE		
Q2	NONE		
Q3	NONE		
Q4	Provide NCSP Manager annual report of succession planning efforts.		Reported in QPRs for Q1, Q2, Q3, and Q4.

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtasks: NNL TS9 Task Title: NNL – Support for NDAG Chair activities M&O Contractor Name: NNL Point of Contact Name: Mike Zerkle Point of Contact Phone: (412) 476-6188</p>	<p style="text-align: right;">Reference: B&R DP0909010 Date of Report Oct 17, 2019</p>																																																				
<p>BUDGET</p>	<p>MAJOR ACCOMPLISHMENTS</p>																																																				
<table border="1"> <caption>Budget Data (Estimated from Graph)</caption> <thead> <tr> <th>Month</th> <th>Approved Budget</th> <th>Planned Spending</th> <th>Costs</th> </tr> </thead> <tbody> <tr><td>Oct</td><td>37,000</td><td>3,000</td><td>5,000</td></tr> <tr><td>Nov</td><td>37,000</td><td>6,000</td><td>9,000</td></tr> <tr><td>Dec</td><td>37,000</td><td>9,000</td><td>9,000</td></tr> <tr><td>Jan</td><td>37,000</td><td>12,000</td><td>9,500</td></tr> <tr><td>Feb</td><td>37,000</td><td>15,000</td><td>9,500</td></tr> <tr><td>Mar</td><td>37,000</td><td>18,000</td><td>11,500</td></tr> <tr><td>Apr</td><td>37,000</td><td>21,000</td><td>12,500</td></tr> <tr><td>May</td><td>37,000</td><td>24,000</td><td>14,500</td></tr> <tr><td>Jun</td><td>37,000</td><td>27,000</td><td>19,000</td></tr> <tr><td>Jul</td><td>37,000</td><td>30,000</td><td>19,500</td></tr> <tr><td>Aug</td><td>37,000</td><td>33,000</td><td>22,000</td></tr> <tr><td>Sep</td><td>37,000</td><td>37,000</td><td>27,000</td></tr> </tbody> </table>	Month	Approved Budget	Planned Spending	Costs	Oct	37,000	3,000	5,000	Nov	37,000	6,000	9,000	Dec	37,000	9,000	9,000	Jan	37,000	12,000	9,500	Feb	37,000	15,000	9,500	Mar	37,000	18,000	11,500	Apr	37,000	21,000	12,500	May	37,000	24,000	14,500	Jun	37,000	27,000	19,000	Jul	37,000	30,000	19,500	Aug	37,000	33,000	22,000	Sep	37,000	37,000	27,000	<ol style="list-style-type: none"> 1. Participated in July 2019 NCSP Budget Execution Meeting. 2. Participated in Sep 2019 DOE NDWG Meeting (LANL). Discussed preparations and planning for LANL 35Cl(n,p) cross section measurement. 3. Participated in Sep 2019 ICNC-2019 Conference (Paris). Authored paper on legacy Bettis HEU solution critical. <ol style="list-style-type: none"> a. M. L. Zerkle and S. N. Bauer, "Solution Critical Experiments Partially Reflected by Lucite," Proc. ICNC-2019, Paris, France, September 15-20, 2019. 4. CEEdT process support as NDAG Chair and CEEdT Team Member for several IERs.
Month	Approved Budget	Planned Spending	Costs																																																		
Oct	37,000	3,000	5,000																																																		
Nov	37,000	6,000	9,000																																																		
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Jun	37,000	27,000	19,000																																																		
Jul	37,000	30,000	19,500																																																		
Aug	37,000	33,000	22,000																																																		
Sep	37,000	37,000	27,000																																																		
<p>Carryover into FY 2019 = \$8k</p> <ol style="list-style-type: none"> 1. Approved FY 2019 Budget = \$37k (includes carryover) 2. Actual spending for 1st Quarter FY 2019 = \$9k 3. Actual spending for 2nd Quarter FY 2019 = \$3k 4. Actual spending for 3rd Quarter FY 2019 = \$8k 5. Actual spending for 4rd Quarter FY 2019 = \$8k 6. Projected carryover into FY 2020 = \$10k (35%) 																																																					

NCSP Quarterly Progress Report (FY-2019 Q4)

NNL TS9 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide the NCSP manager with a summary of NDAG chair activities, meetings, and tasks. (TS9)		
Q2	Provide the NCSP manager with a summary of NDAG chair activities, meetings, and tasks. (TS9)		
Q3	Provide the NCSP manager with a summary of NDAG chair activities, meetings, and tasks. (TS9)		
Q4	Provide the NCSP manager with a summary of NDAG chair activities, meetings, and tasks. (TS9)		

NCSP Quarterly Progress Report (FY-2019 Q4)

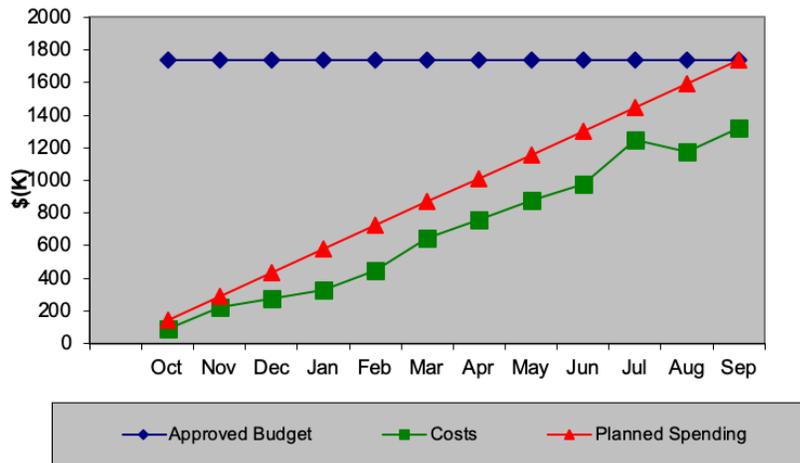
NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Development), TS11 (CEdT Manager Support)
 M&O Contractor Name: ORNL
 Point of Contact Name: Doug Bowen
 Point of Contact Phone: (865) 576-0315

