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Subject: Report WP-NCS Virtual Meeting (No foreign travel)

Date: 10/25/2021

To: Dr. Angela Chambers, Nuclear Criticality Safety Program Manager, National Nuclear Security Administration / NA-511

From: Doug Bowen

Meeting Title: Working Party on Nuclear Criticality Safety - July 2021 Virtual Meeting

Meeting Location: Paris, FR

Meeting Date: July 8-9, 2021

Attendees on behalf of NCSP:

Doug Bowen, Germina Ilas, Will Wieselquist, B.J. Marshall, Kursat Bekar, Travis Greene

Meeting Purpose:

To participate in the annual meeting for the WP-NCS. Reports from subgroups was conducted (SG2 - MOX damp powders, SG4 - Accident analysis, SG5 - experimental needs, SG8 - expert knowledge, SFCOMPO TRG, ICSBEP TRG and other topics. Country reports were presented by Belgium, Switzerland, USA, etc.

Meeting Benefits to the NCSP:

These meetings allow the international NCS community to discuss work in progress on topics of importance and interest to the general community.

Purpose of Travel:

To participate in the WP-NCS meetings as a representative of the NCSP.

Persons Contacted at Meeting:

IRSN, OECD/NEA, and DOE/NNSA staff

Presentations, Chair Responsibilities, Etc.

Attended as an official NCSP representative; SFCOMPO chair, SG8 chair

Distribution:

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Nuclear Energy Agency

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25 June 2021

NUCLEAR ENERGY AGENCY
NUCLEAR SCIENCE COMMITTEE

Working Party on Nuclear Criticality Safety

25th Meeting of the Working Party on Nuclear Criticality Safety (WPNCS)

Proposed Agenda

8-9 July 2021
Remote meeting

Scheduled meeting times:

Thursday, 8 July 2021 from 13:00 to 16:20 Paris
Friday, 9 July 2021 from 13:00 to 16:30 Paris

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OECD/NEA Nuclear Science Committee

25th Meeting of the Working Party on Nuclear Criticality Safety (WPNCS)

8 July 2021 // 1:00-4:20 PM CEST

9 July 2021 // 1:00-4:30 PM CEST

Remote meeting

The 25th Meeting of the Working Party on Nuclear Criticality Safety will take place on Thursday and Friday, 8-9th July 2021 via remote conference (Zoom). The details of the remote conference will be shared to the registered participants.

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Proposed agenda

8 July 2021 (Day 1 of 2)

Time	Topic	Speaker
	Introduction	
13:00	Welcome, self introduction of participants	All
	Administrative items	
13:30	Election of a new chair, and a vice chair	All
13:40	Approval of agenda	Secretariat
13:45	Approval of SR from previous meeting NEA/NSC/WPNCS/DOC(2021)5	Secretariat
13:50	Review of actions from previous meeting	Chair
14:00	Feedback from the Nuclear Science Committee (NSC) by the Head of the Nuclear Science Division	T. Ivanova
14:20	**Coffee break (15')**	
	Reports from subgroups (20' each)	
14:35	SG2: MOX dump powders	C. Carmouze
14:55	SG4: Accident analysis	Y. Yamane
15:15	SG5: Experimental needs	C. Percher, G. McKenzie
15:35	SG8: Expert knowledge	W. Wieselquist
	Reports from technical review groups - part 1	
15:55	SFCOMPO TRG, and revision of the mandate	G. Ilas
16:20	**Adjourn day 1**	

