NUCLEAR CRITICALITY SAFTEY PROGRAM (NCSP)

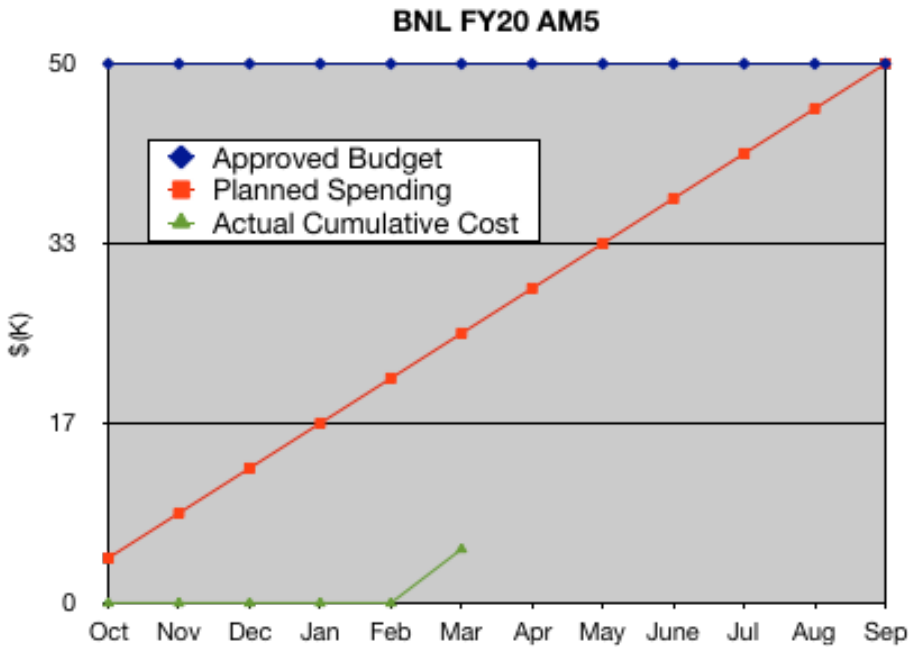
FY2020 2ND QUARTER REPORTS

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: Analytical Methods AM5
Task Title: FUDGE Generation of a Complete ENDF/B-VIII.0 Library for Testing in Production Codes
M&O Contractor Name: BNL
Point of Contact Name: David Brown
Point of Contact Phone: 631-344-2814

Reference: DP 0902000
Date of Report: May 5, 2020

BUDGET



1. **Carryover into FY 2020** = $ 0
2. **Approved FY 2020 Budget** = $ 50,000
3. **Actual spending for 1st Quarter FY 2020** = $0
4. **Actual spending for 2nd Quarter FY 2020** = $5000
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $0

ACCOMPLISHMENTS

FUDGE has support for the full GNDS-1.9 specification, including thermal neutron scattering (TNS) data and unresolved resonance (URR) probability tables. FUDGE has demonstrated the ability to process TNS and the processed data has been used in LLNL simulations along with results from a preliminary implementation of the URR probability tables. We are now working on finalizing the FUDGE treatment of URR probability tables.

NCSP Quarterly Progress Report (FY-2020 Q2)

BNL ND Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide a status report on completing an ENDF/B-VII.0 library with FUDGE. (AM5)		
Q2	Provide a status report on completing an ENDF/B-VII.0 library with FUDGE. (AM5)		
Q3	Provide a status report on completing an ENDF/B-VII.0 library with FUDGE. (AM5)		
Q4	Provide a status report on completing an ENDF/B-VII.0 library with FUDGE. (AM5)		

NCSP Quarterly Progress Report (FY-2020 Q2)

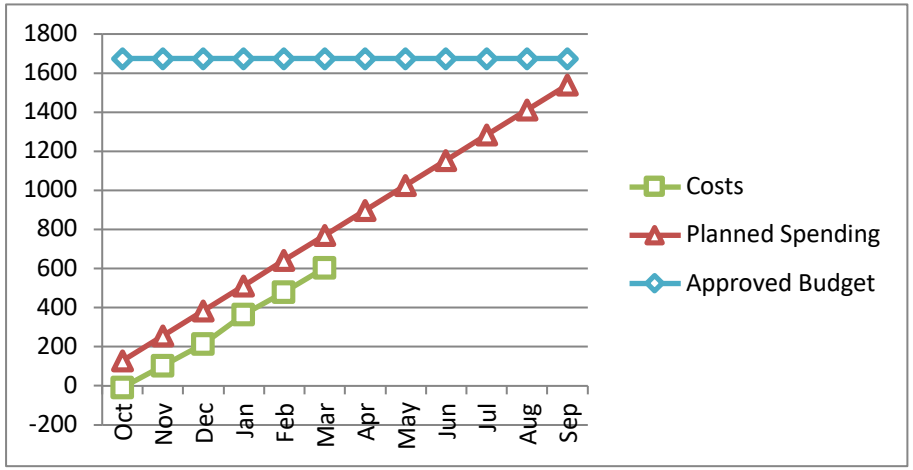
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**	**no**	
Q2	**N/A**	**no**	
Q3	**N/A**	**no**	
Q4	**N/A**	**no**	
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**	No	
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: AM1, 2, 4, 5, 7
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

Reference: B&R DP0902000
Date of Report: May 5, 2020

BUDGET



1. **Carryover into FY 2020 = $0**
2. **Approved FY 2020 Budget = $1,675,000 (includes carryover)**
3. **Actual spending for 1st Quarter FY 2020 = $216,459**
4. **Actual spending for 2nd Quarter FY 2020 = $386,988**
5. **Actual spending for 3rd Quarter FY 2020 = $**
6. **Actual spending for 4rd Quarter FY 2020 = $**
7. **Projected carryover into FY 2021 = $135,000**

MAJOR ACCOMPLISHMENTS

AM-1 (MCNP)

- Our detailed MCNP class report is provided separately. As highlights, we taught both an Introductory and a Criticality class on-site before shutdown. As some upcoming classes have been cancelled, we prototyped an on-line MCNP class during April for Los Alamos students.
- We have merged the new methods for automated acceleration and convergence testing into MCNP6.3, which is now included as part of all XCP-3 distributions.
- Supported MCNP users through MCNP Forum, MCNP web site, email, direct interactions, etc.
- Several presentations were made during TPR week:
  - Forrest Brown, "Automatic Acceleration & Convergence Testing for MC NCS Calculations," (AMWG)
  - Forrest Brown, Mike Rising, Jen Alwin, Chris Perfetti, and Todd Palmer, "Analytical Methods Work (LANL AM-1) in FY2019 to Support NCSP," (TPR)
  - Michael E. Rising, "MCNP Modernization Status," (TPR)
  - Bob Little, "Summary of MCNP Classes in FY 2019," (TPR)
- Updated MCNP Thermal Scattering Library:
  - New and innovative tests have been developed for thermal scattering verification
  - New write-up is being prepared
  - Plots of thermal scattering cross sections are being made
  - All reported problems with the ENDF/B-VIII.0 library have been addressed
  - All ENDF/B-VIII.0 thermal scattering files have been reprocessed

AM-2 (NJOY)

- A presentation was made during TPR week:
  - Jeremy L. Conlin, "NJOY Modernization and Support," (TPR)

- NJOY2016: 3 updates were released in Q2:
  - 2016.54 which corrects an issue due to zero atomic mass ratio values for non-photon particles in MF6
  - 2016.55 which corrects an issue resulting in a corrupted ACE file when the incident particle type is not present in the MF6 MT22 section.
  - 2016.56 improves the plots coming out of ACER following corrections performed by the consistency checks. Parts of the output routines were also rewritten to provide locator checks to better detect corrupted ACE files
  - A total of nine issues were opened in Q2; three were closed (resolved).
- NJOY21: Work on development of modern RECONR continues (leveraged with ASC funding)
  - Linearization of cross sections works
  - LRF-7 capabilities are nearing completion
  - ENDFtk updates to handle unresolved resonances
  - Still on track to deliver modern RECONR by Q4 of FY20
- NJOY21: THERMR modernization is also nearing completion (MIT). Looking to have modernized THERMR and LEAPR integrated into NJOY21 by Fall of 2020.

AM-4 (S/U Comparison Study)

- A presentation was made during TPR week:
  - J. Alwin, F. Brown, J. Clarity, I. Duhamel, L. Leal, R. Little, B. J. Marshall, M. Rising, E. Saylor, K.Spencer, "Sensitivity/Uncertainty Comparison Study with a Focus on Upper Subcriticality Limits" (AMWG)
- We are on track to the meet the Q4 milestone.

AM-5 (Benchmark Comparison Study)

- We have finished a report and are in the process of obtaining an LA-UR: J. Alwin, K. Spencer, F. Brown, I. Duhamel, M. Rising, "LANL Critical Benchmark Comparison Study and Subsequent Revision."
- We have also developed a procedure for review/revision of benchmark models and begun incorporating revised benchmarks into a git repository.

AM-7 (University of Michigan)

- This is a new start in FY20 "Incorporation of Benchmark Experiment Correlations into the Whisper Nuclear Criticality Safety Software." AM-7 is a University Project at the University of Michigan. LANL procurement is

	behind on issuing the contract; we will therefore slip the AM-7 milestones each by two quarters.

NCSP Quarterly Progress Report (FY-2020 Q2)

LANL AM Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	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)		
	Provide MCNP6 Criticality training course (AM1)		
	Continue to distribute MCNP6 with automated acceleration and convergence testing to NCSP early-adopters and collect feedback (AM1)		
	Obtain (University of Michigan) Whisper and explore various approaches for the effective sample size (AM7)		As indicated above, due to delays in LANL procurement, we will need to slip the University of Michigan AM-7 milestones each by two quarters.
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)		

NCSP Quarterly Progress Report (FY-2020 Q2)

	Report on LANL XCP-3, LANL NCS, & IRSN collaboration on detailed differences found in ICSBEP Benchmark Comparison Study (AM5)		
	Provide status of all MCNP6 and Whisper progress at the NCSP Technical Program Review (AM1)		
	Implement the selected effective sample size method into Whisper (AM7)		As indicated above, due to delays in LANL procurement, we will need to slip the University of Michigan AM-7 milestones each by two quarters.
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)		
	Provide training module on the use of MCNP6 unstructured mesh for CAAS analysis (AM1)		
	Issue an MCNP V&V report, including MCNP6 automated acceleration and convergence (AM1)		
	Perform Whisper calculations demonstrating the impact of benchmark experiment correlations on results. (AM7)		
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)		

	Demonstrate modernized ACER capabilities for processing fast neutron files with NJOY21 (AM2)		
	Modernize and implement PURR capabilities in NJOY21 (AM2)		
	Issue report on detailed review, comparisons, and updates to the Sensitivity-Uncertainty Comparison Study (AM4)		
	Provide MCNP6 Criticality training course (AM1)		
	Document and release beta versions of ENDF/B-VIII.1 evaluations in ACE format on LANL website (AM1)		
	Deliver final modified version of Whisper to LANL with an ANS conference paper to disseminate the work (AM7)		
	Process ENDF/B-VIII.1 beta evaluations in ACE format for internal testing at LANL (AM1)		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	OECD/NEA Paris, France May-20 AM2 Attend annual WPEC meeting and associated Sub-Group meetings (Conlin, Haeck) Contributor to multiple sub-groups-Conlin co-leads SG43; Haeck leads SG45.		
	Cambridge, England Apr-20 AM2 IE3 Attend PHYSOR 2020 meeting of the ANS. NCSP task that travel is performed under: LANL AM2 (Conlin, McKenzie, Hutchinson) Present NJOY updates and improvements Present research results.		
	Vienna, Austria TBD-date AM2 Consultancy meeting at IAEA (Conlin, Haeck) Participate in IAEA consultancy meeting on ACE processing		
	OECD/NEA Paris, France Jul-20 AM1 OECD Expert Group Meetings for NCSP, collaboration with IRSN on NCS (Brown, Rising) Participation provides state-of-art information for improving MCNP®, Whisper, and other computational methods		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**

NCSP Quarterly Progress Report (FY-2020 Q2)

Q1	Foreign trip report from the ICNC 2019 Conference & OECD-NEA-WPNCS Subgroup Meetings, held in Paris, France, 15-27 September 2019.	Yes	
Q1	D.H. Timmons, M.E. Rising, C.M. Perfetti, "The Use of MCNP 6.2 KCODE for High Fidelity, Near Critical Benchmarks" (M&C 2019)	Yes	Submitting with Q2 reports
Q1	P. Grechanuk, M.E. Rising, T.S. Palmer, "Identifying Sources of Bias from Nuclear Data in MCNP6 Calculations Using Machine Learning Algorithms" (M&C 2019)	Yes	
Q1	P.A. Grechanuk, M.E. Rising, and T.S. Palmer, "Comparing the Whisper Validation Methodology with Machine Learning Methods" (ICNC)	Yes	
Q1	B. Merryman, F. Brown, J. Alwin, and C. Perfetti, "Investigating Region-Wise Sensitivities for Nuclear Criticality Safety Validation" (ICNC)	Yes	Submitting with Q2 reports
Q2	J. Alwin, F. Brown, J. Clarity, I. Duhamel, L. Leal, R. Little, B. J. Marshall, M. Rising, E. Saylor, K. Spencer, "Sensitivity/Uncertainty Comparison Study with a Focus on Upper Subcriticality Limits" (AMWG)	Yes	
Q2	J. Alwin, K. Spencer, F. Brown, I. Duhamel, M. Rising, "LANL Critical Benchmark Comparison Study and Subsequent Revision."	No	Waiting for LA-UR; will submit during Q3
Q2	Forrest Brown, "Automatic Acceleration & Convergence Testing for MC NCS Calculations," (AMWG)	No	Will submit during Q3
Q2	Forrest Brown, Mike Rising, Jen Alwin, Chris Perfetti, and Todd Palmer, "Analytical Methods Work (LANL AM-1) in FY2019 to Support NCSP," (TPR)	N/A	Already posted on NCSP / TPR Web Page
Q2	Jeremy L. Conlin, "NJOY Modernization and Support," (TPR)	N/A	Already posted on NCSP / TPR Web Page
Q2	Michael E. Rising, "MCNP Modernization Status," (TPR)	N/A	Already posted on NCSP / TPR Web Page
Q2	Bob Little, "Summary of MCNP Classes in FY 2019," (TPR)	N/A	Already posted on NCSP / TPR Web Page
Q3			
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

AM7 Incorporation of Benchmark Experiment Correlations into the Whisper Nuclear Criticality Safety Software

LA-UR-19-20522
Approved for public release; distribution is unlimited.

Title: The Use of MCNP 6.2 KCODE for High Fidelity, Near Critical Benchmarks

Author(s): Timmons, Daniel
Rising, Michael Evan
Perfetti, Christopher M.

Intended for: M&C 2019, INTERNATIONAL CONFERENCE ON MATHEMATICS AND COMPUTATIONAL METHODS APPLIED TO NUCLEAR SCIENCE AND ENGINEERING, 2019-08-25/2019-08-29 (Portland, Oregon, United States)

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The Use of MCNP 6.2 KCODE for High Fidelity, Near Critical Benchmarks

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INTRODUCTION

[1]MCNP® has been used for many years to determine the criticality of a wide variety of nuclear systems prior to performing an experiment for the same system. The two main methods for running the MCNP code are the fixed source method and the KCODE method. The fixed source method can be slow when the K_{eff} is close to 1.000 and may even run indefinitely for systems with eigenvalues of greater than 1.000. This is only a problem when running MCNP using the fixed source method, as the KCODE approach renormalizes the number of fission sites to be sampled after each generation. With the newest update to MCNP, version 6.2, the use of higher fidelity fission models was added when running the fixed source method [1].

The MNCP 6.2 release has incorporated three higher fidelity fission models. These three models are Fission Reaction Event Yield Algorithm (FREYA), Cascading Gamma-Ray Multiplicity Fission (CGMF), and the Lawrence Livermore National Laboratories (LLNL) Fission Library. These new features are limited to the use of running MCNP with the fixed source method, as the physics is handled differently than in the KCODE case. In this work MCNP 6.2 was modified to allow for the use of these higher fidelity fission models while running the KCODE method in MNCP. This allows for shorter runtimes for subcritical systems that are nearly critical. This work will verify the implementation of these features by simulating models of several subcritical systems and computing several detector quantities using the new KCODE approach and the previous fixed-source approach.

The International Criticality Safety Benchmark Project (ICSBEP) is the standard for critical benchmarks and has recently incorporated benchmark specifications for several subcritical systems. These subcritical benchmarks specify detector response values as the benchmarked quantity, and are simulated here using the MCNP fixed source method [2]. Many of these subcritical cases are close to critical and, as noted above, the closer the system is to critical, the longer the runtime using the fixed source method. In contrast, using the KCODE approach produces runtimes that are less dependent of the system's criticality.

The main methodology modifications, aside from modifying the MCNP 6.2 source code to allow for the use of these higher fidelity fission models, involve how the neutron flight time is calculated in MCNP. MCNP writes these flight times to a PTRAC file, which is used to track position of absorption, energy, material of absorption, and more important to this paper, the time of flight of the neutrons. The flight time is calculated differently depending on which mode (i.e. fixed source or KCODE) MCNP uses. The differences in these methods leads to a difference in the resulting times that MCNP writes to the PTRAC file, and thus different simulated detector responses.

BACKGROUND

A plutonium sphere with various nickel-based reflectors surrounding was analyzed and placed into the list of approved ICSBEP benchmarked cases. This model includes 7 cases of varying nickel reflector size analyzed at 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 inches. The eigenvalue varies from the bare plutonium sphere to the 3.0 inch nickel reflected sphere, which affects the fixed-source mode runtime for each case. For example, the third case, the 1.0 inch reflector, had run time for the fixed source method of 45 minutes with a K_{eff} of 0.86420; case seven, the 3.0 inch case, had a run-time of 111 minutes with a K_{eff} of 0.94521. These calculations were performed using MCNP 6.2's fixed source method using the LLNL Fission Library for several fissile nuclides, prompt neutron energies, prompt neutron directions, prompt neutron fission multiplicity, and spontaneously fissioning nuclides.

In order to properly to match these benchmarks using the KCODE method it is of importance that the LLNL Fission Library be available for use in KCODE mode. Although KCODE does not allow for spontaneous fission, these events represent a small fraction of all fission events, and therefore the LLNL Fission Library's induced fission physics are used for all fission events. Since MCNP's code changes allow the LLNL Fission Library to run in KCODE calculations

[1]MCNP® and Monte Carlo N-Particle® are registered trademarks owned by Triad National Security, LLC, manager and operator of Los Alamos National Laboratory. Any third party use of such registered marks should be properly attributed to Triad National Security, LLC, including the use of the ® designation as appropriate. For the purposes of visual clarity, the registered trademark symbol is assumed for all references to MCNP within the remainder of this paper.

is the same as that for FREYA and CGMF, both the FREYA and CGMF fission models can be used for KCODE calculations.

FREYA was developed at LLNL as a way to quickly model the physics of fission events with a high degree of fidelity. This is achieved as FREYA determines the mass split of the compound nucleus, which is obtained from experimental mass yields. After determining the mass of the fission products, FREYA then determines how much energy will be allotted to emission of post fission radiation, samples experimental data using an allotted amount of energy, then subtracts the energy of the prompt fission neutron from the total available energy of the fission fragment. This is repeated until the fission fragment is below a threshold energy, normally set to 10 keV. FREYA then emits gammas based on experimental data [3].

CGMF uses a slightly more complex scheme to determine which particles (neutron or gamma ray) are emitted and then determines all appropriate physics for that particle using empirical data and models. CGMF then removes that particles physics energy from the total available. CGMF then repeats this process until there is no energy left [4]. It is worth noting that CGMF runs 1000 times slower than FREYA, and therefore was not included in this paper's analysis.

The LLNL Fission Library includes more fissile nuclides and more detailed prompt fission spectra than the ENDF data used by MCNP and therefore can be used for higher fidelity modeling [5]. This is significant because as most of the events for the subcritical benchmarks will be fission and therefore the higher fidelity model will give a noticeable, albeit small, change to the times for the neutrons written to the PTRAC file. It is of note that there are small, system dependent, differences in the overall K_{eff} between the FREYA, CGMF, The LLNL Fission Library, and standard MCNP 6.2 models. Also, the average fission multiplicity and prompt neutron energy spectrum are slightly different between each approach [6][7]. This difference will be represented in the output MCNP writes to the PTRAC file.

In a PTRAC file, MCNP calculates the time stamp for each neutron differently based on which method (KCODE or fixed source) is chosen. The fixed source case measures the time from when the neutron was created to when it reaches the final location, which may include any number of fissions in between. The KCODE case however, only measures the time from the start of a history in one generation to the birth of daughter neutrons in the next generation. The runtime increase for the fixed source method occurs because it must track all daughter particles in a fission chain before it can simulate the next fixed-source history; in contrast, the KCODE approach need only simulate one generation of neutrons at a time.

When using the KCODE method, MCNP only records the time from the start to the end of the current neutron history, restarting the neutron time of flight data every generation. In contrast, the fixed source case counts the total travel time for all neutrons in a fission chain relative to the birth of the first neutron in that chain. Therefore, the times for the fixed source case represent the true times of flight for neutron histories and fission chains, while the times written using the KCODE method for MCNP 6.2 only reflect interactions in a single generation. Thus, modifying the KCODE's approach for tracking timeline of a particle's events was the second major modification to MCNP made by this work. A simple approach (and the one that was ultimately pursued by this study) to modify this KCODE method's data was to do so as a part of the post processing of results after the MCNP simulations are finished. There is no drawback to this method if the required parameters, as noted within the ICSBEP benchmark report, are matched.

A normal distribution was chosen to modify the data post MCNP run to make the data match that of the ICSBEP benchmark. A mean of 300 seconds was chosen because it was the mean of the fixed source method's time data. The variance is rather large, at 100 seconds, chosen such that three standard deviations encompassed all possible times. This was only done when the KCODE method was used to get PTRAC time data. As noted, the KCODE case does not model spontaneous fission while the fixed source case does. The simulation results with spontaneous fission are small, and can be compensated for by the even distribution spread of neutrons while running enough neutron events, and therefore spontaneous fission are ignored when trying to match the ISCBEP benchmark values.

These ICSBEP benchmarks for subcritical cases examine three values to judge the accuracy of a code: the singles count rate, the doubles count rate, and the multiplication leakage. The singles count rate is the measure of the expected number of one neutron counts within a user defined gate-width as measured by a detector. The doubles count rate is the expected number of more than one count at a given detector inside the chosen gate-width of the detector. The multiplication leakage is the number of neutrons created that reach a detector per source neutron emitted. These values are experimentally determined and different for each case. It can be seen in Ref. [2] that for all cases MCNP matches the experimental results for the multiplication leakage, singles count

rate, and doubles count rate, within a few standard deviations.

The calculation of the singles count rate, doubles count rate, and multiplication leakage show some obvious trends. The singles count rate is calculated using the first reduced factorial moment divided by the gate-width. The doubles count rate requires the second reduced factorial moment, the first reduced factorial moment, and is divided by the gate-width. The multiplication leakage is dependent on the first through fourth reduced factorial moment, and the gate-width [2]. The reduced factorial moments, mathematical concepts unique to each system used to define aspects of a distribution, are for the time data that is written in the PTRAC file. It is significant that all the data depends heavily on the gate-width and therefore, that changing the gate-width would change all measured data. Another noted trend was that the number of events written to the PTRAC file correlates directly with the singles count rate. Therefore, using the KCODE method, the best way to change the singles counts rate is to change the number of histories run or the number of particles per generation. This change will also change the doubles count rate, and the multiplication leakage, but to a smaller degree. However, there are several other ways to change the three benchmarked values that were explored.

There are several variables that may be changed in the analysis of the each of these cases:

- Gate-Width, which is used to determine the time cutoff between when a count is received, and when a second count received would count as a double count. Three realizations of used in this study: 1024 µs, 2048 µs, and 128 µs.
- The offset time, which is used to correct for the experiment's time not starting exactly at zero. This will change all the time data by a given number of nanoseconds and will change all lower three benchmarked values as it is increased. This was assumed to be zero.
- The number of cases analyzed, which is given to be 100 cases based on the ICSBEP MCNP inputs, changes the number of events that produce data written to a PTRAC file.
- The dead-time of the detector, which is a function of the type of detector used and is provided in the ICSBEP specifications to be 4000 ns. The dead time will have a relatively small effect on the results for the three benchmarked parameters.

RESULTS

Three cases were simulated using the modified version of MCNP 6.2 and were run using the KCODE method. The single count rate, doubles count rate, and multiplication leakage from the simulations were compared with reference values from the ICSBEP benchmark specifications. These results are compared in Table 1. It is of note that Case 2 and Case 3 used 1024µs gate-width. While Case 7 was found using a 128µs gate-width.

MCNP Results	**Singles**	**Doubles**	**Multiplication**
Case 2	12285(10)	4002(13)	4.58(8)
Case 3	15054(7)	7465(16)	5.46(1)
Case 7	25803(30)	34338(173)	8.912(22)
ICSBEP Results			
Case 2	12269(4)	3993(15)	4.55(2)
Case 3	15107(4)	7460(24)	5.42(3)
Case 7	25514(8)	34101(79)	8.28(3)

Table 1 Comparison of Benchmark Data to KCODE Produced Data

Changing the gate-width, although mostly effective, is not the most desirable method for matching the three benchmarked values as this prevents the application of this method universally. This is the case because there are three gate-widths described in the ICSBEP paperwork and the one that must be used must be found prior to using the KCODE method on an unknown case. Case Seven's singles count rate and multiplications leakage not close to the benchmark values. It is also of note that none of singles count rates matched that of the benchmark cases. Therefore, more work on the time modifying algorithm is needed to find a method that will work for all cases and for all events.

The amount of time it took to run each case using the KCODE method depended on the number of histories and the number of neutrons per history. Both variables are also important to the number of events that MCNP writes to the PTRAC file. The amount of PTRAC events for the KCODE method will not match that of the fixed source case exactly, but by directly changing the number of active histories and the number of events written to the PTRAC file it was found that a KCODE simulation using 567 active generations with 20000 neutrons per history lead to roughly the same number of events written to the PTRAC file as a fixed-

source simulation using roughly 10635240 total histories run.

As shown in Table 2, running MCNP in KCODE mode significantly reduced the runtime for each of the three cases.

	KCODE	**Fixed Source**
Case 2	38.7	43.6
Case 3	49.8	45.2
Case 7	67	111

Table 2 Comparison of Runtimes (minutes) for a Single MCNP Event

The amount of time that was saved by running Case 2 was 4.9 minutes (11%) per case with a K_{eff}=0.85420(12). The amount of time that was saved by running Case 3 was 5.4 minutes (12%)per case with a K_{eff}=0.86420(18). The runtime decrease was larger, as expected, for Case 7. Case 7 has a 44 minute (40%) runtime decrease per MCNP run, with 100 MCNP total runs performed. This had an overall run-time decrease for Case 7 of 440 minutes at a K_{eff} of 0.94521(20). Comparing Case 3 to Case 7, showed that Case Seven's run-time decrease was eight times larger for an 11$ change in the reactivity.

CONCLUSION

It has been shown that it is possible to match several, but not all, of the measured subcritical multiplication benchmark quantities by incorporating high-fidelity fission physics models into MCNP. Further work is required on the time of flight-modifying algorithm to prevent having to change the gate-width for each specific system being evaluated by MCNP. This change to the algorithm will allow this method to be used on cases with unknown singles count rates, doubles count rates, and multiplication leakages. The KCODE method still proved to be faster than the fixed source method, especially when the 100 cases were run, which is what is used to get the ISCBEP benchmark.

This work has demonstrated a significant runtime decrease by using the MCNP KCODE approach. This runtime decrease occurred for all three cases, with the largest runtime decrease occurring for Case 7, whose eigenvalue was closest to critical. It was shown that at most a one third runtime decrease occurred for the roughly ten dollar subcritical case, showing promise that this method will be of even faster for systems closer to criticality once the time algorithm has been properly adjusted.

ACKNOWLEDGEMENTS

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INVESTIGATING REGION-WISE SENSITIVITIES FOR NUCLEAR CRITICALITY SAFETY VALIDATION

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ABSTRACT

Criticality safety analysts estimate Upper Subcriticality Limits (USLs) for subcritical systems to account for biases and errors in modeling and simulation tools and to ensure that conditions calculated to be subcritical will actually be subcritical This study investigates the application of the MCNP6-Whisper [1,2] calculational methods to estimate USLs for loosely-coupled systems comprised of two units and makes use of a new MCNP6 capability that allows for the calculation of multiple region-dependent sensitivity profiles in a single calculation [3]. MCNP6 can compute the region-wise sensitivity profiles for each unit, as influenced by the leakage of the other unit, and the sensitivity profile of the overall loosely-coupled system. This investigation deliberately focused on USL estimates for small, simple systems to highlight physical and computational issues associated with these types of systems. Three basic highly enriched uranium (HEU) and plutonium components are used in the loosely-coupled models in this study: bare fast metal sphere, water-reflected fast metal sphere, and thermal solution. These three different units are paired in various combinations, and the MCNP6-Whisper calculations are performed using both the new region-wise sensitivity profile capability and the conventional overall sensitivity profile capability. This study evaluates the Whisper-selected benchmark rankings and calculated baseline USL values for each calculated sensitivity profile at each separation distance for each application model.

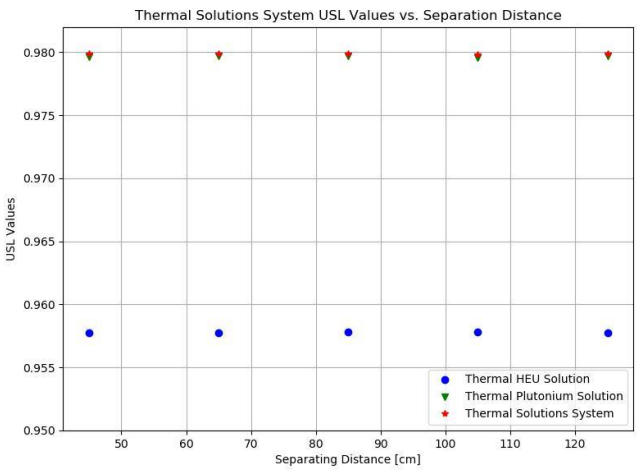

Figure. 1 Thermal Solution System's baseline USL values as a function of unit separation distance.

The thermal solution model baseline USL values determined by Whisper are of great interest, as seen in Figure 1. The USL values for the overall application model closely match the USL values for the thermal plutonium solution assembly, leading to nonconservative USL values for the overall application model.

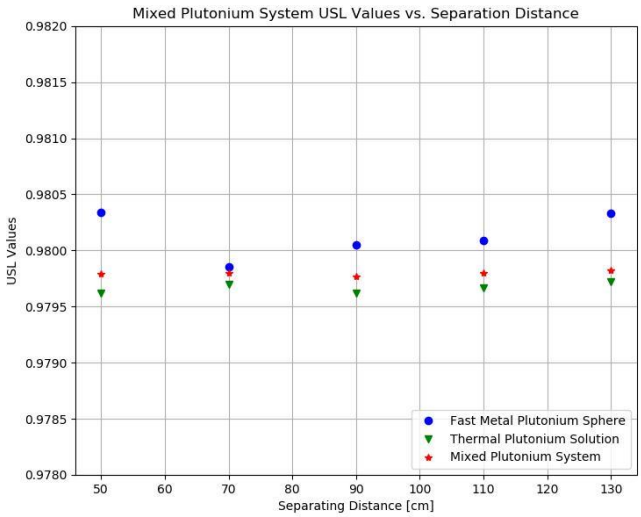

Figure 2. Mixed Plutonium System's baseline USL values versus unit separation distance.

Table I. Benchmark rankings for Fast Metal Plutonium Unit in Mixed Plutonium Unit

Fast Metal Plutonium Assembly	Separation Distance [cm]				
Benchmark Ranking	50	70	90	110	130
1	pmf-044-004.i	pmf-042-002.i	pmf-044-004.i	pmf-044-004.i	pmf-044-004.i
2	pmf-044-005.i	pmf-042-003.i	pmf-044-005.i	pmf-044-005.i	pmf-044-005.i
3	pmf-024-001.i	pmf-044-005.i	pmf-042-002.i	pmf-042-002.i	pmf-031-001.i
4	pmf-036-001.i	pmf-027-001.i	pmf-042-001.i	pmf-031-001.i	pmf-024-001.i
5	pmf-031-001.i	pmf-044-004.i	pmf-031-001.i	pmf-042-001.i	pmf-036-001.i
6	pmf-044-003.i	pmf-042-001.i	pmf-042-003.i	pmf-042-003.i	pmf-042-001.i
7	pmf-042-002.i	pmf-042-004.i	pmf-027-001.i	pmf-027-001.i	pmf-044-003.i
8	pmf-042-001.i	pmf-011-001.i	pmf-011-001.i	pmf-042-004.i	pmf-042-002.i
9	pmf-027-001.i	pmf-042-005.i	pmf-042-004.i	pmf-036-001.i	pmf-027-001.i
10	pmf-042-004.i	pmf-031-001.i	pmf-036-001.i	pmf-011-001.i	pmf-011-001.i

For the mixed plutonium system, there is noticeable variation in the USL values for the fast-reflected metal plutonium unit with respect to separation distance, seen in Figure 2 and Table 1. This suggests that the energy spectra of the neutron leakage from each unit, as a function of separation distance between units, may be of influence in systems with units of dissimilar neutron energy spectra and of negligible influence in systems where units are of similar neutron energy spectra.

This numerical experiment highlights that nonconservative USL estimates may be calculated for loosely-coupled multi-region critical models when using only the overall sensitivity profile of systems. This work suggests that to ensure conservative USL estimates for loosely-coupled systems, both the overall system's sensitivity profiles and region-wise sensitivity profiles should be calculated and utilized by Whisper 1.1.

KEY WORDS

Region-wise, sensitivity, Whisper

1. INTRODUCTION

Criticality safety analysts estimate Upper Subcriticality Limits (USLs) for subcritical systems to account for biases and errors in modeling and simulation tools and to ensure that conditions calculated to be subcritical will actually be subcritical. This study investigates the application of the MCNP6-Whisper [1,2] calculational methods to estimate USLs for loosely-coupled systems comprised of two units and makes use of a new MCNP6 capability that allows for the calculation of multiple region-dependent sensitivity profiles

in a single calculation [3]. MCNP6 can compute the region-wise sensitivity profiles for each unit, as influenced by the leakage of the other unit, and the sensitivity profile of the overall loosely-coupled system.

This investigation deliberately focused on USL estimates for small, simple systems to highlight physical and computational issues associated with these types of systems. Three basic, highly enriched uranium (HEU) and plutonium components are used in the loosely-coupled models in this study: bare fast metal sphere, water-reflected fast metal sphere, and thermal solution. These three different units are paired in various combinations, and the MCNP6-Whisper calculations are performed using both the new region-wise sensitivity profile capability, and the conventional overall sensitivity profile capability. These MCNP6-Whisper calculations are performed using a range of separation distances between the loosely-coupled critical components to examine how USL estimates change as the components become increasingly isolated.

This study evaluates the Whisper-selected benchmark rankings and calculated baseline USL values for each calculated sensitivity profile at each separation distance for each application model. The results are used to provide nuclear criticality safety practitioners with greater insight into the behavior of loosely-coupled system USL estimates and to provide some preliminary recommendations for the determination of the appropriate baseline USL values with regards to nuclear criticality safety applications.

2. MODIFICATIONS TO WHISPER SCRIPTS

The *whisper_mcnp.pl* script is used to insert the required MCNP6 input for the KSEN card, specifying the reactions and energy bins for sensitivities, into the user input and then run MCNP6. The *whisper_usl.pl* script is used to extract sensitivity profiles from the MCNP6 output files and then run the Whisper program for benchmark selection and statistical analysis. These scripts assume that only one sensitivity profile for the entire problem is desired and do not permit sensitivity profiles to be obtained for different regions in the problem.

These scripts were modified and saved as *whisper_mcnp2.pl* and *whisper_usl2.pl*. These modified scripts permit users to specify regions for obtaining sensitivities in a single MCNP6 calculation. It is important to note that only one MCNP6 calculation is performed to obtain the region-wise and overall sensitivity profiles. That is, for a system containing both units A and B, the region-wise sensitivity profile (KSEN1) for unit A includes the effects of interacting with unit B; the region-wise sensitivity profile (KSEN2) for unit B includes the effects of interacting with unit A; and the sensitivity profile for the entire system (KSEN3) is what would normally be produced by MCNP6 using the *whisper_mcnp.pl* script. All three sensitivity profiles are obtained in the single MCNP6 calculation of the entire system. The *whisper_usl2.pl* script runs all three sensitivity profiles separately through Whisper (i.e., three Whisper calculations).

3. ANALYSIS OF TEST PROBLEMS

This study created four application models that used two critical benchmark assemblies in each application model. Parametric studies were conducted using five different separating distances between the centers of the two units. Region-wise sensitivity profiles were calculated for each of the two interacting assemblies and the overall application system using MCNP6.2 in a single combined calculation.