Reference: DP0909010/ORNL
 Date of Report: October 11, 2019

BUDGET

MAJOR ACCOMPLISHMENTS

FY19 NCSP Technical Support



1. Carryover into FY 2019 = \$613K; FY 2020 = \$413K
2. Approved FY 2019 Budget = \$ 1737K (includes carryover)
3. Actual spending for 1st Quarter FY 2019 = \$275K
4. Actual spending for 2nd Quarter FY 2019 = \$369K
5. Actual spending for 3rd Quarter FY 2019 = \$335K
6. Actual spending for 4rd Quarter FY 2019 = \$345K

TS2

- Prepare and maintain elements of NCSP Plan and associated activities:
 - Monitor Five-Year Plan progress,
 - Review/revise task list, and
 - Schedule/participate in meetings and teleconferences.
 - Manage and provide oversight/coordinate efforts for the NCSP Information, Preservation, and Dissemination task element.
 - Manage and provide oversight/coordinate efforts for the NCSP Training and Education Program task element.
- Participated in NCSP management team and other NCSP-related meetings, as required by the NCSP Manager.
- Prepared Q3 QPRs into a single bookmarked PDF file for use in QPR. Conducted Q2 telecon. Started to compile Q4 QPRs.
- Prepared final drafts of an NCSP newsletter
- Participated in CSSG telecons and assisted with CSSG tasks as necessary. Bowen supported CSSG tasking 2018-01 CSO course baseline and developed and completed the CSO course development plan. Course materials are ready for review.
- Finalized efforts to improve documentation of NCSP accomplishments to ensure NCSP work is linked to final 5YP milestones. Lori Scott has created new quarterly reporting templates for distribution to the site task managers.
- Led and participated telecons and WebEx meetings as necessary to track NCSP MGT team actions and deliverables.
- Started the process to populate the NDA website (<http://nda.llnl.gov>) with materials to support the NDA Technical Infrastructure Project.
- Main 5-year plan was completed on schedule (rev. 0) and revised (rev. 1). due to some late FY19/20 G2 funds transfers from MSTs to other sites (LANL, LLNL). The IE section was drafted and sent out for review. Comments incorporated by the end of FY19. New IERs were added to the IER database for tracking in FY20.
- Prepared for the ICSBEP meeting. Bowen/Marshall are both on the ICSBEP review team and started to review TEX and KRUSTY evaluations to prepare for the meetings in Paris in October at OECD/NEA.
- Bowen hired Marsha Henley at ORNL to assist with high-level NCSP tasks as necessary in Q4.

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Development), TS11 (CEdT Manager Support) M&O Contractor Name: ORNL Point of Contact Name: Doug Bowen Point of Contact Phone: (865) 576-0315</p>	<p>Reference: DP0909010/ORNL Date of Report: October 11, 2019</p>
	<p>TS7</p> <ul style="list-style-type: none">• Chris Chapman continued to work on nuclear data evaluations with Vlad Sobes and Marco Pigni for Ce and V nuclear data evaluations. Chris is also working on thermal neutron scattering measurements at the ORNL SNS. Andrew Holcomb continued working on tasks to utilize SAMMY and AMPX for NCSP projects. Jesse Brown has been utilizing these funds to train on GELINA and RPI nuclear data measurements alongside Klaus Guber. <p>TS8</p> <ul style="list-style-type: none">• ORNL continued work on an initial prototype of a new NCSP Program Management Tool that should be completed in FY20 Q1. Bowen supported multiple meetings in person and via WebEx with G2 programmers to discuss desired IER database features for the late FY2019 G2 campaign. This has been an extensive effort. <p>TS11</p> <ul style="list-style-type: none">• ORNL lead a face-to-face IE meeting at LANL. An IE telecon was conducted in FY19 Q4. Due to DAF issues, IE work at NCERC was significantly affected.• The CE_{EDT} manager tracked IER products and Baseline Change Reviews and worked with the NCSP manager to approve tasks, as required.• Bowen, Scott, and Miller worked to prepare the IER prioritization spreadsheets for each site with IER work for 5-year plan (IE section) planning.• Bowen worked with Miller (Sandia) in Q4 to continue transition efforts, although Doug still needed to lead CEDT efforts. and interacting with the task managers.