9 July 2021 (Day 2 of 2)

Time	Topic	Speaker
	Reports from technical review groups - part 2	
13:00	ICSBEP TRG, and revision of the mandate	J. Bess
	Proposals for new subgroups (20' each)	
13:25	Proposal for the life cycle of a WPNCS subgroup	K. Suyama
13:45	Nuclear data uncertainties quantification on spent fuel inventory (follow up to SG7)	C. Carmouze, R. Ichou
14:05	Bias and Correlated Data, Comparison of Methods	A. Hoefer
14:25	**Coffee break (15')**	
14:40	Transport in random geometries	A. Zoia, C. Larmier
15:00	Spent nuclear fuel decay heat: assessing the confidence level in experimental and computational estimations	D. Rochman
15:20	**Country reports**	**All**
	Belgium	A. Kochetkov
	Switzerland	A. Vassiliev
	USA	TBC
	Other countries to be confirmed	TBC
	Conferences	
16:00	Preparation of ICNC2023	K. Suyama
	Closing session	
16:10	AOB	All
16:25	Review of the actions	Secretariat
16:30	Date and place of next meeting	Secretariat
16:35	**Adjourn day 2**	

US Country Report to the OECD-NEA Working Party on Nuclear Criticality Safety (NCS)

9 July 2021

National Context

The United States (US) has fissile material operations involving all portions of the nuclear fuel cycle. Research in the area of advanced reactor concepts continues to investigate use of fuel with > 5 wt.% enrichments, in the area of industrial and government activities the focus is on production and fabrication of reactor fuel with enrichments < 5 wt.%, and there is a growing interest with High Assay Low Enriched Uranium (HALEU), 5wt% < enrichment <19.75wt%, for use in Light Water Reactors (LWR), metallic fueled fast reactors, liquid fueled molten salt reactors, fluoride salt-cooled high temperature reactors, and high temperature gas reactors. Government and industry are also pursuing many concepts for Accident Tolerant Fuels (ATF) in cladding materials, with a lead test rods of ATF currently under irradiation in operating plants. These fuels include coated zirconium alloy and iron-based alloy cladding, and doped uranium oxide and uranium silicide pellets. Along with research into ATF performance, there is much interest with the use HALEU along with high burnup (HBU) fuel. As the industry grows and develops, many criticality safety issues on the front end and back end of the fuel cycle will need to be addressed. The US Department of Energy (DOE) has stopped the planned MOX fuel fabrication plant, and thus the US has limited need for criticality safety relevant to the transport or storage of MOX fuel. The US has expanded its pit manufacturing investment at both LANL and the Savannah River Site.

In 2016, the US Nuclear Regulatory Commission (NRC) received an application for a Consolidated Interim Storage Facility (CISF) in Andrews County, Texas from Waste Control Specialists (WCS). The NRC issued a series of Requests for Additional Information (RAIs) in late 2018, 2019, and 2020 to which the applicant responded. NRC anticipates completing its safety, security, and environmental reviews of the WCS facility in July 2021. In March 2017, Holtec International submitted an application to NRC for a specific license to construct and operate the HI-STORE CISF, to be located in Lea County, New Mexico. The dry cask storage system proposed to be used at the site will be a below-grade design. In February 2018, NRC accepted the application and began a detailed technical review. NRC received hearing petitions and established an Atomic Safety and Licensing Board to rule on the hearing requests. After review and oral argument, the Board denied all hearing petitions and terminated the proceeding. In 2019-2020, the petitioners appealed the Board's hearing decision to the Commission. However, in a series of orders issued in 2020 and 2021, the Commission upheld the Board's initial decision. Some of the petitioners have filed review petitions in the U.S. Court of Appeals, where they remain pending. In March 2020, NRC issued a Draft EIS for Holtec International's Proposed CISF for Spent Nuclear Fuel and High-Level Waste in Lea County, New Mexico. NRC anticipates completing its safety, security, and environmental reviews and issuing a final licensing decision by January 2022. Final repository options and overall storage, transport, and disposal systems are being studied by DOE to provide the technical information for future decisions regarding the back end of the fuel cycle.

