# FY 2024 Consolidated Innovative Nuclear Funding Opportunity Announcement

## Draft Topic Areas

**TOPIC AREA 1 - REACTOR DEVELOPMENT AND PLANT OPTIMIZATION**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

Advanced reactor concepts have the potential to offer significant benefits, including lower costs, enhanced safety and security, greater resource utilization, and simplified operations. NE performs research and development (R&D) to support a range of advanced reactor concepts, including high temperature gas-cooled reactors (HTGRs), sodium-cooled fast reactors (SFRs), molten salt reactors (MSRs), microreactors, and other concepts. Proposals are being sought for activities that could help reduce the technical risks associated with these designs. Some potential challenges that could be addressed include, but are not limited to, advanced reactor component development and testing; advanced reactor transient and safety analysis, including experimental software validation; innovative solutions to material and operational challenges presented by molten salts (as distinct from fuel development described in Topic Area 5); core and system design optimization or modifications; characterization of system changes over time, such as to the reflector geometry in pebble-bed reactors; optimization of fueling strategies; and materials surveillance during reactor operations.

Additionally, advances are of interest in reactor development, design, and testing that improve technical, cost, safety, and security issues associated advanced reactor technologies across a broad range of sizes, coolants, fuels, neutron spectra, and applications. NE is also interested in research related to plant optimization, including, but not limited to, siting, economics, construction and scheduling outcomes, reducing cost and deployment timelines, remote deployment of reactors, environmental justice and equity considerations, and secure operations, among other relevant topics. Proposals should clearly identify the challenge being addressed and how proposed activities will advance the development, demonstration, and future deployment of advanced reactor concepts.

For investigators applying to Topic Area 1: Reactor Development and Plant Optimization, incremental funding is potentially available through participation in the Department of Energy's interactions with the Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) Nuclear Education, Skills and Technology (NEST) program. NEST ties together university research projects across multiple countries to provide students a fuller professional experience as they pursue their degree. NEST funds are provided to allow travel for students to interact with colleagues in other NEST countries in accordance with NEST program rules. Applications submitted to this Topic Area do not require NEST participation. Access to NEST funds do require investigators to agree to participate in NEST. Investigators must clearly indicate in their application if they are willing to join as a NEST project or not.

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**TOPIC AREA 2: EXISTING PLANT OPTIMIZATION**
(Eligible to Lead: Universities Only; Up to 3 years and $1,000,000)

The United States benefits from the largest existing fleet of nuclear reactors in the world. Maintaining access to the carbon-free energy supplied by our current fleet of nuclear reactors is essential to reducing carbon emissions. To support this goal, NE is seeking proposals for research projects to develop technologies or other solutions to significantly reduce operating costs, improve economic competitiveness of existing plants, and extend plant operational lifetimes.

Reduced operating costs could arise from innovation in areas including, but not limited to, implementation of human-factors-informed digital technologies, risk-informed reductions in security conservatism, and plant asset management. Meanwhile, research underpinning the scientific bases for reactor power uprates has the potential to increase revenues. Similarly, understanding the aging of structures, systems, and components (SSCs), have the potential to optimize and extend the safe, cost-effective operational lifetimes of existing reactors. Successful proposals in this topic area will pioneer discoveries, methods, and solutions that bolster the economic and technical sustainability of the current fleet of nuclear reactors.

**TOPIC AREA 3: NON-TRADITIONAL AND NON-ELECTRIC APPLICATIONS**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

Some advanced reactors, such as microreactors, are uniquely suited for servicing non-traditional energy markets such as off-grid communities, remote locations, military bases, maritime applications, and disaster relief missions. Additionally, new large electrical loads pose several challenges to the U.S. electric power grid that could potentially be addressed through use of microreactors or small advanced reactors to serve as dedicated power sources. Proposals are sought for research related to high value opportunities for new and advanced reactors to service non-traditional energy markets and/or provide a dedicated supply of heat and/or electricity to specific applications.