These sensitivities were used by Whisper 1.1 to select and rank the most similar benchmark cases and to determine the baseline USL for each unit and for the overall coupled system. The ten benchmarks with the highest weighting were compared at each separating distance for each unit and the overall coupled system for a given model. The baseline USLs at each separating distance, for each unit and the overall coupled system, were compared to determine the differences between the regional and overall baseline USLs determined by Whisper.

a. Model Descriptions

All four application models used 100,000 neutrons per cycle, 500 inactive cycles, and 500 active cycles in their MCNP6.2 simulations. Truncated benchmark rankings and calculated baseline USL values were made using MCNP6.2 and Whisper-1.1 for regional and overall sensitivity profiles at each separation distance for a given model. ENDF/B-VII.1 nuclear data and standard 44-group “low-fidelity” covariance data were used in all Whisper calculations in this study.

The individual units in the four application models were derived from the International Criticality Safety Benchmark Evaluation Project (ICSBEP). The Bare Fast Metal application model component is comprised

of an HEU sphere taken from the ICSBEP benchmark HEU-MET-FAST-051-015 and a plutonium sphere taken from the ICSBEP benchmark PU-MET-FAST-001-001, with separation distances spanning 20 to 100 centimeters in 20-centimeter increments. The Water-Reflected Fast Metal application model is derived from the ICSBEP benchmarks HEU-MET-FAST-004-001 and PU-MET-FAST-011-001 and has a separating distance between units spanning 70 to 150 centimeters with 20-centimeter increments. The Thermal Solution application model is comprised of HEU-SOL-THERM-050-010 and PU-SOL-THERM-001-01 ICSBEP benchmarks with separating distances between the individual units from 80 to 160 centimeters with 20-centimeter increments. The Mixed Plutonium application model is made of two individual units that are derived from the ICSBEP benchmarks, PU-MET-FAST-011-001 and PU-SOL-THERM-001-001. This application model also had separation distances between the units spanning 80-120 centimeters in 20-centimeter increments.

4. RESULTS AND DISCUSSION

Although creating an accurate sensitivity benchmark profile is important, calculating a conservative baseline USL is of paramount importance to criticality safety analysis. As discussed below, this work shows that for loosely-coupled units, the baseline USLs determined with Whisper using region-wise sensitivity profiles may be more conservative than the Whisper baseline USL for the overall system. These results deserve attention from criticality safety analysts as performing Whisper USL estimates using only sensitivity profiles from the overall system may result in nonconservative USL estimates.
The calculated baseline USL values show the region-wise benchmark rankings bounding the overall benchmark rankings. The greater dominance of one region on the benchmark rankings of the overall system seems to coincide with the region with the greater reactivity.

a. Bare Fast Metal Application Model

The Bare Fast Metal application model region-wise baseline USL values' bound the overall application model's baseline USL values at each separation distance. The baseline USL values do not vary with separation distance, as seen in Figure 3.

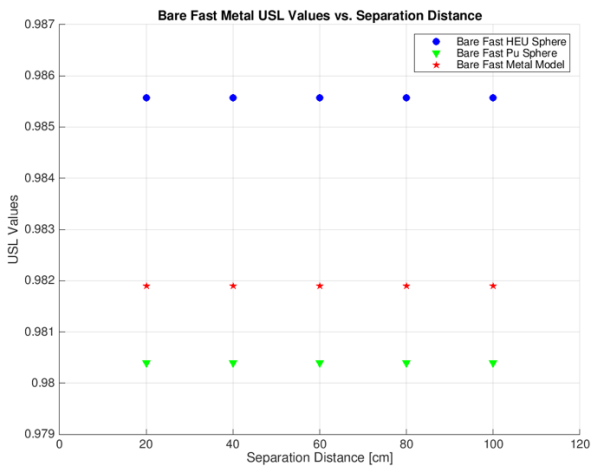

Figure 3. Bare Fast Metal System's USL values as a function of separation distance.

The benchmark rankings for each unit in Tables II and III do not vary with separation distance, and the overall benchmark rankings for this application model reflect a blending of the region-wise sensitivity profiles for the 2 units, as seen by the application model's overall benchmark rankings in Table IV.

Table II. Benchmark rankings for Bare Fast HEU Unit

Bare Fast Metal HEU Assembly	Separation Distance [cm]				
Benchmark Ranking	20	40	60	80	100
1	hmf-051-015.i	hmf-051-015.i	hmf-051-015.i	hmf-051-015.i	hmf-051-015.i
2	hmf-100-002.i	hmf-100-002.i	hmf-100-002.i	hmf-100-002.i	hmf-100-002.i
3	hmf-051-014.i	hmf-051-014.i	hmf-051-014.i	hmf-051-014.i	hmf-051-014.i
4	hmf-100-001.i	hmf-100-001.i	hmf-100-001.i	hmf-100-001.i	hmf-100-001.i
5	hmf-065-002.i	hmf-065-002.i	hmf-065-002.i	hmf-065-002.i	hmf-065-002.i
6	hmf-044-001.i	hmf-044-001.i	hmf-044-001.i	hmf-044-001.i	hmf-044-001.i
7	hmf-001-001.i	hmf-001-001.i	hmf-001-001.i	hmf-001-001.i	hmf-001-001.i
8	hmf-015-001.i	hmf-015-001.i	hmf-015-001.i	hmf-015-001.i	hmf-015-001.i
9	hmf-008-001.i	hmf-008-001.i	hmf-008-001.i	hmf-008-001.i	hmf-008-001.i
10	hmf-044-002.i	hmf-044-002.i	hmf-044-002.i	hmf-044-002.i	hmf-044-002.i

Table III. Benchmark rankings for Bare Fast Plutonium Unit

Bare Fast Metal Plutonium Assembly	Separation Distance [cm]				
Benchmark Ranking	20	40	60	80	100
1	pmf-001-001.i	pmf-001-001.i	pmf-001-001.i	pmf-001-001.i	pmf-001-001.i
2	pmf-022-001.i	pmf-022-001.i	pmf-022-001.i	pmf-022-001.i	pmf-022-001.i
3	pmf-029-001.i	pmf-029-001.i	pmf-029-001.i	pmf-029-001.i	pmf-029-001.i
4	mmf-009-001.i	mmf-009-001.i	mmf-009-001.i	mmf-009-001.i	mmf-009-001.i
5	pmf-023-001.i	pmf-023-001.i	pmf-023-001.i	pmf-023-001.i	pmf-023-001.i
6	pmf-035-001.i	pmf-035-001.i	pmf-035-001.i	pmf-035-001.i	pmf-035-001.i
7	pmf-039-001.i	pmf-039-001.i	pmf-039-001.i	pmf-039-001.i	pmf-039-001.i
8	pmf-030-001.i	pmf-030-001.i	pmf-030-001.i	pmf-030-001.i	pmf-030-001.i
9	pmf-009-001.i	pmf-009-001.i	pmf-009-001.i	pmf-009-001.i	pmf-009-001.i
10	pmf-025-001.i	pmf-025-001.i	pmf-025-001.i	pmf-025-001.i	pmf-025-001.i

Table IV. Benchmark rankings for Bare Fast Metal System

Bare Metal Fast System	Separation Distance [cm]				
Ranked Benchmark	20	40	60	80	100
1	mmf-007-013.i	mmf-007-013.i	mmf-007-013.i	mmf-007-013.i	mmf-007-013.i
2	mmf-007-012.i	mmf-007-012.i	mmf-007-012.i	mmf-007-012.i	mmf-007-012.i
3	mmf-007-018.i	mmf-007-018.i	mmf-007-018.i	mmf-007-018.i	mmf-007-018.i
4	mmf-007-011.i	mmf-007-011.i	mmf-007-011.i	mmf-007-011.i	mmf-007-011.i
5	mmf-010-001.i	mmf-010-001.i	mmf-010-001.i	mmf-010-001.i	mmf-010-001.i
6	mmf-007-006.i	mmf-007-006.i	mmf-007-006.i	mmf-007-006.i	mmf-007-006.i
7	mmf-007-017.i	mmf-007-017.i	mmf-007-017.i	mmf-007-017.i	mmf-007-017.i
8	mmf-007-005.i	mmf-007-005.i	mmf-007-005.i	mmf-007-005.i	mmf-007-005.i
9	mmf-007-010.i	mmf-007-010.i	mmf-007-010.i	mmf-007-010.i	mmf-007-010.i
10	mmf-007-021.i	mmf-007-021.i	mmf-007-021.i	mmf-007-021.i	mmf-007-021.i

b. Water-Reflected Fast Metal Application Model

The Water-Reflected Fast Metal application model baseline USL values follow the plutonium sphere region-wise baseline USL values, matching the more conservative baseline USL values, as seen in Figure 4.

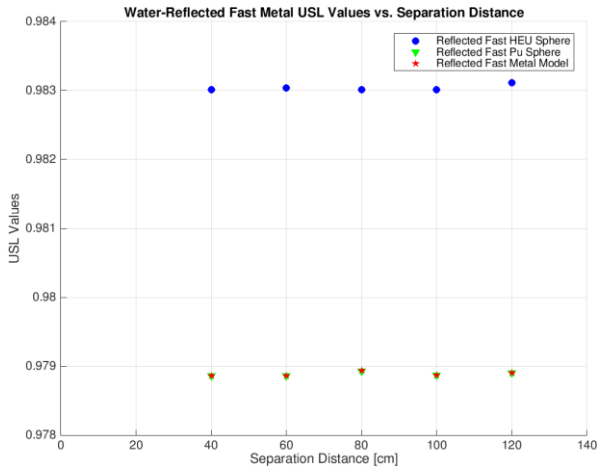

Figure 4. Water-Reflected Fast Metal System's USL values as a function of separation distance.

The baseline USL values, regionally and over the whole application model, vary negligibly with separation distance. However, the benchmark rankings for this application model vary with separation distance, as seen in Tables V and VI for the individual units and in Table VII for the overall system. The domination of the plutonium unit in this overall system is apparent in the benchmark rankings.

Table V. Benchmark rankings for Water-Reflected Fast Plutonium Unit

Reflected Fast Plutonium Assembly	Separation Distance [cm]				
Benchmark Ranking	40	60	80	100	120
1	pmf-011-001.i	pmf-011-001.i	pmf-011-001.i	pmf-011-001.i	pmf-011-001.i
2	pmf-044-004.i	pmf-042-001.i	pmf-042-001.i	pmf-044-004.i	pmf-044-004.i
3	pmf-042-001.i	pmf-044-004.i	pmf-044-004.i	pmf-042-001.i	pmf-042-001.i
4	pmf-027-001.i	pmf-027-001.i	pmf-042-002.i	pmf-027-001.i	pmf-027-001.i
5	pmf-042-002.i	pmf-042-002.i	pmf-027-001.i	pmf-042-002.i	pmf-042-002.i
6	pmf-031-001.i	pmf-031-001.i	pmf-031-001.i	pmf-031-001.i	pmf-031-001.i
7	pmf-044-005.i	pmf-044-005.i	pmf-044-005.i	pmf-044-005.i	pmf-044-005.i
8	pmf-042-003.i	pmf-042-003.i	pmf-042-003.i	pmf-042-003.i	pmf-042-003.i
9	pmf-042-004.i	pmf-042-004.i	pmf-042-004.i	pmf-042-004.i	pmf-042-004.i
10	pmf-036-001.i	pmf-036-001.i	pmf-036-001.i	pmf-036-001.i	pmf-036-001.i

Table VI. Benchmark rankings for Water-Reflected Fast HEU Unit

Reflected Fast HEU Assembly	Separation Distance [cm]				
Benchmark Ranking	40	60	80	100	120
1	hmf-004-001.i	hmf-004-001.i	hmf-004-001.i	hmf-004-001.i	hmf-004-001.i
2	hmf-078-001.i	hmf-078-001.i	hmf-078-001.i	hmf-078-001.i	hmf-078-001.i
3	hmf-011-001.i	hmf-011-001.i	hmf-011-001.i	hmf-007-035.i	hmf-084-011.i
4	hmf-007-035.i	hmf-084-011.i	hmf-007-035.i	hmf-011-001.i	hmf-011-001.i
5	hmf-078-011.i	hmf-007-035.i	hmf-078-011.i	hmf-091-001.i	hmf-016-002.i
6	hmf-078-009.i	hmf-016-002.i	hmf-078-017.i	hmf-078-011.i	hmf-084-002.i
7	hmf-078-017.i	hmf-091-001.i	hmf-078-009.i	hmf-078-017.i	hmf-078-005.i
8	hmf-078-005.i	hmf-078-005.i	hmf-078-005.i	hmf-078-009.i	hmf-009-002.i
9	hmf-078-015.i	hmf-078-017.i	hmf-078-015.i	hmf-078-005.i	hmf-078-017.i
10	hmf-078-013.i	hmf-078-011.i	hmf-078-013.i	hmf-078-015.i	hmf-010-002.i

Table VII. Benchmark rankings for Water-Reflected Fast Metal System

Reflected Fast Metal System	Separation Distance [cm]				
Benchmark Ranking	40	60	80	100	120
1	pmf-011-001.i	pmf-011-001.i	pmf-011-001.i	pmf-011-001.i	pmf-011-001.i
2	pmf-042-001.i	pmf-042-001.i	pmf-042-001.i	pmf-044-004.i	pmf-042-001.i
3	pmf-044-004.i	pmf-027-001.i	pmf-027-001.i	pmf-042-001.i	pmf-044-004.i
4	pmf-027-001.i	pmf-044-004.i	pmf-044-004.i	pmf-027-001.i	pmf-027-001.i
5	pmf-042-002.i	pmf-042-002.i	pmf-042-002.i	pmf-042-002.i	pmf-042-002.i
6	pmf-031-001.i	pmf-031-001.i	pmf-031-001.i	pmf-031-001.i	pmf-031-001.i
7	pmf-044-005.i	pmf-044-005.i	pmf-044-005.i	pmf-044-005.i	pmf-044-005.i
8	pmf-042-003.i	pmf-042-003.i	pmf-042-003.i	pmf-042-003.i	pmf-042-003.i
9	pmf-042-004.i	pmf-042-004.i	pmf-042-004.i	pmf-042-004.i	pmf-042-004.i
10	pmf-036-001.i	pmf-036-001.i	pmf-036-001.i	pmf-036-001.i	pmf-036-001.i

The reflected plutonium unit in this application model is more reactive than the reflected HEU unit, with k-effective values (for isolated single units) of 1.00014 ± 0.00011 and 0.99406 ± 0.00011, respectively.

c. Thermal Solution Application Model

The thermal solution model has benchmark rankings that are dominated by the thermal plutonium solution unit, as seen in Tables VIII-X.

Table VIII. Benchmark rankings for a Thermal HEU Solution Unit

Thermal HEU Solution Assembly	Separation Distance [cm]				
Benchmark Ranking	45	65	85	105	125
1	hst-050-010.i	hst-050-010.i	hst-050-010.i	hst-050-010.i	hst-050-010.i
2	hst-050-001.i	hst-050-001.i	hst-050-001.i	hst-050-001.i	hst-050-001.i
3	hst-050-008.i	hst-050-008.i	hst-050-008.i	hst-050-008.i	hst-050-008.i
4	hst-050-002.i	hst-050-002.i	hst-050-002.i	hst-050-002.i	hst-050-002.i
5	hst-050-004.i	hst-050-004.i	hst-050-004.i	hst-050-004.i	hst-050-004.i
6	hst-050-006.i	hst-050-006.i	hst-050-006.i	hst-050-006.i	hst-050-006.i
7	hst-009-001.i	hst-009-001.i	hst-009-001.i	hst-009-001.i	hst-009-001.i
8	hst-009-002.i	hst-050-011.i	hst-009-002.i	hst-050-011.i	hst-050-011.i
9	hst-050-011.i	hst-009-002.i	hst-050-011.i	hst-009-002.i	hst-009-002.i
10	hst-050-003.i	hst-050-005.i	hst-050-009.i	hst-050-005.i	hst-050-005.i

Table IX. Benchmark rankings for a Thermal Plutonium Solution Unit

Thermal Plutonium Solution Assembly	Separation Distance [cm]				
Benchmark Ranking	45	65	85	105	125
1	pst-001-001.i	pst-001-001.i	pst-001-001.i	pst-001-001.i	pst-001-001.i
2	pst-002-005.i	pst-011-165.i	pst-011-165.i	pst-002-005.i	pst-010-009.i
3	pst-010-009.i	pst-010-009.i	pst-010-009.i	pst-010-009.i	pst-002-005.i
4	pst-011-165.i	pst-002-005.i	pst-002-005.i	pst-010-002.i	pst-011-165.i
5	pst-010-002.i	pst-010-002.i	pst-010-002.i	pst-011-165.i	pst-010-002.i
6	pst-002-006.i	pst-002-006.i	pst-002-004.i	pst-002-006.i	pst-002-004.i
7	pst-002-007.i	pst-002-004.i	pst-002-006.i	pst-002-007.i	pst-002-006.i
8	pst-002-004.i	pst-002-007.i	pst-002-007.i	pst-002-004.i	pst-002-007.i
9	pst-002-003.i	pst-002-003.i	pst-002-003.i	pst-002-003.i	pst-002-003.i
10	pst-001-002.i	pst-001-002.i	pst-001-002.i	pst-001-002.i	pst-001-002.i

Table X. Benchmark rankings for a Thermal Solution System

Thermal Solution System	Separation Distance [cm]				
Benchmark Ranking	45	65	85	105	125
1	pst-001-001.i	pst-001-001.i	pst-001-001.i	pst-001-001.i	pst-001-001.i
2	pst-007-010.i	pst-010-002.i	pst-010-002.i	pst-010-002.i	pst-010-002.i
3	pst-010-002.i	pst-007-010.i	pst-007-010.i	pst-007-010.i	pst-007-010.i
4	pst-002-006.i	pst-010-009.i	pst-010-009.i	pst-010-009.i	pst-010-009.i
5	pst-010-009.i	pst-002-006.i	pst-002-006.i	pst-002-006.i	pst-002-006.i
6	pst-002-005.i	pst-002-005.i	pst-002-005.i	pst-002-005.i	pst-002-005.i
7	pst-007-005.i	pst-007-005.i	pst-002-004.i	pst-002-004.i	pst-007-005.i
8	pst-007-009.i	pst-002-004.i	pst-007-005.i	pst-001-002.i	pst-002-004.i
9	pst-001-002.i	pst-001-002.i	pst-001-002.i	pst-007-005.i	pst-001-002.i
10	pst-007-007.i	pst-007-009.i	pst-007-007.i	pst-007-007.i	pst-007-009.i

The calculated k-effectives for individual isolated units of the thermal plutonium and HEU solutions are 1.00578 ± 0.00013 and 0.99113 ± 0.00015, respectively. This is consistent with the idea that the significantly more reactive unit in a coupled system will dominate the benchmark rankings. For this case, the baseline USL values determined by Whisper are of great interest, as seen in Figure 1.

This illustrates an incomplete dominance of the thermal plutonium solution over the baseline USL of the overall model.

d. Mixed Plutonium Application Model

The benchmark rankings for the mixed plutonium units are shown in Tables I and XI, and the rankings for the overall system in Table XII.

Table XI. Benchmark rankings for a Thermal Plutonium Solution Unit

Thermal Plutonium Solution Assembly	Separation Distance [cm]				
Benchmark Ranking	50	70	90	110	130
1	pst-001-001.i	pst-001-001.i	pst-001-001.i	pst-001-001.i	pst-001-001.i
2	pst-010-009.i	pst-011-165.i	pst-011-165.i	pst-011-165.i	pst-011-165.i
3	pst-011-165.i	pst-010-009.i	pst-010-009.i	pst-010-009.i	pst-010-009.i
4	pst-010-002.i	pst-002-005.i	pst-002-005.i	pst-002-005.i	pst-002-005.i
5	pst-002-005.i	pst-010-002.i	pst-010-002.i	pst-010-002.i	pst-010-002.i
6	pst-002-004.i	pst-002-004.i	pst-002-006.i	pst-002-004.i	pst-002-004.i
7	pst-002-006.i	pst-002-006.i	pst-002-004.i	pst-002-006.i	pst-002-006.i
8	pst-002-007.i	pst-002-007.i	pst-002-007.i	pst-002-003.i	pst-002-003.i
9	pst-002-003.i	pst-002-003.i	pst-002-003.i	pst-002-007.i	pst-002-007.i
10	pst-001-002.i	pst-001-002.i	pst-001-002.i	pst-011-163.i	pst-011-163.i

Table XII. Benchmark rankings for a Mixed Plutonium System

Mixed Plutonium System	Separation Distance [cm]				
Benchmark Ranking	50 cm	70 cm	90 cm	110 cm	130 cm
1	pst-001-001.i	pst-001-001.i	pst-001-001.i	pst-001-001.i	pst-001-001.i
2	pst-010-002.i	pst-010-002.i	pst-010-002.i	pst-010-002.i	pst-010-002.i
3	pst-010-009.i	pst-010-009.i	pst-010-009.i	pst-010-009.i	pst-010-009.i
4	pst-002-006.i	pst-002-005.i	pst-002-006.i	pst-002-005.i	pst-002-005.i
5	pst-002-005.i	pst-002-006.i	pst-002-005.i	pst-002-006.i	pst-002-004.i
6	pst-007-010.i	pst-002-004.i	pst-007-010.i	pst-002-004.i	pst-002-006.i
7	pst-002-004.i	pst-007-010.i	pst-002-004.i	pst-007-010.i	pst-007-010.i
8	pst-001-002.i	pst-001-002.i	pst-001-002.i	pst-002-003.i	pst-002-003.i
9	pst-007-005.i	pst-007-005.i	pst-002-003.i	pst-001-002.i	pst-001-002.i
10	pst-002-003.i	pst-002-003.i	pst-002-007.i	pst-002-007.i	pst-007-005.i

For the mixed plutonium system there is noticeable variation in the USL values for the fast-reflected metal plutonium unit with respect to separation distance, seen in Figure 2.

This suggests that the energy spectra of the neutron leakage from each unit, as a function of separation distance between units, may be of influence in systems with units of dissimilar neutron energy spectra and of negligible influence in systems where units are of similar neutron energy spectra.

5. CONCLUSIONS

This numerical experiment highlights that nonconservative USL estimates may be calculated for loosely-coupled multi-region critical models when using only the overall sensitivity profile of systems. This work suggests that to ensure conservative USL estimates for loosely-coupled systems, both the overall system's sensitivity profiles and region-wise sensitivity profiles should be calculated and utilized by Whisper 1.1. This study also suggests a relationship between the calculated k_{eff} of the individual units, the sensitivity profile domination of the overall model, and the baseline USL values.

In systems where the two units have similar neutron energy spectra there is little variation in the region-wise USL values or the overall system USL values with respect to separation distance between units. For the mixed plutonium system there is noticeable variation in the USL values for the fast-reflected metal plutonium unit with respect to separation distance. This suggests that the energy spectra of the neutron leakage from each unit, as a function of separation distance between units, may be of influence in systems with units of dissimilar neutron energy spectra and of negligible influence in systems where units are of similar neutron energy spectra.

ACKNOWLEDGMENTS

This work was supported and encouraged by the DOE/NNSA Nuclear Criticality Safety program.

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[1] F.B. Brown, M.E. Rising, J.L. Alwin, "User manual for whisper-1.1," LA-UR-17-20567 (2017)

[2] F.B. Brown, M.E. Rising, J.L. Alwin, "Release Notes for whisper-1.1,", LA-UR-17-23504 (2017)

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S/U Comparison Study with a Focus on USLs

LANL-AM4, ORNL-AM9, IRSN-AM14

U.S. DOE Technical Program Review
Analytical Methods Working Group Meeting
Santa Fe, NM
February 10, 2020

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LA-UR-20-21211

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LANL-AM4, ORNL-AM9, IRSN-AM14

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

LANL, ORNL, and IRSN - compare results from various methods on a small set of benchmark problems

Cases:

- HEU-MET-FAST-013: sphere of highly enriched uranium reflected by steel
- HEU-SOL-THERM-001-008: bare cylinder partially filled by uranium nitrate solution
- PU-MET-FAST-022: bare Pu metal system
- PU-SOL-THERM-001-001: water reflected tank filled with plutonium nitrate (4.6% ^{240}Pu)

Differences in USL expected due to:

- benchmark collection and selection (GLLS, expert, c_k)
- Method of calculating bias and bias uncertainty (EVT, USLSTATS, GLLSM)
- Calculated k-eff and uncertainty values (MCNP6, SCALE, MORET)
- Sensitivity profile energy groups
- MOS included in USL?

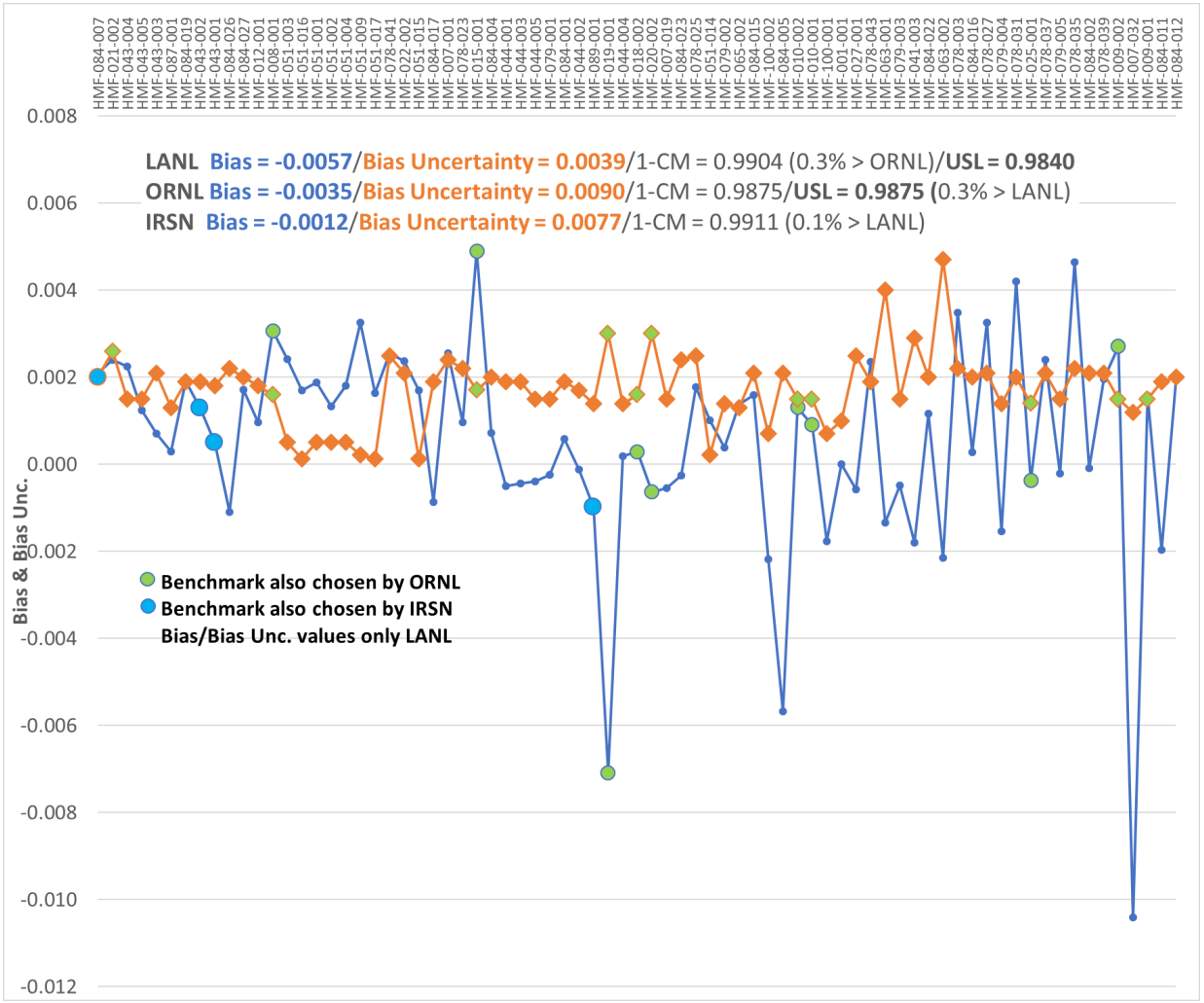
- Overall, differences based on methods, perhaps larger based on benchmarks
- Difference in calculational margins LANL/ORNL/IRSN:
  - HMF: 0.3 % LANL → ORNL
    - 0.1 % LANL → IRSN
    - 0.4 % ORNL → IRSN
  - HST: 1.9 % LANL → ORNL
    - 3.0 % LANL → IRSN
    - 2.6% ORNL → IRSN
  - PMF: 0.9 % LANL → ORNL
    - 1.0 % IRSN → IRSN
    - 0.03% ORNL → IRSN
  - PST: 0.4 % LANL → ORNL
    - 1.0% LANL → IRSN
    - 0.6% ORNL → IRSN

Summary Comparison

	LANL		ORNL			IRSN		
CODE	MCNP6.2/Whisper-1.1		SCALE6.2.2/USLSTATS			MORET5.D.1/MACSENS		
BENCHMARKS	1088		428			1566		
STATISTICAL ANALYSIS	EVT		USLSTATS			GLLSM		
COVARIANCE DATA	BLO, 44g		SCALE6.2.3, 252g			SCALE6.2, 44g		
HMF013								
CALCULATIONAL MARGIN	**0.0096**	**0.0082**	**0.0125**	**0.0172**	**0.0200**	**0.0097**	**0.0087**	**0.0083**
CONFIDENCE LEVEL	99%	95%	95%	95%	95%	1 sigma	1 sigma	1 sigma
# BENCHMARKS SELECTED	75	75	59	40	9	67	49	303
SELECTION METHOD	C_K wgt (0.999-0.972)	C_K wgt (0.999-0.972)	C_k>0.80	C_K>0.90	C_K>0.95	ALL HMF	Expert/HM F+PMF refl	PMF,HMT, PST,HST
HST001								
CALCULATIONAL MARGIN	**0.0319**	**0.0251**	**0.0137**	**0.0154**	**0.0143**	**0.0067**	**0.0025**	
CONFIDENCE LEVEL	99%	95%	95%	95%	95%	1 sigma	1 sigma	
# BENCHMARKS SELECTED	51	51	65	46	43	100	44	
SELECTION METHOD	C_K wgt (1-0.972)	C_K wgt (1-0.972)	C_k>0.80	C_K>0.90	C_K>0.95	ALL HST	Expert judgment/ -refl/poison	
PMF022								
CALCULATIONAL MARGIN	**0.0143**	**0.0122**	**0.0050**	**0.0084**	**0.0258**	**0.0047**	**0.0047**	**0.0037**
CONFIDENCE LEVEL	99%	95%	95%	95%	95%	1 sigma	1 sigma	1 sigma
# BENCHMARKS SELECTED	51	51	8	4	3	29	27	7
SELECTION METHOD	C_K wgt (0.999-0.956)	C_K wgt (0.999-0.956)	C_k>0.80	C_K>0.90	C_K>0.95	ALL PMF	All PMF-outliers	Expert
PST001								
CALCULATIONAL MARGIN	**0.0143**	**0.0115**	**0.0105**	**0.0108**	**0.0108**	**0.0043**	**0.0043**	
CONFIDENCE LEVEL	99%	95%	95%	95%	95%	1 sigma	1 sigma	
# BENCHMARKS SELECTED	38	38	100	85	85	105	100	
SELECTION METHOD	C_K wgt (0.999-0.996)	C_K wgt (0.999-0.996)	C_k>0.80	C_K>0.90	C_K>0.95	ALL PST	All PST except PST001	

HMF013 – LANL/ORNL Comparison

- Higher LANL Bias
  - HMF-084-005, HMF-007-032
- Unclear why many chosen by ORNL weren't for LANL
  - HMF-025, HMF-040



c_k	LANL Benchmark	ORNL Benchmark	c_k	IRSN Benchmark
0.9991	HMF-084-007	HMF-021-001S	0.9948	HMF001 C01
0.9979	HMF-021-002	HMF-021-001	0.9945	HMF026.C01 to 32
0.9976	HMF-043-004	HMF-024-001	0.9592	HMF33 C01 to 02
0.9976	HMF-043-005	HMF-080-001	0.9581	HMF34 C01 to 03
0.9960	HMF-043-003	HMF-086-002	0.9560	HMF36 C01 to 02
0.9960	HMF-087-001	HMF-086-001	0.9559	HMF043 C01 to 02
0.9957	HMF-084-019	HMF-086-003	0.9558	HMF089 C01
0.9931	HMF-043-002	HMF-086-004	0.9558	HMF090 C01
0.9887	HMF-043-001	HMF-086-005	0.9558	PMF25 C01
0.9847	HMF-084-026	HMF-015-001	0.9400	PMF28 C01
0.9829	HMF-084-027	HMF-025-004	0.9378	PMF 032 01
0.9816	HMF-012-001	HMF-025-005	0.9378	PMF 45 C06 and 07
0.9815	HMF-008-001	HMF-008-001	0.9377	HMF001 C01
0.9812	HMF-051-003	HMF-025-003	0.9374	HMF026.C01 to 32
0.9812	HMF-051-016	HMF-025-002	0.9371	HMF33 C01 to 02
0.9811	HMF-051-001	HMF-025-001	0.9366	HMF34 C01 to 03
0.9811	HMF-051-002	HMF-040-001	0.9357	HMF36 C01 to 02
0.9811	HMF-051-004	HMF-018-001	0.9346	HMF043 C01 to 02
0.9810	HMF-051-009	HMF-018-001S	0.9344	
0.9809	HMF-051-017	HMF-065-001	0.9341	
0.9807	HMF-078-041	HMF-010-001	0.9341	
0.9806	HMF-022-002	HMF-010-002	0.9339	
0.9806	HMF-051-015	HMF-019-001	0.9337	
0.9805	HMF-084-017	HMF-019-001S	0.9337	
0.9803	HMF-007-001	HMF-020-001	0.9334	
0.9802	HMF-078-023	HMF-020-001S	0.9334	
0.9801	HMF-015-001	HMF-092-001	0.9320	
0.9801	HMF-084-004	IMF-005-001S	0.9301	
0.9800	HMF-044-001	IMF-005-001	0.9295	
0.9800	HMF-044-003	HMF-009-001	0.9289	
0.9799	HMF-044-005	HMF-009-002	0.9285	
0.9799	HMF-079-001	HMF-092-002	0.9219	
0.9799	HMF-084-001	HMF-016-001	0.9181	
0.9798	HMF-044-002	HMF-011-001	0.9180	
0.9797	HMF-089-001	HMF-016-002	0.9179	
0.9796	HMF-019-001	HMF-092-003	0.9129	
0.9795	HMF-044-004	HMF-092-004	0.9126	
0.9794	HMF-018-002	HMF-017-001	0.9074	
0.9794	HMF-020-002	HMF-093-001	0.9055	
0.9793	HMF-007-019	IMF-019-001	0.9040	
0.9792	HMF-084-023	IMF-019-002	0.8977	
0.9791	HMF-078-025	HMF-005-002	0.8975	
0.9790	HMF-051-014	HMF-005-005	0.8973	
0.9789	HMF-079-002	HMF-005-003	0.8961	
0.9787	HMF-065-002	HMF-005-006	0.8932	
0.9786	HMF-084-015	IMF-009-001	0.8910	
0.9785	HMF-100-002	HMF-005-004	0.8898	
0.9784	HMF-084-005	IMF-004-001S	0.8827	
0.9783	HMF-010-002	IMF-004-001	0.8825	
0.9781	HMF-010-001	IMF-003-001S	0.8793	
0.9778	HMF-100-001	IMF-003-001	0.8786	
0.9775	HMF-001-001	HMF-038-001	0.8672	
0.9772	HMF-027-001	HMF-005-001	0.8641	
0.9769	HMF-078-043	HMF-038-002	0.8567	
0.9768	HMF-063-001	IMF-008-001	0.8560	
0.9768	HMF-079-003	HMF-052-001	0.8551	
0.9767	HMF-041-003	HMF-094-001	0.8498	

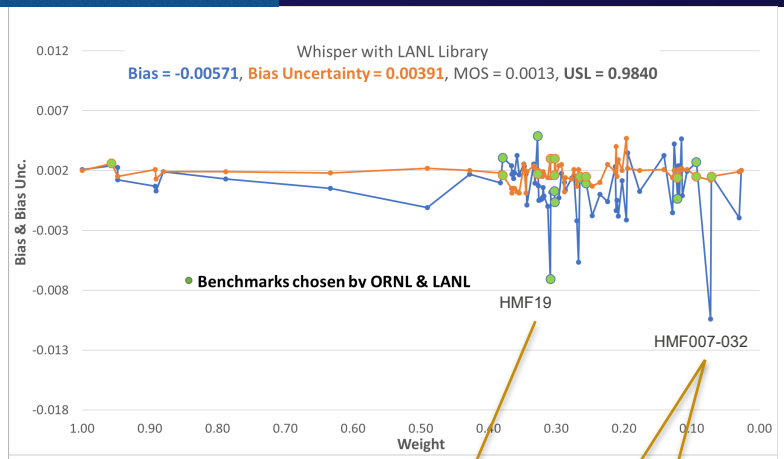
c_k	LANL Benchmark
0.9766	HMF-084-022
0.9764	HMF-063-002
0.9763	HMF-078-003
0.9759	HMF-084-016
0.9748	HMF-078-027
0.9745	HMF-079-004
0.9744	HMF-078-031
0.9743	HMF-025-001
0.9742	HMF-078-037
0.9742	HMF-079-005
0.9741	HMF-078-035
0.9741	HMF-084-002
0.9739	HMF-078-039
0.9735	HMF-009-002
0.9729	HMF-007-032
0.9728	HMF-009-001
0.9717	HMF-084-011