The NRC has approved several fuel cycle facility and transportation package designs for accident tolerant fuel (ATF) and advanced reactor fuel, is currently evaluating several others, and anticipates multiple similar applications in the near future. These applications are characterized by materials that differ from typical low enriched uranium (LEU) LWR fuels, in both the fuel and cladding, and several of them involve uranium enrichments beyond the 5% typically considered for LWR fuel, or HALEU. The NRC has approved an enrichment increase for two enrichment facilities: one for commercial fuel up to 5.5% enrichment, and another for HALEU research and development activities for up to 20% enrichment. The NRC has approved a fuel fabrication facility criticality analysis needed to support an enrichment increase up to 8% enrichment. The NRC has approved several transportation package amendments for ATF lead test assemblies or assembly components, and for HALEU metal and oxides that could support advanced reactor fuel fabrication and transport up to 20% enrichment. The NRC has approved an amendment to a fresh fuel transportation package design to ship loose rods at greater than 5% enrichment, as well as fuel assemblies with ATF features such as doped pellets and coated cladding. The NRC is currently reviewing several amendments to fresh fuel assembly transportation packages to ship fuel assemblies enriched to greater than 5%. The NRC has approved one package design for spent ATF fuel, as well as an amendment to an existing package certificate to allow a higher mass of 20% enriched TRISO fuel particles. The NRC expects to receive applications in the near future for additional fuel cycle facility amendments for enrichments up to 20%, fresh fuel assembly packages with enrichments up to 10%, and for UF_6 packages with enrichments up to 20%.

The DOE, including its autonomous National Nuclear Security Administration (NNSA), and the NRC each have responsibility for providing regulatory oversight on criticality safety – DOE for operations within the DOE complex and NRC for industry operations. The American Nuclear Society (ANS) is the US professional organization that works to develop consensus standards for criticality safety and organize technical meetings on criticality safety. Each of these organizations develops, sponsors, or supports training classes and workshops to support education and knowledge exchange in the field of criticality safety. The number of universities offering classes and degree certificates focused on criticality safety has risen over the last few years.

Research and Development (R&D) Programmes

The DOE and NRC both support research activities in the area of nuclear criticality safety. The DOE Nuclear Criticality Safety Program (NCSP) has provided a central focus for research and technology development for about 20 years. The DOE NCSP (see http://ncsp.llnl.gov/) has five elements: Integral Experiments, Analytical Methods, Nuclear Data, Information Preservation and Dissemination, and Training and Education. Integral experiments (and hands-on training classes) are conducted at the National Criticality Experiments Research Center (NCERC) in Nevada, run by Los Alamos National Laboratory, and at Sandia National Laboratories (SNL) in New Mexico.

All four critical experiment machines at NCERC (Planet, Godiva, Comet, and Flattop) are available, and the facility operates as a user facility to help meet national and international program needs. The SPR/CX critical assembly at Sandia is available and the Annular Core Research Reactor at Sandia is used to demonstrate the consequences of a criticality accident for course students.

The NCSP has conducted "hands-on" critical experiment training classes at NCERC during the past year, although the courses were reduced due to COVID. Usually, each year the NCSP conducts two 2-week training class for NCS practitioners and two 1-week training course for regulators, managers, and operations professionals who need to understand the fundamentals of nuclear criticality safety. The 2-week classes include one week of classroom training at the National Atomic Testing Museum in Las Vegas, NV, followed by one week of hands-on critical experiment training at either SNL or NCERC. The 1-week manager's courses focus on hands-on experience with less technical lectures and are also conducted at SNL or NCERC. Since establishing the NCSP hands-on training courses in 2011, over 450 students have taken the NCS hands-on training courses. COVID-19 has affected the training courses this year, causing the cancelation of two of the 1-week manager's courses.

With regard to information preservation and dissemination, the NCSP through the course of its activities is preparing several benchmark evaluations for submission to the International Criticality Safety Benchmark Evaluation Project (ICSBEP) in the upcoming years. Efforts continue to encourage users of the ICSBEP Handbook to report errors and questions in order to suitably revise existing benchmark evaluation data currently found therein. Under DOE support, two SFCOMPO benchmark evaluations have been completed by ORNL and submitted for final approval at the SFCOMPO TRG meeting in July 2021.