Additionally, both existing and advanced nuclear reactors are attractive energy sources for multiple applications where clean, reliable energy, or high-quality heat is needed with very high availability, such as the production of hydrogen, synthetic fuels, polymers, chemicals, and minerals; refineries; and district heating. Nuclear reactors offer the ability to provide heat and electricity at the location where it is needed, greatly reducing the cost to transmit/distribute energy. NE is seeking proposals that advance the potential for commercial deployment of nuclear power for such applications including, but not limited to, thermal and electrical requirements for specific industrial applications and design, optimization or modeling of the infrastructure needed to connect the nuclear plant to the industrial application and/or their integrated operations.

For investigators applying to Topic Area 3: Non-Traditional and Non-Electric Applications, incremental funding is potentially available through participation in the Department of Energy's interactions with the Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) Nuclear Education, Skills and Technology (NEST) program. NEST ties together university research projects across multiple countries to provide students a fuller professional experience as they pursue their degree. NEST funds are provided to allow travel for

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**TOPIC AREA 4 – NUCLEAR FUEL RECYCLE TECHNOLOGIES**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

Deployment of advanced nuclear reactors will inevitably introduce new challenges for devising and implementing an efficient, safe, secure, and economical nuclear fuel cycle that meets society's need for clean energy and expectations for environmental stewardship. Innovative technologies and processes for the recovery, recycle and reuse of valuable components from used nuclear fuel, including development of transmutation targets to destroy long lived isotopes, will enable sustainable nuclear energy development.

NE seeks proposals for R&D on advanced fuel recycle technologies that have the potential to improve resource utilization and energy generation, reduce long-term radiotoxicity, reduce waste generation, and limit proliferation risk. Specific emphasis is on developing advanced fuel recycling technologies and addressing fundamental materials separations and recovery challenges that present significant degrees of technical risks and financial uncertainties. Areas for emerging technologies and future research directions are described in the following workshop reports: (1) Innovative Separations R&D Needs for Advanced Fuel Cycles (https://info.ornl.gov/sites/publications/Files/Pub172641.pdf) and (2) Technology and Applied R&D Needs for Molten Salt Chemistry (https://www.ornl.gov/sites/default/files/Molten%20Salt%20Workshop_Final_092917.pdf).

**TOPIC AREA 5 – FUELS**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

Advancements in fuel systems, fabrication processes, cladding concepts, and evaluation techniques are important to ensure that a robust supply chain of well-characterized and optimized fuels is available to support the emerging advanced reactor fleet. NE is seeking proposals for R&D to enhance the performance or resilience of innovative fuels for light-water reactor (LWR) or advanced reactor applications. Topics of interest include, but are not limited to accident tolerant fuels, silicon carbide fuel cladding, TRISO-particle fuels, metallic fuels, and salt fuels. All aspects of fuel design, testing, and evaluation will be considered.

NE has cooperated with U.S. fuel suppliers to develop ATF concepts with significant support from the U.S national laboratories and universities. Near-term concepts include coated zirconium cladding and doped $UO_2$ pellets. Longer term concepts include iron-chromium-aluminum cladding, silicon carbide composite cladding, and high uranium density fuels. Proposals are

sought in areas that can contribute to enhancing LWR safety and performance including, but not limited to, potential applications of ATF fuel concepts to Small Modular Reactors (SMRs).

Silicon Carbide fuel cladding is being studied as part of the ATF Program in order to provide robust safety performance for high temperature thermal hydraulic transient conditions. Proposals are sought for activities that enable the goal of licensing silicon carbide cladding for operating nuclear reactors. Potential focus areas could include, but are not limited to, non-destructive evaluation methods, quality assurance characterization techniques, and advances in silicon carbide fuel cladding fabrication methods.

TRISO-particle fuel has demonstrated robust safety performance for high temperature applications. Numerous U.S. companies are pursuing the use of TRISO fuel in their advanced high temperature reactor concepts. Proposals are sought for activities that enable the goal of licensing and operating nuclear reactors that utilize TRISO fuel. Potential focus areas could include, but are not limited to, a comprehensive understanding of fuel and fuel matrix properties under irradiated conditions; addressing unique challenges associated with the use of TRISO fuel in non-typical environments; and activities to evaluate or develop novel TRISO-fuel forms, including new fuel kernel compositions.