NCSP Quarterly Progress Report (FY-2019 Q4)

ORNL TS Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Manage C _{Ed} T process and coordinate execution of planned IERs each FY. (TS2)		
	Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization effort by the NCSP Management Team. (TS2)		
	Provide the NCSP manager with a summary of NCSP IE task TS11 as described in the task description. (TS11)		
Q2	Manage C _{Ed} T process and coordinate execution of planned IERs each FY. (TS2)		
	Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization effort by the NCSP Management Team. (TS2)		
	Provide the NCSP manager with a summary of NCSP IE task TS11 as described in the task description. (TS11)		
Q3	Manage C _{Ed} T process and coordinate execution of planned IERs each FY. (TS2)		
	Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization effort by the NCSP Management Team. (TS2)		

NCSP Quarterly Progress Report (FY-2019 Q4)

	Provide the NCSP manager with a summary of NCSP IE task TS11 as described in the task description. (TS11)		
Q4	Manage C _e dT process and coordinate execution of planned IERs each FY. (TS2)		
	Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization effort by the NCSP Management Team. (TS2)		
	Provide the NCSP manager with a summary of NCSP IE task TS11 as described in the task description. (TS11)		
	Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY. (TS2)		
	Publish final Five-Year Plan. (TS2)		
	Provide NCSP Manager annual report of succession planning efforts. (TS7)		
	Provide NCSP Manager a status report of progress on the development of a program management tool. (TS8)		

NCSP Quarterly Progress Report (FY-2019 Q4)

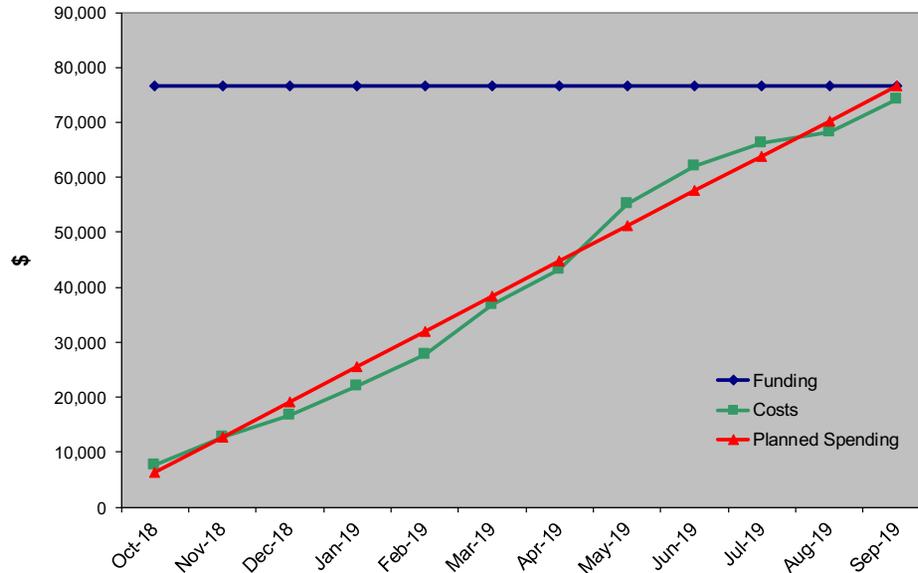
NCSP Element: SNL TS3
Task Title: Support for Experimentalist Succession Planning
M&O Contractor Name: Sandia National Laboratories (SNL)
Point of Contact Name: Gary A. Harms
Point of Contact Phone: (505)845-3244

Reference: B&R DP 0909010
Date of Report: September 30, 2019

BUDGET

MAJOR ACCOMPLISHMENTS

Sandia NCSP Task TS-3 – Secure the Future of the SCX



1. Carryover into FY 2019 = \$1,682
2. Approved FY 2019 Budget = \$75,000 (new) + \$1,682 (carryover) = \$76,682
3. Actual spending for 1st Quarter FY 2019 = \$16,753
4. Actual spending for 2nd Quarter FY 2019 = \$20,018
5. Actual spending for 3rd Quarter FY 2019 = \$25,363
6. Actual spending for 4th Quarter FY 2019 = \$11,956
7. Projected carryover into FY 2020 = \$2,592

- We have a matrixed employee who is being trained as an experimenter.
- The new experimenter has completed the documentation of the IER-451 experiments. The evaluation LEU-COMP-THERM-099 that documents the experiments in the ICSBEP Handbook.
- The new experimenter has taken the lead role on the CEdT for IER-230.
- The new experimenter has been actively participating in the NCS community by attending conferences and publishing papers.
- We have hired a nuclear engineering graduate intern from Missouri S&T to develop knowledge and participate in Sandia's process for performing integral experiments.

NCSP Quarterly Progress Report (FY-2019 Q4)

SNL TS3 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	NONE		
Q2	NONE		
Q3	NONE		
Q4	Provide NCSP Manager annual report of succession planning efforts.		

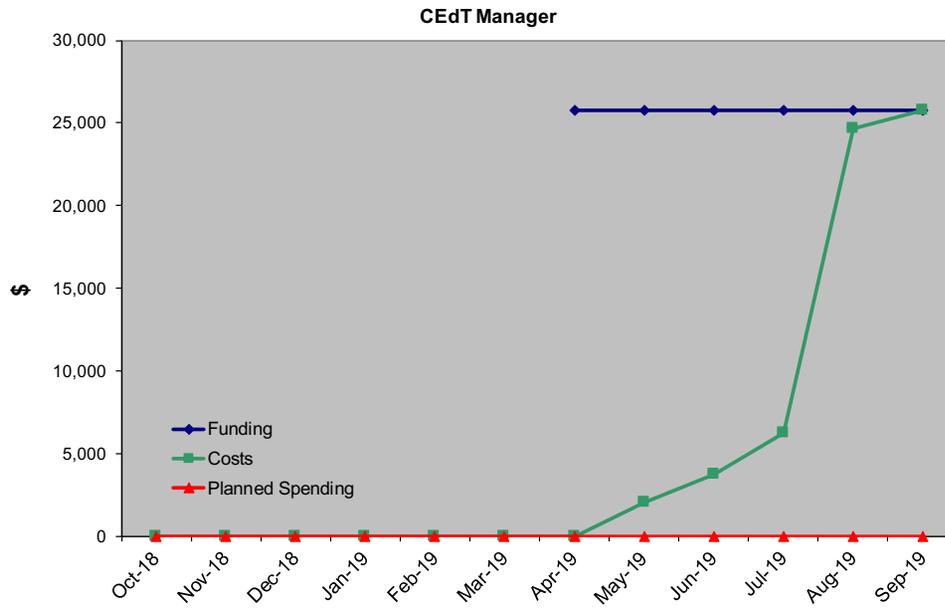
NCSP Quarterly Progress Report (FY-2019 Q4)