LANL/ORNL
Chosen ORNL/not in LANL
Chosen ORNL/not LANL
Chosen LANL/IRSN

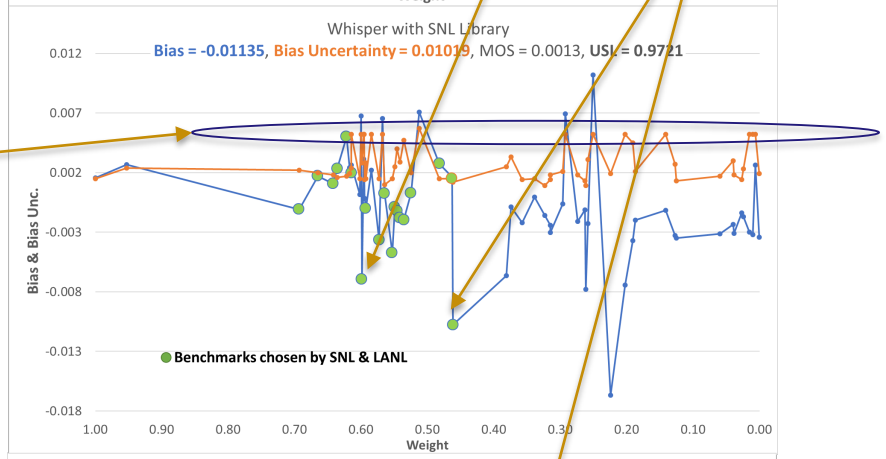
HMF013 – LANL/ORNL/SNL/SRNL
Benchmark Comparison

- LANL
  - Bias = -0.0057
  - Bias unc. = 0.0039
- ORNL
  (0.3% > LANL)
  - Bias = -0.0035
  - Bias unc. = 0.0090
- IRSN
  (0.1% < LANL)
  - Bias = -0.0012
  - Bias unc. = 0.0077
- Whisper w/SNL Benchmarks
  (1.2% > LANL)
  - Bias = -0.01135
  - Bias unc. = 0.01019
- Whisper w/SRNS Benchmarks
  (1.2% > LANL)
  - Bias = -0.01252
  - Bias unc. = 0.00868

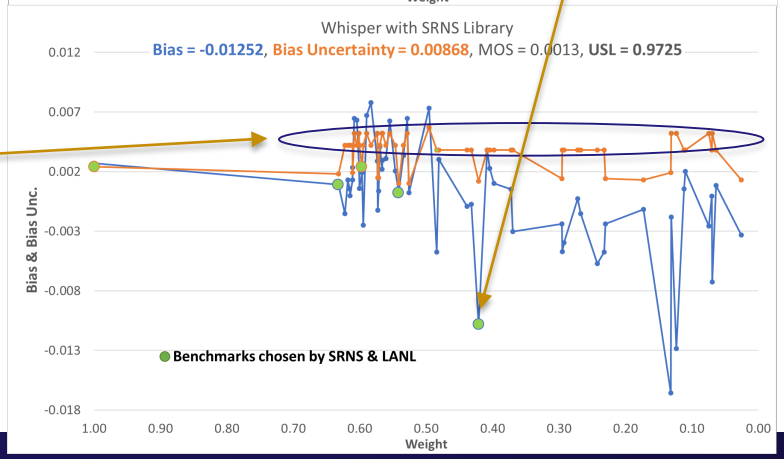
- Higher USL LANL, IRSN & ORNL
  - HMF-019-001,-007-032 higher wgt
  - -007-033, etc.
  - Higher SNL bias uncertainty HMF-023
  - Higher SRNS bias uncertainty HMF-023, HMF-026
  - HMF-007, -023,-026 not selected ORNL



HMF-023

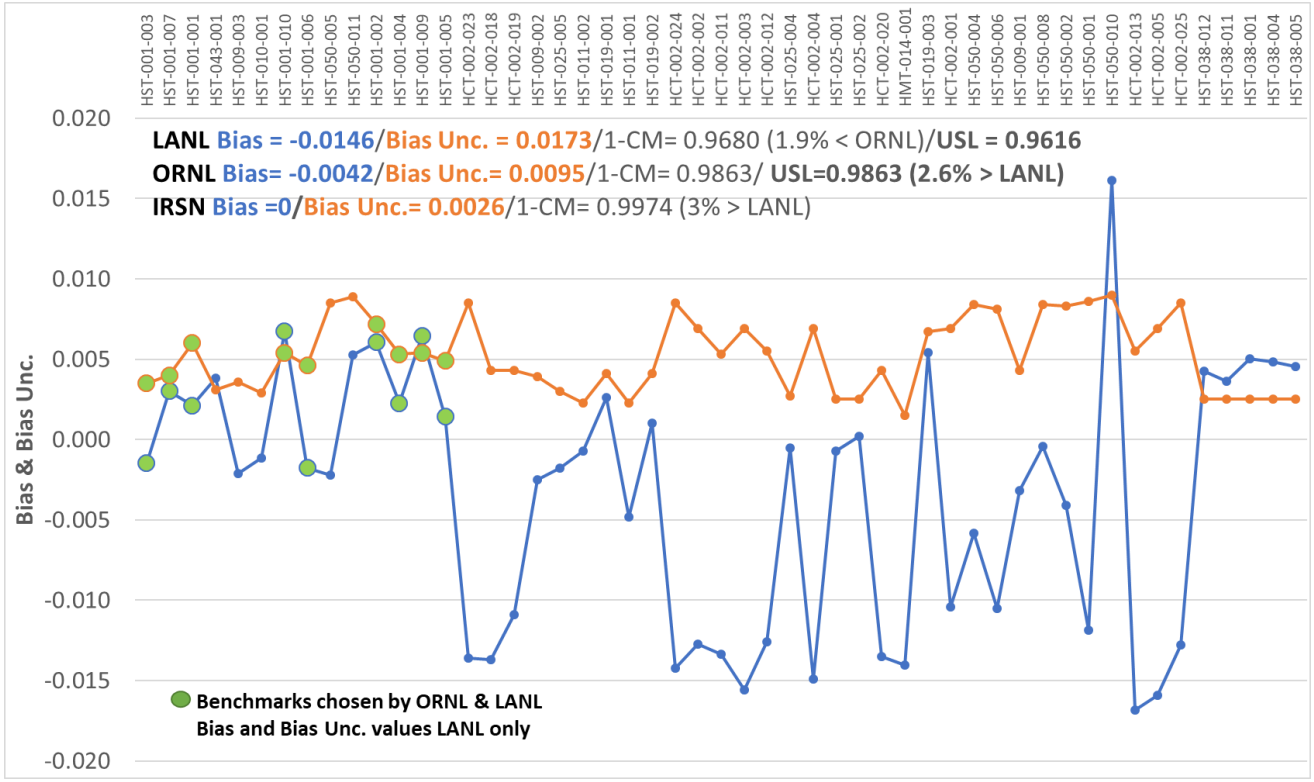


HMF-023
HMF-026



HST001 – LANL/ORNL Comparison

- Higher LANL bias & bias uncertainty due to HCT-002
  - unlike ORNL (after HST-001-005)
  - not chosen IRSN
- HST-028, -029, -030 from VALID & chosen with high c_k ORNL
  - not in LANL library
  - not chosen IRSN

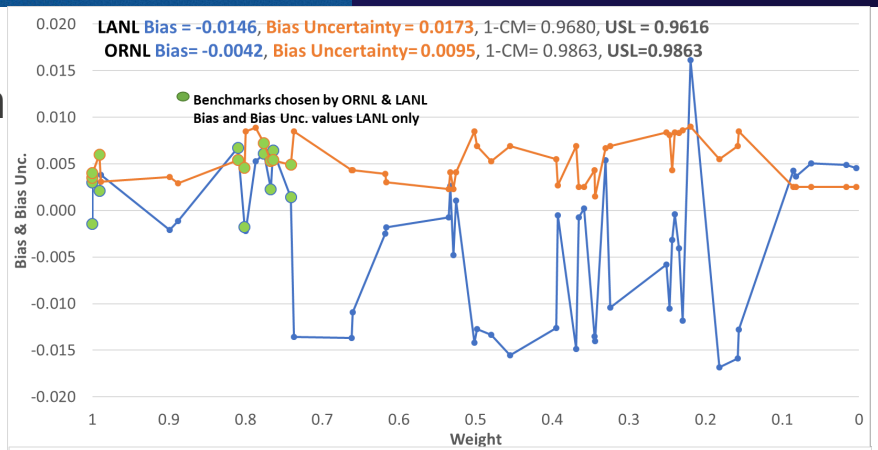


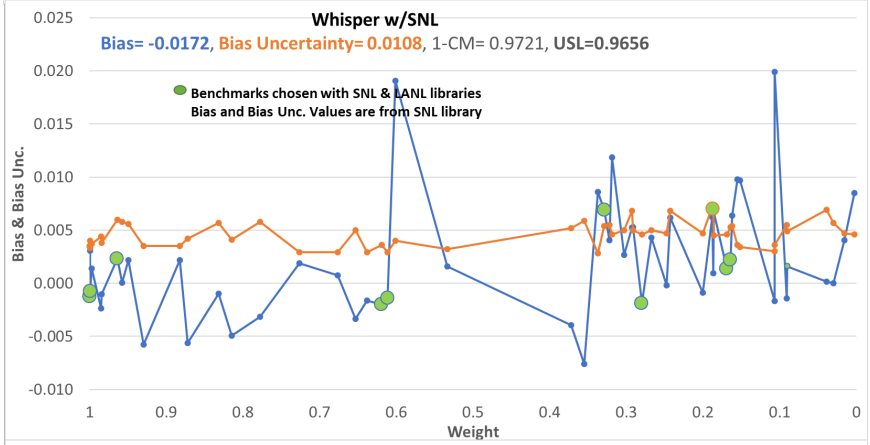
c_k	LANL Benchmark	ORNL Benchmark	c_k	IRSN Benchmark
1.0000	HST-001-003	HST-001-003	1.0000	HST-001-001
1.0000	HST-001-007	HST-001-007	1.0000	HST-001-002
0.9997	HST-043-001	HST-001-001	0.9992	HST-001-003
0.9997	HST-001-001	HST-001-004	0.9966	HST-001-004
0.9971	HST-009-003	HST-001-009	0.9966	HST-001-005
0.9968	HST-010-001	HST-001-002	0.9960	HST-001-006
0.9946	HST-001-010	HST-028-011	0.9957	HST-001-007
0.9944	HST-001-006	HST-028-009	0.9956	HST-001-009
0.9943	HST-050-005	HST-028-013	0.9955	HST-001-010
0.9940	HST-050-011	HST-029-001	0.9954	HST-006-001
0.9937	HST-001-002	HST-030-004	0.9953	HST-006-002
0.9934	HST-001-004	HST-016-001	0.9952	HST-006-003
0.9933	HST-001-009	HST-028-015	0.9952	HST-006-004
0.9927	HST-001-005	HST-028-016	0.9942	HST-006-005
0.9926	HCT-002-023	HST-028-017	0.9941	HST-006-006
0.9905	HCT-002-018	HST-028-014	0.9938	HST-006-007
0.9904	HCT-002-019	HST-028-018	0.9938	HST-006-008
0.9892	HST-009-002	HST-030-005	0.9929	HST-006-009
0.9892	HST-025-005	HST-029-007	0.9927	HST-006-010
0.9869	HST-019-001	HST-001-010	0.9924	HST-006-011
0.9869	HST-011-002	HST-001-006	0.9917	HST-006-022
0.9867	HST-011-001	HST-029-002	0.9917	HST-006-023
0.9866	HST-019-002	HST-028-012	0.9916	HST-006-024
0.9860	HCT-002-024	HST-030-006	0.9915	HST-006-025
0.9859	HCT-002-002	HST-029-003	0.9905	HST-006-026
0.9854	HCT-002-011	HST-030-001	0.9896	HST-042-001
0.9846	HCT-002-003	HST-001-005	0.9893	HST-042-002
0.9830	HCT-002-012	HST-028-003	0.9892	HST-042-003
0.9829	HST-025-004	HST-028-005	0.9892	HST-042-004
0.9822	HCT-002-004	HST-028-001	0.9891	HST-042-005
0.9821	HST-025-001	HST-029-006	0.9884	HST-042-006
0.9819	HST-025-002	HST-028-007	0.9881	HST-042-007
0.9815	HCT-002-020	HST-028-010	0.9881	HST-042-008
0.9815	HMT-014-001	HST-014-001	0.9874	HST-050-001
0.9812	HST-019-003	HST-028-008	0.9849	HST-050-002
0.9810	HCT-002-001	HST-030-007	0.9845	HST-050-003
0.9789	HST-050-004	HST-028-006	0.9815	HST-050-004
0.9788	HST-050-006	HST-029-005	0.9814	HST-050-005
0.9787	HST-009-001	HST-029-004	0.9796	HST-050-006
0.9786	HST-050-008	HST-030-002	0.9786	HST-050-007
0.9784	HST-050-002	HST-028-004	0.9785	HST-050-008
0.9783	HST-050-001	HST-028-002	0.9743	HST-050-009
0.9780	HST-050-010	HST-030-003	0.9697	HST-050-010
0.9770	HCT-002-013	HST-014-002	0.9277	HST-050-011
0.9763	HCT-002-005	HST-016-002	0.9134	
0.9763	HCT-002-025	LST-003-001	0.9002	
0.9743	HST-038-012	LST-004-001	0.8874	
0.9742	HST-038-011	LST-003-002	0.8726	
0.9736	HST-038-001	LST-004-002	0.8693	
0.9723	HST-038-004	LST-003-003	0.8634	
0.9719	HST-038-005	LST-003-004	0.8590	
		HST-013-004	0.8517	
		LST-004-003	0.8489	
		HST-013-003	0.8452	
		LCT-002-001	0.8330	
		LCT-002-002	0.8312	
		LCT-002-003	0.8296	

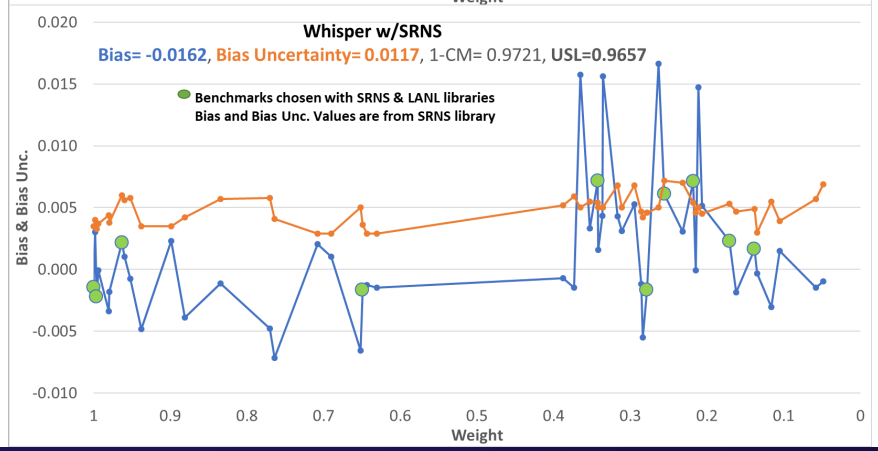
LANL/ORNL
Chosen ORNL/not in LANL
Chosen ORNL/not LANL
Chosen IRSN/LANL

HST001 - LANL/ORNL Comparison & SNL/SRNS Libraries w/Whisper

- LANL
  - Bias = -0.0146
  - Bias unc. = 0.0173
- ORNL
  (1.9% < LANL)
  - Bias = -0.0042
  - Bias unc. = 0.0095
- IRSN
  (3.0 % < LANL)
  - Bias = 0.0014 → 0
  - Bias unc. = 0.00257
- Whisper w/SNL Benchmarks
  (0.4% < LANL)
  - Bias = -0.0172
  - Bias unc. = 0.0108
- Whisper w/SRNS Benchmarks
  (0.4% < LANL)
  - Bias = -0.0162
  - Bias unc. = 0.0117
- Higher LANL bias & bias uncertainty due to benchmarks unlike ORNL (after HST-001-005) HCT-002
- SNL & SRNS collection very similar
  - Higher bias

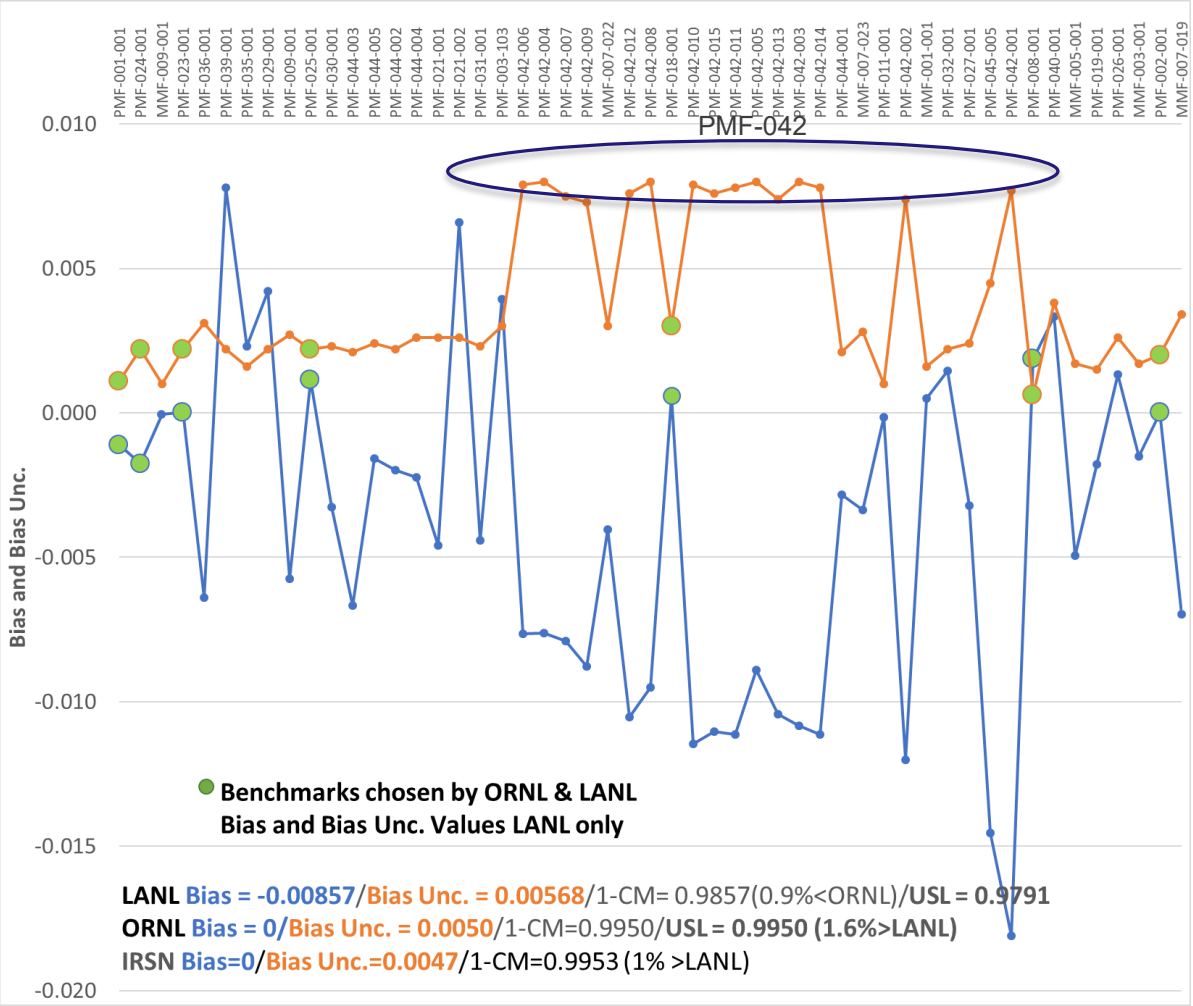






PMF022 – LANL/ORNL Comparison

- LANL higher bias & bias uncertainty due to PMF-042 (not outliers)
- Why wasn't PMF005 chosen LANL?
  - W elastic and inelastic scatter, S less than ~e-02
  - Whisper did choose MMF005, also with W, S less than ~e-05



c_k	LANL Benchmark	ORNL Benchmark	c_k	IRSN Benchmark
0.9993	PMF-001-001	PMF-001-001	0.9983	PMF001-001
0.9954	PMF-024-001	PMF-024-001	0.9865	PMF002-001
0.9952	PMF-023-001	PMF-023-001	0.9813	PMF005-001
0.9952	MMF-009-001	PMF-005-001	0.9422	PMF006-001
0.9947	PMF-036-001	PMF-025-001	0.8951	PMF010-001
0.9947	PMF-039-001	PMF-002-001	0.8915	PMF011-001
0.9940	PMF-035-001	PMF-018-001	0.8829	PMF019-001
0.9931	PMF-029-001	PMF-008-001	0.8040	PMF023-001
0.9921	PMF-009-001			PMF024-001
0.9918	PMF-025-001			PMF025-001
0.9887	PMF-030-001			PMF027-001
0.9886	PMF-044-003			PMF028-001
0.9884	PMF-044-005			PMF029-001
0.9858	PMF-044-002			PMF030-001
0.9852	PMF-044-004			PMF031-001
0.9828	PMF-021-001			PMF032-001
0.9824	PMF-021-002			PMF035-001
0.9810	PMF-031-001			PMF038-001
0.9759	PMF-042-006			PMF039-001
0.9759	PMF-003-103			PMF040-001
0.9757	PMF-042-004			PMF045-001
0.9756	PMF-042-007			PMF045-002
0.9754	PMF-042-009			PMF045-003
0.9752	MMF-007-022			PMF045-004
0.9750	PMF-042-012			PMF045-005
0.9749	PMF-042-008			PMF045-006
0.9747	PMF-018-001			PMF045-007
0.9746	PMF-042-010			
0.9743	PMF-042-015			
0.9742	PMF-042-011			
0.9740	PMF-042-005			
0.9740	PMF-042-013			
0.9739	PMF-042-003			
0.9737	PMF-042-014			
0.9733	PMF-044-001			
0.9731	MMF-007-023			
0.9722	PMF-011-001			
0.9714	PMF-042-002			
0.9705	MMF-001-001			
0.9670	PMF-032-001			
0.9668	PMF-027-001			
0.9662	PMF-045-005			
0.9647	PMF-042-001			
0.9644	PMF-008-001			
0.9625	PMF-040-001			
0.9621	MMF-005-001			
0.9615	PMF-019-001			
0.9612	PMF-026-001			
0.9580	MMF-003-001			
0.9574	PMF-002-001			
0.9557	MMF-007-019			

LANL/ORNL
Chosen ORNL/not LANL
IRSN/LANL

NUREG/CR-6698 method, 95% confidence = 0.994 = EVT, 95% confidence

AT 95% IF ALL BENCHMARKS MATCH :

LANL		ORNL
-0.00325	BIAS	0.00110 (0)
0.0028	BIAS σ	0.00500
0.00126	MOS_{ND}	-
0.9940	1-CM	0.9950
0.9877	USL	0.9950

ck	LANL Benchmark	ORNL Benchmark	ck
0.9993	PMF-001-001	PMF-001-001	0.9983
0.9954	PMF-024-001	PMF-024-001	0.9865
0.9952	PMF-023-001	PMF-023-001	0.9813
0.9918	PMF-025-001	PMF-005-001	0.9422
0.9747	PMF-018-001	PMF-025-001	0.8951
0.9644	PMF-008-001	PMF-002-001	0.8915
0.9574	PMF-002-001	PMF-018-001	0.8829
0.6531	PMF-005-001	PMF-008-001	0.8040

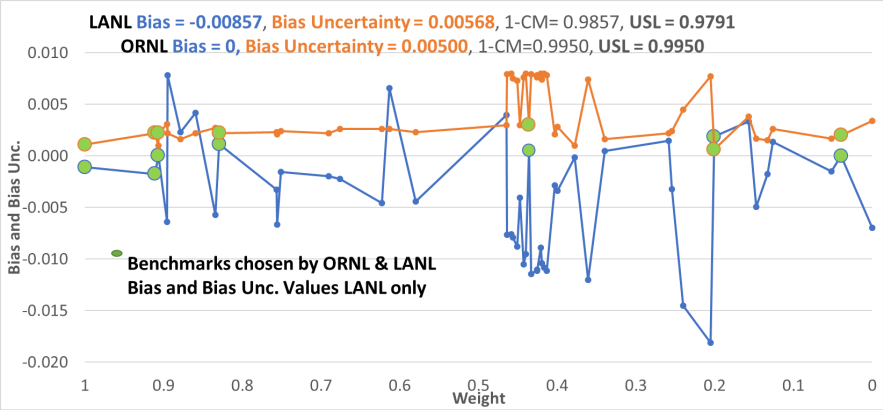
* Whisper non-coverage penalty MOS=0.03074 excluded

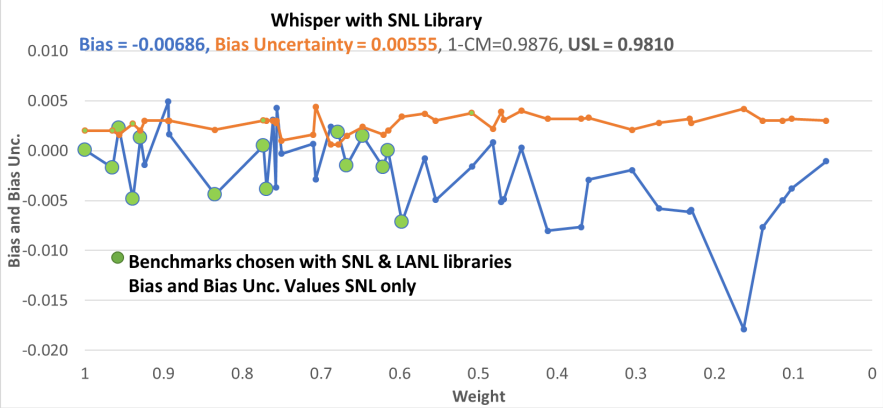
C_k = 0.9127 without W

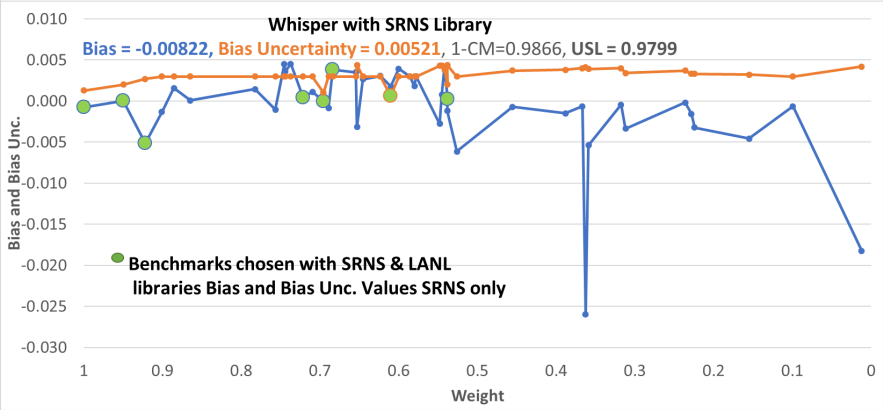
PMF022 - LANL/ORNL Comparison & SNL/SRNS Libraries w/Whisper

- LANL
  - Bias = -0.00857
  - Bias unc. = 0.00568
- ORNL
  (0.9% < LANL)
  - Bias = 0.0011 → 0
  - Bias unc. = 0.00500
- IRSN
  (1.0% < LANL)
  - Bias = 0.0018 → 0
  - Bias unc. = 0.00466
- Whisper w/SNL Benchmarks
  (0.2% < LANL)
  - Bias = -0.00686
  - Bias unc. = 0.00555
- Whisper w/SRNS Benchmarks
  (0.1% < LANL)
  - Bias = -0.00822
  - Bias unc. = 0.00521
- LANL higher bias & bias uncertainty due to PMF042 (not outliers)

- Results indicate method equivalency if:
  - Identical benchmarks in collection
  - Calculational Margins compared, not MOS

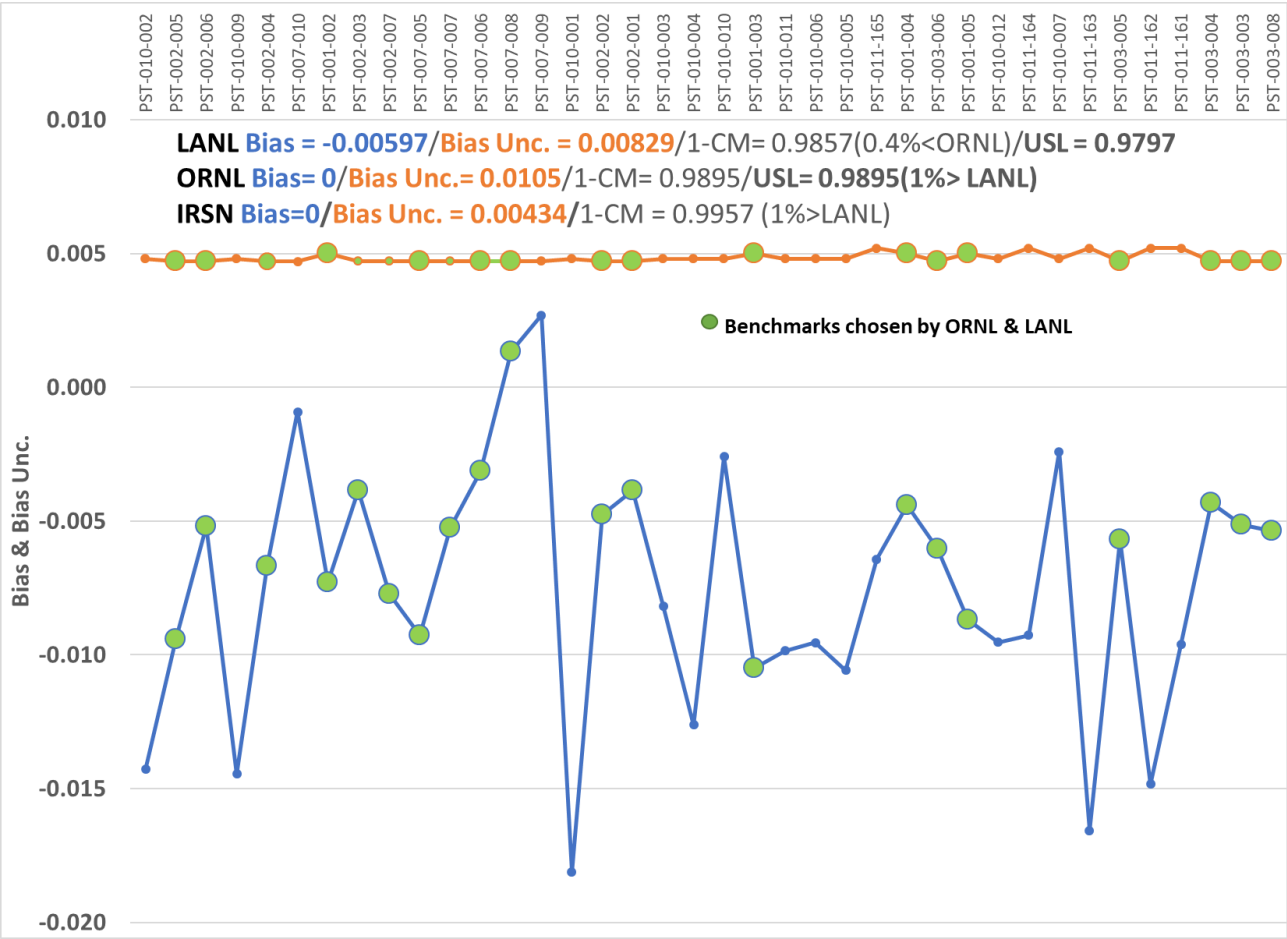






PST001 – LANL/ORNL Comparison

- Higher bias LANL:
  - PST-010-001
  - 011-162, -011-163

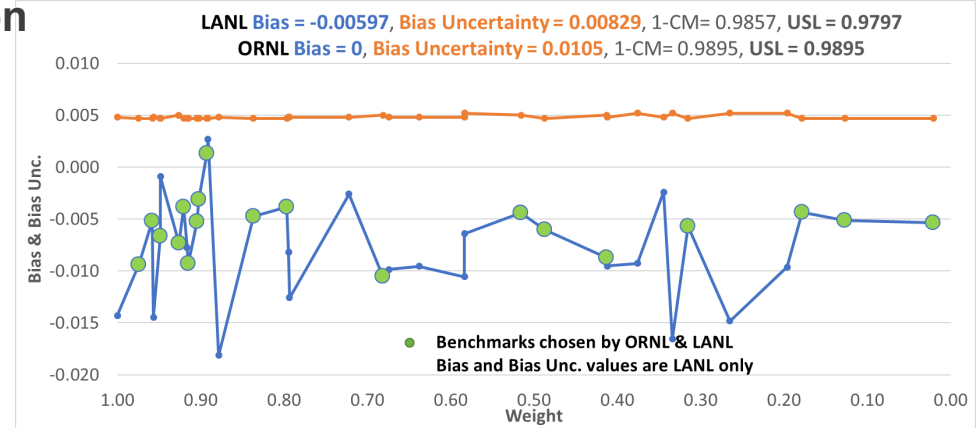


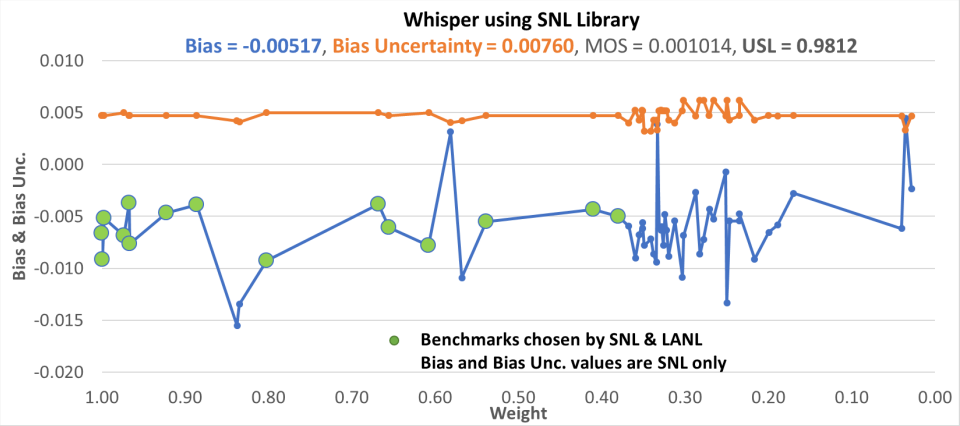
c_k	LANL Benchmark	ORNL Benchmark	c_k	IRSN Benchmark
0.9998	PST-010-002	PST-002-005	0.9992	PST-004 2,3,5,6,8,11
0.9997	PST-002-005	PST-002-004	0.9990	PST-010 1-4
0.9997	PST-002-006	PST-002-006	0.9990	PST-018 1-9
0.9997	PST-010-009	PST-007-008	0.9989	PST-028 1-15
0.9996	PST-002-004	PST-002-003	0.9988	PST-030 1-16
0.9996	PST-007-010	PST-001-002	0.9984	PST-031 6-7
0.9995	PST-001-002	PST-002-007	0.9984	PST-032 1-17
0.9995	PST-002-003	PST-007-003	0.9983	PST-033 15-17, 27,30-32,34,38,49,54,59,60-63
0.9995	PST-002-007	PST-007-005	0.9982	PST-043 1-15
0.9995	PST-007-005	PST-007-004	0.9981	
0.9995	PST-007-007	PST-007-007	0.9980	
0.9994	PST-007-006	PST-007-006	0.9979	
0.9994	PST-007-008	PST-002-002	0.9978	
0.9994	PST-007-009	PST-002-001	0.9974	
0.9994	PST-010-001	PST-020-013	0.9972	
0.9992	PST-002-002	PST-020-008	0.9967	
0.9990	PST-002-001	PST-011-005	0.9956	
0.9990	PST-010-003	PST-001-003	0.9955	
0.9990	PST-010-004	PST-020-007	0.9955	
0.9988	PST-010-010	PST-020-014	0.9950	
0.9986	PST-001-003	PST-020-012	0.9948	
0.9986	PST-010-011	PST-003-006	0.9942	
0.9984	PST-010-006	PST-020-005	0.9942	
0.9982	PST-010-005	PST-011-004	0.9940	
0.9982	PST-011-165	PST-011-003	0.9937	
0.9980	PST-001-004	PST-020-011	0.9933	
0.9979	PST-003-006	PST-001-004	0.9932	
0.9976	PST-001-005	PST-020-004	0.9931	
0.9976	PST-010-012	PST-011-002	0.9928	
0.9975	PST-011-164	PST-001-005	0.9925	
0.9973	PST-010-007	PST-003-005	0.9925	
0.9973	PST-011-163	PST-011-001	0.9918	
0.9972	PST-003-005	PST-005-007	0.9910	
0.9970	PST-011-162	PST-003-004	0.9908	
0.9968	PST-011-161	PST-003-003	0.9903	
0.9967	PST-003-004	PST-020-001	0.9897	
0.9965	PST-003-003	PST-020-009	0.9897	
0.9961	PST-003-008	PST-005-006	0.9896	
		PST-004-011	0.9894	
		PST-020-002	0.9888	
		MST-007-001	0.9884	
		PST-003-002	0.9879	
		PST-005-005	0.9877	
		PST-003-008	0.9870	
		PST-004-010	0.9870	
		PST-003-001	0.9865	
		PST-020-006	0.9862	
		PST-003-007	0.9861	
		PST-005-004	0.9852	
		PST-020-010	0.9847	
		PST-020-003	0.9841	
		PST-020-015	0.9841	
		PST-005-009	0.9829	
		PST-007-002	0.9826	
		PST-005-003	0.9824	
		PST-004-009	0.9822	
		PST-007-001	0.9817	

