Projects awarded under DOE/U.S. Nuclear Regulatory Commission Criticality Safety for Commercial-Scale HALEU for Fuel Cycle and Transportation (DNCSH) project's first proposal call.

Benchmark Validation for Transportation of TRISO HALEU Fuel for Advanced Reactors- The HTR-PROTEUS IRPhEP Handbook benchmarks are among the highest quality for TRISO-HALEU fuel systems, but significant variability in computed eigenvalues has been noted in configurations relevant to transportation. The team will investigate these variabilities, subcritical measurements, kinetics data, and potential criticality effects from hydrogen introduction. The project will generate additional benchmark evaluations to support validation for industry and the U.S. NRC.	
Lead Lab: INL	Partners: BWXT, Kairos, X-Energy, Radiant, JFoster & Associates, and the University of Michigan

THETA: TRISO-form HALEU-fueled Experiment for Transport Applications - Kairos Power, LLC, is singularly focused on developing and delivering Fluoride-salt cooled high temperature reactors, using HALEU TRISO fuel, to the US electric power market by the end of this decade. The ICSBEP only includes one benchmark series with TRISO, and none with the kernels modeled explicitly. The overarching outcome of this proposal addresses the need for validation for TRISO fuel transportation upset scenarios, particularly water infiltration of pebble fuel containers/canisters. These scenarios have a complex neutron flux and are expected to have a bias not quantifiable by other fuel forms. Additionally, the benchmark described to address transportation upset scenarios also improves the benchmark coverage of water infiltration upsets in fuel storage and handling applications. It is built on the Deimos advanced reactor testbed platform adding stainless steel reflector, interstitial polyethylene and interstitial borated polyethylene**.**	
Lead Lab: LANL	Partners: Kairos

Benchmark of Historical Y-12 Critical Experiments with UF6 Cylinder Model 8A Containers (Co-Award)- Lawrence Livermore National Laboratory (LLNL), in partnership with Oak Ridge National Laboratory (ORNL), proposes to benchmark a series of experiments that were completed in 1973 at the Oak Ridge Critical Experiments Facility (ORCEF) but were never benchmarked as part of the ICSBEP. The experiments performed were array studies with bare, polyethylene-reflected and concrete-reflected configurations that were designed for nuclear criticality safety validation of transportation and storage configurations. The experiments used UF6 cylinder model 8A containers and were filled with highly enriched uranium at 97.7% enrichment UF6. The proposed benchmarks would fill an important gap as the ICSBEP does not currently have any UF6 cylinder benchmarks.	
Lead Lab: LLNL	Partners: ORNL, CS Engineering, University of Tennessee

PETALE benchmark - In 2020, the Ecole Polytechnique Fédérale de Lausanne (EPFL, Switzerland) and the Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA, France) jointly conducted PETALE, a series of criticality experiments in the CROCUS reactor to validate the nuclear data of stainless steel and its main constituents (Fe, Ni, Cr). This proposal aims to benchmark these experiments for inclusion in ICSBEP and to provide additional validation cases for isotopes related to structural materials. With the experiments already completed, this proposal will fund the benchmarking effort.	
Lead Lab: LLNL	Partners: EPFL, University of California-Berkeley

Thermal/Epithermal eXperiments (TEX) Additional Chlorine Configurations to Provide Validation for TerraPower's Molten Chloride Salt Fuel - Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL) propose a series of three new critical experiments using chlorine absorbers to address the criticality safety needs of TerraPower for molten salt fuel fabrication and transport (I.C.4 in the proposal call; Point 1 in the workshop initial survey results). These experiments are an extension of a Nuclear Criticality Safety Program (NCSP) funded experiment, the Thermal / Epithermal eXperiment (TEX) with Chlorine, that is scheduled to be completed at the National Criticality Experiments Research Center (NCERC) in FY24. Specifically, these experiments will use high-density cast chloride salt absorbers in a highly enriched uranium assembly to target the thermal 35Cl(n,ɣ) absorption and fast 35Cl(n,p) absorption, which are nuclear data needs identified for	

the TerraPower's Molten Chloride Reactor Experiment (MCRE) and the Molten Chloride Fast Reactor (MCFR). Current chlorine benchmarks are insufficiently sensitive to perform adequate criticality safety analyses for fuel fabrication, staging/loading, and transportation (stages T2 and U1 in I.A of the call) and, while not specified in this call, provide validation for power production and spent fuel transportation, storage, and disposition (stages U2, U4, T3, and S1).	
Lead Lab: LLNL	Partners: LANL, TerraPower