NCSP Element: SNL TS
Task Title: C_{Ed}T Manager
M&O Contractor Name: Sandia National Laboratories (SNL)
Point of Contact Name: Gary A. Harms
Point of Contact Phone: (505)845-3244

Reference: B&R DP 0909010
Date of Report: September 30, 2019

BUDGET

MAJOR ACCOMPLISHMENTS



- A Sandia employee is spinning up as the C_{Ed}T manager.

1. Carryover into FY 2019 = \$0
2. Approved FY 2019 Budget = \$25,758 (from IE carryover)
3. Actual spending for 1st Quarter FY 2019 = \$0
4. Actual spending for 2nd Quarter FY 2019 = \$0
5. Actual spending for 3rd Quarter FY 2019 = \$3,690
6. Actual spending for 4th Quarter FY 2019 = \$25,758
7. Projected carryover into FY 2020 = \$0

NCSP Quarterly Progress Report (FY-2019 Q4)

SNL TS Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	NONE		
Q2	NONE		
Q3	NONE		
Q4	NONE		

NCSP Quarterly Progress Report (FY-2019 Q4)

<p>NCSP Element and Subtasks: Y12 TS10 Task Title: TPR and Foreign Travel M&O Contractor Name: Y12 Point of Contact Name: Kevin Reynolds Point of Contact Phone: (865) 241-9067</p>	<p style="text-align: right;">Reference: B&R DP0909010 Date of Report: October 25, 2019</p>
BUDGET	MAJOR ACCOMPLISHMENTS
<div style="text-align: center;"> <p>Y-12 Budget/Incurred Costs</p> <p>Dollars</p> <p>Month</p> <p>— FY19 Budget + Carryover — Planned Spending — Actual Costs</p> </div> <ol style="list-style-type: none"> 1. Carryover into FY 2019 = \$0 2. Approved FY 2019 Budget = \$35k (includes carryover) 3. Actual spending for 1st Quarter FY 2019 = \$0 4. Actual spending for 2nd Quarter FY 2019 = \$13,174.34 5. Actual spending for 3rd Quarter FY 2019 = \$41,562.16 6. Actual spending for 4rd Quarter FY 2019 = \$36,400.76 7. Projected carryover into FY 2020 = \$0.00 (overspent by \$56,137.26) 	<ul style="list-style-type: none"> • Q1: Abstracts for ICNC drafted and submitted for two papers to be presented in support of NCSP funding. • Q1: TPR arrangements begun (ongoing) • Q2: TPR planning complete and meeting held at Pantex • Q3: TPR complete – no actions • Q3: ICNC2019 foreign travel for Kevin Reynolds, Travis Wilson and Kristen Wessels being entered. • Q4: Attended ICNC 2019 (Kevin Reynolds, Kristen Wessels, and Travis Wilson). Travis won best oral presentation for a young engineer at the meeting.

NCSP Quarterly Progress Report (FY-2019 Q4)

Y12 TS10 Milestones:

STATUS (copy color code and paste below in 'STATUS' field)

Complete 	On Schedule 	Behind Schedule 	Missed Milestone 
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QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports all TPR hosting activities in NCSP Quarterly Progress Reports. (TS10)		
Q2	Provide status reports all TPR hosting activities in NCSP Quarterly Progress Reports. (TS10)		Original budget was for TPR and 2 trips to ICNC 2019. I believe Angela approved a third trip (Kristen Wessels) and so we will need additional funds to cover this trip. TPR was under budget by almost \$6k
Q3	Provide status reports all TPR hosting activities in NCSP Quarterly Progress Reports. (TS10) – only if still applicable		Account overspent due to adding third ICNC trip. Original budget was for 2 persons to travel to ICNC.
Q4	Provide status reports all TPR hosting activities in NCSP Quarterly Progress Reports. (TS10) – only if still applicable		Account overspent – I have asked for details associated with Q3 and Q4 costs to determine how much was travel and how much was TPR (maybe some was incorrect charging?).
	Provide Foreign Trip Report for ICNC. (TS10)		

Summary of MCNP Criticality Classes in FY 2019

F.B. Brown, M.E. Rising, J.L. Alwin
Monte Carlo Methods, Codes, & Applications Group (XCP-3), LANL

FY2019 – Q4 classes are highlighted in red.

Total Students

- FY2019 – Q4: 54 students (SU, Crit, UNM, Intro, Intermed classes)
- FY2019 – all: 193 students (SU, Crit, UNM, Intro, Intermed classes)

Classes sponsored by DOE-NNSA-NCSP

- **Sensitivity-Uncertainty Tools & Practices for NCS Validation (LANL-TE4)**
 - May 15 & 16, 2019, Hanford & PNNL 17 students
 - **July 8, 2019, LANL – NCS group 15 students (local class, mcnp-whisper)**

This is a joint effort between LANL & ORNL, covering background material and specific usage of MCNP6-Whisper and SCALE-KENO-TSUNAMI-TSURFER. D. Bowen coordinates scheduling at DOE sites.