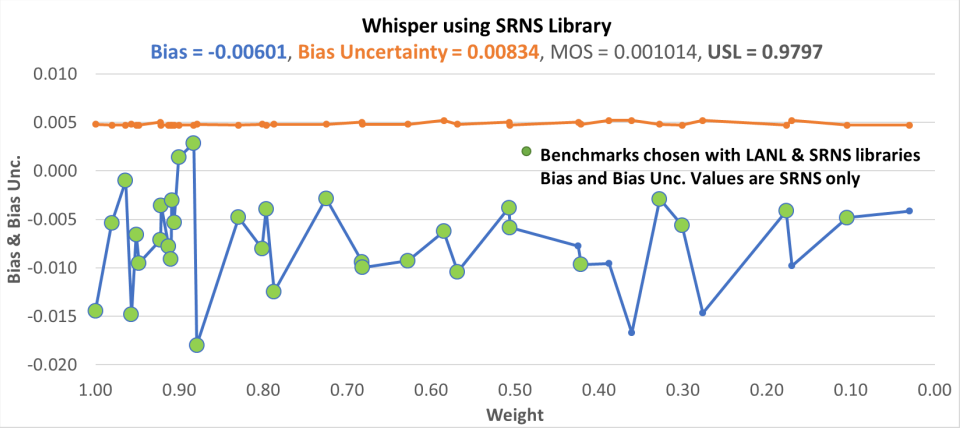
LANL/ORNL	LANL/IRSN
Chosen ORNL/not in LANL	
Chosen ORNL/not LANL	

PST001 - LANL/ORNL Comparison & SNL/SRNS Libraries w/Whisper

- LANL
  - Bias = -0.00597
  - Bias unc. = 0.00829
- ORNL
  (0.4% < LANL)
  - Bias = 0.0025 → 0
  - Bias unc. = 0.0150
- IRSN
  (1.0% < LANL)
  - Bias = 0.0044 → 0
  - Bias unc. = 0.00434
- Whisper w/SNL Benchmarks
  (0.1% < LANL)
  - Bias = -0.00517
  - Bias unc. = 0.0076
- Whisper w/SRNS Benchmarks
  (0% < LANL)
  - Bias = -0.00601
  - Bias unc. = 0.00834
- Higher bias & bias uncertainty
  - PST-010-001, -011
  - LANL and SRNS benchmarks nearly same with same USL

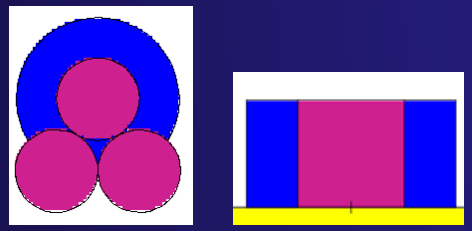






- Proposed Application studies:
  - Pu & HEU Systems: metal, oxide, solution

  - Metal and Oxide:
  - 3 right circular cylinders in close proximity
  - Water and steel reflection
  - Height-to-Diameter =1
  - HEU metal = 20kg, 93 at% ^{235}U, 18.75 g/cm^3
  - HEU oxide = 10kg, 93 at% ^{235}U, 10.8 g/cm^3
  - Pu metal = 2.3kg, 100% ^{239}Pu, 19.85 g/cm^3
  - Pu oxide = 3.5kg, 100% ^{239}Pu, 11.5 g/cm^3



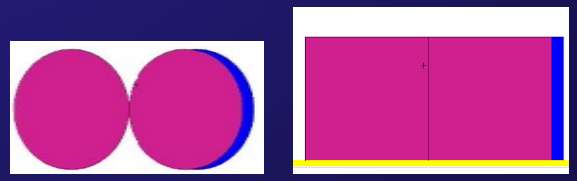
MCNP6 Geometry plot plan & side view

- Solution (Metal-Water Mixture):
  - 2 right circular cylinders in close proximity
  - Water and steel reflection
  - Height-to-Diameter =1
  - HEU solution = 1000g HEU @ 40 g/L, 93 at% ^{235}U
  - Pu solution = 250 g Pu @ 30 g/L, 100% ^{239}Pu

Results using Whisper to compare collections:

Application Case	Whisper USL with LANL Collection	Whisper USL with SNL Collection	Whisper USL with SRNS Collection
HEU Metal	0.9821	0.9713	0.9726
HEU Oxide*	0.9790	0.9676	0.9521
HEU Solution	0.9732	0.9733	0.9741
Pu Metal	0.9788	0.9807	0.9797
Pu Oxide	0.9779	0.9802	0.9790
Pu Solution	0.9809	0.9792	0.9809

* SRNS collection has HCM-001, HCM-002 which were chosen
LANL collection does not contain any HCM
SNL collection does contain HCM-001, but not HCM-002

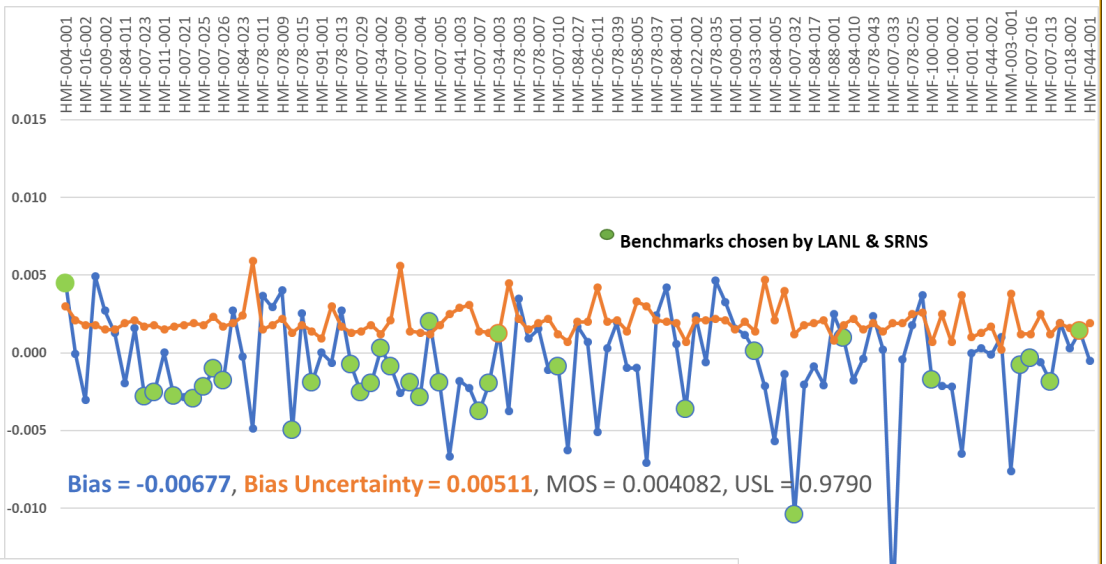


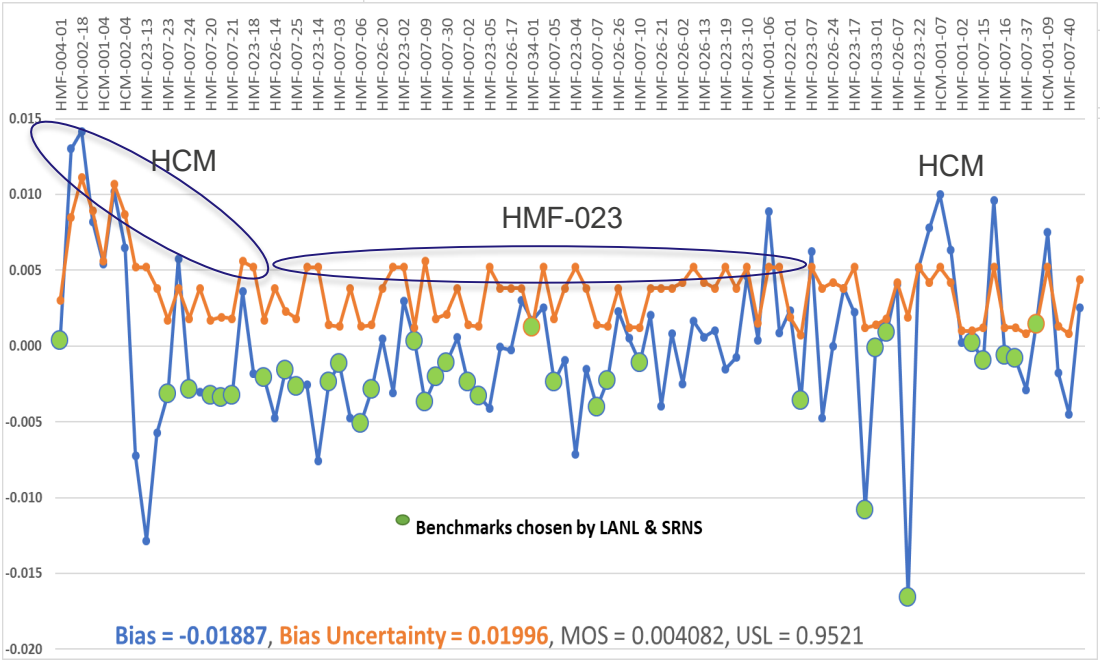
MCNP6 Geometry plot plan & side view

HEU Oxide – Whisper Comparison w/LANL & SRNS Libraries

- Higher USL LANL
  - HCM
  - HMF-023

2.8% USL difference may indicate a need to add HCM, HMF-023 to library





ck	LANL Benchmark		SRNS Benchmark	ck
0.9680	HMF-004-001		HMF-004-01	0.9727
0.9581	HMF-084-002		HCM-002-01	0.9527
0.9580	HMF-016-002		HCM-002-18	0.9484
0.9570	HMF-078-001		HCM-002-05	0.9481
0.9552	HMF-009-002		HCM-001-04	0.9476
0.9491	HMF-010-002		HCM-002-19	0.9466
0.9473	HMF-084-011		HCM-002-04	0.9455
0.9461	HMF-084-015		HMF-023-03	0.9444
0.9438	HMF-007-023		HMF-023-13	0.9442
0.9438	HMF-007-024		HMF-026-03	0.9442
0.9429	HMF-011-001		HMF-007-23	0.944
0.9410	HMF-007-020		HCM-001-05	0.9438
0.9410	HMF-007-021		HMF-007-24	0.9437
0.9410	HMF-007-022		HMF-026-15	0.9422
0.9410	HMF-007-025		HMF-007-20	0.9415
0.9410	HMF-007-028		HMF-007-22	0.9415
0.9406	HMF-007-026		HMF-007-21	0.9413
0.9404	HMF-078-005		HCM-001-03	0.9411
0.9403	HMF-084-023		HMF-023-18	0.941
0.9400	HMF-031-001		HMF-007-26	0.9406
0.9398	HMF-078-011		HMF-026-14	0.9406
0.9397	HMF-078-017		HMF-007-28	0.9404
0.9395	HMF-078-009		HMF-007-25	0.9403
0.9394	HMF-007-006		HMF-023-08	0.9403
0.9394	HMF-078-015		HMF-023-14	0.9402
0.9391	HMF-007-027		HMF-007-27	0.9399
0.9388	HMF-091-001		HMF-007-03	0.9394
0.9387	HMF-020-002		HMF-026-08	0.9392
0.9387	HMF-078-013		HMF-007-06	0.939
0.9385	HMF-007-003		HMF-007-29	0.9389
0.9385	HMF-007-029		HMF-026-20	0.9385
0.9385	HMF-007-035		HMF-023-15	0.9382
0.9379	HMF-034-002		HMF-023-02	0.9381
0.9378	HMF-007-030		HMF-034-02	0.938
0.9374	HMF-007-009		HMF-007-09	0.9377
0.9373	HMF-007-002		HMF-007-35	0.9376
0.9370	HMF-007-004		HMF-007-30	0.9375
0.9366	HMF-034-001		HMF-026-04	0.9375
0.9356	HMF-007-005		HMF-007-02	0.9373
0.9356	HMF-041-004		HMF-007-04	0.9373
0.9354	HMF-041-003		HMF-023-05	0.9373
0.9354	HMF-041-005		HMF-026-05	0.9372
0.9350	HMF-007-007		HMF-026-17	0.937
0.9346	HMF-007-008		HMF-026-30	0.937
0.9346	HMF-034-003		HMF-034-01	0.9369
0.9339	HMF-041-006		HMF-023-12	0.9366
0.9337	HMF-078-003		HMF-007-05	0.9361
0.9332	HMF-010-001		HMF-026-25	0.9361
0.9331	HMF-078-007		HMF-023-04	0.9359
0.9329	HMF-084-026		HMF-026-16	0.9357
0.9328	HMF-007-010		HMF-007-07	0.9353
0.9325	HMF-090-001		HMF-007-08	0.9344
0.9324	HMF-084-027		HMF-026-26	0.9339
0.9322	HMF-084-004		HMF-034-03	0.9339
0.9321	HMF-026-011		HMF-007-10	0.9332
0.9310	HMF-084-016		HMF-026-10	0.9331
0.9305	HMF-078-039		HMF-026-21	0.933
0.9305	HMF-089-001		HMF-026-09	0.9326
0.9300	HMF-058-005		HMF-026-02	0.9325
0.9299	HMF-019-001		HMF-023-09	0.9321
0.9299	HMF-078-037		HMF-026-13	0.9319
0.9295	HMF-078-031		HMF-026-27	0.9315
0.9294	HMF-084-001		HMF-023-19	0.9314
0.9293	HMF-007-036		HMF-026-32	0.9312
0.9292	HMF-022-002		HMF-023-10	0.9311
0.9292	HMF-084-003		HMF-024-01	0.9311
0.9291	HMF-078-035		HCM-001-06	0.9303
0.9289	HMF-078-027		HMF-023-20	0.9298
0.9287	HMF-009-001		HMF-022-01	0.9292
0.9285	HMF-084-022		HMF-007-36	0.929
0.9284	HMF-033-001		HMF-023-07	0.929
0.9279	HMF-063-002		HMF-026-22	0.9288
0.9279	HMF-084-005		HMF-026-24	0.9288
0.9275	HMF-063-001		HMF-026-31	0.9288
0.9274	HMF-007-032		HMF-023-17	0.9287
0.9273	HMF-016-001		HMF-007-32	0.9279
0.9272	HMF-084-017		HMF-033-01	0.9278
0.9270	HMF-058-004		HMF-012-01	0.9261
0.9267	HMF-088-001		HMF-026-07	0.9258
0.9258	HMF-012-001		HMF-007-33	0.9255
0.9255	HMF-084-010		HMF-023-22	0.9253
0.9254	HMF-044-005		HMF-026-19	0.9247
0.9253	HMF-078-043		HCM-001-07	0.9241
0.9252	HMF-044-004		HMF-026-29	0.924
0.9251	HMF-007-033		HMF-001-02	0.9239
0.9247	HMF-044-003		HMF-001-01	0.9238
0.9244	HMF-078-025		HMF-007-15	0.9226
0.9241	HMF-078-033		HCM-001-08	0.9221
0.9241	HMF-100-001		HMF-007-16	0.9219
0.9238	HMF-078-029		HMF-007-13	0.9212
0.9235	HMF-100-002		HMF-007-37	0.9208
0.9234	HMM-002-001		HMF-033-02	0.9207
0.9232	HMF-001-001		HCM-001-09	0.9204
0.9230	HMF-087-001		HMF-007-11	0.92
0.9227	HMF-044-002		HMF-007-40	0.9196
0.9225	HMF-051-014		HMM-001-01	0.9196
0.9225	HMM-003-001			
0.9222	HMF-007-015			
0.9222	HMF-007-016			
0.9220	HMF-027-001			
0.9214	HMF-007-013			
0.9214	HMF-084-019			
0.9213	HMF-018-002			
0.9209	HMF-033-002			
0.9208	HMF-044-001			

- Results: Δ CM 0.1 % - 3.0%

Case	ORNL CM	$\Delta LANL_{EVT}$ $\Delta LANL_{NUREG}$	IRSN CM	$\Delta LANL_{EVT}$ $\Delta LANL_{NUREG}$
HMF-013	0.0125	-0.3% -1.0%	0.0087	0.1% -0.6%
HST-001	0.0137	1.9% 0.3%	0.0026	3.0% 1.4%
PMF-022	0.0050	0.9% 0.3%	0.0047	1.0% 0.3%
PST-001	0.0150	-0.4% 0.4%	0.0043	1.0% 1.0%

- FY20 Work
  - Finish USL comparison benchmark cases
  - Choose applications and compare USLs
  - Issue Report showing similarities and differences
    - Bias and Bias uncertainty
    - MOS
    - Benchmarks and correlation coefficients
    - Share sensitivity profiles?
- Acknowledgements
  - NCSP
  - ORNL- Ellen Saylor, BJ Marshall, Justin Clarity, Doug Bowen
  - IRSN- Isabelle Duhamel, Luis Leal
  - SRNS- Scott Finfrock
  - SNL- John Miller, Shawn Henderson, Mac Cook
  - LANL- Forrest Brown, Mike Rising, Bob Little, Kristy Spencer

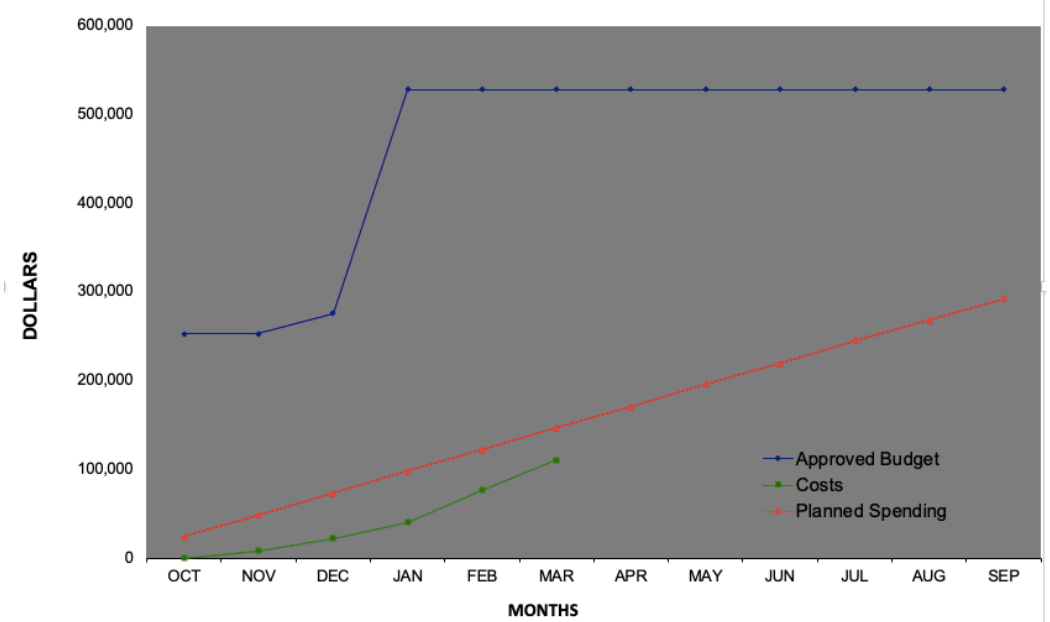
NUCLEAR CRITICALITY SAFETY PROGRAM
U.S. DEPARTMENT OF ENERGY

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtasks: AM2, 3, 5, 6, 7, 8
Task Titles: See last page
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: May 8, 2020

BUDGET



1. **Carryover into FY 2020** = $209,244
2. **Approved FY 2020 Budget** = $528,244 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $21,786
4. **Actual spending for 2nd Quarter FY 2020** = $88,862
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $42,260 (8%)

MAJOR ACCOMPLISHMENTS

1. LLNL-PRES-804222, "Importance of LLNL's Advanced Fission Physics Modeling (FREYA) in ISSA, A Time-Dependent Benchmark," was presented at the TPR on February 12, 2020 (AM2).
2. LLNL-PRES-804127, "LLNL Analytical Methods Update," was presented at the TPR on February 10, 2020 (AM3, AM5, AM8).
3. Provided additional high-precision COG (k_{eff}) benchmark results using ENDF/B-VII.1, ENDF/B-VIII.0 and JEFF-3.3 to Isabelle Duhamel (IRSN) for a total of 2,915 ICSBEP benchmark cases for inclusion in the Benchmark Intercomparison Study (AM5) as follows:

```
 PU: 766     U233: 193     MIX: 204
HEU: 818     IEU:  188     LEU: 743
```

4. The preprint "An Analytic Benchmark for Neutron Boltzman Transport with Downscattering" was provided by Vlad Sobes, Barry Ganapol, etc., and analysis of this 0-D continuous energy analytical benchmark is in progress. LLNL completed cross section processing with FUDGE and PREPRO uncovering typographical errors subsequently corrected in the paper. COG calculations in progress for completion next quarter. (AM6).
5. FUDGE processed thermal scattering law (TSL) data is implemented now in COG, ARDRA, MERCURY and TART, and testing based on UCRL-ID-153656, "Thermal Scattering Law Data: Implementation and Testing using the Monte Carlo neutron transport codes COG, MCNP and Tart" is in progress. (AM8)
6. LLNL hosted the 9th meeting of the Analytical Methods Working Group on February 10, 2020. The agenda for this meeting and the previous two meetings have been added to the AMWG subpage at https://ncsp.llnl.gov/am_workinggroup.php.

NCSP Quarterly Progress Report (FY-2020 Q2)

LLNL AM Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
Q1	Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, AM5, AM6, AM7, and AM8).		IRSN to appoint a replacement for Matthieu Duluc to lead AM3
Q2	Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, AM5, AM6, AM7, and AM8).		
Q3	Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, AM5, AM6, AM7, and AM8).		
Q4	Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3, AM5, AM6, AM7, and AM8).		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	Paris, France October 17, 2019 AM, IE, IP&D, ND, TS5 IRSN-LLNL Meeting (Percher, Heinrichs, Kim) Coordinate joint IRSN-LLNL work as described in Appendix E of the Five-Year Execution Plan.	**Yes** (LLNL-MI-796017)	
Q2	**N/A**	**N/A**	
Q3	**N/A**	**N/A**	
Q4	Chiba, Japan May-20 AM, IE Joint International Conference on Supercomputing in Nuclear Applications and Monte Carlo (Kim, Norris) Premier conference on analytical methods and computing.	**N/A**	The conference was cancelled on April 1, 2020 due to COVID-19 and will not be rescheduled.
	Aldermaston, United Kingdom TBD-date AM, IE, I&D, ND, T&E, TS5 JOWOG29/30 Meetings (Coleman, Zywiec) Coordinate joint AWE-LLNL work as described in Appendix F of the Five Year Execution Plan.		

Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	Dave Heinrichs, Soon Kim, Ed Lent, David Griesheimer, Mike Zerkle, "β_{eff} Benchmarks," LLNL-PRES-796197, November 4, 2019	**Yes**	
	Isabelle Duhamel et al., "International Criticality Benchmark Comparison for Nuclear Data Validation," Transactions of the American Nuclear Society: **121**, 873-876, November 2019.	**Yes**	
Q2	Dave Heinrichs, Soon Kim, Ed Lent, "LLNL Analytical Methods Update," LLNL-PRES-804127, February 10, 2020.	**Yes**	
	Tony Nelson, Ed Lent, Dave Heinrichs, "Importance of LLNL's Advanced Fission Physics Modeling (FREYA) in ISSA, A Time-Dependent Benchmark," LLNL-PRES-804222, February 12, 2020.	**Yes**	
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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

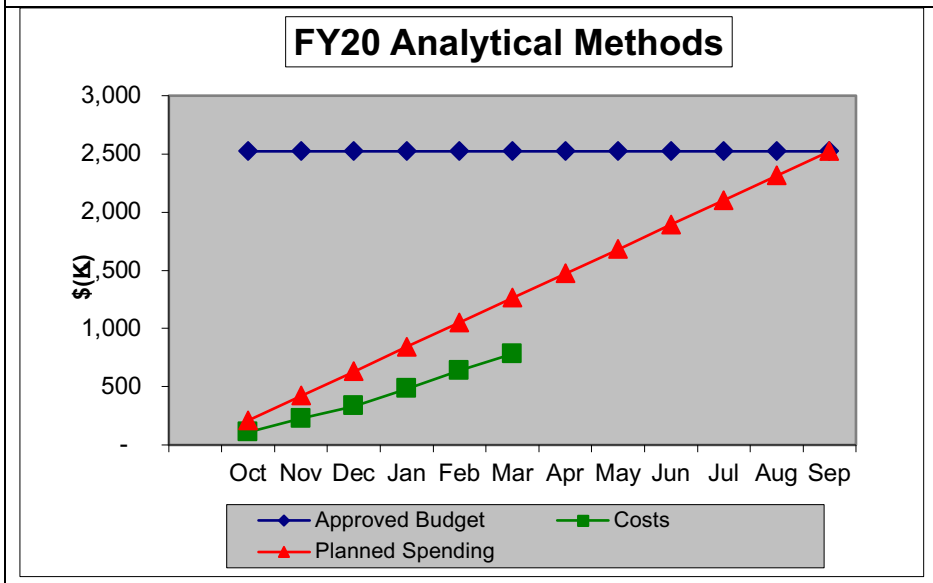
AM8 FUDGE Generation of a Complete ENDF/B-VIII.0 Library for Testing in Production Codes

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: ORNL – AM1, 2, 3, 6, 9, 10, 11, 15, 16, 20
Task Titles: See last page
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0909010/ORNL
Date of Report: April 2020

BUDGET



1. **Carryover into FY 2020** = $367K
2. **Approved FY 2020 Budget** = $2,522K (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $334K
4. **Actual spending for 2nd Quarter FY 2020** = $448K
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $

MAJOR ACCOMPLISHMENTS

AM1 – Radiation Safety Information Computational Center (RSICC)

- Distributed 365 software packages.
- 91 SCALE, 177 MCNP®, and 0 COG packages distributed.
- RSICC quarterly report issued.

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

- Deployed SCALE 6.3 beta8, beta9, and beta10 release internally and externally with the following updates
  - Infrastructure/Maintenance
    - Updated QA templates developers fill out to link to list of product owners, domain experts, and additional information in a wiki
    - Support case insensitive input for Shift-based sequences
    - Reduced memory and CPU usage for some KENO reaction tallies
    - Standardized TSUNAMI-IP Fortran source code
    - Removed QT data structures (a graphical user interface language) from fundamental SCALE components in place of C++ standard library structures
  - Code/Data enhancements (partial or whole support from NCSP)
    - Added CSAS-Shift IFP eigenvalue sensitivity which is far more performant than previous implementations in KENO
    - Improved mixing table outputs for CSAS-Shift
    - Generated AMPX sample covariance libraries from perturbation factors to check/ensure consistency of TSUNAMI and Sampler
    - Updated AMPX tools to read the R-ext parameter
    - Fixed AMPX library converter to down convert 6.2 to 6.1 libraries
    - Fixed a minor defect in KENO kinematics setup for problems with thermal scatterers at multiple temperatures
    - Fixed a labelling error in KENO fission source distribution 3D map file output
    - Updated SCALE 6.3 data directory to include new ENDF/B-VIII compositions and HDF5-formatted libraries (a standard binary data format)
    - Allow users to control the scattering Pn order in multigroup Shift-based sequences
    - Fixed minor Fulcrum issues including recursive unit error checking and enabling refreshing visualizations when data files change

	• Updated Sampler to recognize HDF5 libraries
	• Updated installation testing comparisons of local and reference values with uncertainty to improve robustness
	• Code updates for the next production release SCALE 6.2.4 (To be delivered to RSICC end of April)
	  • Updates to improve cross-platform installation testing
	  • Documentation updates describing maintenance updates present in 6.2.4
	• Planning initiated for ORNL/AM2 Q3 and Q4 activities for 6.3.0 release. Selected the following.
	  • Finalization of modern USLStats (now called Vader)
	  • Finalization of data directory (documentation, etc.)
	  • Automating the VALID criticality safety suite so that the effect of updated code/data on the validation basis can be more easily analyzed
	  • Development of a CSAS Primer
	  • Development of the SCALE Newsletter
	  • Finalization of the FY19 annual report
	  • Speed improvements to TSUNAMI-IP used in validation/bias assessment
	  • Additions of new benchmarks to the VALID criticality safety suite
	  • Efforts on the OECD/NEA SG-8 Criticality safety benchmark rating project
	  • Improvements to CSAS-Shift allowed starting sources
	AM3 - AMPX Maintenance and Modernization
	• Gave the combined AMPX/SAMMY status report at the TPR in Santa Fe.
	• Work continued on generating the low level GNDS access classes from the JSON files that define the GNDS format and the use of the code. We added code that reads the kinematic data for incident neutron data. MG library were generated using ENDF and GNDS formatted files and the 2-D matrices were compared to ensure that the GNDS data produce the same scattering matrices within expected precision.
	• Since we got permission to release AMPX as open-source, we want to release parts of AMPX and SCALE that can be open-sourced. Work has started in identifying and separating the parts that are necessary for AMPX and are not export controlled.
	AM6 – Slide Rule Application
	• Mathieu Dupont, who recently joined ORNL staff, has reviewed completed tasks and contacted IRSN for project progress. IRSN confirmed their interest to continue their collaboration on the project but they currently do not have time to work on it.

	AM9 - Sensitivity / Uncertainty Comparison Study with a Focus on Upper Subcritical Limits • Briefly met with other task participants at TPR meeting in February, currently no ORNL deliverables to report on **AM10 - Proposed Benchmark Intercomparison Study** • No effort required from ONRL at this time, IRSN presented results at TPR meeting in February **AM11 - Proposed 1D Multipoint Analytical Benchmark Intercomparison** • LLNL and ORNL collaboration. Nothing to report – no input from LLNL **AM15 - The Effects of Temperature on the Propagation of Nuclear Data Uncertainty in Nuclear Criticality Safety Calculations** • Established workflow on the Oak Ridge network for modifying and compiling AMPX source code • Became familiar with DICE, a tool for exploring the ICSBEP (International Criticality Safety Benchmark Evaluation Project) as well as VALID: a repository of SCALE inputs with pre-computed sensitivity data files • Ran initial sensitivity calculations using inputs to TSUNAMI, which lays the groundwork for evaluating the impact of temperature on cross section uncertainty **AM20 - Nuclear Data and Cross Section Testing using ENDF/B-VIII.0** • All VALID cases have been ran with ENDF/B-VIII.0 using both continuous energy and 252-group libraries in serial and parallel with SCALE 6.3b9 KENO V.a and VI. • Currently SDFs are being generated for selected VALID cases using the SCALE 6.2 validation inputs as templates in TSUNAMI-3D-K5 and -K6. • Uncertainty data are being examined with the 56-group covariance data from ENDF/B-VIII.0 and -VII.1 for comparisons. • Direct perturbations will be performed on select cases/isotopes to examine any large differences between ENDF/B-VIII.0 and -VII.1 uncertainty data.

NCSP Quarterly Progress Report (FY-2020 Q2)

ORNL AM Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	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, AM15, AM16, AM20)		
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, AM15, AM16, AM20)		
	Issue an annual SCALE maintenance report to the NCSP Manager. (AM2)		This is behind schedule and will be completed in Q4. The FY19Q4 newsletter and SCALE annual report will be delayed due to the focus on completing SCALE 6.2.4 first. Both are in progress.
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)		

	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, AM15, AM16, AM20)		
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, AM15, AM16, AM20)		
	Publish annual newsletter to users to communicate software updates, user notices, generic technical advice, and training course announcements. (AM2)		
	Document AMPX modernization and technical support for SCALE CE, multigroup, and covariance libraries and report status annually to the NCSP Manager. (AM3)		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	OECD/NEA Paris, France Oct-19 TS1, IE, AM2 ICSBEP and IRPhE Technical Review Meetings (Bowen, Marshall) Provide oversight of NCSP IE tasks as ICSBEP tasks are the end product of the NCSP IE process.	**Yes**	
Q2	Cambridge, England Apr-20 AM2 Attend PHYSOR 2020 meeting of the ANS. (Bowen, Greene) Present papers for ANS subcritical limits and progress on GA Tech NCSP tasks.	**NO**	**TRIP CANCELLED**
Q3	Paris, France TBD – date AM, IE, IP&D, ND1, TS7 IRSN Meetings (Wiarda, Holcomb) Coordinate joint IRSN-ORNL work per 5YP such as the Pu SlideRule; Collaborate with IRSN on the resonance evaluation of the isotopes of lead for the NCSP.	**NO**	**TRIP CANCELLED**
	Geel, Belgium April 2020 ND1 ND Measurements with Zr 90 @ GELINA	**NO**	**TRIP CANCELLED**
Q4	OECD/NEA Paris, France TBD – date TS1, IE, AM2 WPNCS Meetings (Marshall, Bowen, Clarity, Wieselquist) AM collaboration; provide relationship between IAEA and ISO with respect to NCS standards.		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	Dorothea Wiarda, Andrew Holcomb, Friederike Bostelmann, "Current Status of AMPX", November 2019	**Yes**	

	William Wieselquist, Brad Rearden, "Recent Developments in SCALE", November 2019 B.J. Marshall, "Energy-dependent Bias between ENDF/B-VII.1 and ENDF/B-VIII.0 for LCT Benchmarks, CSEWG, November 2019 B.J. Marshall, "Energy-dependent Bias between ENDF/B-VII.1 and ENDF/B-VIII.0 for LCT Benchmarks, ANS, November 2019 W.J. Marshall, "Bias between ENDF/B-VIII.0 and ENDF/B=VII.1 for LEU Pin Array System"		
Q2	None		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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

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

AM20 Nuclear Data and Cross Section Testing Using ENDF/B-VIII.0

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtasks: IPD1, 2, 4, 5, 6

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
IPD5-IT Support at NNSS
IPD6-Benchmark Evaluation of LLNL 'Pulsed Spheres'

M&O Contractor Name: Lawrence Livermore National Laboratory

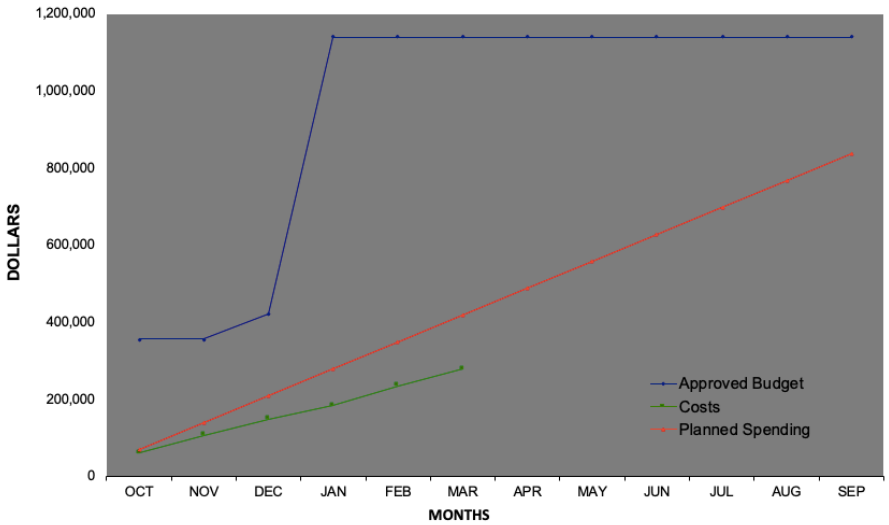
Point of Contact Name: David Heinrichs

Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010

Date of Report: May 8, 2020

BUDGET



1. **Carryover into FY 2020** = $230,063
2. **Approved FY 2020 Budget** = $1,141,063 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $147,416
4. **Actual spending for 2nd Quarter FY 2020** = $131,454
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $91,285 (8%)

MAJOR ACCOMPLISHMENTS

1. ICSBEP (IPD1)

- **IER-209**, LCT101, 7uPCX, 0.855 cm pitch, variable water height. Gary Harms (SNL) is addressing final review comments.
- **IER-184**, TEX baseline with PANN plates moderated by polyethylene. Catherine Percher (LLNL) completed the evaluation, which will be featured as the cover art on the 2020 edition of the Handbook.
- **IER-299**, HMF101, KRUSTY cold/warm criticals. Jesson Hutchinson (LANL) issued a revised draft. LLNL review to commence next quarter.
- LST012, Rev. 1, TRACY: Unreflected 10%-Enriched Uranyl Nitrate Solution in a 50-cm Diameter Annular Tank issued by JAEA and reviewed by LLNL.