Evaluation of already performed critical experiments and design of new critical experiments with the new 19.75 wt% 235U enriched IPEN/MB-01 core for ICSBEP publication - The IPEN/MB-01 reactor has recently been reconfigured with a new plate-type fuel core. The fuel elements are made of U3Si2-Al with an average density of 2.8 gU/cm3 and 19.75 wt% enriched in 235U. As pointed out in the EAW#1 topic area I.C.2, there is a lack of critical experiments at this enrichment level. Several critical experiments were already performed with this new core between 2020 and 2024, including different critical configurations with different fuel elements arrangements, with the control rods fully withdrawn or at specific positions, or adjustments of control rod position to find critical configurations at different temperatures between 20 and 80degrees C. The goal of the work performed would be to create a first ICSBEP benchmark from the already performed experiments, and then to create a second evaluation with additional critical configurations, including the use of lower enriched fuel rods to lower the average enrichment, and the insertion of graphite elements near the fuel plates.	
Lead Lab: ORNL	Partners: GE Vernova, IPEN

Evaluation of SLOWPOKE-2 Refuel Measurements – Existing data on criticality measurements taken at the Safe LOW POwer (K) critical Experiment (SLOWPOKE-2) reactor at the Royal Military College of Canada will be evaluated for a benchmark to be included in the ICSBEP handbook. In 2021, the entire reactor core was removed, replaced with a core of fresh HALEU (19.75 wt%) uranium dioxide fuel pins, and taken to criticality at very low power.	
Lead Lab: ORNL	Partners: Canadian Nuclear Laboratories

High-Temperature Graphite Double Differential Scattering Cross Sections: Measurement, Evaluation, and Validation - Currently, there is no high-resolution experimental validation for high-temperature thermal neutron scattering cross sections in graphite. The existing graphite ENDF thermal scattering law sub-libraries go up to 2000K, and were generated utilizing phonon densities of states calculated at 0 K using density functional theory or at room temperature using classical molecular dynamics. These approaches ignore the anharmonicity effect, where temperature influences graphite's atomic vibrations and thermal neutron scattering. As noted in EAW#1 topic area I.C.5, there is a need for high-quality nuclear data benchmarks to assure the NRC licensing procedure. This proposal aims to fill gaps in nuclear data for high-temperature graphite which affects the design of high-temperature reactors.	
Lead Lab: ORNL	Partners: Yarmouk University
Evaluation and BM Development of Reactor Critical Experiments of the RPI Reactor Critical Facility with Noteworthy Non-fissile SS Element Sensitivity - The Rensselaer Polytechnic Institute (RPI) Reactor Critical Facility (RCF) is a pool-type reactor fueled with SPERT-type 4.807 wt% enriched UO2, stainless-steel clad fuel rods. The RCF is highly flexible in the allowable arrangement of fuel and in the addition of experimental components to the core. The RCF was used to perform critical experiments involving a stainless-steel pipe placed at the center of the core between 2016 and 2018. The proposed work is to create an evaluation of the basic core configuration as well as those non-fissile stainless-steel focused experiments for submission and publication in the International Criticality Safety Benchmark Evaluation Project (ICSBEP) Handbook. Many important structural materials are inadequately represented in the ICSBEP handbook, including the major components of steels. This evaluation would provide a new uncorrelated LEU assembly for use in validation of non-fission materials. Evaluation of the RCF critical configurations responds to the EAW#1 topic area I.C.3 by providing new validation data with sensitivity to different non-fissile stainless-steel elements.	
Lead Lab: ORNL	Partners: INL, Rensselaer Polytechnic Institute

Characterization of ISU's AGN-201 Reactor for Qualification as an ICSBEP Benchmark - This proposal is to characterize the critical (i.e., keff = 1.0) configurations of the Aerojet General Nucleonics (AGN)-201 reactor operated by Idaho State University (ISU). The AGN-201 reactor has a graphite	

reflected core comprised of a fuel system with UO2 enriched to approximately 20 wt% U-235 that is matrixed in polyethylene [1]. The critical configuration of the reactor will be performed and submitted for inclusion into the ICSBEP Handbook. In addition, non-fissile structural materials will be inserted in the critical configuration to address validation gaps in these areas	
Lead Lab: ORNL	Partners: GE Vernova, Idaho State University