- **Criticality Calculations with MCNP6 (LANL-AM1)**
 - Mar 18-22, 2019, LANL, 7 students
 - May 6-9, 2019, Sandia, 17 students
 - **Aug 5-9, 2019, LANL, 10 students**
 - Oct 21-24, 2019, Y-12, scheduled

MCNP criticality class for NCS & reactor physics practitioners, with focus on best practices. Includes 1 day on NCS validation using MCNP6-Whisper. For classes at LANL, NCSP-sponsored students do not pay registration fees. For classes at other DOE sites, there are no registration fees.

- **Monte Carlo Techniques for Nuclear Systems (LANL-AM1)**
 - **Aug 24 – Dec 6, 2019, UNM, 18 students**

This is a 1-semester class for senior undergrads & graduate students at the University of New Mexico. Required for UNM graduation in Nuclear Engineering. Includes Monte Carlo theory & practical use of MCNP6. Several of the students are part of the LANL NCS intern program. (This teaching is partially supported by NCSP, ASC, and other programs.)

Other Classes

- **Introduction to MCNP6**
 - Dec 3-7, 2018, LANL, 15 students
 - Mar 4-8, 2019, LANL, 15 students
 - Apr 1-5, 2019, OECD-NEA, Paris, 7 students
 - June 3-7, 2019, LANL, 15 students
 - June 17-21, 2018, LANL, 15 students
 - **July 29 – Aug 2, 2019, LANL, 11 students**
 - Oct 21-25, 2019, LANL, scheduled

Standard introductory class, includes 1/2 day on criticality calculations (without coverage of NCS validation using mcnp6-whisper). Classes are supported by student registration fees.

- **Intermediate MCNP6**
 - Mar 11-15, 2019, LANL, 15 students
 - Apr 8-12, 2019, OECD-NEA, Paris, 16 students
 - Oct 7-11, 2019, OECD-NEA, Paris, scheduled
 - Oct 28 – Nov 1, 2019, LANL, scheduled

Classes are supported by student registration fees.

2019 Q4 – SCALE Training Courses Report for the Nuclear Criticality Safety Program

<u>Class Name</u>	Best Practices in Modeling and Simulation of Nuclear Materials for Nuclear Safeguards Practitioners
<u>Class Dates</u>	August 12 – 15, 2019
<u>Location</u>	Oak Ridge, TN
<u>Number of Attendees</u>	19: 3 IAEA staff, 3 from international research institutions, 2 university professors, 5 graduate students, 2 undergraduate students and 4 ORNL staff.
<u>Short Description</u>	This was a four day hands-on training course offered by ORNL to provide instruction on best practices for M&S of nuclear materials to solve problems specific to nuclear safeguards.
<u>Sponsor</u>	NA-241, Office of International Nuclear Safeguards

<u>Class Name</u>	ORIGEN Training on Spent Nuclear Fuel Inventory Reporting
<u>Class Dates</u>	September 9 – 17, 2019
<u>Location</u>	Institute of Nuclear Physics in Tashkent, Uzbekistan
<u>Number of Attendees</u>	8
<u>Short Description</u>	Assist the Institute of Nuclear Physics staff on use of SCALE/ORIGEN software for calculating the spent fuel inventory for their research reactor and capture the required information on the Inventory Change Report for submission to the International Atomic Energy Agency.
<u>Sponsor</u>	NA-241, Office of International Nuclear Safeguards

STATUS REPORT

on the

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

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	Task Title	DOE Reference	FY 2019 IRSN Contribution	IRSN Technical POC	DOE Technical POC	DOE LAB
Analytical Methods						
IRSN-AM15	MCNP Maintenance and Support / Uncertainty Analysis Development / Modernization / etc.	LANL-AM1	Interest for uncertainty analysis, source convergence development and modernization strategy	E. DUMONTEIL	F. BROWN	LANL
<p>Q2: Theoretical modeling of variance to mean ratio and spatial correlation of critical and under-critical systems with intrinsic sources.</p> <p>Q3: End of theoretical modeling of uncertainties with intrinsic sources</p> <p>Q4: presentation at OECD/NEA/SG6 and ICTT 2019 + exchanges with Forrest at this time. Iteration with Forrest over the finalization of the EGAMCT report.</p>						
IRSN-AM16	Multi-Physics Methods for Simulation of Criticality Excursions	LLNL-AM2	Technical exchanges on the proposed multiphysics tasks for simulating criticality excursions.	M. DULUC	D. HEINRICHS	LLNL
<p>Task not started.</p> <p>To be deleted from the list of IRSN contributions.</p>						
IRSN-AM1	Validation and qualification methods	ORNL-AM2 ORNL-IPD4	Covariance matrices establishment of the selection of Integral Experiments	I. DUHAMEL	D. BOWEN B. REARDEN	ORNL
<p>This task was initiated in the frame of the OECD/NEA UACSA expert group. Experimental correlations were established for LCT007 and LCT039 – need to contact Brad Rearden to discuss about the experiments of interest for the FY2019.</p> <p>Q4: no progress. IRSN proposal to work on experimental correlations of MIRTE 1 experiments but a lot of discussions about the calculations of experimental correlations on the SG1 subgroup of the OCDE/AEN/WPNCS Will also be discussed at the ICSBEP meeting in October 2019</p>						
IRSN-AM3	Monte Carlo & sensitivity calculations	ORNL-AM2	Technical exchanges on sources convergence issues, sensitivity coefficients calculations and kinetics parameters calculations	B. DECHENAUX	D. BOWEN B. REARDEN	ORNL
<p>No action is planned. This task should be removed from future planning in view of the departure of original contributors from both parties.</p> <p>Task completed.</p>						
IRSN-AM5	Update of the slide rule	ORNL-AM6 LLNL-AM3 AWE-AM1	Subtask 2 of IRSN proposal Update of the “slide rule” for the rapid response estimation of a criticality accident (using COG, MCNP, MAVRIC, ATTILA...)	M. DULUC	D. BOWEN D. HEINRICHS C. WILSON	ORNL LLNL AWE
<p>Q2: Report published.</p> <p>The next step will be in particular the number of fissions estimate (meeting about this subject during the TPR meeting, Amarillo).</p>						
IRSN-AM7	ACE QA testing and implementation	LANL-AM2	Implementation of the defined QA tests in ACeTk and integration in GAIA	L. LEAL	J. CONLIN	LANL
<p>Report provided by LANL to IRSN by Wim Haeck with detailed descriptions.</p>						
IRSN-AM8	Analytical Methods Working Group	NCSP-TS2	IRSN participation to NCSP analytical methods Working Group and IRSN participation to TPR meeting	S. EVO	F. BROWN D. BOWEN	NCSP
<p>Q2: IRSN participation in AMWG and TPR meeting in March 2019 at Pantex Plant.</p>						