2. Website and Systems (IPD2)

Provided NCSP website updates as requested by NCSP Management including:

- Information, registration, agenda and presentations for the TPR
- New heritage video from Bob Wilson on the 1978 Idaho criticality accident
- Training courses additions, deletions, and notices
- CSSG tasking and responses
- Quality assurance and accessibility reviews and improvements

4. IT Support at NNSS (IPD5)

- Maintained & updated iSRD and NTS-SLAN/NCERC networks. Renewed 7 and created 3 new NTS-SLAN accounts. Performed continuous monitoring and authenticated scans of NCERC network devices.
- Provided equipment inspections, certifications and data transfers supporting LANL IER-489, 492, 494, and 506.

5. Benchmark Evaluation of LLNL 'Pulsed Spheres' (IPD6)

This quarter focused simulation of the 'neutron source' created by the incident deuteron beam on the Ti-T target assembly (with no additional shell) with comparison to experimental results.

NCSP Quarterly Progress Report (FY-2020 Q2)

LLNL IP&D Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
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 he NCSP website, databases, and provide user assistance as required. (IPD2).		
	Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. (IPD4)		
	Provide status report on progress on IT support at NNSS, and the benchmark evaluation of LLNL 'Pulsed Spheres.' (IPD5, IPD6).		
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)		WPEC SG47 on SINBAD will occur on Tuesday, May 12, 2020, via WebEx only.
	Maintain, operate and modernize he NCSP website, databases, and provide user assistance as required. (IPD2)		

	Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. (IPD4)		
	Provide status report on progress on IT support at NNSS and the benchmark evaluation of LLNL 'Pulsed Spheres.' (IPD5, IPD6).		NTS-SLAN shut down on March 26, 2020, in response to cessation of programmatic work due to COVID-19 concerns.
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 he NCSP website, databases, and provide user assistance as required. (IPD2)		
	Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. (IPD4)		
	Provide status report on progress on IT support at NNSS, and the benchmark evaluation of LLNL 'Pulsed Spheres.' (IPD5, IPD6).		
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)		
	Provide status reports on LLNL participation in US and International IPD collaborations (including ICSBEP) and provide brief summary report to NCSP Manager on items of NCSP interest. (IPD1)		
	Maintain, operate and modernize he NCSP website, databases, and provide user assistance as required. (IPD2)		
	Provide a status report for the evaluation of the LLNL "Hot Box" for inclusion in the ICSBEP Handbook. (IPD4)		

	Provide status report on progress on IT support at NNSS, and the benchmark evaluation of LLNL 'Pulsed Spheres.' (IPD5, IPD6).		

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	Paris, France October 21-25, 2019 AM, IE, IP&D, ND, TS5 ICSBEP, IRPhE, and SINBAD Technical Review Meetings (Heinrichs, Kim, Percher) Conduct ICSBEP for benchmarks listed in Appendix C of the Five-Year Execution Plan.	**Yes** (LLNL-MI-796017)	
Q2	**N/A**		
Q3	**N/A**		
Q4	OECD/NEA Paris, France Jun-20 IPD1 TS5 WPNCS Meeting (Percher, Scorby) Participate in activities of the Working Party on Nuclear Criticality Safety and expert group meetings on MC methods and excursion analyses.		

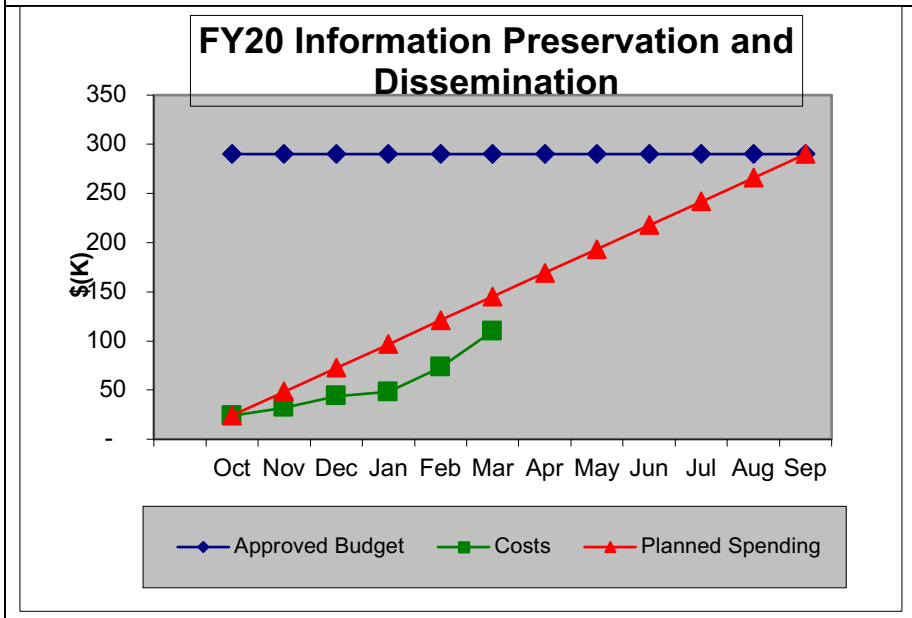
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	Catherine Percher, Jesse Norris, "PU-MET-MIX-002: TEX Plutonium Baseline Assemblies: Plutonium/ Aluminum Metal Alloy Plates with Varying Thicknesses of Polyethylene Modera-tor and a Thin Polyethylene Reflector", LLNL-TR-785164-DRAFT, October 19, 2019	**No**	Final report to be uploaded into IER-184 C_EdT webpage.
Q2			
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: ORNL – IPD5, 6
Task Titles:
IPD5-Oak Ridge Health Physics Research Reactor CAAS Benchmark Evaluation
IPD7- Preserving the "Howard Dyer" Library at ORNL
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0909010/ORNL
Date of Report: April 2020

BUDGET



1. **Carryover into FY 2020** = $15K
2. **Approved FY 2020 Budget** = $290K (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $44K
4. **Actual spending for 2nd Quarter FY 2020** = $66K
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021** = $

MAJOR ACCOMPLISHMENTS

IPD 5 – Oak Ridge Health Physics Research Reactor CAAS Benchmark Evaluation

- Reported at the TPR Meeting in February that the decision was made to continue on with the benchmark modeling. Work has begun on developing the HPPR models with calculations to start in the near future.

IPD 7 - Preserving the "Howard Dyer" Library at ORNL

- Library scanning has been completed and returned to ORNL. The method for sharing the information with the NCS community is still being determined.

NCSP Quarterly Progress Report (FY-2020 Q2)

ORNL IPD Milestones:

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

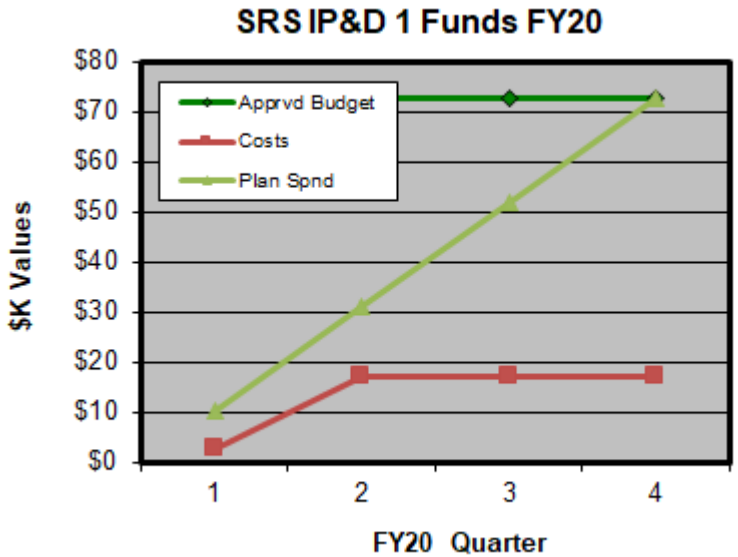
Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
Q1	Provide a status report on progress made on IPD tasks. (IPD5, IPD7)		
Q2	Provide a status report on progress made on IPD tasks. (IPD5, IPD7)		
Q3	Provide a status report on progress made on IPD tasks. (IPD5, IPD7)		
Q4	Provide a status report on progress made on IPD tasks. (IPD5, IPD7)		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		

NCSP Quarterly Progress Report (FY-2020 Q2)

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: April 22, 2020**
BUDGET	**MAJOR ACCOMPLISHMENTS**
 1. **Carryover into FY 2020** = $31.2K 2. **Approved FY 2020 Budget** = $72.5K (includes carryover) 3. **Actual spending for 1st Quarter FY 2020** = $2.7K 4. **Actual spending for 2nd Quarter FY 2020** = $14.3K 5. **Actual spending for 3rd Quarter FY 2020** = $TBD 6. **Actual spending for 4rd Quarter FY 2020** = $TBD 7. **Projected carryover into FY 2021** = $TBD	Finally reached concurrence on acceptable disclaimer. Attended Technical Program Review. CritView documentation is in progress. Will be included in upcoming distribution

NCSP Quarterly Progress Report (FY-2020 Q2)

SRS IP&D Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on SRS progress with CritView. (IPD1)		
Q2	Provide status reports on SRS progress with CritView. (IPD1)		
	Develop QA documents for current version to meet current SRS/DOE requirements. (IPD1)		
Q3	Provide status reports on SRS progress with CritView. (IPD1)		
Q4	Provide status reports on SRS progress with CritView. (IPD1)		
	Issue Preliminary (updated) CritView version for internal testing. (IPD1)		
	Issue Preliminary User Guide to support internal testing. (IPD1		

NCSP Quarterly Progress Report (FY-2020 Q2)

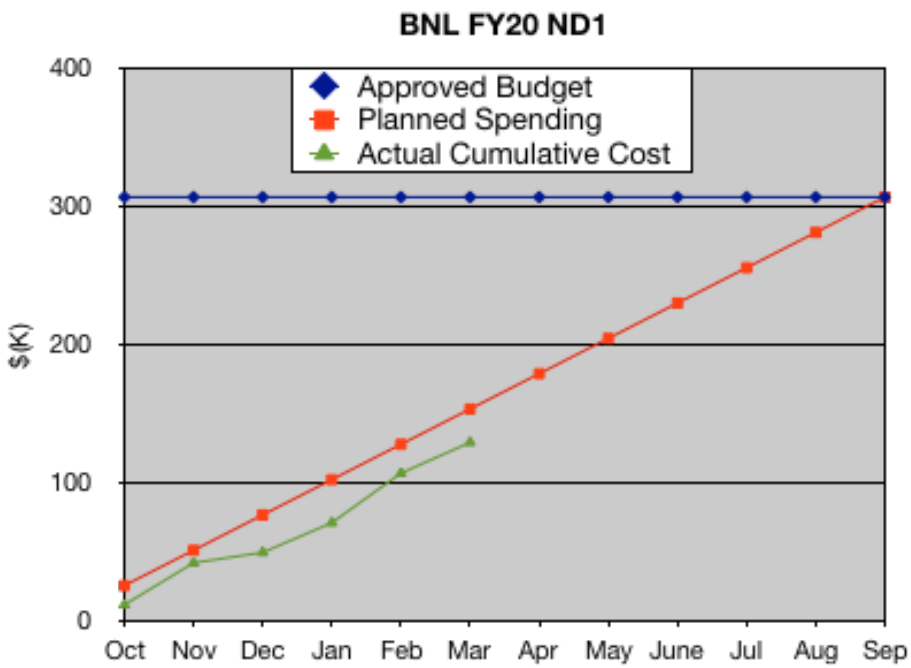
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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: DP 0902000
Date of Report: May 5, 2020

BUDGET



1. **Carryover into FY 2020** = $35,688
2. **Approved FY 2020 Budget** = $306,688
3. **Actual spending for 1st Quarter FY 2020** = $49,500
4. **Actual spending for 2nd Quarter FY 2020** = $79,698
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $

MAJOR ACCOMPLISHMENTS

All ENDF projects (source code, trackers, etc.) have been moved to git.nndc.bnl.gov. ADVANCE and git.nndc.bnl.gov are communicating and GitLab is triggering builds on ADVANCE which are being posted on the NNDC website. We have begun adding CSEWG member user accounts. So far only ~15 CSEWG members have activated their accounts.

We have also begun adding new and revised evaluations and are clearing the backlog of evaluation. NCSP Dy evaluations have been checked and formatting errors corrected. NCSU & NNL thermal scattering law data submitted since the ENDF/B-VIII.0 release has been checked. RPI thermal scattering data is still queued for addition.

NCSP Quarterly Progress Report (FY-2020 Q2)

BNL ND Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

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)		**With the new ADVANCE/GitLab system, we are revising how we will review new evaluation. More information will become available as we figure out the proper review criteria for new/revised evaluations.**
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)		
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)		
	If mandated by CSEWG, release new ENDF library. (ND1)		
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)		

NCSP Quarterly Progress Report (FY-2020 Q2)

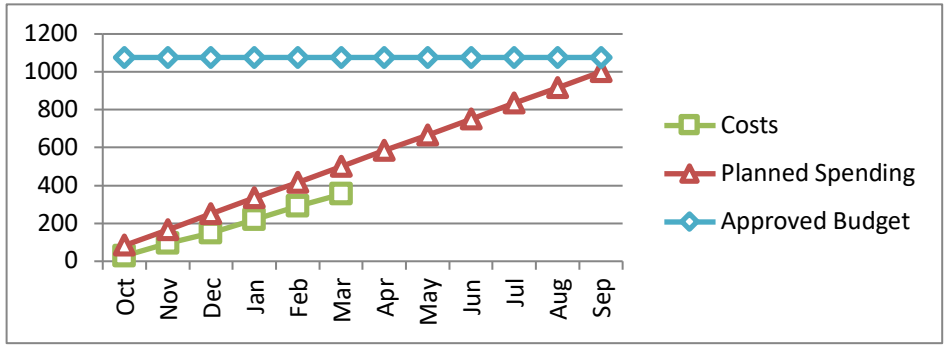
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**	**no**	
Q2	**N/A**	**no**	
Q3	**N/A**	**no**	
Q4	**N/A**	**no**	
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**	No	
Q2			
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: ND1, 2, 3
Task Title:
ND1: Nuclear Data Evaluation and Testing
ND2: Prompt Fission Neutron Spectra (PFNS) Measurement of Plutonium-240
ND3: Unresolved and Fast Measurements of Uraunium-233 (n,gamma)
M&O Contractor Name: LANL
Point of Contact Name: Brian Bluhm / Bob Little
Point of Contact Phone: 505-667-2440 / 505-665-3487

Reference: DP0902000
Date of Report: May 5, 2020

BUDGET



1. **Carryover into FY 2020 = $0**
2. **Approved FY 2020 Budget = $1,076,000 (includes carryover)**
3. **Actual spending for 1st Quarter FY 2020 = $147,361**
4. **Actual spending for 2nd Quarter FY 2020 = $206,073**
5. **Actual spending for 3rd Quarter FY 2020 = $**
6. **Actual spending for 4rd Quarter FY 2020 = $**
7. **Projected carryover into FY 2021 = $76,000**

MAJOR ACCOMPLISHMENTS

- Several presentations were made during TPR Week:
  - Paul Koehler, "DICER (Device for Indirect Capture Experiments on Radionuclides) Instrument," (NDWG)
  - Mark Paris, "R-matrix evaluation of ^{10}Be (n+^{9}Be) system," (NDWG)
  - Denise Neudecker, "Nuclear Data Validation Using ICSBEP Benchmarks and Machine Learning," (NDWG)
  - Michael Rising, "Update on subcritical benchmarks, validation, and simulations," (NDWG)
  - Wim Haeck, "FAUST Benchmark and Validation Framework," (NDWG)
  - Bob Little, "LANL ND-1," (TPR)
  - Denise Neudecker et al., "Identifying Questionable ICSBEP Benchmark Data and Underestimated Uncertainties Using Machine Learning Methods," (TPR)
  - Mark Paris and Gerry Hale, "R-matrix code capabilities and modernization," (TPR)

- We have worked on further analyzing the available data on 234U and 236U, with the scope of identifying the inconsistent data sets, and correcting the uncertainties for the measurements where these are unrealistically small or missing all together. This has allowed us to improve the evaluation process and quality of the evaluated data.
- With funding from other programs, e.g., ASC, we are developing an evaluation tool with the goal of being able to perform simultaneous consistent evaluations of multiple channels and targets. At the moment, we are using the new tool, based on the Kalman filter, on two targets that are included in Appendix B, 234U and 236U, with the eventual goal of including all Uranium isotopes in the evaluation, with 233U among targets to be included in the future (evaluation planned at the moment for

FY2021&2022). Thus, this approach will allow us to connect the evaluations for major actinides, where plenty of data are available, with the evaluation of minor actinides, where data are scarcer.

- We have kept constant contact with the experimental colleagues who are performing the data analysis for the capture of 234U, experiment performed in the past at DANCE. We see the increased need for 234U data above the resonance region, as our new evaluation tool predicts the same shape for the energy dependence of the cross section as a function of energy as the default theoretical calculation, but increases the strength by a significant factor with respect to the existing evaluation. Since there are no available data on 234U capture, the DANCE data is essential for a reliable evaluation. If the data is provided to us this quarter, or the beginning of the next quarter, we should be able to produce a constrained evaluation based on the newest data by the end of the FY.
- We have constructed a preliminary 9Be(n,X) data deck (about 53k lines, which requires detailed checking) for input to EDA that includes angular distributions and integrated cross section data for elastic, inelastic and reaction (n,alpha) data up to incident neutron energy of 12 MeV. This work was aided with recent code development (funded by LANL, non-NCSP, sources) of a Perl code (c5toeda) that converts c5 formatted experimental data from the exfor-csisrs database to eda-native formatted observable data.
- ND-2 “Prompt fission neutron spectra (PFNS) measurement of Pu-240” is a new start in FY20. During the quarter we worked with LLNL to develop a plan for Livermore to procure the 30 mg of material from ORNL, procure the Parallel Plate Avalanche Counter (PPAC) parts, have the material properly electroplated onto thin Ti foils, and assemble the PPAC with 10 cells. This project will be executed in FY20 and FY21. An initial FY20 transfer of funds to LLNL is in progress.
- ND-3 “Unresolved and fast measurements of U-233(n,g)” is a new start in FY20.
    - A postdoc has started looking at the DANCE U233 data from 2009 with both the BaF2 ball and from the PPAC. The focus has centered on the performance of the PPAC fission tagger, as this will impact how cleanly capture and fission can be disentangled at higher energies.
    - A proposal has been submitted to the LANSCE Nuclear Physics Advisory Committee for an additional measurement of 233U(n,g) in the coming CY20 runcycle using DANCE.
        - Note – not unexpectedly, details of the CY20 LANSCE operational schedule are not yet determined.

NCSP Quarterly Progress Report (FY-2020 Q2)

LANL ND Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	MILESTONE	STATUS	COMMENTS
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)		
	Complete review of previous "thin" target U233 measurements and finalize specifications for new "thick" U233 target. (ND3)		
Q4	Provide status reports on LANL participation in US and International Nuclear Data collaborations. (ND1)		
	Acquire Pu240 PPAC target (ND2)		
	Deliver nuclear data evaluations as indicated in Appendix B of this document. (ND1)		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	OECD/NEA Paris, France TBD-date ND1 The NEA/WPEC Subgroup 38 is developing a modern nuclear database (XML) structure. (Paris) Contributor to multiple sub-groups-Paris co-leads SG38.		
	OECD/NEA Paris, France TBD-date ND1 The NEA/WPEC Subgroup 45 is "Validation of Nuclear Data Libraries (VaNDaL) Project." (Herman) Contributor to multiple sub-groups-Herman co-leads SG45.		
	OECD/NEA Paris, France TBD-date ND1 The NEA/WPEC Subgroup 46 is "Efficient and Effective Use of Integral Experiments for Nuclear Data Validation." (Herman) Contributor to multiple sub-groups-Herman co-leads SG46.		
Q4	**N/A**		

Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	Bob Little, "LANL ND-1," (TPR)	N/A	Already posted on NCSP / TPR Web Page
Q2	Denise Neudecker et al., "Identifying Questionable ICSBEP Benchmark Data and Underestimated Uncertainties Using Machine Learning Methods," (TPR)	N/A	Already posted on NCSP / TPR Web Page
Q2	Mark Paris and Gerry Hale, "R-matrix code capabilities and modernization," (TPR)	N/A	Already posted on NCSP / TPR Web Page
Q2	Paul Koehler, "DICER (Device for Indirect Capture Experiments on Radionuclides) Instrument," (NDWG)	No	We will transmit during Q3
Q2	Mark Paris, "R-matrix evaluation of ^{10}Be (n+^{9}Be) system," (NDWG)	No	We will transmit during Q3
Q2	Denise Neudecker, "Nuclear Data Validation Using ICSBEP Benchmarks and Machine Learning," (NDWG)	No	We will transmit during Q3

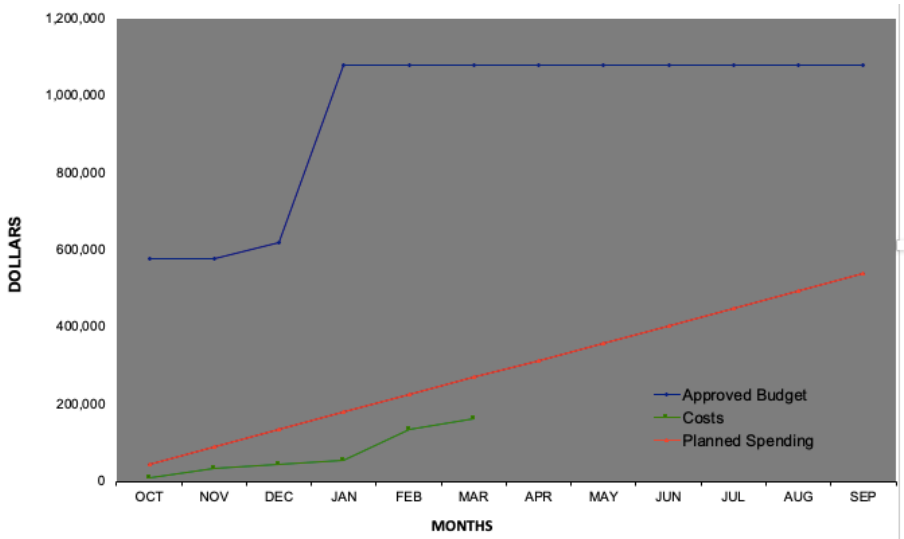
Q2	Michael Rising, "Update on subcritical benchmarks, validation, and simulations," (NDWG)	No	We will transmit during Q3
Q2	Wim Haeck, "FAUST Benchmark and Validation Framework," (NDWG)	No	We will transmit during Q3
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: ND1, 2, 3, 5, 6, 7
Task Titles: See last page
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: May 8, 2020

BUDGET



1. **Carryover into FY 2020** = $494,744
2. **Approved FY 2020 Budget** = $1,080,744 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $42,353
4. **Actual spending for 2nd Quarter FY 2020** = $120,734
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $86,500 (8%)

MAJOR ACCOMPLISHMENTS

1. Presented LLNL-PRES-804223, "Nuclear Data ND1 (LLNL)," which summarizes progress to date on delayed fission gammas, at the TPR on February 11. (ND1)
2. NCSU continued development of the molecular dynamics (MD) simulations of the hydrofluoric acid system described in previous reports. At this stage, the analysis focused on testing the generation of the velocity autocorrelation function (VACF) that is extracted from the time dependent atomic trajectories. Based on the VACF, excitation spectra were generated by Fourier analysis. The excitation spectra provided reasonable information of the low frequency components that originate from the intermolecular interactions. Currently, the high energy components are being examined. These components originate from intramolecular forces, which may need further adjustment. (ND2)
3. NCSU released the *FLASSH* beta 3 code with improved capabilities. This includes allowing generic application of the one-phonon component to any generated TSL, and advanced liquid physics models and capabilities that allow the use of various formulations to describe the diffusional component including for high viscosity liquids. In addition, provisions were made to include supporting crystalline data information for typical moderator materials. Finally, various GUI improvements were completed that enhance the ability to perform TSL analysis without errors. (ND3)
4. NCSU developed the use of partial directional density of states (DOSs) in the analysis of the TSL for non-cubic atomic systems for utilization in Doppler broadening analysis. As an initial test of the validity of the non-cubic module, verification procedures were implemented. Using graphite inputs and DOS, cubic partial DOSs were developed. These cubic partial DOSs were then used as input for the non-cubic module while the full DOS was used in the cubic module. The results demonstrated the expected agreement between the cubic and non-cubic modules, offering verification of the module's ability to replicate cubic results. This approach reduces the number and magnitude of the inputs required for high fidelity calculations while still providing all the needed directional information and dependencies. (ND5)
5. LLNL received pre-publication radiative capture gamma production data in ^{113}Cd(n,γ) in EXFOR format courtesy of Michael Fleming (OECD NEA). Analysis of this data is in progress. (ND6)

NCSP Quarterly Progress Report (FY-2020 Q2)

LLNL ND Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
Q1	Provide status on LLNL/NCSU nuclear data activities to NCSP Manager (ND1 {subtask 1 and 2}, ND2, ND3, ND5, ND6, ND7)		Costs include actual (LLNL) and estimated (NCSU) expenditures as LLNL has yet to receive invoices for Q1 from NCSU.
Q2	Provide status on LLNL/NCSU nuclear data activities to NCSP Manager (ND1 {subtask 1 and 2}, ND2, ND3, ND5, ND6, ND7)		Costs include actual (LLNL) and estimated (NCSU) expenditures as LLNL has yet to receive invoices for Q1-Q2 from NCSU.
Q3	Provide status on LLNL/NCSU nuclear data activities to NCSP Manager (ND1 {subtask 1 and 2}, ND2, ND3, ND5, ND6, ND7)		
Q4	Provide status on LLNL/NCSU nuclear data activities to NCSP Manager (ND1 {subtask 1 and 2}, ND2, ND3, ND5, ND6, ND7)		
	Deliver thermal neutron scattering data evaluations as indicated in Appendix B of the 5-Year Plan. (ND2)		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	C. A. Manring, A. I. Hawari, "Development of Neural Thermal Scattering (NeTS) Modules for Reactor Physics Applications," Transactions of the American Nuclear Society: **121**, 1351-1353, November 2019	**Yes**	
Q2	A. Hawari et al., "Thermal Scattering Law S(α,β): Measurement, Evaluation and Application," International Evaluation Co-operation Volume 42, Organization for Economic Co-operation and Development, Nuclear Energy Agency, NEA No. 7511, © OECD 2020.	**Yes**	
	D. Heinrichs et al., "Nuclear Data ND1 (LLNL)", LLNL-PRES-804223, February 11, 2020.	**Yes**	Available at ncsp.llnl.gov/TPRAgendas/2020/
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

Task Titles:

ND1 Subtasks 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

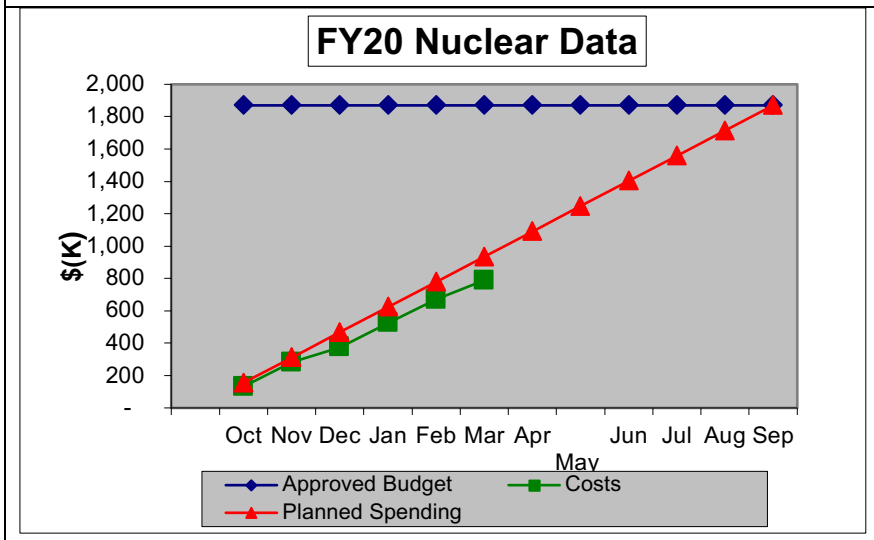
ND7 'Alpha-N' Benchmark Measurements

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: ORNL – ND1, 3, 4, 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

Reference: DP0909010/ORNL
Date of Report: April 2020

BUDGET



1. **Carryover into FY 2020** = $95K
2. **Approved FY 2020 Budget** = $1870K (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $374K
4. **Actual spending for 2nd Quarter FY 2020** = $415K
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 = $**

MAJOR ACCOMPLISHMENTS

ND1 – Nuclear Data Measurement and Evaluation

- **Status report on all nuclear data support activities.**
  - Participate in the NCSP-TPR meeting in February in Santa Fe.
  - Participate in the NCSP-NDAG meeting in Santa Fe.
  - Mentor new staff member for the NCSP (from Klaus).
  - 140,142Ce evaluation (Chapman/Pigni) - The inclusion of newly measured data on oxide sample for 142Ce is in progress. Review of the oxygen resonance parameters was performed and several corrections to it were also performed. The fit will include the neutron energy range between 100-200 keV not included in the previous evaluation. The related spin assignment analysis was initiated.
  - 233U evaluation (Pigni) - The validation process of the resonance evaluation was initiated. The initial selection of the benchmarks showed inconsistencies in the benchmark specification and not in the evaluation. However, this is still preliminary and additional work is needed and in progress including the setting of the ORNL valid suite of benchmarks. The preliminary analysis included the newly evaluated prompt neutron spectrum.
  - 63,65Cu evaluation (McDonnel/ Pigni) - Preliminary fit to increase the capture cross sections was generated and a correction to it is still in progress. At the same time, the validation procedure through ORNL VALID suite of benchmarks is being set up.
  - 181Tantalum (Barry/Brown/Pigni) - A preliminary ENDF file (version 0) was generated and it is currently under ORNL/RPI review for further improvements in the statistics of the resonance parameters, external function, unresolved resonance region, and uncertainty quantification.
  - 50,53Cr (Pigni) - Preliminary ENDF files to improve the performance of the benchmarks were generated by including the newly recommended thermal values and resonance integral.
- **Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B of the 5-year plan.**
  - Travel to JRC-Geel delayed due to COVID-19 (behind schedule).
  - The new transmission data for Ce-142 were reduced to final transmission for analysis (green).
  - The sorted Ce-142 capture and transmission data were tested with SAMMY for analysis (green).

NCSP Element and Subtask: ORNL – ND1, 3, 4, 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	Reference: DP0909010/ORNL Date of Report: April 2020
BUDGET	**MAJOR ACCOMPLISHMENTS**
	○ Natural Zr data obtained during previous experimental campaigns were prepared for data reduction. The data cover various sample thickness transmission and capture data with different background filters. **Y12 ND1 – GELINA depleted Uranium target cost estimate and construction** • Meeting with MSC Inc. in Oak Ridge. Determine possible support during construction. U-Mo part was casted by MSC, need to be machined to shape. MSC outsourced the housing construction after producing up to date technical drawings from the target assembly. Only the question about thermocouples remains. Relayed this to JRC-Geel but due to COVID-19 no response yet (green). **ND3 – Isotopic Sample Lease to Support ND1 ND Measurements** • Plan to return Ce-142 sample by the end of May. (green) • Started production process for Zr-90 sample. But due to COVID-19 delayed (behind schedule). **ND4 – Thermal Neutron Total Cross Section Measurements for Improvement of Criticality Calculations and Propagation of Scattering Kernel Uncertainties** • Joint task with RPI (RPI-ND2) • RPI has not yet provided ORNL with data to analyze due to their beamline upgrades • RPI task has not progressed to the point where ORNL ND4 funding can be used **ND6 – SAMMY Nuclear Data Evaluation Code Modernization** • Gave the combined SAMMY/AMPX status report at the TPR in Santa Fe. • Since we got permission to distribute SAMMY as an open source project, we created a web-site (https://code.ornl.gov/RNSD/SAMMY) for external users. Unfortunately, a SCALE beta version is still needed to use this version until we create a similar website for the open source part of AMPX and SCALE. • In the previous quarter we worked on restructuring some of the covariance containers in SAMMY. This quarter the work continued to ensure that the covariance matrix of the physical parameters is entirely in C++ storage containers. The same remains to be done for covariance matrix of the u-parameters and the pup'ed parameters. • All resonance parameters except for radius information, is now used directly from C++ storage and no longer uses the SAMMY array structures, which have been deleted. • Some additional container arrays were eliminated, and some minor defects were fixed.

NCSP Element and Subtask: ORNL – ND1, 3, 4, 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	**Reference:** DP0909010/ORNL **Date of Report:** April 2020
BUDGET	**MAJOR ACCOMPLISHMENTS**
	• Work started on using the AMPX reading routines for ENDF files. Initially the reading of File 3, i.e. point-wise cross section data, was switched. • Work continued on the multiple scattering code in SAMMY to replace and test yield normalization, yield data-structures, and associated analytical derivatives • The first parameterization of direct reactions in the phenomenological R-matrix formalism has been derived for the SAMMY pipeline of new features. • **ND7 - Nuclear Data Evaluation and Testing for Nuclear Criticality Safety Applications** • Produced initial results for ZEUS VALID, with continuous-energy results completed and satisfactory to VALID standards. • Incorporated CE results into an initial VALID report for future submission. Sensitivity data are within 3% of Direct Perturbations, well below a 0.005 absolute difference, with 1 of 40 DP confirmations greater than 2-sigma. • Followed the methodology of cross section data path extraction to prepare for isotope-swapping of the following NCSP isotopes of interest, in addition to CIELO and Cu: Gd-155, Gd-156, Gd-157, Gd-158, Gd-160, Np-237. • Drafted Masters' thesis demonstrating ENDF-7.1 and ENDF-8.0 performance of O-16, Fe-56, Cu-63, Cu-65 (isotopes referenced in Appendix B of the five-year plan) for 23 ICSBEP benchmark evaluations containing 102 configurations. • Framed journal article to publish results of O-16, Fe-56, Cu-63, Cu-65 performance by the end of Q3. **ND10 - Monte Carlo Evaluation of Differential and Integral Data** • Gave a progress report on Bayesian Monte Carlo Evaluation Framework of Differential and Integral Data (ND10) at the NCSP TPR, February 11-12, 2020, Santa Fe, NM. • Software development to incorporate modernized SCALE tool for ENDF file reading and writing into ND10 evaluation framework has been initiated. • Software development to incorporate modernized SCALE tools for matrix operations into ND10 evaluation framework has been initiated. • Metropolis-Hastings Monte Carlo algorithm is being implemented in a simple testing environment to demonstrate its feasibility for evaluation of nuclear data in the ND10 evaluation framework.