Integral experiment research over the last year has included: completion of a combination subcritical/critical series of HEU experiments. Design work is being completed for multiple different temperature-dependent critical experiments; SNL and Oak Ridge National Laboratory (ORNL) are collaborating on a design of heating and cooling the water of the SNL water lattice, Los Alamos National Laboratory (LANL) was working on a heated HEU experiment to investigate yttrium hydride thermal scattering laws, and Lawrence Livermore National Laboratory (LLNL) is working with LANL and the United Kingdom's (UK's) National Nuclear Laboratory (NNL) to design a -40 °C variation on the uranium TEX experiments.

With regard to Analytical Methods, Monte Carlo N-Particle (MCNP) and SCALE are key codes used for criticality safety within the DOE complex and are supported by the NCSP and DOE, with nuclear data libraries generated by NJOY and AMPX; SCALE also receives support from the NRC. A key area of development has been sensitivity/uncertainty methods using continuous energy data and investigating advanced validation methods. The multi-laboratory Nuclear Data Advisory Group (NDAG) prioritizes nuclear data measurements and evaluations supported by the NCSP and coordinates NCSP activities with the US National Nuclear Data Center to assure inclusion in the Evaluated Nuclear Data Files (ENDF). Funding to help support processing of ENDF data for the criticality safety codes is also provided by the NCSP, including expanded cross section covariance data that are available for the key NCS analyses code packages, and support of the transition of nuclear data from the traditional ENDF-6 to the new General Nuclear Database Structure (GNDS) format. The ENDF/B-VIII.0 was released in late 2017 and has many new features including expanded thermal scattering data for reactor grade graphite and pyrolytic carbon needed for advanced reactors as well as water in ice form to temperatures below -40 °C as requested by International Atomic Energy Agency (IAEA) transportation guidelines. LANL participated in the development and recent release of the ENDF/B-VIII.0 nuclear data. ACE files for use with MCNP are now available for download on a public website. Fundamental R&D work that is continuing at LANL

includes the investigation and development of: region-dependent sensitivity-uncertainty data for NCS validation, methods to diagnose and accelerate Monte Carlo source convergence, diagnostic tests for undersampling and clustering, the impact of correlated fission multiplicity models in criticality calculations, studies into the validation for chlorine, exploring the use of machine learning techniques with criticality benchmark sensitivity data to help identify potentially problematic nuclear data, and more.

The SCALE and MCNP teams both provided training classes to US and international participants. Classes in the theory and practice of Monte Carlo criticality calculations with MCNP6 are given regularly at LANL and other sites. A new 1-day training class on the use of sensitivity-uncertainty methods in NCS validation has also been conducted numerous times, by personnel from both LANL and ORNL. Two 1-day sensitivity-uncertainty training classes were jointly instructed by LANL and ORNL staff in early 2021. To help educate future nuclear engineers, the LANL methods and code developers are teaching 2 semester-long courses at the University of New Mexico. In early 2020, LANL hosted an in-person MCNP criticality class. Subsequent classes in 2020 and 2021 were hosted virtually, including a recently complete 3-day virtual course dedicated to criticality calculations and NCS validation. These virtual classes, born out of necessity to continue training new MCNP practitioners, have so far included 350+ online attendees over ~12 weeks of instruction, including 3 weeks of half-day classes hosted virtually by the OECD/NEA in early 2021 to make up for the cancelled in-person classes scheduled in 2020. In 2020 and early 2021, SCALE offered one week of training on uncertainty analysis methods for criticality safety at OECD NEA and five weeks of training classes on criticality safety, nuclear data, and uncertainty analysis methods for criticality safety at ORNL, with US and international attendance that covers the gamut of the code's capabilities starting from nuclear data assessment through to application. Due to the pandemic, two SCALE courses scheduled for March 2020 at OECD NEA were postponed to April 2021 and were held virtually. The SCALE training courses at ORNL in October-November2021, which will be offered as virtual events, will include two weeks of training in nuclear data fundamentals and methods of burnup credit for criticality safety. The SCALE Users' Group Workshop that was held virtually from ORNL for three days in July 2020, with over 250 participants, out of which 35% were internationals, included three hands-on tutorials and nine presentations on methods and best practices for criticality safety, nuclear data, and uncertainty analysis for criticality safety. In April 2021, an Arrangement was signed between UT-Battelle/ORNL and OECD/NEA to cooperate on the joint organization of conferences at which ORNL intends to conduct training on topics of mutual interest. Cooperation under this Arrangement commenced upon signature and will continue for a period of 3 years until 2024, with ORNL to carry out training on modeling and simulation tools in accordance with the OECD/NEA's needs. The MCNP and the Monte Carlo codes in the SCALE code system continue to be highly regarded Monte Carlo codes. MCNP includes the Whisper code to support sensitivity-uncertainty based methods for NCS validation. The SCALE code includes both the TSUNAMI and SAMPLER packages. The TSUNAMI package is used for code validation, gap analysis and has been used for experiment design as the package provides sensitivity-uncertainty and similarity information. SAMPLER extends TSUNAMI's capabilities by including the ability to understand impact to keff from model input parameter uncertainty. There are estimated to be over 20,000 users of MCNP throughout the world with ~1,200 licenses annually processed and distributed by the Radiation Safety Information Computational Center (RSICC) at ORNL in recent years. ORNL released SCALE 6.2.4 that provides increased performance and updates based on user feedback, which incorporates all updates made since the 6.2.0 release SCALE is the most highly requested