Evaluation of Critical Configurations of the Missouri S&T Reactor - The Missouri S&T Reactor (MSTR) is a light-water moderated, pool-type research reactor fueled with U3Si2/Al fuel with a nominal enrichment of 19.75 wt% 235U. The reactor can be operated in a fully light-water reflected mode, or adjacent to a graphite thermal column. The MSTR has not yet been evaluated in either the International Criticality Safety Benchmark Evaluation Project (ICSBEP) Handbook or the Internation Reactor Physics Evaluation Project (IRPhE) Handbook, thus providing a new, uncorrelated HALEU assembly for use in validation. Evaluation of MSTR critical configurations responds to proposal topics I.C.2 and I.C.5 by filling the gap of 10-20 wt% enrichment and providing new graphite validation data.	
Lead Lab: ORNL	Partners: Missouri S&T

ZED-2 Measurements with In-Core Absorbers - New criticality measurements with large samples of non-fissile structural materials (e.g. Ni, Ta, Mo, Fe) will be performed in the Zero Energy Deuterium (ZED-2) Reactor in Chalk River to support I.C.3. “Non-fissile material validation” to be submitted for inclusion in the ICSBEP handbook. These critical experiments will not be performed with HALEU fuel, but instead rely on fuels already available in the ZED-2 inventory, such as those employed for the measurements listed in ICSBEP evaluation LEU-MET-THERM-003 or IRPhEP evaluation ZED2-HWR-EXP-001. The absorbers will be exposed to a thermal neutron spectrum and their sensitivity will be maximized during the experimental design phase to increase their use for validation.	
Lead Lab: ORNL	Partners: Canadian Nuclear Laboratories

Temperature Dependent Transmission and S(alpha, beta) Measurements of Advanced Nuclear Moderators - As indicated in Section I.C.5 of the call, high-quality nuclear data, including differential (i.e., S(alpha, beta)) and quasi-integral (i.e., transmission or total cross-section) measurements, are needed to validate and increase our confidence in the nuclear data libraries used at different stages of the NRC regulatory process (from design to criticality safety validation). Therefore, we propose to perform temperature-dependent transmission and thermal scattering law (TSL), also known as S(alpha, beta), measurements of various advanced neutron moderators.	
Lead Lab: ORNL	Partners: X-Energy

eDeimos Experiments with Westinghouse for new HALEU Benchmarks - This experiment series will build on the already planned experiment series with Westinghouse (eDeimos), which includes multiple critical experiments using High Assay Low Enriched Uranium (HALEU) Tri-structural ISOtropic (TRISO) fuel compacts in a graphite and zirconium hydride moderated system. Three DNCSH specific configurations will be added; these configurations and other already planned experiments will be benchmarked for the International Criticality Safety Benchmark Evaluation Project (ICSBEP). eDeimos will use a mixture of Compact Nuclear Power Source (CNPS) HALEU TRISO currently at the National Criticality Experiments Research Center (NCERC) and new HALEU TRISO being procured by Westinghouse. Currently there is a significant lack of benchmarks using HALEU fuel, only two benchmarks using HALEU TRISO, and none using HALEU TRISO compacts; this project will add valuable data to the ICSBEP by meeting three DNCSH proposal topic areas: 10-20% Enrichment Gap, Non-Fissile Material Validation, and Graphite and Advanced Moderator Nuclear Data.	
Lead Lab: LANL	Partners: Westinghouse

HALEU Critical Experiments in Water Moderated UO2 Fuel Rod Lattices - Sandia National Laboratories proposes new critical benchmark experiments to expand on the existing experiments performed at the Sandia Pulsed Reactor Facility – Critical Experiments (SPRF/CX). These experiments will require the use of UO2 fuel rods that meet the same dimensional requirements of the current Seven Percent Critical Experiment (7uPCX) fuel rods but with increased 235U enrichment to nearly 20 wt.% (compliant with the existing Safety Basis for SPRF/CX). This will target the need for high quality integral critical benchmark experiments within the enrichment range of 10-20wt.% 235U. The proposed	

design allows for reuse of much of the equipment and nonfissile materials (e.g., grid plates, safety/control rods, support materials, molybdenum sleeves, titanium/tantalum rods) from the previous 7uPCX experiments, as well as future exploration of nuclear data for advanced moderators (e.g., using fuel arrays with interstitial BeO or graphite rods/sleeves) and non-fissile material validation	
Lead Lab: SNL	Partners: Orano

Critical Experiments Targeting Optimum Moderation Conditions - Storage and transportation scenarios require consideration of a variety of moderation conditions. Particularly for dry fresh fuel storage arrays, a consideration is that the maximum reactivity may occur at low water densities, which may be experienced during fire-fighting or other off-nominal scenarios. There are currently no experiments designed to target these conditions. The validation of optimum moderation conditions will become important as enrichments increase, and criticality margins decrease and will fill a crucial data gap.	
Lead Lab: PNNL	Partners: SNL, ORNL