NCSP Quarterly Progress Report (FY-2020 Q2)

ORNL ND Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND3, ND4, ND6, ND7m 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, ND4, ND6, ND10).		Due to COVID-19, our ND measurement work will likely be behind schedule.
	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, ND4, ND6, 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).		
Q4	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND3, ND4, ND6, 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).		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	IRMM Geel, Belgium Nov 2019 ND1, TS7 Perform resonance region nuclear data measurements using GELINA facility at IRNN in accordance with Appendix B of the Five-Year Plan Participate in WPEC and attend IAEA International Nuclear Data Evaluation Network (INDEN) meeting WPEC and INDEN Paris, France, Vienna, Austria Nov, 2019 Participate in WPEC annual meeting, coordinate international nuclear data collaborations for the NCSP, and present NCSP/ORNL nuclear data evaluation work. Attend IAEA International Nuclear Data Evaluation Network (INDEN) meeting ND1 INDEN Vienna, Austria Oct, 2019 ND1 Attend IAEA International Nuclear Data Evaluation Network (INDEN) meeting	**Yes**	
Q2	**N/A**		
Q3	OECD/NEA Paris, France Jun-20 ND1, TS Participate in WPEC annual meeting, coordinate international nuclear data collaborations for the NCSP, and present NCSP/ORNL nuclear data evaluation work (Sobes, Pigni, Wiarda) Technical meeting of international experts on nuclear data including SG38 (GND), EG-GNDS, SG42 (thermal scatter), SG44 (covariance), SG45 (validation), SG46 (IE for ND evaluation)	**No**	**CANCELLED**
	Vienna, Austria TBD – date ND1 Participate in IAEA working group meeting to improve nuclear data evaluations to support new evaluations of interest to the NCSP (Sobes, Pigni)	**No**	**CANCELLED**

	IAEA International Nuclear Data Evaluation Network (INDEN), Vienna, 1 week. International nuclear data evaluation collaboration. Represent NCSP and ORNL interests in international nuclear data evaluation.		
Q4	Tokyo, Japan Sep-20 ND10 Participate in the 5th International Workshop on Nuclear Data Covariances 2020, (CW2020) (Pigni). Present NCSP-funded project Bayesian Monte Carlo Evaluation of Differential and Integral Data (ND10, Arbanas). Present the progress on fission modeling and generation of covariance matrices for fission product yields with physical constraints.		
	IRMM Mol, Belgium Jan-19 Apr-19 Jun-19 Sep-19 ND, TS7 Perform resonance region nuclear data measurements using GELINA facility at IRMM in accordance with Appendix B of the Five-Year Plan (Guber) Continues cross-section measurements to support the production of new cross-section evaluations per the schedule in Appendix B of the Five-Year Plan.		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	Dorothea Wiarda, "Issues in ENDF/B-VIII.0 GNDS Covariances", November, 2019 Dorothea Wiarda, Goran Arbanas, Andrew Holcomb, Marco Pigni, “Current Status of SAMMY”, November 2019 Marco Pigni, “Updates to R-matrix Evaluations for Fissile Actinides: 233,235U, 239Pu”, November 2019 Marco Pigni, “Status of the n+35Cl cross sections”, November 2019Updates to R-matrix Evaluations of Fissile Actinides: 233,235U, 239Pu" Klaus Guber, ORNL, C. Paradela, S. Kopecky, J. Heyse, P. Schillebeeckx, EC-JRC, “ORNL neutron cross section measurements for the US Nuclear Criticality Safety Program”, November 2019 Jesse Brown, Y. Danon RPI, D. Barry, B. Epping, M. Rapp, Naval Nuclear Laboratory, “Differential Transmission Benchmark Method to Validate		

	Resolved and Unresolved Resonance Parameter Evaluations", November 2019 Jesse Brown, Dorothea Wiarda, "Format proposal: R-external function", November 2019		
Q2	**None**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

Task Titles:

ND1 Nuclear Data Measurement and Evaluation

ND3 Isotopic Sample Leases to Support ND1 ND Measurements

ND4 Thermal Neutron Total Cross Section Measurements for Improvement of Criticality Calculations and Propagation of Scattering Kernel Uncertainties

ND6 SAMMY Nuclear Data Evaluation Code Modernization

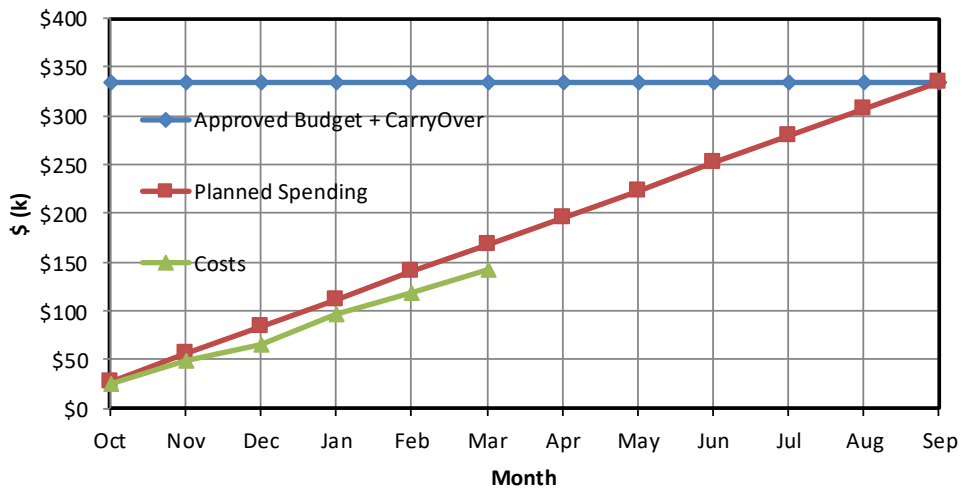
ND10 Monte Carlo Evaluation of Differential and Integral Data

NCSP Quarterly Progress Report (FY-2020 Q2)

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: 4 21, 2020

BUDGET



1. **Carryover into FY 2020** = $ -8,913
2. **Approved FY 2020 Budget** = $ 335,087 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $ 65,388
4. **Actual spending for 2nd Quarter FY 2020** = $ 77,593
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $ 30K

MAJOR ACCOMPLISHMENTS

- Cu scattering publication in progress.
- Preparing for Cr-53 experiment:
  - Performed work to characterize detector response to different input signals, as well as different digitizer settings.
  - Developed a fully scripted MCNP model of detector system.

NCSP Quarterly Progress Report (FY-2020 Q2)

RPI ND1 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	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 FY-18 (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)		No travel to report
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)		Except delays, due to COVID-19 the experimental program was halted since mid-march.

	Complete capture measurement 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)		
	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)		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	OECD/NEA Paris, France May-20 ND1 ND2 Participate in WPEC, and WPEC (Danon, Lui) As US Measurements Chair, participate in WPEC and SG-40 annual meeting to present NCSP/RPI nuclear data measurement work. Participate in SG (thermal scattering meeting) to present NCSP/RPI thermal scattering measurements and analysis.		
Q4	**N/A**		

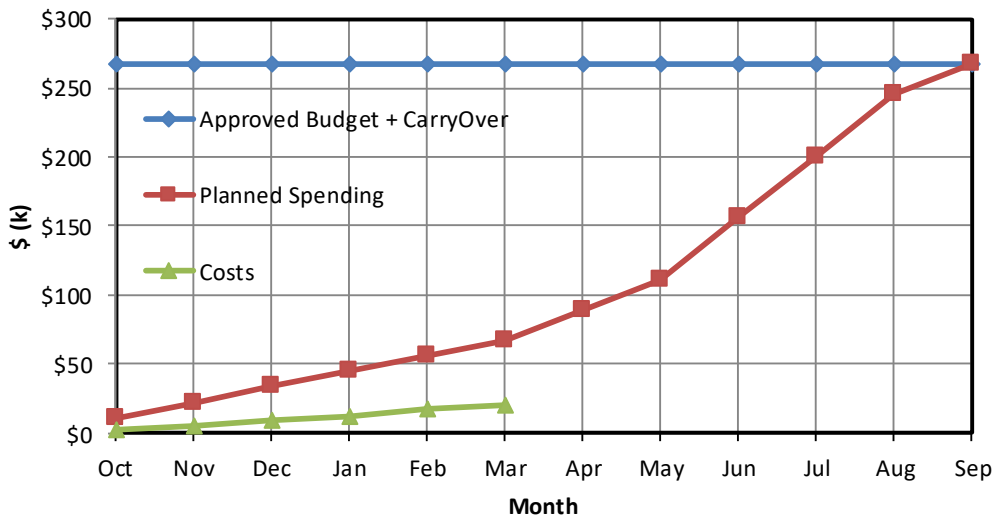
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**none**		
Q2	**none**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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: 4 21, 2020

BUDGET



1. **Carryover into FY 2020** = $ 116,888
2. **Approved FY 2020 Budget** = $ 266,888 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $ 8,827
4. **Actual spending for 2nd Quarter FY 2020** = $11,998
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $50,000

MAJOR ACCOMPLISHMENTS

- Finalized design of accessory components (i.e. table).
- Completed investigation of non-cryogenic low-energy neutron gain improvements (beam filters position).

NCSP Quarterly Progress Report (FY-2020 Q2)

RPI ND2 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	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)		
	Submit cryostat order to vendor (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)		No travel to report
	Complete design and order of auxiliary support for cold moderator. (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)		

	Complete cryostat test. (ND2)		Except delays, due to COVID-19 the experimental program was halted since mid-march.
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 test. (ND2)		

NCSP Quarterly Progress Report (FY-2020 Q2)

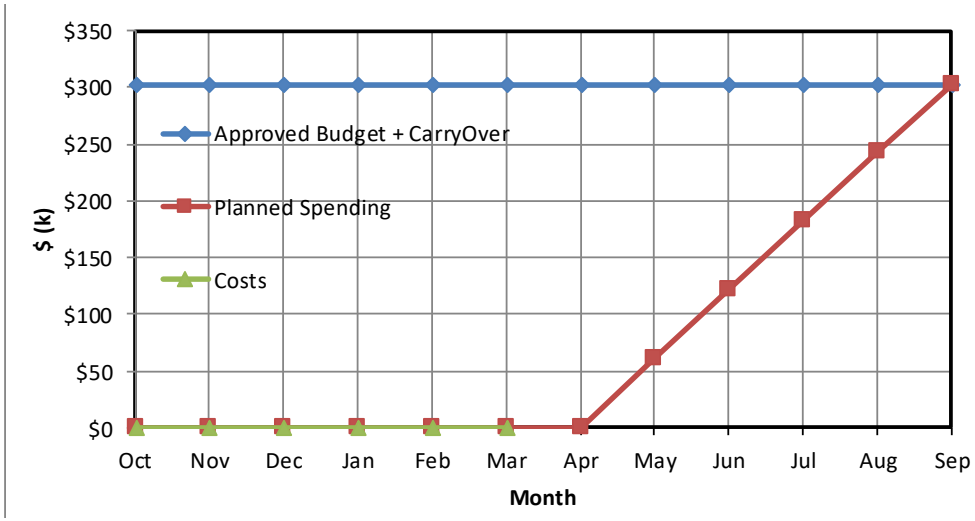
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	OECD/NEA Paris, France May-20 ND1 ND2 Participate in WPEC, and WPEC (Danon, Lui) As US Measurements Chair, participate in WPEC and SG-40 annual meeting to present NCSP/RPI nuclear data measurement work. Participate in SG (thermal scattering meeting) to present NCSP/RPI thermal scattering measurements and analysis.		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**none**		
Q2	**none**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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: 4 21, 2020

BUDGET



1. **Carryover into FY 2020** = $ 0
2. **Approved FY 2020 Budget** = $ 303K (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $ 0
4. **Actual spending for 2nd Quarter FY 2020** = $ 0
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $ 0

MAJOR ACCOMPLISHMENTS

- Successful Factory Acceptance of the Tapered Phase Velocity Structure
- Issued "RPI Phase II Final design Report"
- First RF Modulator (M1263-1) prepared and ready for SAT (delayed due to COVID-19)

NCSP Quarterly Progress Report (FY-2020 Q2)

RPI ND3 Milestones:

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

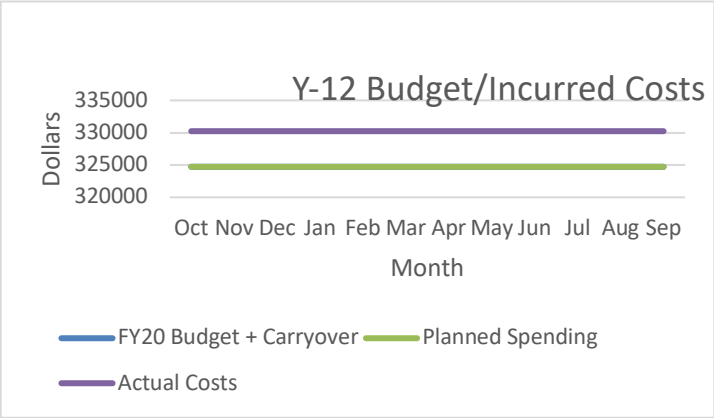
Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND3)		
	Factory acceptance test of RF Modulators 4 (ND3)		
Q2	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND3)		
	Factory acceptance test of Tapered Phase Velocity accelerating structure. (ND3)		
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 Acceptance test of first Speed of Light accelerating structure and Delivery and of TPV and SOL1 Accelerator Sections. (ND3)		
	Factory Acceptance test of Modulator 5 (remotely viewed). (ND3)		
Q4	Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND3)		
	Site acceptance testing of Modulator 1. (ND3)		
	•Site acceptance testing and conditioning of first speed of light accelerating structure. (ND3)		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**none**		Publications will be submitted in Quarter 2
Q2	**none**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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	**Reference: B&R DP0909010** **Date of Report: May 1, 2020**
BUDGET	**MAJOR ACCOMPLISHMENTS**
 1. **Carryover into FY 2020** = $324,722.59 2. **Approved FY 2020 Budget** = $0.00 + $324,722.59 = $324,722.59 (includes carryover) 3. **Actual spending for 1st Quarter FY 2020** = $330,234.00 4. **Actual spending for 2nd Quarter FY 2020** = $NO DATA 5. **Actual spending for 3rd Quarter FY 2020** = $ 6. **Actual spending for 4rd Quarter FY 2020** = $ 7. **Projected carryover into FY 2021 =** $	Q1: Fabrication of new target has begun. Completion estimated in summer (Q3) with delivery in Q4 Alight overage in cost of target manufacture to be covered by carryover in accounts from previous year. Q2: No report from manufacturer as none is expected until Q3 for completion of fabrication.

NCSP Quarterly Progress Report (FY-2020 Q2)

Y12 ND Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

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)		
Q2	Provide a status report of the fabrication of a depleted uranium/molybdenum target per IRMM/GELINA specifications to the NCSP Manager. (ND1)		
Q3	Provide a status report of the fabrication of a depleted uranium/molybdenum target per IRMM/GELINA specifications to the NCSP Manager. (ND1)		
Q4	Provide a status report of the fabrication of a depleted uranium/molybdenum target per IRMM/GELINA specifications to the NCSP Manager. (ND1)		

NCSP Quarterly Progress Report (FY-2020 Q2)

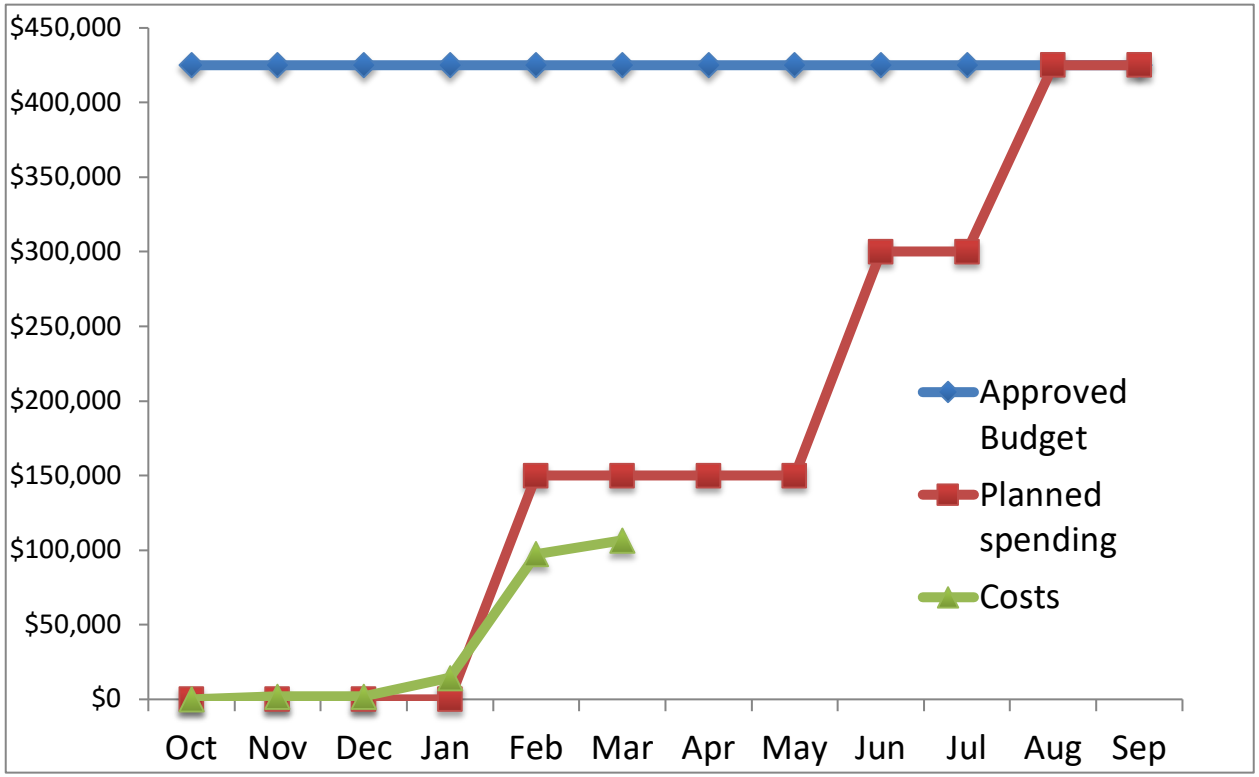
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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: April 15, 2020

BUDGET



1. **Carryover into FY 2020 = $0K**
2. **Approved FY 2020 Budget = $425K**
3. **Actual spending for 1st Quarter FY 2020 = $2K**
4. **Actual spending for 2nd Quarter FY 2020 = $100K**
5. **Actual spending for 3rd Quarter FY 2020 = $0K**
6. **Actual spending for 4rd Quarter FY 2020 = $0K**
7. **Projected carryover into FY 2022 = $0K**

MAJOR ACCOMPLISHMENTS

- NCSP Class conducted in February

NCSP Quarterly Progress Report (FY-2020 Q2)

LANL TE3 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	**TASK**	**STATUS**	**ISSUES/PATH FORWARD**
Q1	Provide status reports on all training activities to the NCSP Manager. (TE3)		
Q2	Provide status reports on all training activities to the NCSP Manager. (TE3)		
Q3	Provide status reports on all training activities to the NCSP Manager. (TE3)		
Q4	Provide status reports on all training activities to the NCSP Manager. (TE3)		

NCSP Quarterly Progress Report (FY-2020 Q2)

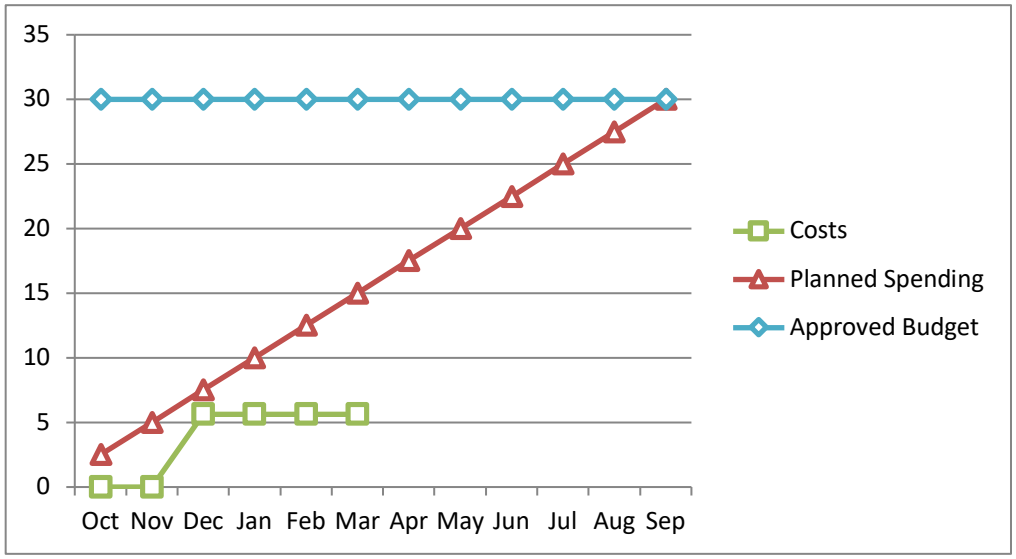
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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 DP090200
Date of Report: May 5, 2020

BUDGET



1. **Carryover into FY 2020 = $0**
2. **Approved FY 2020 Budget = $30,000 (includes carryover)**
3. **Actual spending for 1st Quarter FY 2020 = $5,628**
4. **Actual spending for 2nd Quarter FY 2020 = $0**
5. **Actual spending for 3rd Quarter FY 2020 = $**
6. **Actual spending for 4rd Quarter FY 2020 = $**
7. **Projected carryover into FY 2021 = $0**

MAJOR ACCOMPLISHMENTS

- Location / dates for joint S/U training still being determined for FY20. Most recent outreach was to Idaho National Laboratory, but with travel on hold, details obviously still need to be worked out.

NCSP Quarterly Progress Report (FY-2020 Q2)

LANL TE4 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide status reports on all training activities to the NCSP Manager. (TE4)		
Q2	Provide status reports on all training activities to the NCSP Manager. (TE4)		
Q3	Provide status reports on all training activities to the NCSP Manager. (TE4)		
Q4	In collaboration with ORNL, provide introductory 1-day S/U workshop training to one or more DOE sites in FY20. (TE4)		

NCSP Quarterly Progress Report (FY-2020 Q2)

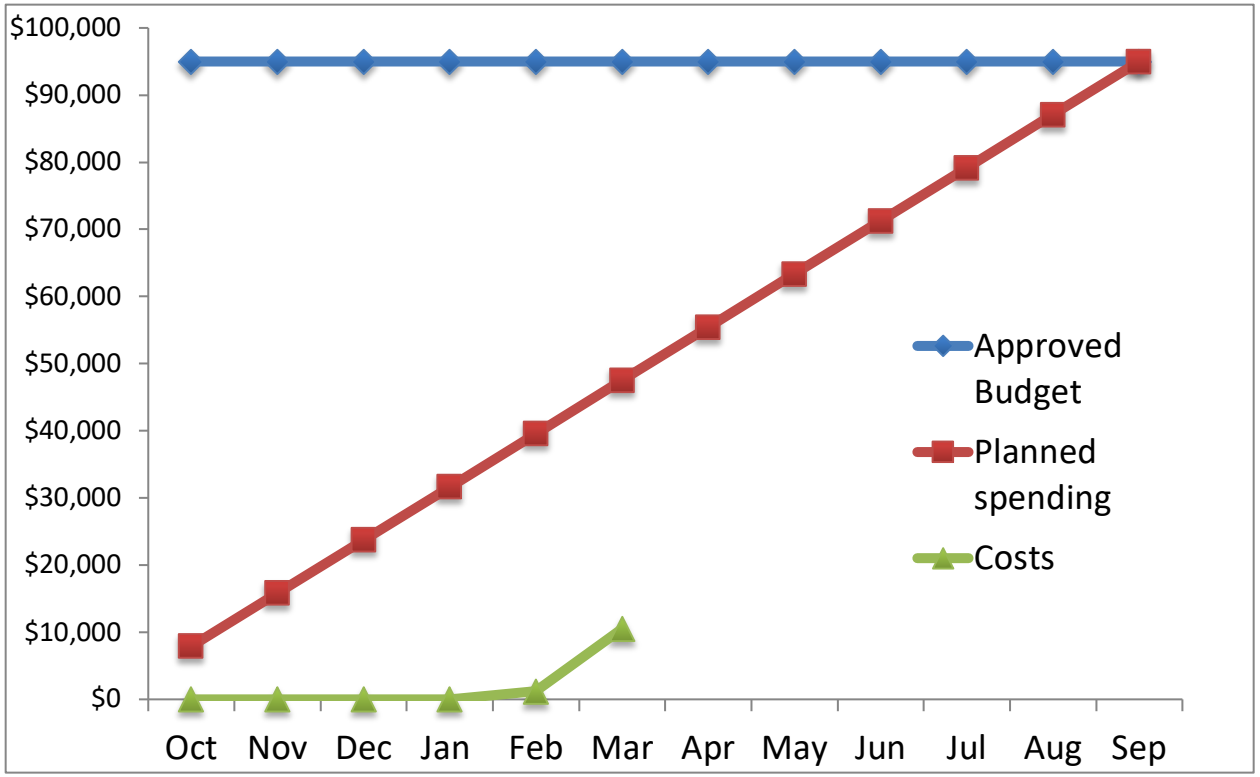
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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

Reference: B&R DP0909010
Date of Report: April 15, 2020

BUDGET



1. **Carryover into FY 2020 = $0K**
2. **Approved FY 2020 Budget = $50K**
3. **Actual spending for 1st Quarter FY 2020 = $0K**
4. **Actual spending for 2nd Quarter FY 2020 = $10K**
5. **Actual spending for 3rd Quarter FY 2020 = $0K**
6. **Actual spending for 4rd Quarter FY 2020 = $0K**
7. **Projected carryover into FY 2021 = $0K**

MAJOR ACCOMPLISHMENTS

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NCSP Quarterly Progress Report (FY-2020 Q2)

LANL TE6 Milestones:
STATUS (copy color code and paste below in 'STATUS' field)

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	**TASK**	**STATUS**	**ISSUES/PATH FORWARD**
Q1	Provide status reports on all training activities to the NCSP Manager. (TE6)		
Q2	Provide status reports on all training activities to the NCSP Manager. (TE6)		
Q3	Provide status reports on all training activities to the NCSP Manager. (TE6)		
Q4	Provide status reports on all training activities to the NCSP Manager. (TE6)		

NCSP Quarterly Progress Report (FY-2020 Q2)

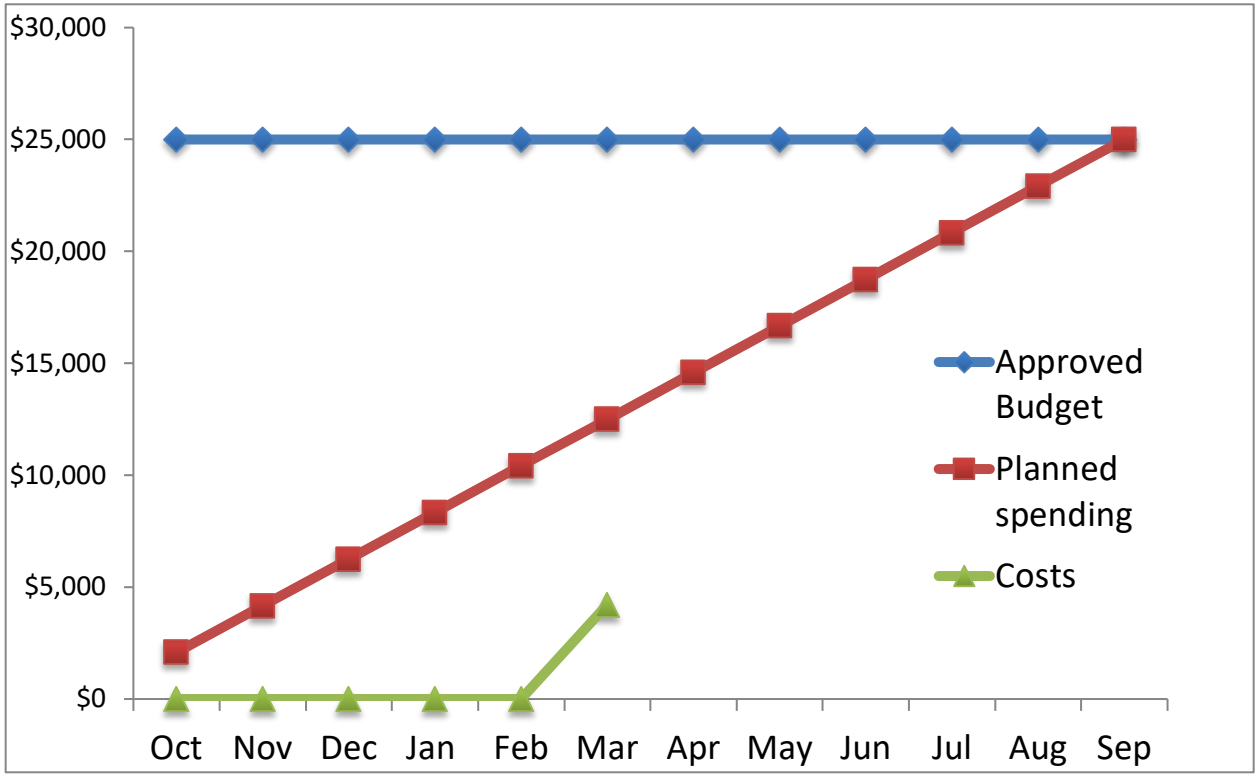
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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

Reference: B&R DP0909010
Date of Report: April 15, 2020

BUDGET



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

MAJOR ACCOMPLISHMENTS

- First Planning Meeting held in Los Alamos March 10-11, 2020.

*Costs were originally charged to another code. They have been moved here.

NCSP Quarterly Progress Report (FY-2020 Q2)

LANL TE7 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	**TASK**	**STATUS**	**ISSUES/PATH FORWARD**
Q1	Provide status reports on all training activities to the NCSP Manager. (TE7)		
Q2	Provide status reports on all training activities to the NCSP Manager. (TE7)		
Q3	Provide status reports on all training activities to the NCSP Manager. (TE7)		
Q4	Provide status reports on all training activities to the NCSP Manager. (TE7)		

NCSP Quarterly Progress Report (FY-2020 Q2)

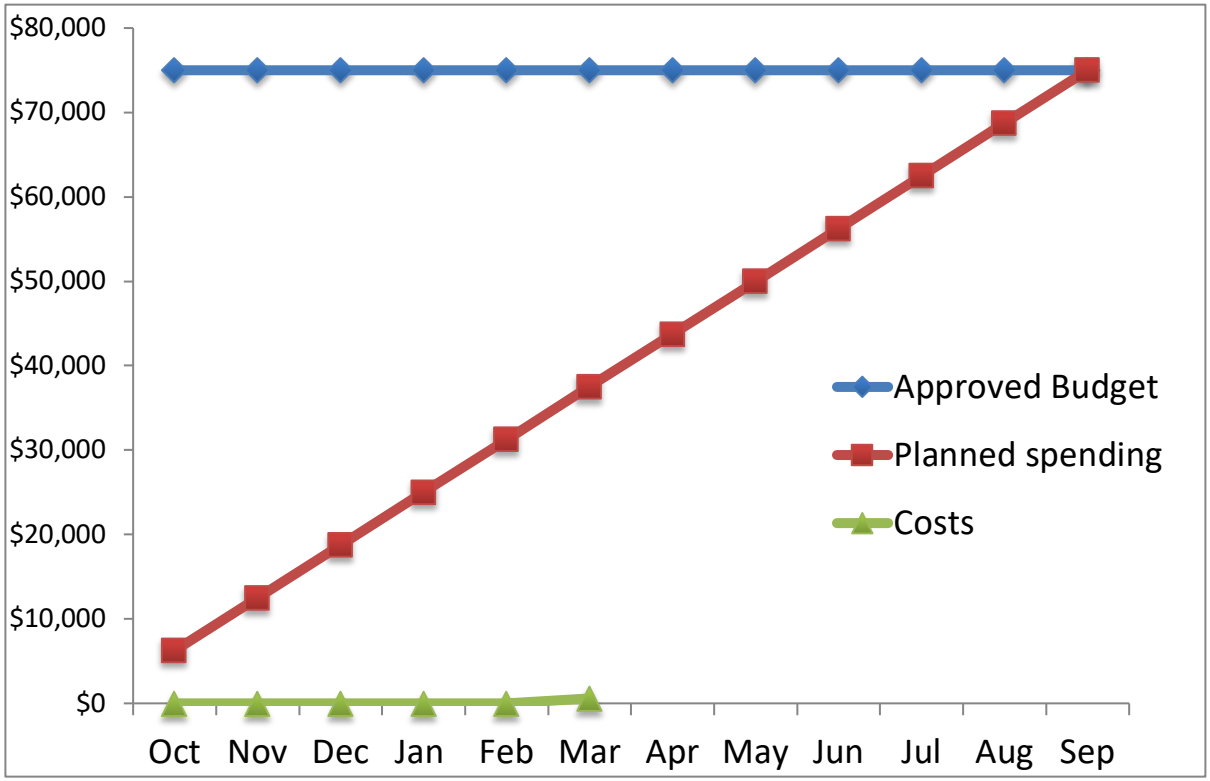
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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: April 15, 2020

BUDGET



1. **Carryover into FY 2020 = $0K**
2. **Approved FY 2020 Budget = $75K**
3. **Actual spending for 1st Quarter FY 2020 = $0K**
4. **Actual spending for 2nd Quarter FY 2020 = $1K**
5. **Actual spending for 3rd Quarter FY 2020 = $0K**
6. **Actual spending for 4rd Quarter FY 2020 = $0K**
7. **Projected carryover into FY 2021 = $0K**

MAJOR ACCOMPLISHMENTS

- Work started late in 2nd quarter on new simulation aid.

NCSP Quarterly Progress Report (FY-2020 Q2)

LANL TE8 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	**TASK**	**STATUS**	**ISSUES/PATH FORWARD**
Q1	Provide status reports on all training activities to the NCSP Manager. (TE8)		
Q2	Provide status reports on all training activities to the NCSP Manager. (TE8)		
Q3	Provide status reports on all training activities to the NCSP Manager. (TE8)		
Q4	Provide status reports on all training activities to the NCSP Manager. (TE8)		

NCSP Quarterly Progress Report (FY-2020 Q2)

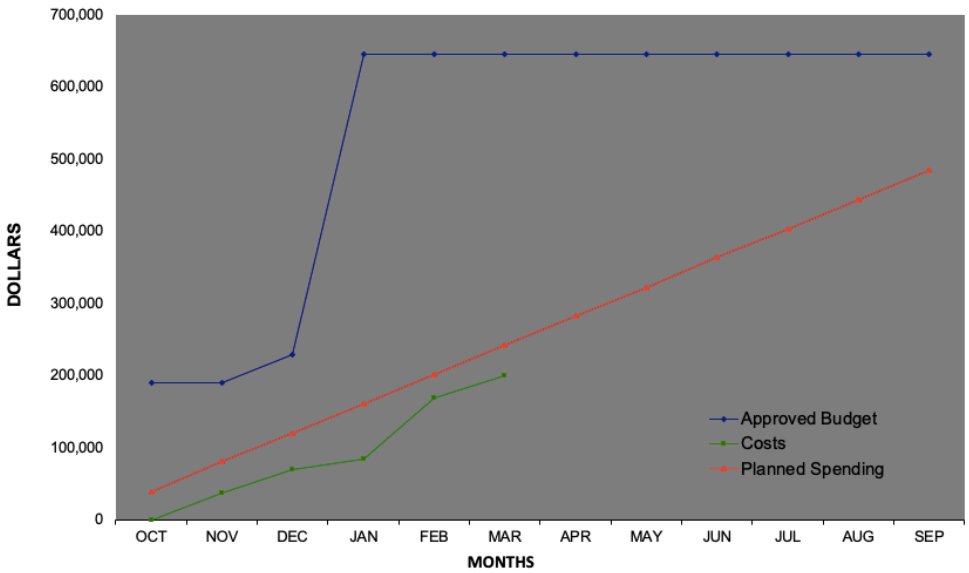
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtasks: TE1, 3, 6, 7, 9
Task Titles: See last page
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: May 8, 2020

BUDGET



1. **Carryover into FY 2020** = $118,004
2. **Approved FY 2020 Budget** = $645,004 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $69,642
4. **Actual spending for 2nd Quarter FY 2020**= $130,260
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $51,600 (8%)

MAJOR ACCOMPLISHMENTS

1. Provided registration and logistics support (TE1, TE3) for:
   - 2-week CSE course on Jan 27-Feb 7, 2020 at NATM/NCERC
   - 1-week Managers course on March 30-April 3, 2020 at SNL
   - 2-week Y-12 course on April 6-17, 2020 at ORNL/NCERC
   - 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-week CSE course on Jan 25-Feb 5, 2021 at NATM/NCERC/SNL
   - 1-week Managers course on April 5-9, 2021 at SNL
   - 1-week Managers course on June 7-11, 20201 at NCERC
   - 2-week CSE course on Aug 9-20, 20201at NATM/NCERC/SNL
2. Provided academic and hands-on instruction for the two-week Criticality Safety Engineer course at NATM and NCERC on January 27-February 7, 2020 including the following modules:
   - NCS Fundamentals
   - NCS Evaluation
   - Introduction to Experimental Methods
   - TACS
   - CSE Workshop
   - Emergency Response
3. Provided update on incorporating beryllium shells into the TACS subcritical experiments at the NCSP TPR in Santa Fe, NM, on February 12, 2020.
4. Participated in all T&E teleconferences (TE1, TE3, TE9).