code from the NEA Data Bank, with distributions to over 2000 Data Bank members over the past decade, with mirrored distribution also available from the RIST data center in Japan. Currently, there are over 10,000 SCALE users in 62 nations. SCALE 6.3 will be released later this year which will include a number of updates supporting its use with ATF and non-LWRs, and a new MC package called Shift, which has been integrated into the CSAS sequence for criticality calculations. Shift allows for much shorter calculation times, as it is able to take advantage of parallel processing on multiple cores.

In the Nuclear Data program element, prioritized nuclear data measurements and evaluations continue to be performed to support NCS operations in the US. During the past year, new differential measurements have been performed on ^{54}Fe and measurements continue on zirconium (Zr) samples. Measurements on Zr elastic scattering angular distribution have been complete. New measurements of ^{233}U capture and ^{240}Pu PFNS have also been performed. A new sub-thermal neutron transmission capability has been developed at Rensselear Polytechnic Institute (RPI) and neutron transmission measurements on polystyrene (C_8H_8) and polyethylene (C_2H_4) and measurements on yttrium hydride (YH_x) are in progress. Also, substantial progress has been made to expand the RPI linear accelerator neutron capture measurement capabilities into the keV range that is important for many nuclei pertinent to criticality safety. Furthermore, the NCSP has partnered with NNSA Naval Reactors (NR) to invest in an accelerator refurbishment effort at RPI to ensure the US has a differential data measurement capability for performing needed cross-section measurements. With regard to new cross-section evaluation work, the NCSP has completed new resonance region evaluations for $^{140,142}Ce$ and full energy range evaluation for ^{9}Be. New fast energy range evaluations for ^{208}Pb, ^{234}U and ^{236}U have also been completed. New thermal neutron scattering law evaluations for hydrogen fluoride (HF), enriched lithium hydride (^{7}LiH), enriched lithium deuteride (^{7}LiD), beryllium carbide (Be_2C), delta-phase zirconium hydride (ZrH_x), epsilion-phase zirconium hydride (ZrH_2), uranium hydride (UH_3) and a revision to Y-YH_2 have been developed. Development of TSL evaluations for light water (H_2O), polystyrene (C_8H_8), calcium hydride (CaH_2), uranium metal (U-metal), uranium carbide (UC), beryllium hydride (BeH_2) and zirconium carbide (ZrC) as part a NCSP/NR collaboration. These new evaluations are undergoing testing and are expected to be available with the next release of the ENDF data library. A new initiative known as the Nuclear Data Interagency Working Group (NDIAWG) recently coordinated multi-faceted funding opportunity announcement for new nuclear data evaluations to support a number of priority programmatic needs for the DOE Office of Nuclear Physics, Isotope Program, Office of Nuclear Energy, NNSA/Defense Nuclear Nonproliferation Research and Development, Department of Homeland Security, and Domestic Nuclear Detection Office. It is hoped that substantial new initiatives will provide many updated nuclear data evaluations with high quality uncertainties will become available to the community. The initial fruit of the NDIAWG is expected to be updated fission product yield evaluations. The DOE Office of Nuclear Energy has initiated a new Nuclear Data and Benchmarking Program that is focused on identifying gaps and providing enhancements in data measurement, evaluation, and covariance generation as well as benchmark experiments and application studies import to emerging nuclear energy applications, especially focused on advanced reactors and advanced fuels.