	REFERENCE		IRSN Contribution / POC			
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IRSN-AM9	Cross sections processing validation	ORNL-AM3	Development of an interface between GAIA and AMPX and test interface capabilities. AMPX training desired by IRSN staff in FY2019.	R. ICHOU	D. WIARDA D. BOWEN	ORNL
Tool for generating AMPX multigroup cross section library with DRAGON. Task needs completion. Possibility of an AMPX training course?						
IRSN-AM13	Benchmark intercomparison study	LLNL-AM5 ORNL-AM10 LANL-AM5	Definition of common set of developed benchmark models Calculations for Pu and HEU systems. (Completion of this task before ORNL-AM9 and LANL-AM4 would be useful to identify common benchmarks.)	I. DUHAMEL	D. HEINRICHS D. BOWEN F. BROWN	LLNL ORNL LANL
IRSN-AM13 in progress –Results from different labs collected – preliminary analyses done → feedback on COG and MORET input decks – common paper for ICNC (abstract submitted) Q2: preliminary analyses presented at TPR meeting in March 2019 – common paper planned for ICNC 2019 Q3: common paper was submitted at ICNC conference (accepted) and at ANS winter meeting (pending notification) Q4: presentation at ICNC and common paper for ANS winter meeting – KENO results with ENDF/B-VIII.0 were received ; MCNP results with ENDF/B-VIII.0 and feedback on identified errors are waiting.						
IRSN-AM14	Sensitivity/Uncertainty comparison study with a focus on Upper Subcritical Limits	ORNL-AM9 LANL-AM4	Definition of three test cases Calculations and intercomparison technical report	I. DUHAMEL	F. BROWN D. BOWEN	LANL ORNL
In progress – LANL and ORNL results are available Q2 : technical exchanges during AM meeting in March Q3: a new release of MACSENS is available and new results will be provided soon Q4 MACSENS calculation in progress						
IRSN-AM17	Technical Data for the Pitzer Formulation of Solution Compositions to Include Uranium/Plutonium Solutions with Selected Admixed Absorbers	ORNL-AM16 LANL-AM6 LLNL-AM7	Contribution to measurements definition. Comparison of density laws (isopiestic law for instance)...	N. LECLAIRE	D. BOWEN	ORNL
Measurements should have been performed last autumn 2018. IRSN contacted Jennifer Alwyn and the measurements were not performed due to budget issues. Pending resolution of these issues, the action could be performed in 2019-2020. Plutonium sulfate densities should be retrieved from US laboratories and a comparison could be done with plutonium nitrate densities. It is also planned to make density vs temperature measurements. Action to be revived when measurements planned.						
Integral Experiments						
IRSN-IE1 IER 184	TEX - Ta experiment	LLNL-IE4	Sensitivity/uncertainty calculations Contribution to the evaluation of the first experiments.	M. BROVCHENKO	C. PERCHER	LLNL
IRSN is involved in TEX program since the beginning in 2011 and participated in the kick-off meeting. IRSN is part of the CED team and review the CED reports. In addition, in 2014 and 2015, IRSN performed sensitivities calculations on the designed configurations for TEX-Ta experiments. Regular VTC were organized to discuss the status of experiments. IRSN participated at the 2 last experiments in NNSS and will be involved in the ICSBEP evaluation in 2019 as independent reviewer. Q4: IRSN contributed to the ICSBEP evaluation as the independent reviewer						
IRSN-IE3 IER 209	New 7uPCX experiment	SNL-IE1	Contribution to ICSBEP reevaluation.	N. LECLAIRE	G. HARMS	SNL
These experiments were finally not presented at the October 2018 meeting						