NCSP Quarterly Progress Report (FY-2020 Q2)

LLNL T&E Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
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, TE6, TE7)		
	Conduct subcritical measurements using beryllium shells and finalize training materials addressing the concept of superior reflection. (TE7)		
	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, TE6, TE7)		1-week Managers course scheduled for March 30-April 3 and 2-week Y12 course scheduled for April 6-17 were cancelled due to COVID-19 concerns.
	Conduct subcritical measurements using beryllium shells and finalize training materials addressing the concept of superior reflection. (TE7)		Instructors conducted subcritical measurements using beryllium shells in Q2.
	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, TE6, TE7)		
	Conduct subcritical measurements using beryllium shells and finalize training materials addressing the concept of superior reflection. (TE7)		
	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, TE6, TE7)		
	Conduct subcritical measurements using beryllium shells and finalize training materials addressing the concept of superior reflection. (TE7)		
	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-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
Q4			
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	Catherine Percher, "LLNL 2019 Incorporation of Superior Reflectors into the Training Assembly for Criticality Safety," LLNL-PRES-804864, February 12, 2020.	**Yes**	
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

Task Titles:

TE1 Conduct Hands-on Training at the DAF (TACS)

TE3 Classroom Criticality Safety Training

TE6 Mobile (CAT III or IV material) Hands on Critical or Near Critical Demonstration Capability

TE7 Criticality Simulator to Demonstrate Criticality Physics Fundamentals to Process Operators

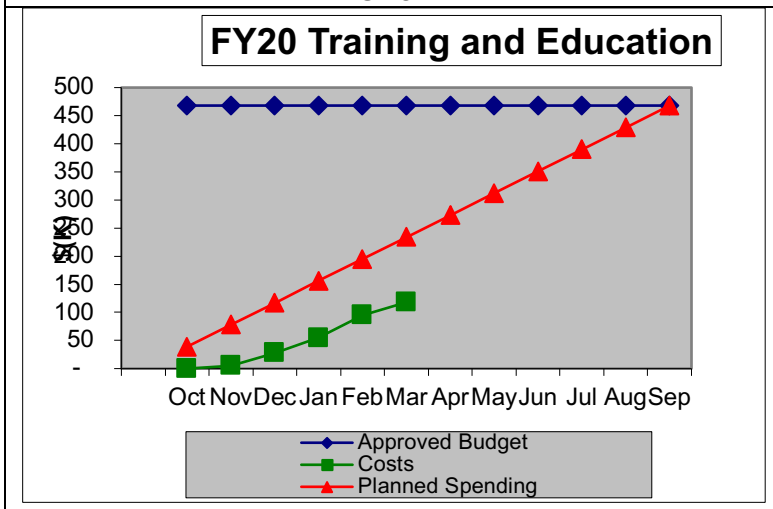
TE9 Design and Develop a New NCSP T&E Course for Criticality Safety Officers at DOE/NNSA Nuclear Facilities

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: TE1, 3, 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

Reference: DP0909010/ORNL
Date of Report: April 2020

BUDGET



1. **Carryover into FY 2020 = $128K**
2. **Approved FY 2020 Budget** = **$468K** (includes carryover)
3. **Actual spending for 1st Quarter FY 2020 = $28K**
4. **Actual spending for 2nd Quarter FY 2020 = $90K**
5. **Actual spending for 3rd Quarter FY 2020 = $**
6. **Actual spending for 4th Quarter FY2020 = $**
7. **Projected carryover into FY 2021 = $**

MAJOR ACCOMPLISHMENTS

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

- Course dates for the 1-week MGR/CSO and 2-week HOC courses have been set for FY21. COVID-19 issues may result in changes.
- In FY2020 Q2, D. Bowen supported the coordination and execution of the 1st 2-week hands-on course at NATM, SNL, and NCERC. The course went quite well and all students passed.
- Bowen, Lousteau, Scott, Henley, and Marshall participated in the activities for the 2-week course in Q2.
- Due to COVID-19, the April 1-week Manager Course at Sandia was cancelled.

TE3 - Hand-calculation Primer Expansion, LA-14244-M

- Dr. Robert Busch (UNM/Retired) has been added to the CS Engineering sub-contract to assist with the Primer (he was coauthor of the original Primer)
- Bowen and Busch now planning the revision scope to finish at the end of FY21.

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

- At the TPR, LANL and ORNL staff discussed locations to offer the next S/U course and decided that INL was a promising location.
- Marshall sent an email attempting to establish contact with INL personnel
- COVID-19 restrictions were put in place and no travel or realistic scheduling can be done at this time, therefore no additional efforts have been made

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

- CSO Table top meeting was completed at LANL with Angela Chambers, LANL, and SNL staff. Comments were compiled to produce a final set of course materials for the course Pilot in June 2020.

TE10 - Design of an Subcritical Assembly at ORNL for use with the CSO Courses

- A feasibility report draft is nearing completion. A new proposal was submitted to the NCSP for FY21 to take the feasibility report and begin to fabricate and prepare for installation at ORNL. The feasibility report should be completed

NCSP Element and Subtask: TE1, 3, 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	**Reference:** DP0909010/ORNL **Date of Report:** April 2020
	by the end of Q3. This report was delayed due to Y-12 delays in receiving the MC&A records for the AGN-201 fuel documents.

NCSP Quarterly Progress Report (FY-2020 Q2)

ORNL TE Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	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 a status report on progress made to develop an updated Hand Calculation Primer (TE3)		Lack of funding in Q1 delayed this task.
	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)		Yellow highlight – this was done a long time ago.
	Provide a status report on progress made to develop an updated Hand Calculation Primer (TE3)		
	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)		Not know whether we can perform a training course at INL in FY20 or not due to COVID-19 issues.
	Provide a status report of the status of efforts to develop a new CSO/FMH course for the NCSP for piloting in FY20. (TE9)		

	Complete 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)		Behind schedule due to delays with Y-12. A proposal was submitted for the next step of this process.
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 a status report on progress made to develop an updated Hand Calculation Primer (TE3)		
	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)		
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)		
	Provide a status report on progress made to develop an updated Hand Calculation Primer (TE3)		
	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-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**none**		Publications will be submitted in Quarter 2
Q2			
Q3			
Q4			

Task Title:

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

TE3 Hand-calculation Primer Expansion, LA-14244-M

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

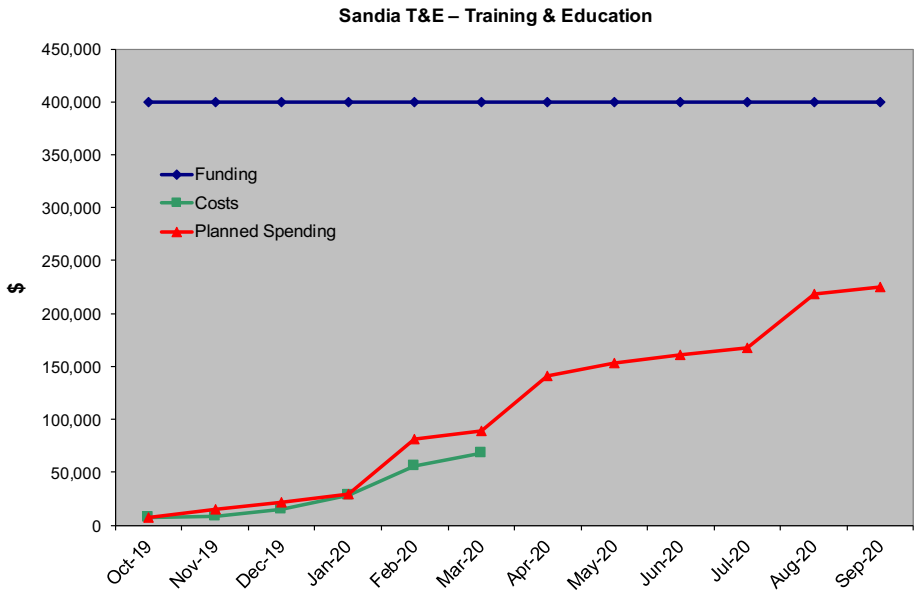
TE10 Design of a Subcritical Assembly at ORNL for use with the CSO/FMH Courses

NCSP Quarterly Progress Report (FY-2020 Q2)

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: **April 31, 2020**

BUDGET



1. **Carryover into FY 2020** = $374,875
2. **Approved FY 2020 Budget** = $399,875 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $15,052
4. **Actual spending for 2nd Quarter FY 2020** = $52,775
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $

MAJOR ACCOMPLISHMENTS

- We delivered the experimental portion of a Hands-On criticality safety course for NCSEs in February 2020.
- The new CSO T&E course development is driven by ORNL. We attended a tabletop review meeting of the proposed course content at LANL.
- We were prepared to deliver a Hands-On criticality safety course for Managers at the end of the quarter. The course was postponed due to the COVID 19 pandemic.

NCSP Quarterly Progress Report (FY-2020 Q2)

SNL T&E Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

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-2020 Q2)

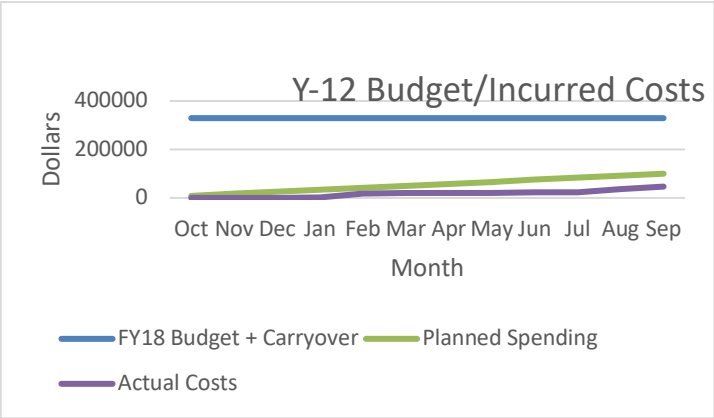
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	Hands-On Training – Water Moderated Critical Experiments – Sandia National Laboratories, SAND2019-14993 TR, Sandia National Laboratories, 2019.	Yes	
Q2			
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtasks: Y12 TE1, 3, 4
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
M&O Contractor Name: Y12
Point of Contact Name: Kevin Reynolds
Point of Contact Phone: (865) 241-9067

Reference: B&R DP0909010
Date of Report: May 1, 2020

BUDGET



1. **Carryover into FY 2020** = $229,223.19
2. **Approved FY 2020 Budget** = $100,000 + $229,223.19 = $329,223.19 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $7,939
4. **Actual spending for 2nd Quarter FY 2020** = $NO DATA
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $

MAJOR ACCOMPLISHMENTS

Q1: No actions taken this quarter.

Q2: No travel or onsite operations due to COVID-19. No actions taken this quarter.

NCSP Quarterly Progress Report (FY-2020 Q2)

Y12 TE Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
Q1	Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1, TE3)		
	Provide a progress report on Y12 support to ORNL for a subcritical assembly feasibility study (TE4)		
Q2	Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1, TE3)		
	Provide a progress report on Y12 support to ORNL for a subcritical assembly feasibility study (TE4)		
Q3	Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1, TE3)		
	Provide a progress report on Y12 support to ORNL for a subcritical assembly feasibility study (TE4)		
Q4	Conduct hands-on training classes at NFO and NCERC to support the training classes in accordance with the approved schedule. (TE1, TE3)		
	Provide a progress report on Y12 support to ORNL for a subcritical assembly feasibility study (TE4)		

NCSP Quarterly Progress Report (FY-2020 Q2)

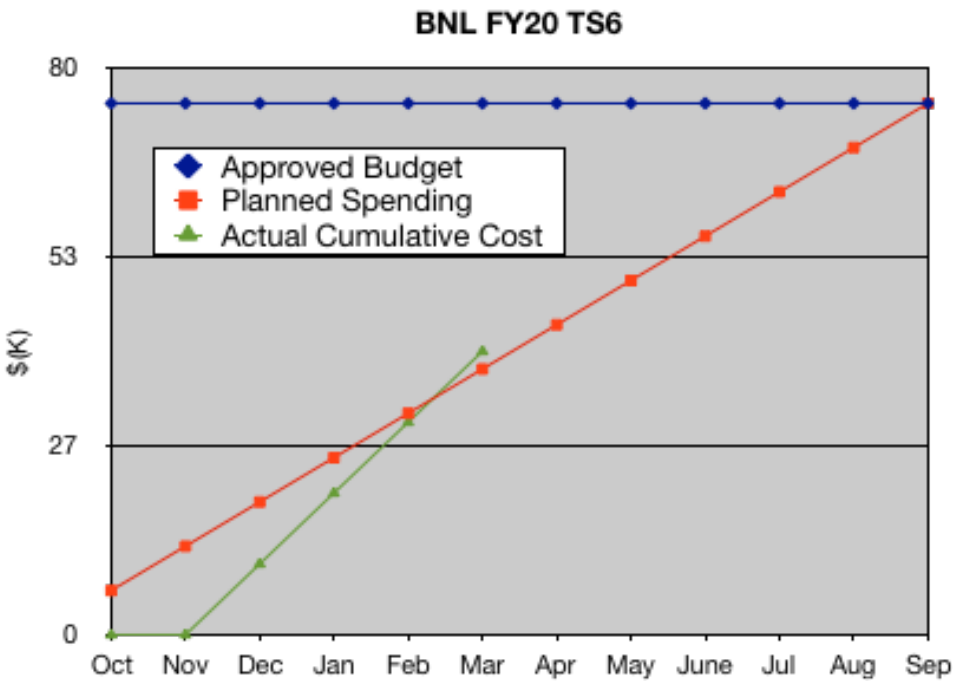
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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

Reference: DP0902000
Date of Report: May 5, 2020

BUDGET



1. **Carryover into FY 2020** = $0
2. **Approved FY 2020 Budget** = $75,000
3. **Actual spending for 1st Quarter FY 2020** = $10,000
4. **Actual spending for 2nd Quarter FY 2020** = $30,000
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $

ACCOMPLISHMENTS

Sophia Hollick (a DOE SULI student collaborator, Fall 2019) completed development of new algorithm to estimate the mean resonance spacing D from resonance data. This algorithm performed far better than any existing technique for estimating D. However, it ran into trouble with missing and misclassified resonances.

Following on Sophia's work, Pedro Rodriguez (a DOE SULI student collaborator, Spring 2020) began the development of a Bayesian classifier that can both pinpoint missing resonances and suggest the appropriate spin group for misclassified resonances using some results from Random Matrix Theory (RMT).

This summer, Sophia and Pedro will combine efforts to extend the classifier with more RMT physics and unleash the classifier on the resonance data within the Atlas of Neutron Resonances.

We aim to submit this work for publication this FY.

NCSP Quarterly Progress Report (FY-2020 Q2)

BNL TS6 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

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-2020 Q2)

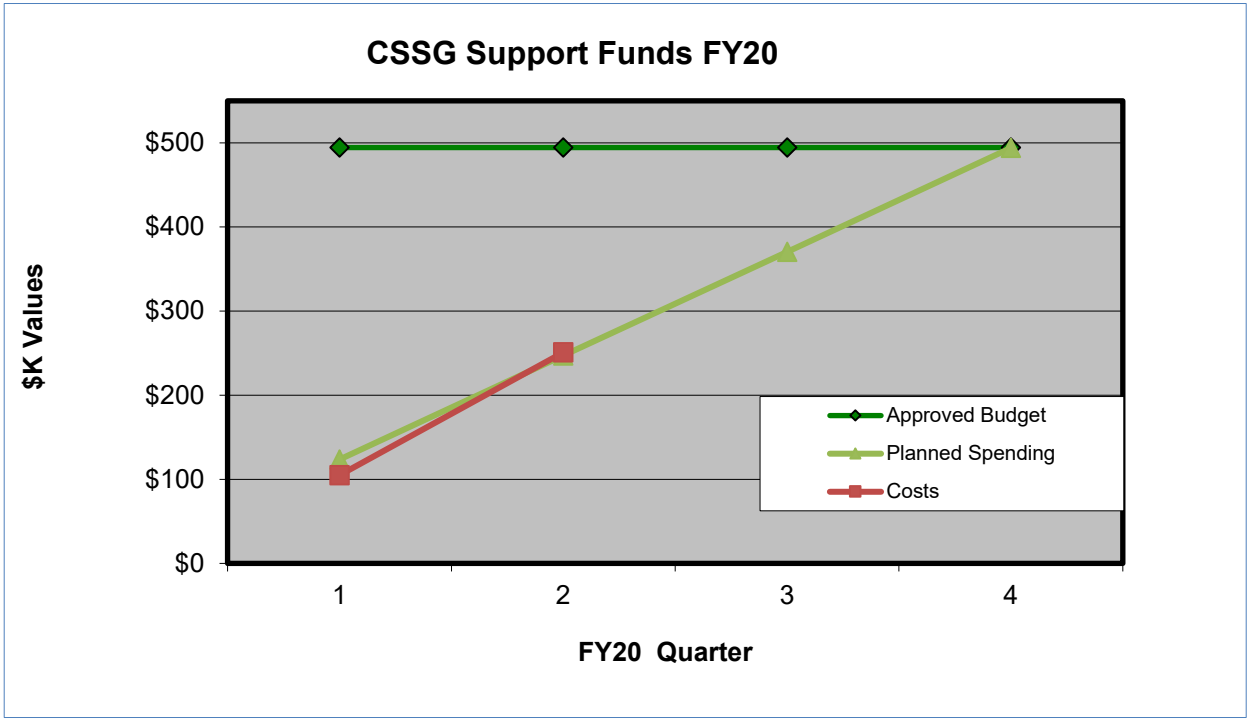
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**	**No**	
Q2	**N/A**	**No**	
Q3	**N/A**	**No**	
Q4	**N/A**	**No**	
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**	No	
Q2	**N/A**		
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: TS1
Task Title: CSSG Support
M&O Contractor Name(s): ANL, LANL, LLNL, ORNL, SRS
Point of Contact Name: David Hayes (CSSG Deputy Chair)
Point of Contact Phone: 505-667-4523

Reference: B&R DP 0909010
Date of Report: April 23, 2020

BUDGET



1. **Carryover into FY 2020** = $ 21,452
2. **Approved FY 2020 Budget** = $ 494,452
3. **Actual spending for 1st Quarter FY 2020** = $104,850
4. **Actual spending for 2nd Quarter FY 2020** = $145,992
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021** = $0

MAJOR ACCOMPLISHMENTS

- February CSSG Face to Face Meeting
- Meeting with D. Sigg (Follow-up required)
- Tasking 2020-01 (1158)
- Tasking 2020-02 (FY21 Proposals)
- Tasking 2020-03 (420.1 White Paper)
- CSSG Telecons

NCSP Quarterly Progress Report (FY-2020 Q2)

CSSG TS Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide the NCSP manager with a summary of CSSG activities, meetings, and tasks. (TS1)		**No Issues**
Q2	Provide the NCSP manager with a summary of CSSG activities, meetings, and tasks. (TS1)		**Taskings 2020-01, 2020-02, 2020-03 all behind schedule. Expect completion by EO APR.**
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)		

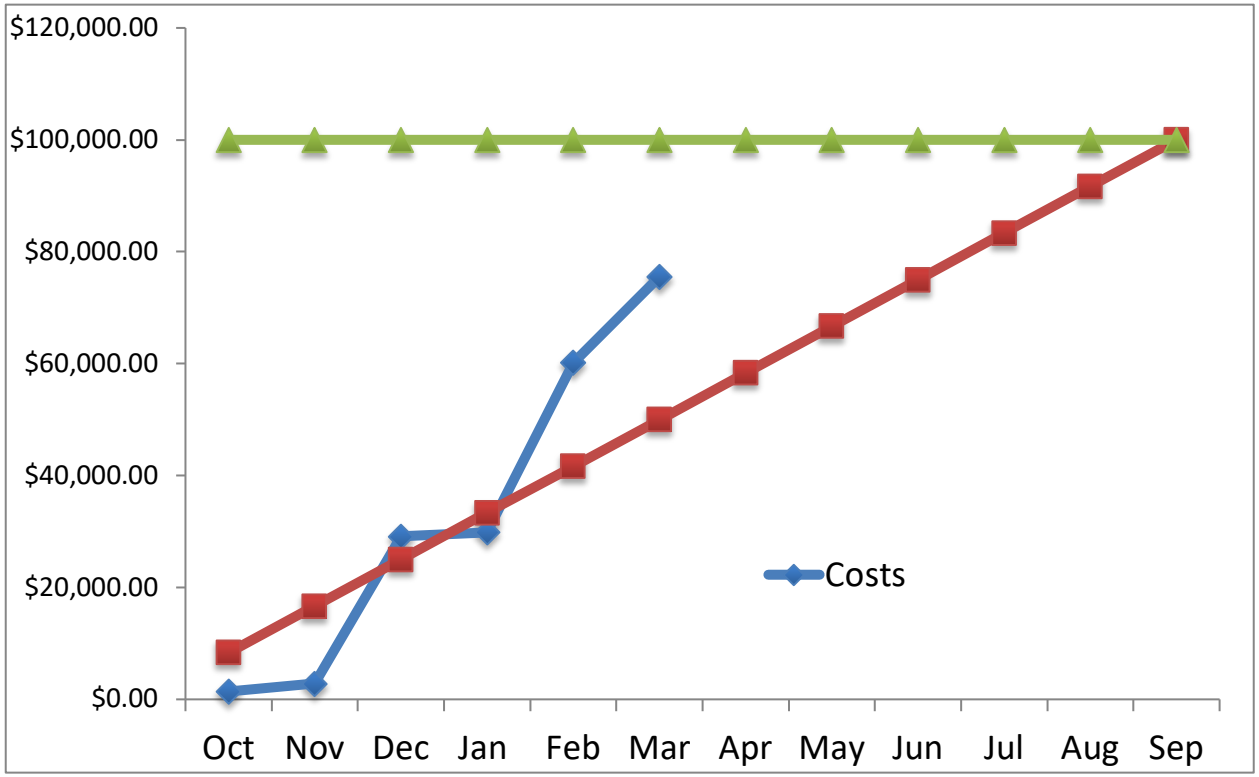
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		

NCSP Quarterly Progress Report (FY-2020 Q2)

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 K. Bluhm
Point of Contact Phone: (505) 667-2440

Reference: B&R DP0909010
Date of Report: April 15, 2020

BUDGET



1. **Carryover into FY 2020** = $0K
2. **Approved FY 2020 Budget** = $100K (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $29K
4. **Actual spending for 2nd Quarter FY 2020** = $46K
5. **Actual spending for 3rd Quarter FY 2020** = $0K
6. **Actual spending for 4rd Quarter FY 2020** = $0K
7. **Projected carryover into FY 2021** = $0K

MAJOR ACCOMPLISHMENTS

- Review of proposals and ranking provided to NCSP Management.

NCSP Quarterly Progress Report (FY-2020 Q2)

LANL TS4 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	NONE		
Q2	NONE		
Q3	NONE		
Q4	Provide NCSP Manager annual report of succession planning efforts.		

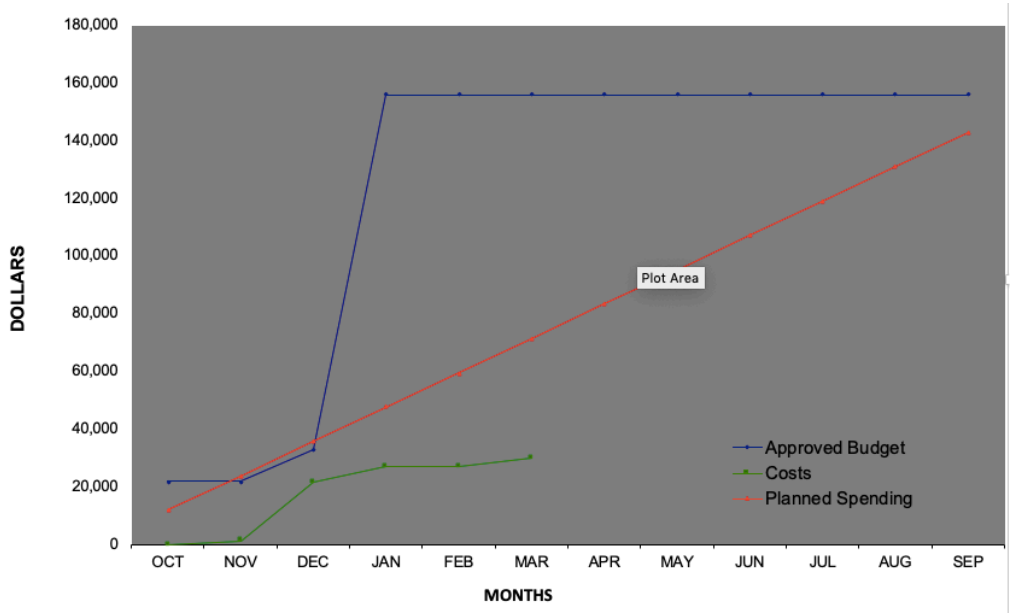
NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3			
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: May 8, 2020

BUDGET



1. **Carryover into FY 2020** = $0
2. **Approved FY 2020 Budget** = $156,000 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $21,715
4. **Actual spending for 2nd Quarter FY 2020** = $ 8,256
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $0 (0%)

MAJOR ACCOMPLISHMENTS

1. All 'non-essential' foreign travel cancelled by NA-1 due to COVID-19 concerns. Cancelled trips include:

   - International Youth Nuclear Congress (IYNC2020) on March 8-13, 2020, in Sydney, Australia (Shauntay Coleman)

   - International Conference on the Physics of Reactors (PHYSOR2020) on March 29 - April 3, 2020, in Cambridge, UK (Catherine Percher).

   - Joint International Conference on Supercomputing in Nuclear Applications and Monte Carlo (SNA+MC 2020) on May 18-22, 2020, in Tokyo, Japan (Soon Kim).

   - 32nd WPEC Meeting at OECD NEA HQ on May 11-15, 2020, in Paris, France (Heckmaier, Percher)

2. Jesse Norris and Daniel Seifman attended the NCSP Analytical Methods Working Group Meeting and Technical Program Review (TPR) in Santa Fe, NM, on February 10-12, 2020 (AM, IE, IP&D, T&E).
3. Tony Nelson is no longer in the LLNL Nuclear Criticality Safety Division having joined Design Physics. Tony is succeeded by Jesse Norris as PI for IER-297, TEX-HEU-HF (IE).
4. Ruby Araj (U. Michigan) joined the LLNL Nuclear Criticality Safety Division on March 2, 2020 (IE).
5. Pam Williams is assisting Stacy Peterson with development and maintenance of the https://ncp.llnl.gov and https://nda.llnl.gov websites (IPD, TS).

NCSP Quarterly Progress Report (FY-2020 Q2)

LLNL TS5 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	NONE		
Q2	NONE		
Q3	NONE		
Q4	Provide NCSP Manager annual report of succession planning efforts.		

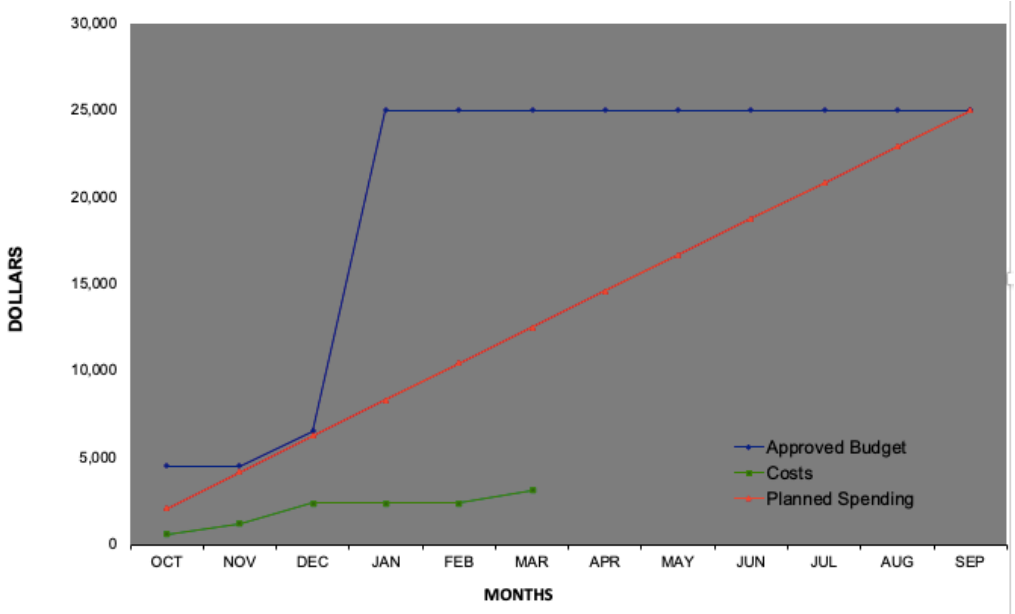
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtasks: TS16
Task Title: LLNL - NDA Website Support
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: May 8, 2020

BUDGET



1. **Carryover into FY 2020** = $0
2. **Approved FY 2020 Budget** = $25,000 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $2,400
4. **Actual spending for 2nd Quarter FY 2020** = $716
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4th Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $0 (0%)

MAJOR ACCOMPLISHMENTS

1. Added https://nda.llnl.gov as a top menu item of https://ncsp.llnl.gov.
2. Added and updated documents linked from https://nda.llnl.gov.

NCSP Quarterly Progress Report (FY-2020 Q2)

LLNL TS5 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide the NCSP manager with a summary of NDA Website support		
Q2	Provide the NCSP manager with a summary of NDA Website support		
Q3	Provide the NCSP manager with a summary of NDA Website support		
Q4	Provide the NCSP manager with a summary of NDA Website support		

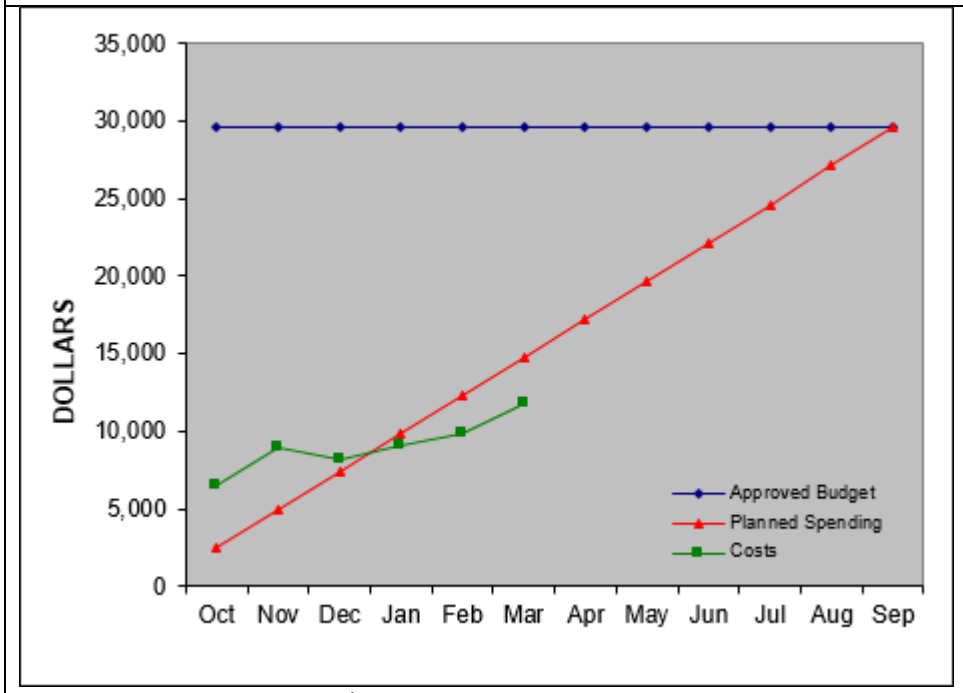
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	"DOE NNSA Nondestructive Assay Program," LLNL-WEB-765077, Approved: January 3, 2019.	**Yes**	
Q3	**N/A**		
Q4	**N/A**		

NCSP Quarterly Progress Report (FY-2020 Q2)

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

Reference: B&R DP0909010
Date of Report: May 7, 2020

BUDGET



1. **Carryover into FY 2020** = $0.5k
2. **Approved FY 2020 Budget** = $29.5k (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $8k
4. **Actual spending for 2nd Quarter FY 2020** = $4k
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2020 =** $ (0%)

MAJOR ACCOMPLISHMENTS

1. Completed NDAG technical review of NCSP FY2021 proposals.
2. Participated in NCSP Technical Program Review including
   a. Chaired NDAG Meeting
   b. Participated in CSSG review of NCSP FY2021 proposals in ex-officio capacity as NDAG Chair.
3. Participated in WANDA-2020 Workshop in Washington, DC including
   a. Co-chairing the "Transport, Scattering and Shielding" session.
   b. Completed summary of "Transport, Scattering and Shielding" session for the workshop minutes.
4. PHYSOR-2020 Conference, three authored/coauthored papers accepted for conference. Conference cancelled due to COVID-19 emergency.
   a. M. L. Zerkle, J. C. Holmes, and J. L. Wormald, "Re-evaluation of the TSL for Yttrium Hydride"
   b. J. L. Wormald, M. L. Zerkle, and J. C. Holmes, "Generation of the TSL for Zirconium Hydrides from Ab Initio Methods" (Received Best Paper Award)
   c. J. C. Holmes, M. L. Zerkle, and A. I. Hawari, "Validation of Thermal Scattering Laws for Light Water at Elevated Temperatures with Diffusion Experiments"
5. Participated in April 2020 IE Meeting remotely as NDAG Chair.
6. CEdT process support as NDAG Chair and CEdT Team Member for several IERs

NCSP Quarterly Progress Report (FY-2020 Q2)

NNL TS9 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

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-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	OECD/NEA Paris, France Oct-19 TS9 ICSBEP and IRPhE Technical Review Meetings (Zerkle) Provide oversight of NCSP IE tasks as ICSBEP tasks are the end product of the NCSP IE process.	No	Report prepared, release approval delayed due to COVID-19 emergency.
Q3	Cambridge, England Apr-20 TS9 Attend PHYSOR 2020 meeting of the ANS. NCSP task that travel. (Zerkle) Present paper on thermal neutron scattering.	No	Conference cancelled due to the COVID-19 emergency.
	OECD/NEA Paris, France May-20 TS9 Participate in WPEC annual meeting (Zerkle) As NDAG Chair, participate in WPEC.		
Q4	**N/A**		

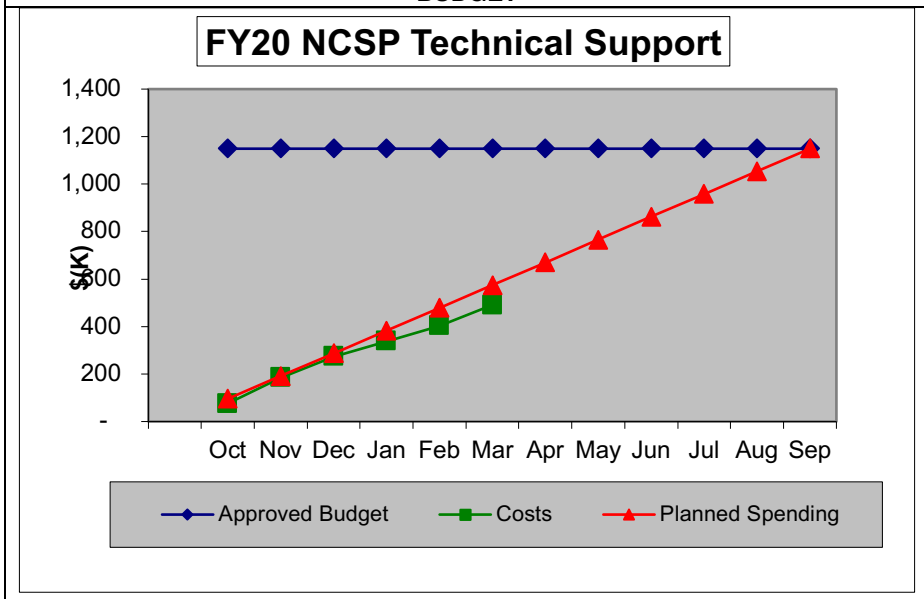
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	M. L. Zerkle, J. C. Holmes, and J. L. Wormald, "Re-evaluation of the TSL for Yttrium Hydride," *PHYSOR-2020*, Cambridge, UK, March 29-April 2, 2020 (accepted).	No	Will be submitted in Q3, release delayed due to COVID-19
	J. L. Wormald, M. L. Zerkle, and J. C. Holmes, "Generation of the TSL for Zirconium Hydrides from Ab Initio Methods," *PHYSOR-2020*, Cambridge, UK, March 29-April 2, 2020 (accepted)	No	Will be submitted in Q3, release delayed due to COVID-19. Won Best Paper Award for Session.
	J. C. Holmes, M. L. Zerkle, and A. I. Hawari, "Validation of Thermal Scattering Laws for Light Water at Elevated Temperatures with Diffusion Experiments," PHYSOR-2020, Cambridge, UK, March 29-April 2, 2020 (accepted)	No	Will be submitted in Q3, release delayed due to COVID-19.
Q2			
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: TS2 (Support for Lead Lab to Execute the NCSP**), TS7** (AM/ND Succession Planning), **TS8** (NCSP MGT Tool Development), **TS11** (CEdT Manager Support), **TS13** (NDA Technical Support Group and NDA Technical Infrastructure Project)
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0909010/ORNL
Date of Report: April 2020

BUDGET



1. **Carryover into FY 2020** = $183K
2. **Approved FY 2020 Budget** = $ (includes carryover) $1149K
3. **Actual spending for 1st Quarter FY 2020** = $273K
4. **Actual spending for 2nd Quarter FY 2020** = $ 218K
5. **Actual spending for 3rd Quarter FY 2020** = $ –
6. **Actual spending for 4rd Quarter FY 2020** = $ –
7. **Projected carryover into FY 2021 = $ –**

MAJOR ACCOMPLISHMENTS

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 Q1 QPRs into a single bookmarked PDF file for use in QPR. Conducted Q1 telecon.
- Scott began to work on the FY20 Spring 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. Led and executed a CSO table top exercise at LANL in March 9-10, 2020.
- Led and participated telecons and WebEx meetings as necessary to track NCSP MGT team actions and deliverables.
- Continue the process to populate the NDA website (http://nda.llnl.gov) with materials to support the NDA Technical Infrastructure Project.
- Working on NCSP website enhancements and fixes
- Rev. 2 of the FY20 Main 5-year plan and Rev. 1 of the Integral Experiment section was completed in March.
- Continued to train Marsha Henley on NCSP MGT team work.
- Scott is working on adding legacy and FY20 foreign travel reports to the NCSP website.

TS7

- Chris Chapman continued to work on nuclear data evaluations with Marco Pigni on Ce and V nuclear data evaluations. Chris is also working on thermal neutron scattering measurements at the ORNL SNS. Jesse Brown has been utilizing these funds to train on GELINA and RPI nuclear data measurements alongside Klaus Guber. Jordan McDonnell was hired in Q2 to support ND1 and AM2 tasks and will be using some of this funding.