The NRC recently completed long running efforts in the application of burnup credit for spent PWR and BWR fuel in transport and storage conditions. Recommendations for isotopic depletion and criticality code validation for burnup credit have been incorporated into the standard review plans for both dry

storage and transportation (NUREG-2215 and -2216, respectively). Depletion validation recommendations are in the process of being updated to include precision radiochemical assay (RCA) on PWR samples that will provide higher quality high burnup data sets which will allow the opportunity for extrapolation into high burnup applications.

The US DOE and NRC are jointly funding ORNL to conduct precision radiochemical assay (RCA) measurements for obtaining high accuracy code validation data for nuclide inventories in spent nuclear fuel. The high-accuracy characterization of nuclide inventories, particularly in the high-burnup range, is critical for spent fuel storage and transportation, given industry's interest in higher burnup fuel and the existing gaps in validation data for this burnup range. The measurement program has started, with measurements planned to include over 50 actinides and fission products of importance to burnup credit criticality, radiation shielding, and decay heat calculations. The measurement program was delayed by the COVID-19 pandemic, but work has resumed, and the measurements are expected to be completed this year. For criticality safety, the new measurements will expand the RCA basis used to update NUREG/CR-7108 on depletion code validation, to provide bias and bias uncertainty estimates for several codes using ENDF/B-VII.1 and -VIII.0 cross section libraries. Additionally, the new measurements may be later contributed to expand the SFCOMPO database. Currently, the database includes very high-burnup (>60 GWd/MTU) nuclide inventory data for only three PWR samples. To the extent possible, depletion validation recommendations will be expanded to cover higher enrichments and extended burnup.

As a result of preparations for ATF, HALEU and HBU program, the NRC is using the SCALE code to study the impacts on the current understanding of the system performance under various conditions. In the near term, a scoping study to cover the front end of the fuel cycle has been completed assessing the HALEU validation basis in fresh fuel transport packages (ADAMS No: ML21040A518).

Separate but connected work is the new extensive SCALE validation report, to be published in Summer 2021, covering criticality safety, reactor physics, and radiation shielding for advanced reactor applications. This new work will also include the input decks used. This new volume, titled "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 5 – Radionuclide Characterization, Criticality, Shielding, and Transport in the Nuclear Fuel Cycle" (ADAMS No. ML20308A744), is expected to be released this year.

International Collaborations

The NNSA continues to interact with Atomic Weapons Establishment (AWE) and NNL in the UK and the Commissariat à l'Énergie Atomique (CEA) and L'Institut de Radioprotection et de Sûreté Nucléaire (IRSN) in France to identify and collaborate on nuclear criticality safety issues of mutual interest, such as integral experiments, computational methods, and improved nuclear data. During the past year, the collaborations have resulted in personnel from the US performing collaborative work at IRSN, CEA, and AWE. After the closure of Fast Critical Assembly (FCA) in Japan, the US continues to perform experimental work with the Japan Atomic Energy Agency (JAEA). Likewise, personnel from AWE, NNL, and IRSN have visited the US to perform collaborative work tasks at NCSP sites. Within the DOE NCSP, ORNL and Institute for Reference Materials and Measurements (IRMM) collaborate to perform neutron

cross-section measurements in the resonance region to address differential data needs identified as important to improvement of nuclear criticality safety analyses. The NCSP has a collaboration agreement with the EU Joint Research Center in Geel, Belgium. Over the last couple of years, differential measurements have been taken with natural La and Ce-142. In FY20, measurements are planned with stable isotopes of Zirconium (Zr-90, 91, 92, 94) per the NCSP 5-year plan.