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But they will be presented at the ICSBEP 2019 meeting. IRSN is the independent reviewer.						
IRSN-IE6 IER 306	Rh foils experiment	SNL-IE1	IRSN proposal: preliminary evaluation of experimental uncertainties prior to the experiment's CED-2 report.	N. LECLAIRE	G. HARMS	SNL
CED 1 report has been sent to the NCSP team review and is also in the IRSN validation process and will be issued in October 2019. Preliminary effects on keff of experimental uncertainties have been calculated and will be added in the CED-2 report in 2019. (supported by a sub-contract) Comments from Gary Harms, David Ames, Mike Zerkle, Dave Heinrichs (NCSP team) have been received and have been already taken into account (zoom on figures, editorial, new configurations).. Technical issues with respect to the use of Al-clad rods in nitrate solutions and with the diameter of Rh sleeves were raised. Zircaloy sleeves or recladding of 7uPCX rods should be planned. Investigation of a rhodium block should also be envisioned. Additional configurations are therefore planned and will be added in the CED-2 report.						
IRSN-IE7 IER 305	Mo foils and rods experiment	SNL-IE1	IRSN proposal: Leading the CED-3a report; Supplying the Mo rods for the experiment.	N. LECLAIRE	G. HARMS	SNL
The CED-2 report has been postponed to the end of 2019. As a consequence, this task should not be totally done in 2019. We looked at potential suppliers for the Mo sleeves and estimated the costs. However, we waited for the CED-2 report to be finished before proceeding to the supplying of sleeves.						
IRSN-IE8 IER 451	Ti experiment	SNL-IE1	Analysis of the experiments Comparison with MIRTE program	N. LECLAIRE	G. HARMS	SNL
The independent review of experiments was done for the ICSBEP October 2018 meeting. The experiments were calculated with MORET 5. Some comparisons of sensitivity profiles were expected with the sensitivity obtained with TSUNAMI. In addition, we also planned to compare them with the sensitivities obtained for the MIRTE experiments. A feedback on titanium cross sections was also provided (prior and posterior uncertainty analysis using GLLSM). These tasks were subject to a subcontract beginning in May 2019, which is now finished. A report from the subcontractor was issued. IRSN planned to deliver its own report no later than at the end of 2019.						
IRSN-IE11 IER 297	TEX - Hf experiment	LLNL-IE4	Contribution to Jemima plates characterization. Contribution to CED report.	M. BROVCHENKO	C. PERCHER	LLNL
IRSN was involved in the review of the CED2 report and provide some sensitivity calculations to LLNL. The status of the program has been discussed regularly during VTC until 2017 with LLNL. On stand-by, waiting from execution of baseline experiments planned in FY2020						
IRSN-IE15 IER 253	International intercomparison exercise using FLATTOP	LLNL-IE1 AWE-IE3	Participation in the design, contribution to the experiments with IRSN materials, and the report.	M. DULUC F. TROMPIER	D. HEINRICHS C. WILSON	LLNL AWE
Exercise done in May 2018. Report released. No further action.						
IRSN-IE19	Solution reactor	Y12-IE2	Strong IRSN interest for participation in the design, specification... of a solution reactor	M. DULUC	P. ANGELO	Y-12
Task started. A first contact with Peter Angelo. Reports about the CRAC and SILENE review sent to NCSP.						
IRSN-IE25 IER 296	TEX - MOX experiment	LLNL-IE4	IRSN leads this proposal for design and will author the CED-1 & 2 reports with LLNL support. Characterization of moderator and reflector plates. IRSN contribution to the moderator and reflector plates funding.	M. BROVCHENKO	C. PERCHER	LLNL
Design optimization for TEX-MOX ongoing. (Supported by sub-contracts in 2018 and 2019) CED1 report is on-going and will be sent soon to the CED team						

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IRSN-IE26 IER 295	TEX - Iron experiment	LLNL-IE4	Contribution to the experiments design. Contribution to CED reports and review.	M. BROVCHENKO	C. PERCHER	LLNL
This task is on stand-by for NCSP						
IRSN-IE27 IER 175	GODIVA CAAS benchmark	ORNL-IE4	Participation in the design. Provide IRSN materials for irradiation, analysis of results.	M. DULUC	D. BOWEN	ORNL
Task not started. Q3: A first contact with Doug BOWEN and Riley CUMBERLAND.						
IRSN-IE28 IER 406	Cf-252 CAAS benchmark	LLNL-IE1	Participation in the design. Provide IRSN materials for irradiation, analysis of results	M. DULUC F. TROMPIER	D. HEINRICHS	LLNL
Discussion in progress to perform additional measurement in 2019.						
IRSN-IE29	Correction factor for dosimetry linked to the orientation of the victim	LLNL-IE1 AWE-IE7	Participation in the design. Provide IRSN materials for irradiation, analysis of results.	M. DULUC F. TROMPIER	D. HEINRICHS C. WILSON	LLNL AWE
Task not started						
IRSN-IE30	Full dosimetry exercise around GODIVA/FLATTOP reactors	LLNL-IE1	Participation in the design. Provide IRSN materials for irradiation, analysis of results	M. DULUC F. TROMPIER	D. HEINRICHS	LLNL
Task not started						
IRSN-IE33	Sodium activation experiment around GODIVA/FLATTOP	LLNL-IE1	Participation in the design. Provide IRSN materials for irradiation, analysis of results	M. DULUC F. TROMPIER	D. HEINRICHS	LLNL
Task not started						
IRSN-IE34	HEU critical and Subcritical measurements	LANL-IE23	Participation in the definition and the design of the experiment	W. MONANGE	J. HUTCHINSON	LANL
Q3: Task in progress. IRSN's simulations in progress.						
IRSN-IE35 IER 434	Godiva benchmark for time dependent code validation	LANL-IE3	Participation in the preliminary design and CED-1 report.	M. DULUC	J. GODA	LANL
Task not started						
IRSN-IE36	ICSBEP Shielding benchmarks for shipping containers	LLNL-IE13 AWE-IE8	Participation in the preliminary design and CED-1 report	M. DULUC	D. HEINRICHS C. WILSON	LLNL AWE
Task not started						
IRSN-IE37	Critical and subcritical measurements with a Zero-Power research reactor (On going task)	LANL-IE21	Analysis of the experiments, participation in the final technical report.	E. DUMONTEIL	J. HUTCHINSON	LANL
Q2: End of Nick Thompson postdoc at IRSN. The work on error bars estimation on power and positions has mostly been achieved. Simulations with intrinsic sources are on-going. Q3: Simulations with intrinsic sources are still ongoing (problem with HPC at IRSN) and should be done by end of august 2019. The writing of the paper is ongoing (end of theory and experimental sections by end of July 2019 and end of numerical section by end of september 2019). Q4: Discussion at OECD/NEA with the NEN2 group to define an experimental setup to measure correlations vs decoupling. Delay (problems with HPC at IRSN still make it difficult to finish the simulation program) => end of analysis foreseen by the end of Q4						