Metallic fuels for advanced reactors can operate in open or closed fuel cycles. The design of open cycle metallic fuels focuses on optimizing fuel life and energy output and facilitating storage and disposal. For example, chemically reactive or liquid bonds are to be avoided in this group due to complications with storage and disposal. Closed cycle metallic fuel designs seek to maximize fuel burnup to support an efficient and economic fuel cycle, facilitate reprocessing, and minimize geologic repository burden. Fuel/clad bonding is acceptable in this group as long as it does not hinder reprocessing operations. Both open and closed metal fuel cycle applications place a high priority on manufacturability, economics, safety, and resource utilization. Proposals are sought that will develop and evaluate new or already proposed metallic fuel innovations. Ideally, results will support modeling of metallic fuel performance.

Unlike conventional reactors in which the fuel and coolant are separate phases, some MSR concepts use a molten salt solution as both the fuel and the coolant. There has been considerable effort in characterizing and modeling the thermophysical and thermochemical properties of molten salt as well as the atomic level structure and chemistry of potential salt fuels as a function of composition. Additional progress is needed to develop scalable process chemistries and technologies to produce molten salt fuels that meet the MSR developer specifications for impurities such as oxygen and water. Process chemistries and technologies should be able to produce fuel salt from a variety of non-irradiated enriched uranium sources including high purity $UF_6$ and U metal as well as uranium oxides, carbides, silicides, or nitrides. In addition to high purity enriched uranium sources, there are mixed sources where enriched uranium is incorporated in an inert metal, ceramic, or graphite matrix. Proposals are sought for development of robust scalable processes and/or equipment for preparing molten fluoride or molten chloride startup or make-up fuel salt to meet one or more MSR vendor specifications using one or more types of the more plentiful non-irradiated enriched uranium source materials.

Innovative fuel concepts that support next generation LWR fuel and other advanced reactor applications of fuel design, testing, and evaluation will also be considered.

**TOPIC AREA 6 – SPENT FUEL, WASTE SCIENCE & TECHNOLOGY AND INTEGRATED WASTE MANAGEMENT SYSTEM**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

NE seeks to provide a sound technical basis for the safety and security of long-term storage, transportation, and disposal of spent nuclear fuel and wastes from the nuclear energy enterprise. NE is seeking proposals for R&D in the areas of disposal research, storage, transportation, and the Integrated Waste Management System (IWMS), each of which is described further below.

The disposal research area seeks to develop a sound technical basis for multiple viable disposal options, identify and research sources of uncertainty that challenge the viability of disposal concepts, increase confidence in robustness of disposal concepts to site-specific complexity, and develop the science and engineering tools required to address these needs. The areas of highest priority for disposal research are described in the following document: Sevougian, et al. 2019, 'DOE SFWST Campaign R&D Roadmap Update Rev. 1' SAND2019-9033R, which can be found at https://www.osti.gov/biblio/1559571. Topics of interest could include, but are not limited to, waste package failure modes, post closure criticality, radio geochemistry, buffer materials, and modeling & simulation.

Spent nuclear fuel (SNF) will continue to be stored, typically in dry cask storage systems (DCSS), until a determination on final disposition is made. Over 90% of DCSSs in the United States are welded dry storage canisters (DSC), typically fabricated from 5/8-inch thick (Type 304 or 316) stainless steel, stored either vertically or horizontally. The U.S. Nuclear Regulatory Commission has identified key safety functional areas for storage, including retrievability, thermal performance, confinement, radiation protection, and subcriticality. It is important to demonstrate that these safety functions are met during extended storage and after transportation. The areas of highest priority for storage and transportation are described in the following document: Teague et al. 2019, 'Gap Analysis to Guide DOE R&D in Supporting Extended Storage and Transportation of Spent Nuclear Fuel: An FY2019 Assessment', SAND2019-15479R, which can be found at https://www.osti.gov/servlets/purl/1592862. Topics of interest could include, but are not limited to, chlorine induced stress corrosion cracking in the canister wall, canister internal environment monitoring, fuel cladding degradation, and stresses and strains on fuel bundle components due to transportation or seismic loads.