Under OECD/NEA WPEC, US National Laboratories are worked with other international partners on the CIELO (Collaborative International Evaluated Library Organization) to improve nuclear evaluations, many of which support improved evaluations for nuclear criticality safety. Specifically, the CIELO collaboration has focused efforts on completing new evaluations for ^{235}U, ^{238}U, ^{239}Pu, ^{56}Fe, and ^{16}O.

Under an IAEA CRP, US National Laboratories are working with other international partners on new fission product yield evaluations for the major fissile nuclides.

In addition, the NCSP provides support for the US participation in the ICSBEP. The DOE-NE currently provides support for the US leadership of the ICSBEP following past funding provided via the Nuclear Energy Advanced Modeling and Simulation (NEAMS) program.

Future Challenges

Organizations face a continuing challenge to maintain a fully compliant criticality safety program with qualified personnel experienced in both the principles of criticality safety and the fissile material operations, with the need for planning to support the needs of the advanced reactor community. In addition, a challenge is related to the availability of experiments to use for benchmarks in criticality reviews to support analysis of accident tolerant fuels. A further challenge exists related to succession planning for key staff expertise needed to support NCS. To meet this challenge, the NCSP is continuing to invest in succession planning for key NCS technology capabilities that include specialists in integral experiments, nuclear data, and analytical methods.

Holdup residues can contribute significantly to the inventory of nuclear material within process equipment and, at any time, can represent the largest portion of inventory uncertainty. As such, these residues can challenge assumptions and limits needed for nuclear criticality safety. The NNSA has initiated work to establish a safety-related *in situ* nondestructive assay (NDA) program to manage and direct R&D tasks needed to improve NDA capabilities for quantifying nuclear material holdup. A mission and vision document for the NDA technology program is in development and should be published in the coming year.

Input to/from NEA NSC Programmes of Work

The US continues to engage in each of the Expert Groups and Subgroups of the Working Party on Nuclear Criticality Safety as well as in other NEA working parties. US participants are actively engaged or are leading activities within the Nuclear Science Committee WPNCS. The US leadership continues for ICSBEP and SFCOMPO. US leadership is also provided with the Technical Monitor for Uncertainty Analysis for Criticality Safety Assessment overseeing two subgroups. Involvement in other NSC activities

include: Working Party on International Nuclear Data Evaluation Co-operation (WPEC), Working Party on Reactor Systems (WPRS), Expert Group on Improvement of Integral Experiments Data for Minor Actinide Management (EGIEMAM-II), Expert Group on Accident Tolerant Fuels for Light Water Reactors (EGATFL), The Working Party on Scientific Issues of the Fuel Cycle (WPFC), Expert Group on Multi-physics Experimental Data, Benchmarks and Validation (EGMPEBV), and WPEC Subgroups: 44 on Investigation of Covariance Data in General Purpose Nuclear Data Libraries, 45 on Validation of Nuclear Data Libraries (VaNDaL) Project, 46 on Efficient and Effective Use of Integral Experiments for Nuclear Data Validation, 47 on Use of Shielding Integral Benchmark Archive and Database for Nuclear Data Validation, 48 on Advances in Thermal Scattering Law Analysis, and 50 on Developing an Automatically Readable, Comprehensive and Curated Experimental Reaction Database. Additionally, the US engages with the activities of Committee on the Safety of Nuclear Installations (CSNI) not listed here. These engagements are sponsored by numerous agencies, but the DOE/NNSA or NRC are the primary sponsor of the participants and their contributions.