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element and Subtask: TS2 (Support for Lead Lab to Execute the NCSP**), TS7** (AM/ND Succession Planning), **TS8** (NCSP MGT Tool Development), **TS11** (CEdT Manager Support), **TS13** (NDA Technical Support Group and NDA Technical Infrastructure Project) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0909010/ORNL **Date of Report:** April 2020
	TS8 • ORNL continued work on an initial prototype of a new NCSP IER database. There were some issues getting the new IER system implemented in the G2 system and NNSA/programmers made some fundamental mistakes with coding due to reorganization and staffing issues. Bowen supported multiple meetings in person and via WebEx with G2 programmers to discuss desired IER database features. Bowen worked with John Miller to begin adding members to the databases and to test its capabilities. This has been an extensive effort. IER database is due to be implemented in Q3 of FY2020. **TS11** • Bowen assisted John Miller on C_EDT tasks as needed (IER approvals, milestone tracking, and meeting execution support) • Supported monthly IE calls in Q2 and associated BCR approvals and IER milestone tracking • The C_EDT manager tracked IER products and Baseline Change Reviews and worked with the NCSP manager to approve tasks, as required. • Bowen worked with Miller (Sandia) in Q2 to continue C_EDT transition efforts **TS13** • Efforts continue on the TSG efforts to generate the new ANSI/ANS-8.28 standard for NDA administrative requirements in NCS programs. The first ANS-8 ballot was completed. Comments are being resolved. • Worked with Cecil Parks on a DOE-wide NDA program with the this task being part of that effort. Plans to visit the NA-50 administrator is in progress.

NCSP Quarterly Progress Report (FY-2020 Q2)

ORNL TS Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	TASK	STATUS	ISSUES/PATH FORWARD
Q1	Manage CEdT 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 NCSP Manager a status report of progress on the development of a program management tool. (TS8)		Implementation of IER system is due in Q2 or Q3 of FY2020. Reorg efforts with the G2 system programmers has led to some delays and mistakes.
	Provide the NCSP manager with a summary of NCSP CEdT support. (TS11)		
	Provide the NCSP manager an update of NDA Technical Support Group and NDA Technical Infrastructure Project activities. (TS13)		
Q2	Manage CEdT 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 NCSP Manager a status report of progress on the development of a program management tool. (TS8)		

NCSP Quarterly Progress Report (FY-2020 Q2)

	Provide the NCSP manager with a summary of NCSP CEdT support. (TS11)		
	Provide the NCSP manager an update of NDA Technical Support Group and NDA Technical Infrastructure Project activities. (TS13)		
Q3	Manage CEdT 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 NCSP Manager a status report of progress on the development of a program management tool. (TS8)		
	Provide the NCSP manager with a summary of NCSP CEdT support. (TS11)		
	Provide the NCSP manager an update of NDA Technical Support Group and NDA Technical Infrastructure Project activities. (TS13)		
Q4	Manage CEdT 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 NCSP Manager a status report of progress on the development of a program management tool. (TS8)		
	Provide the NCSP manager with a summary of NCSP CEdT support. (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 the NCSP manager an update of NDA Technical Support Group and NDA Technical Infrastructure Project activities. (TS13)		

NCSP Quarterly Progress Report (FY-2020 Q2)

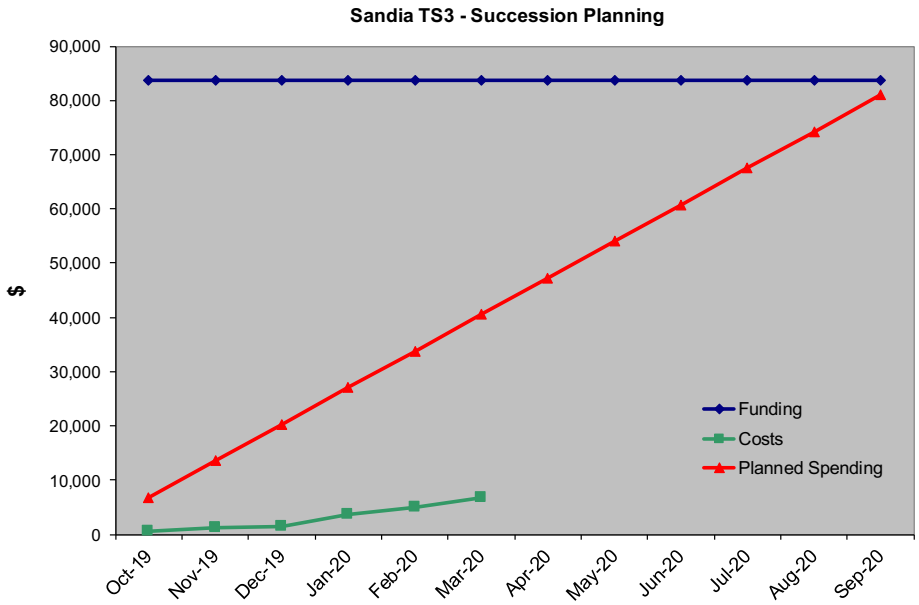
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	London, UK Jun-20 NCSP-TS2 ISO TC85/SC5 Plenary and WG8 Nuclear Criticality Safety Meetings (Bowen) Continue to provide US leadership with ISO Nuclear Criticality		
Q4	Aldermaston, United Kingdom Mar 20 NCSP-TS2 Coordinate NCSP work as described in Appendix F of the Five Year Execution Plan. Bowen invited to participate.		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1			
Q2			
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

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: **April 31, 2020**

BUDGET



1. **Carryover into FY 2019** = $2,593
2. **Approved FY 2020 Budget** = $83,593 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $1,400
4. **Actual spending for 2nd Quarter FY 2020** = $5,250
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $

MAJOR ACCOMPLISHMENTS

- We have a matrixed employee who is performing as an experimenter.
- The new experimenter has completed and published the evaluation of the IER-451 experiments.
- The new experimenter is now working on the IER-230 experiments.
- The new experimenter has been actively participating in the NCS community by attending conferences and publishing papers.
- Our year-round graduate student intern is making substantial progress on documenting some critical experiments done at Sandia in the late ‘80s and early ‘90s.

NCSP Quarterly Progress Report (FY-2020 Q2)

SNL TS3 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

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-2020 Q2)

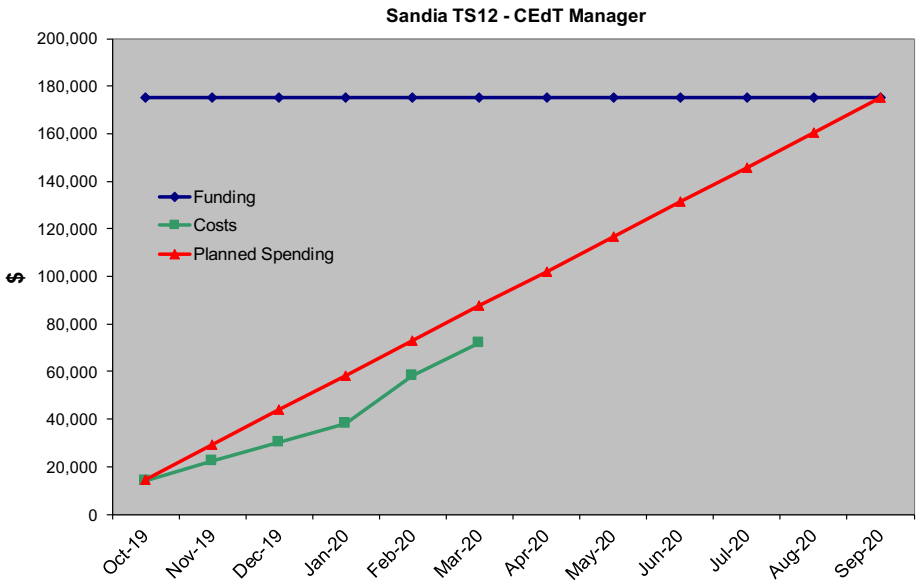
Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1	D. E. Ames, TITANIUM AND ALUMINUM SLEEVE EXPERIMENTS IN FULLY-REFLECTED WATER-MODERATED U(4.31)O_2 FUEL ROD LATTICES WITH 2.8 CM PITCH, LEU-COMP-THERM-099, International Handbook of Evaluated Criticality Safety Benchmark Experiments, NEA/NSC/DOC(95)3, September, 2019.	Yes	
	D. E. Ames, "Sandia BUCCX Titanium and Aluminum Sleeve Experiments," ANS Winter Meeting and Expo, Washington DC, Nov. 2019.	Yes	
Q2			
Q3			
Q4			

NCSP Quarterly Progress Report (FY-2020 Q2)

NCSP Element: SNL TS12
Task Title: Sandia – NCSP C_EdT Manager Support
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: **April 31, 2020**

BUDGET



1. **Carryover into FY 2019** = $0
2. **Approved FY 2020 Budget** = $175,000 (includes carryover)
3. **Actual spending for 1st Quarter FY 2020** = $30,102
4. **Actual spending for 2nd Quarter FY 2020** = $41,846
5. **Actual spending for 3rd Quarter FY 2020** = $
6. **Actual spending for 4rd Quarter FY 2020** = $
7. **Projected carryover into FY 2021 =** $

MAJOR ACCOMPLISHMENTS

- Performed duties as the C_EdT Manager in support of the IE program element.
- Interacted with the various C_EdT Leads, NCSP Management Team, and other NCSP members. Facilitated IE update meetings and issued meeting agenda and minutes.
- Attended the TPR meeting.
- Tracked progress and BCRs on IER action items and 2020 milestones including WFO IER action items.
- Worked in the IER database and assisted others in the transition to the new database.
- Assisted the DOE NCS Program Management Team on a broad scope of items.

NCSP Quarterly Progress Report (FY-2020 Q2)

SNL TS3 Milestones:

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

Complete	On Schedule	Behind Schedule	Missed Milestone

QUARTER	MILESTONE	STATUS	ISSUES/PATH FORWARD
Q1	Provide the NCSP manager with a summary of NCSP CEdT support. (TS12)		
Q2	Provide the NCSP manager with a summary of NCSP CEdT support. (TS12)		
Q3	Provide the NCSP manager with a summary of NCSP CEdT support. (TS12)		
Q4	Provide the NCSP manager with a summary of NCSP CEdT support. (TS12)		

NCSP Quarterly Progress Report (FY-2020 Q2)

Foreign Trip Reports (from Appendix C – 5YP)			
Quarter	**Foreign Trip Report** (please provide details for reports not listed below)	**Submitted yes/no**	**If no, state status of submittal**
Q1	**N/A**		
Q2	**N/A**		
Q3	**N/A**		
Q4	**N/A**		
Publications (add each publication on an individual line)			
Quarter	**Publication Reference**	**Submitted yes/no**	**If no, state status of submittal**
Q1			
Q2			
Q3			
Q4			

Summary of MCNP Criticality Classes in FY 2020

F.B. Brown[1], M.E. Rising[1], J.L. Alwin[2]
[1] Monte Carlo Codes (XCP-3), [2] Radiation Transport Applications (XCP-7), LANL

FY2020 – Q1 & Q2 classes are highlighted in red.

Total Students

- FY2020 – Q1: 100 students (Criticality, UNM, Intro, Intermediate, VR, UM, NJOY classes)
- FY2020 – Q2: 36 students (Criticality, UNM, Intro classes)

Classes sponsored by DOE-NNSA-NCSP

- **Criticality Calculations with MCNP6 (LANL-AM1)**
  - **Oct 21-24, 2019, Y-12 22 students**
  - **March 9-13, 2020 LANL 10 students**
  - **August 3-7, 2020 LANL 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, NCS students do not pay registration fees. For classes at other DOE sites, there are no registration fees.

- **Sensitivity-Uncertainty Tools & Practices for NCS Validation (LANL-TE4)**
  - TBD TBD TBD

  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.

- **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. 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.)

- **Advanced Monte Carlo Methods (LANL-AM1)**
  - **Jan 23 – May 7, 2020, UNM 11 graduate students**

  This is an advanced class covering details of transport theory, Monte Carlo, advanced computing methods, and code development. Material from this course is also used to teach LANL staff members. (This teaching is partially supported by NCSP, ASC, and other programs.)

Other Classes - supported by student registration fees.

- **Introduction to MCNP6**
  - **Oct 21-25, 2019, LANL 14 students**
  - **March 2-6, 2020 LANL 15 students**
  - **April 27-30, 2020 Online Pilot scheduled**
  - **June 1-5, 2020 LANL postponed**
  - **June 15-19, 2020 OECD-NEA postponed**
  - **July 6-10, 2020 LANL scheduled**

  Introductory class, includes 1/2 day on criticality calculations (without coverage of NCS validation & Whisper).

- **Intermediate MCNP6**
  - **Oct 7-11, 2019, OECD-NEA, Paris 13 students**
  - **Oct 28 – Nov 1, 2019 LANL 13 students**
  - **June 22-26, 2020 OECD-NEA scheduled**
  - **July 20-24, 2020 LANL scheduled**
  - **Sept 28- Oct 2, 2020 LANL scheduled**
- **Unstructured Mesh with Attila4MC**
  - **Nov 5-9, 2019 LANL 9 students**
  - **July 13-17, 2020 LANL scheduled**
- **Variance Reduction**
  - **Oct 14-18, 2019 OECD-NEA, Paris 11 students**
  - **July 27-31, 2020 LANL scheduled**
  - **Sept 28- Oct 2, 2020 LANL scheduled**
- **Using NJOY to Create MCNP ACE Files & Visualize Nuclear Data**
  - **June 16-18, 2020 LANL postponed**

2020 Q2 – SCALE Training Courses Report for the Nuclear Criticality Safety Program

Class Name	SCALE Criticality Safety and Radiation Shielding
Class Dates	Feb 3 – 7, 2020
Location	Oak Ridge National Lab, Oak Ridge, TN
Number of Attendees	14
Short Description	This course provides instruction on the use of the KENO-VI Monte Carlo code for criticality safety calculations and the MAVRIC (Monaco with Automated Variance Reduction using Importance Calculations) shielding sequence with 3-D automated variance reduction for deep-penetration problems. KENO-VI is a 3D eigenvalue Monte Carlo code for criticality safety and Monaco is a 3D fixed-source Monte Carlo code for shielding analysis. Both codes use the SCALE Standard Composition Library and the SCALE Generalized Geometry Package (SGGP), which allows for versatile modeling of complex geometries and provides convenient, efficient methods for modeling repeated and nested geometry configurations such as lattices. The MAVRIC sequence is based on the CADIS (Consistent Adjoint Driven Importance Sampling) methodology. For a given tally in a Monte Carlo calculation that the user wants to optimize, the CADIS method uses the result of an adjoint calculation from the Denovo 3D deterministic code to create both an importance map for weight windows and a biased source distribution. MAVRIC is completely automated in that from a single user input, it creates the cross sections (forward and adjoint), computes the adjoint fluxes, creates the importance map and biased source, and then executes Monaco. An extension to the CADIS method using both forward and adjoint discrete ordinates calculations (FW-CADIS) is included in MAVRIC so that multiple point tallies or mesh tallies over large areas can be optimized (calculated with roughly the same relative uncertainty). Both KENO and Monaco use ENDF/B-VII.0 or ENDF/B-VII.1 cross-section data distributed with SCALE to perform continuous energy (CE) or multigroup (MG) calculations. Both codes can also be used with the Fulcrum consolidated SCALE user interface and KENO3D for interactive model setup, computation, output review, and 3-D visualization. Instruction is also provided on the SCALE material input and resonance self-shielding capabilities and the data visualization capabilities within Fulcrum for visualizing fluxes, reaction rates, and cross-section data as well as mesh tallies. KENO-VI and MAVRIC can be applied together to perform an integrated criticality accident alarm system (CAAS) analysis.

Class Name	SCALE/ORIGEN Standalone Fuel Depletion, Activation, and Source Term Analysis Course
Class Dates	Feb 10 – 14, 2020
Location	Oak Ridge National Lab, Oak Ridge, TN
Number of Attendees	17
Short Description	This is a hands-on class that covers the use of ORIGEN for isotopic depletion, decay, decay heat, and radiation source-terms calculations. The course features the use of the Fulcrum consolidated SCALE graphical interface and Fulcrum plotting capabilities for displaying nuclear data and results. The class includes solving activation, spent fuel, and nuclear safeguards and security analyses. This class provides an introduction to the ORIGAMI tool for convenient characterization of spent nuclear fuel with radially and axially varying burnup. Advanced applications

	including simulation of chemical processing, continuous feed and removal are also covered.

Class Name	SCALE Sensitivity and Uncertainty Analysis for Criticality Safety Assessment and Validation
Class Dates	Feb 17 – 21, 2020
Location	Oak Ridge National Lab, Oak Ridge, TN
Number of Attendees	15
Short Description	Sensitivity and uncertainty analysis methods provide advanced techniques for code and data validation including the identification of appropriate experiments, detailed quantification of bias and bias uncertainty, identification of gaps in available experiments, and the design of new experiments. The Sampler sequence within SCALE provides a flexible tool for quantifying uncertainties due to manufacturing tolerances as well as composition and dimensional uncertainties in criticality safety assessments. This 5-day training class provides a foundation on sensitivity and uncertainty analysis and applies these methods to criticality safety validation applications, as well as instruction on the use of Sampler for uncertainty quantification. Topics covered include: • The TSUNAMI sensitivity and uncertainty analysis techniques for determining the sensitivity of the k-eff eigenvalue to cross section uncertainties using both multigroup and continuous-energy physics. • SCALE's comprehensive cross section covariance data library, which is applied to these sensitivity coefficients to estimate the data-induced uncertainty in k-eff. • The TSUNAMI-IP code, which determines the correlation between benchmark and application systems in terms of their shared sources of data-induced uncertainty. • The USLSTATS trending analysis tool, which uses similarity coefficients from TSUNAMI-IP (among other parameters) to estimate the computational bias and bias uncertainty for design and licensing applications. • The TSURFER data adjustment tool, which uses generalized linear least squares to adjust nuclear data parameters to minimize discrepancies between computed predictions and the results of integral experiments; these adjustments can then be used to estimate bias and bias uncertainty in design and licensing applications. • The SAMPLER code for uncertainty assessment, which randomly samples nuclear data and/or system compositions and dimensions to quantify the uncertainty in system k-eff. This course will cover the theoretical basis for these analysis techniques and will also conduct exercises for attendees to familiarize themselves with these tools. It is recommended that attendees are familiar with the KENO Monte Carlo code or are experienced SCALE users, although these are not necessary prerequisites.

Class Name	SCALE/Polaris Lattice Physics, Depletion and Uncertainty Analysis
Class Dates	Feb 24 - 28, 2020
Location	Oak Ridge National Lab, Oak Ridge, TN
Number of Attendees	8
Short Description	Polaris is a new 2-dimensional (2-D) lattice physics capability in the SCALE code system for LWR analysis. Polaris provides an easy-to-use input for defining lattice geometries, material compositions, and reactor state conditions. Other features of Polaris include a new resonance self-shielding implementation based on the novel embedded self-shielding method (ESSM), a new 2-D method of characteristics (MOC) neutron transport solver, and the integration of the ORIGEN depletion and decay solver for depleting material compositions. For the first three days of this five days course, attendees will learn how to model typical PWR and BWR assemblies (VVER currently not supported): develop geometry models, perform depletion simulations, setup branch and history calculations to generate few-group cross sections for full-core nodal diffusion analysis (.t16 file), and perform reflector calculations. Sampler is a new uncertainty analysis capability in SCALE that propagates uncertainties in nuclear data and input parameters to estimate the resulting uncertainty in calculated responses for most codes and sequences within the SCALE code system. Using stochastic sampling to generate perturbed calculation models, Sampler can automate multiple runs (i.e. samples) of a calculation model and then post-process the outputs to quantify the uncertainty in user-selected quantities of interest. In the final two days of this course, attendees will learn how to use Sampler with Polaris to quantity the uncertainty in lattice physics quantities of interest (reactivity, nodal cross sections, isotopic inventories) from a broad range of input uncertainty sources (nuclear data, geometry, composition, and reactor condition). Additional topics for this course include overviews of several modeling scenarios for Polaris (control blade, IFBA, spacer grid, thermal expansion, and detector modeling); how to generate depleted material composition data files (.f71 file) for subsequent use in ORIGEN calculations; and how to utilize Sampler/Polaris outputs for uncertainty analysis for full-core nodal calculations.

The two NEA Data Bank courses, SCALE Sensitivity/Uncertainty Analysis and Uncertainty Quantification for Criticality Safety Validation (March 16 – 20, 2020) and Source Terms and Radiation Shielding for Spent Fuel Transportation and Storage Applications (March 23 – 27, 2020) were cancelled due to COVID-19. The SCALE Sensitivity/Uncertainty Analysis and Uncertainty Quantification for Criticality Safety Validation course has tentatively been rescheduled for Sept 7 – 11, 2020. Another date to have the Source Terms course is still in the planning process.

STATUS REPORT
on the
International Collaboration with the Atomic Weapons Establishment (AWE)

Reference			AWE Contributions and POCs			
AWE Reference	**Task Description**	**NCSP Reference**	**FY2018 AWE Contribution**	**AWE Technical POC**	**Collaborator POC**	**DOE Lab**
Analytical Methods						
AWE-AM1	Slide rule update	ORNL-AM6 LLNL-AM3 IRSN-AM5	Perform calculations; attend meetings; review analysis and reports	R. JONES	M. DULUC	ORNL
AWE effort currently on hold due to lack of resource.						
INTEGRAL EXPERIMENTS						
AWE-IE1	Inaugural international inter-comparison of nuclear accident dosimetry using Flattop	LLNL-IE1 IRSN-IE15	Co-author final report (CED-4b)	P. ANGUS	D. STONE	LLNL
Report completed and issued by C. Wilson before his departure in 2019. Next inter-comparison exercise anticipated to be 2021.						
AWE-IE2	Development of Passive Neutron Spectrometer (PNS)		Fully commission TLD version of the PNS; Perform validation irradiations at NPL; develop unfolding tools for directionality	P. ANGUS	D. STONE	LLNL
3x PNS developed and built. Irradiations at NPL planned for March 2020, with potential involvement from US community.						
AWE-IE3 **IER 406**	Cf-252 CAAS benchmark	LLNL-IE1 IRSN-IE28	Perform/support PNS(TLD) measurements with a shadow cone	P. ANGUS	D. HEINRICHS	LLNL
Dependent on completion of IE2.						
AWE-IE4 **IER 175**	Godiva-IV CAAS benchmark	ORNL-IE4 IRSN-IE27	Review of experiment design. Provide measurement capability as required	T. BIRKETT	J. SCORBY	ORNL
AWE involvement complete. Any further work dependent on future ORNL programme.						
AWE-IE5	Correction factor for dosimetry linked to orientation of the victim	LLNL-IE1 IRSN-IE29	Participate in experiment design; use PNS data to determine directional components of neutron fields (Godiva, Flattop, LLNL RCL)	P. ANGUS	D. HEINRICHS	LLNL
Dependent on completion of IE2 (unfolding tools for directionality). Linked with IE11 (2021 International inter-comparison)						
AWE-IE6	ICSBEP shielding benchmark for shipping containers	LLNL-IE13 IRSN-IE36	Participate in experiment design; PNS(TLD) could be deployed as primary measurement device AWE to do some preliminary design	P. ANGUS	S. KIM	LLNL

Reference			AWE Contributions and POCs			
AWE Reference	**Task Description**	**NCSP Reference**	**FY2018 AWE Contribution**	**AWE Technical POC**	**Collaborator POC**	**DOE Lab**
Not started due to long lead time (2023) and dependence on PNS availability (see IE2). Scope definition required.						
AWE-IE7 **IER 153**	Measure fission neutron spectrum shape using threshold activation detectors	LANL-IE3	Provide input into foil selection; use AWE unfolding codes to provide independent analysis. TBC AWE to provide foil suggestions per MYERS	P. ANGUS	T. CUTLER B. MYERS	LANL
Awaiting LANL to advise on the extent of AWE involvement.						
AWE-IE8	Diagnostic development for measurement of correlated leakage radiations	LLNL-IE1	A feasibility study is being developed at AWE to ascertain suitable counting scenarios and methods. An experimental design will then be produced in the following years based upon the outcomes of this study	N. KELSALL	D. HEINRICHS	LLNL
An internal AWE report has been issued summarizing the outcome of the fast neutron liquid scintillation trials conducted at the DAF in 2019. This will inform future measurement aspirations but the schedule for measurement campaigns is on hold during the COVID-19 pandemic.						
AWE-IE9	(Neutron multiplicity experiments) AWE/LLNL NCT 5 year measurement campaign	LLNL-PROPOSAL 18	Participate in experiment design, measurements and reporting	N. KELSALL	D. HEINRICHS	LLNL
AWE has issued an internal report summarizing the results from analysis of bulk material measurements. During the next quarter it is anticipated that, following suitable modification, this report will be re-issued in a form that can be shared with the NCSP.						
AWE-IE10	Enhanced methods of criticality accident dosimetry.	LLNL-IE1 IRSN-30 IRSN-33 Naval Dosimetry Center	Develop prototypes, participate in design, execution and reporting of dosimetry experiments	P. ANGUS	F. TROMPIER	LLNL
No progress to date. Potentially use IE11 as an opportunity to compare & test any new instrumentation.						
AWE-IE11	International inter-comparison of nuclear accident dosimetry AWE to assist in preliminary design FY19 and FY20	LLNL-IE18 SNL-IE4	Produce experiment design; participate in exercise; produce final report. Repeat 2 - 3 years	P. ANGUS	D. STONE	LLNL
Next international inter-comparison is scheduled for 2021.						
AWE-IE12	CIDAAS testing	Proposal 20	Deploy AWE CIDAAS for test irradiation. Repeat 2 - 3 years	T. BIRKETT	J. SCORBY	LLNL
AWE successfully tested CIDAAS in May 2018 and provided support to CED-4. Technical report detailing the results has been issued.						
AWE-IE13	Characterization of AFRRI TRIGA reactor radiation field	LLNL-IE18 SNL-IE4	Provide support to experiment design	P. ANGUS	A. ROMANYUKHA	LLNL

Reference			AWE Contributions and POCs			
AWE Reference	**Task Description**	**NCSP Reference**	**FY2018 AWE Contribution**	**AWE Technical POC**	**Collaborator POC**	**DOE Lab**
	AWE will provide onsite measurement					
AWE was fully prepared for July 2019 trial, prior to the regulatory shut-down of TRIGA. If trial is re-scheduled for 2020 AWE will be able to support it, provided sufficient notice is given.						
INFORMATION PRESERVATION AND DISSEMINATION						
AWE-IPD1	Conduct benchmark evaluations of legacy IEU integral experiments Requires no NCSP funding	LLNL-IPD1	Assess feasibility of sponsoring PhD; determine availability of data	R. JONES	D. HEINRICHS	LLNL
Considered unlikely to make any material progress.						
TRAINING AND EDUCATION						
AWE-TE1	Hands-on criticality safety training	ORNL-TE1 LANL-TE1 LLNL-TE1 LLNL-TE3 SNL-TE1 IRSN-TE1	AWE personnel to attend training course	R. JONES	D. BOWEN B. MYERS D. HEINRICHS G. HARMS S. EVO (IRSN)	ORNL
No AWE personnel attended courses during the reporting period. Currently no AWE personnel are expected to attend courses in the next quarter.						

STATUS REPORT
on the
International Collaboration with the Institut de Radioprotection et de Sûreté Nucléaire (IRSN) for FY2020

	REFERENCE		IRSN Contribution / POC			
IRSN Reference	**Task Title**	**DOE Reference**	**FY 2020 IRSN Contribution**	**IRSN Technical POC**	**DOE Technical POC**	**DOE LAB**
Analytical Methods						
IRSN-AM1	Validation and qualification methods	ORNL-AM2 ORNL-IPD4	Determination of the experimental correlations of MIRTE 1 experiments. To be discussed with ORNL.	I. DUHAMEL	D. BOWEN	ORNL
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. 2019-Q4: 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 FY20-Q1: No progress FY20-Q2: MIRTE 1 final evaluation provided to ICSBEP – ORNL calculated keff results for all the experiments (received by IRSN – analysis in progress)						
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 R. JONES	ORNL LLNL AWE
The next step will be in particular the number of fissions estimate (meeting about this subject during the TPR meeting, Amarillo). Short document to be written IRSN has to propose a new technical POC following the change of position of M. Duluc (decision in progress).						
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
Report provided by LANL to IRSN by Wim Haeck with detailed descriptions. Integration in GAIA in progress						
IRSN-AM8	Analytical Methods Working Group	NCSP-TS2	IRSN participation to NCSP analytical methods Working Group and IRSN participation to TPR meeting	S. PIGNET	F. BROWN D. BOWEN	NCSP
IRSN participation to TPR in February 2020 and presentation at AMWG meeting Participation to the NDAG meeting						
IRSN-AM9	Cross sections processing validation	ORNL-AM3	Development of an interface between GAIA and AMPX and test interface capabilities.	R. ICHOU	D. WIARDA D. BOWEN	ORNL
Tool for generating AMPX multigroup cross section library with DRAGON. Task needs completion. AMPX training course planned in May 2020 at IRSN postponed due to COVID-19						
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	I. DUHAMEL	D. HEINRICHS D. BOWEN F. BROWN	LLNL ORNL LANL

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			benchmarks.) IEU and LEU systems will be included in FY 2020.			
FY20-Q1: MCNP feedback on identified errors were received and integrated by IRSN for HEU and Pu– Analysis of LEU and IEU results in progress – FY20-Q2: Presentation on LEU and IEU comparison during the AM meeting in February – discussions with DOE labs to increase the number of common cases – Addition of PST41 and LCT074 results from IRSN , LLNL and ORNL in the database – Publication for ANS Winter meeting planned (if travels possible at that time).						
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 FY20-Q1: ORNL/LANL/IRSN meeting during the 2019 ANS winter meeting in November–Discussions are planned during the AM meeting in February in Santa Fe FY20-Q2: IRSN results sent in January 2020 – presentation of the comparison by Jen Alvin during the AM meeting in February; IRSN intend to send additional results using other covariances soon.						
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
FY20-Q1: Iteration over the finalization of the EGAMCT report (issues with D. Mennerdhal's comments). Action to be closed as soon as OCDE/NEA report is published.						
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
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. FY20-Q2: No progress						
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. 2019-Q4: IRSN contributed to the ICSBEP evaluation as the independent reviewer FY20-Q1 and Q2: exchanges on the ICSBEP review						
IRSN-IE3 **IER 209**	New 7uPCX experiment	SNL-IE1	Contribution to ICSBEP reevaluation.	N. LECLAIRE	G. HARMS	SNL
2019 –Q4: These experiments were presented at the ICSBEP 2019 meeting. IRSN was the independent reviewer. 2020-Q2 : Review finalization : MORET 5 k_{eff} calculations were performed, as well as sensitivity calculations, and sent to SNL.						

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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 has been validated by IRSN. It will be issued in January 2020. Preliminary effects on keff of experimental uncertainties have been calculated and will be added in the CED-2 report in 2020. (supported by a sub-contract) Some 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) in the CED-1 report. 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 resin block should also be envisioned for the CED-2 report. Additional configurations are therefore planned and will be added in the CED-2 report. FY20-Q2: CED2 report approved by NCSP team and issued by IRSN						
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
FY20-Q2: CED-2 report under IRSN final internal review, draft to be sent before end of June. Deadline postponed to third quarter of 2020 (September). IRSN has also looked at potential suppliers for the Mo sleeves and estimated the costs. Priority is on CED-2 report finalization before 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. FY20-Q2: comparison with MIRTE Ti experiments in progress – report to be published before end of the year.						
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. FY20-Q2: Experiments delayed. Stand-by						
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 in 2019. A first contact with Peter Angelo. Reports about the CRAC and SILENE review sent to NCSP in Q1FY2020 – no feedback since.						
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 draft report sent to Catherine Percher for distribution to CED-team. Ongoing studies about possible additional measurements for flux map and temperature.						

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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
Not funded in FY2020.						
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
Some contacts with Doug BOWEN and Riley CUMBERLAND. Discussions on detectors. VTC in Q1-FY2020. A list of detectors that could be provided by IRSN has been sent in January. No feedback since						
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 measurements. Experiments postponed due to COVID-19 to later date (contingent upon LLNL communication)						
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 or TRIGA (AFFRI)	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 **IER 488**	MUSIC (HEU) critical and Subcritical measurements.	LANL-IE23	Participation in the definition and the design of the experiment	W. MONANGE	J. HUTCHINSON	LANL
Task in progress. IRSN's simulations in progress.IRSN staff waiting for schedule of experiments..						
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 **IER 514**	ICSBEP/SINBAD Shielding benchmarks for shipping containers	LLNL-IE1 AWE-IE8	Participation in the preliminary design and CED-1 report	M. DULUC	D. HEINRICHS R. JONES	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
Delay (problems with HPC at IRSN still make it difficult to finish the simulation program) VTC with LANL team to discuss about the common paper to finalize the task.						
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

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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.						
IRSN-IE42	Neptunium Subcritical Observations (NeSO) experiment	LANL-IE3	Independent review of the ICSBEP evaluation.	W. MONANGE	J. HUTCHINSON	LANL
Participation to the experiments in 2019. Independent review of the ICSBEP evaluation planned in FY2020.						
IRSN-IE43 **IER 515**	Critical experiment with americium	LANL-IE3	Participation in experiments design and CED reports.	M. BROVCHENKO	G. MCKENZIE	LANL
Not funded in FY2020. To be proposed for FY2021.						
IRSN-IE44 **IER 516**	ZTA (Zirconium Test Assembly)	LANL-IE3	Participation in experiments design and CED reports.	N. LECLAIRE	T. CUTLER	LANL
Not funded in FY2020. To be proposed for FY2021.						
IRSN-IE45 **IER 517**	Integral Experiments for Validation of Molybdenum Neutron Cross Sections	LANL-IE3	Participation in experiments design and CED reports.	J.B. CLAVEL	D. HAYES T. CUTLER	LANL
Not funded in FY2020. To be proposed for FY2021.						
IRSN-IE46 **IER 518**	High Multiplication Subcritical (Multiplicity) Benchmark Experiments	LLNL-IE1	Participation in experiments design and CED reports.	W. MONANGE	D. HEINRICHS G. HARMS	LLNL SNL
Not funded in FY2020. To be proposed for FY2021.						
Information Preservation and Dissemination						

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IRSN-IPD1	ICSBEP reviewing	LLNL-IPD1	IRSN ICSBEP reviewing tasks are reported in the IE tasks	I. DUHAMEL	D. HEINRICHS	LLNL
Review of LCT101 (SNL) and TEX-Ta (LLNL) done for October ICSBEP 2019 meeting FY-2020-Q2: review of the LCT101 (SNL) and TEX-Ta (LLNL) evaluations following the ICSBEP meeting – Collaboration with ORNL and LLNL on PST041 and LCT074 evaluation (KENO and COG results were included in the ICSBEP evaluation and included in the benchmark intercomparison)						
IRSN-IPD3	ICSBEP benchmark reviewing	LLNL-IPD1	IRSN ICSBEP reviewing tasks	I. DUHAMEL	J. FAVORITE	LANL
Task not started – IRSN interest 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}Mo, Gd, Hf and ^{239}Pu isotopes.	L. LEAL	D. BOWEN	ORNL
2019: ^{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}Mo evaluation. New capture data from NTOF included in the Gd-155 and Gd-157 evaluation. Improved Gd resonance parameters available. Paper on Gd for ND2019 conference. Generation of covariance data for ^{155,157}Gd. Testing of the Gd evaluation has started. FY20-Q1: The Fe resonance evaluation continues FY20-Q2: work in progress for Rh URR evaluation with RPI Benchmarks testing for Iron (56 and 54) to test the new evaluations Gd 156, 158, 160 evaluations provided to IRSN by ORNL for final tests, IRSN and RPI working for improvements in URR Preliminary evaluation of Mo isotopes up to 100 eV using IRSN measurements at J-PARC on natural Molybdenum (cf. Physor conference) Hf postponed, Pb to be started very soon. Working on Pu239 evaluation in progress combining integral and differential data.						
IRSN-ND2	Nuclear data processing	LANL-ND1	Benchmark testing of ^{235}U and ^{239}Pu cross section library	L. LEAL	J. CONLIN	LANL
Test performed and new ^{235}U and ^{239}Pu resonance parameters generated. Benchmark testing on the ^{235}U and ^{239}Pu underway. Sensitivity analysis of the benchmark results will be done New Pu239 capture data measured at LANL by Shea Mosby included in the evaluation; Testing of the evaluation on the TEX experiments are under way FY20-Q1: Full paper submitted to Physor 2020 FY20-Q2 : benchmark testing of new Pu9 evaluation on TEX experiments and PST experiments in progress						
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
Existing resonance evaluation extended to 2 keV. New resonance parameters derived. New ^{233}U fission and capture cross section data from n_TOF may become available shortly. The data will be incorporated in the evaluation and benchmark testing will be performed.						
Training and Education						
IRSN-TE1	Hands-on criticality safety training	ORNL-TE1 LANL-TE3 LLNL-TE1 SNL-TE1	IRSN attendance to NCSP classes. Possible lectures by IRSN working with NCSP training and education coordinator.	S. PIGNET	D. BOWEN	NCSP
2 IRSN staff authorized to attend the hands-on training in 2020.						