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IRSN-IE39	Thermal/Epithermal Experiments (TEX) Plutonium Experiments at Low Temperatures	LLNL-IE19	Participation in experiments design and CED reports. To be discussed with LLNL.	M. BROVCHENKO	D. HEINRICHS	LLNL
Task not started. Discussions during October 17 meeting at IRSN. IRSN will be part of the CeD team						
IRSN-IE40	CAAS performance testing	LLNL-IE21	Participation in testing activities. Provide IRSN materials and French CAAS probes. To be discussed with LLNL.	M. DULUC	D. HEINRICHS	LLNL
Task not started						
IRSN-IE41	Thermal/Epithermal Experiments (TEX) with Chlorine and Lithium	LLNL-IE23	Participation in experiments design and CED reports. To be discussed with LLNL.	M. BROVCHENKO	D. HEINRICHS	LLNL
Task not started. Discussions during October 17 meeting at IRSN. IRSN will be part of the CeD team						
IRSN-IE42	Neptunium Subcritical Observations (NeSO) experiment	LANL-IExx	Participation in experiments and independent review of the ICSBEP evaluation.	W. MONANGE	J. HUTCHINSON	LANL
Q2: Participation to the experiments. Independent review of the ICSBEP evaluation?						
Information Preservation and Dissemination						
IRSN-IPD1	ICSBEP reviewing	LLNL-IPD1	IRSN ICSBEP reviewing tasks are reported in the IE tasks	I. DUHAMEL	D. HEINRICHS	LLNL
ICSBEP reviews of SCRAP, ISSA and titanium experiments in October 2018 – Review of TEX-Ta done for October ICSBEP 2019 meeting						
IRSN-IPD3	ICSBEP benchmark reviewing	LLNL-IPD1	IRSN ICSBEP reviewing tasks	I. DUHAMEL	J. FAVORITE	LANL
Not started – waiting for FLATTOP re-evaluation						
Nuclear Data						
IRSN-ND1	Contribution to new evaluations	ORNL-ND1	Contribution to new evaluation and validation for ⁵⁴ Fe, ¹⁰³ Rh, ⁵⁵ Mn and Gd isotopes	L. LEAL	D. BOWEN	ORNL
¹⁰³ Rh resolved evaluation completed. Progress on the ⁵⁴ Fe and ⁵⁶ Fe and preliminary resonance evaluation generated. IRSN benchmark assembled for testing the ⁵⁵ Mn evaluation. New capture data from NTOF included in the Gd-155 and Gd-157 evaluation. Improved Gd resonance parameters available. Q2: Paper on Gd for ND2019 conference. Generation of covariance data for ^{155,157} Gd.						

	REFERENCE		IRSN Contribution / POC			
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Q3: Testing of the Gd evaluation has started; The Fe resonance evaluation continue						
IRSN-ND2	Nuclear data processing	LANL-ND1	Benchmark testing of ²³⁵ U and ²³⁹ Pu cross section library	L. LEAL	J. CONLIN	LANL
<p>Test performed and new ²³⁵U and ²³⁹Pu resonance parameters generated.</p> <p>Benchmark testing on the ²³⁵U and ²³⁹Pu underway. Sensitivity analysis of the benchmark results will be done</p> <p>Q3: Abstract submitted to Physor 2020;</p> <p>New Pu239 capture data measured at LANL by Shea Mosby included in the evaluation;</p> <p>Testing of the evaluation on the TEX eperiments are under way</p>						
IRSN-ND3	Nuclear data processing	LLNL-ND4	Resonance evaluation of ²³³ U (Pending prioritization of ²³³ U ND tasks for the NCSP)	L. LEAL	D. HEINRICHS	LLNL
<p>Existing resonance evaluation extended to 2 keV. New resonance parameters derived.</p> <p>New ²³³U fission and capture cross section data from n_TOF may become available shortly. The data will be incorporate in the evaluation and benchmark testing will be performed</p>						
Training and Education						
IRSN-TE1	Hands-on criticality safety training	ORNL-TE1 LANL-TE3 LLNL-TE1 SNL-TE1	IRSN attendance to NCSP classes. Possible lectures by IRSN working with NCSP training and education coordinator.	S. EVO	D. BOWEN	NCSP
2 IRSN staff attending the hands-on training in January 2019.						