NE is working toward implementing an IWMS for SNF and high-level radioactive waste (HLW), including federal consolidated interim storage, eventual permanent disposal, and associated transportation. Freight rail is expected to be the primary mode for SNF transport. Siting for storage and disposal facilities is following a consent-based approach with broad public participation and communications. NE is also evaluating considerations for integration of advanced reactor fuel concepts into the IWMS. This topic area is focused on research and analysis to fill relevant information gaps, as well as provide independent expert input and/or review. Example topics of interest could include, but are not limited to, innovative approaches to computationally and visually represent to the public the risks and likely outcomes of SNF train derailment and release, means of estimating the amount and characteristics of dust generated by pebble-based TRISO SNF during handling and transportation under normal and hypothetical

accident conditions, and means of assessing the integrity of the pebbles and potential for additional amounts of dust generation when subjected to possible external events during extended storage such as a design-basis earthquakes.

**TOPIC AREA 7 – CONSENT-BASED SITING FOR SNF MANAGEMENT**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

The U.S. Department of Energy (DOE) is committed to a consent-based siting process in managing the nation's spent nuclear fuel. A consent-based siting process prioritizes the well-being and needs of people and communities, centers upon equity and environmental justice, and is collaborative, phased, and adaptive. As DOE works toward siting one or more federal consolidated interim storage facilities for spent nuclear fuel using a consent-based process, it aims to reduce barriers to meaningful participation and public engagement. To that end, understanding the factors that may influence the quality and/or extent of public engagement would allow DOE to tailor the consent-based siting process to better fit the needs of different people and communities.

NE is seeking qualitative, quantitative, and mixed methods research examining public engagement, broadly construed, within the context of consent-based siting. Empirical research addressing the following topics, in no particular order, is of interest: a) methods to measure public engagement and its characteristics, either in general or specific to different people or communities, b) the ways in which considerations regarding equity (e.g., intergenerational) and/or environmental justice may impact public engagement, c) factors influencing the quality and/or extent of the government's perceived or actual engagement (including, but not limited to DOE), d) what community-led development, as it relates to consent-based siting, means to different people and communities, and e) how discussions on regional development may impact public or government engagement (e.g., local, State, Tribal, federal).

**TOPIC AREA 8 – MODELING AND SIMULATION**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

Science-based, verified, and validated modeling and simulation capabilities are essential for the design, implementation, and operation of nuclear energy systems and fuel cycle technologies. This topic area focuses on nuclear energy related modeling and simulation projects that develop or improve tools for many different applications including, but not limited to: high fidelity reactor modeling, including neutronics, structural dynamics, and thermal hydraulics; multi-scale, multi-physics models for characterizing complex neutron kinetics, dynamics, microstructural, and thermomechanical phenomena; verification and validation; Uncertainty quantification; and flow modeling, among other relevant areas.

Applications under this Topic Area should primarily focus on development or improvement of modeling tools, while the use of modeling and simulation tools would be in one of the other Topic Areas that best relates to the reactor, fuel type or technology being investigated. One exception to this would be development of single or multi-physics benchmarks, which should be proposed under this Topic Area. Applications to develop a benchmark must allocate adequate time and resources to complete and publish the benchmark.

**TOPIC AREA 9 – MEASURING, MONITORING, AND CONTROLS**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

Robust sensors, instrumentation, and controls are needed to enhance capabilities, provide for higher accuracy, and to accommodate new and challenging operational environments in the existing fleet and advanced reactors. NE seeks proposals for sensor development that adds new capabilities to existing technologies or develops novel technologies to support relevant and challenging operational conditions.

NE has identified the value of coupling instrumentation and controls (I&C) with artificial intelligence (AI) and machine learning (ML) and integrating these techniques into digital twin (DT) platforms. Topics of interest in this area could include, but are not limited to, development of techniques and/or applications relevant to the current fleet or advanced reactors and means of meaningfully training models using existing research reactor data.

**TOPIC AREA 10 – LICENSING, SAFETY, AND SECURITY**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

There is a continued need for enhancing understanding of licensing and safety requirements as they apply to the safe and secure operations of reactors and all fuel cycle related facilities. NE is seeking proposals in the areas of safeguards and security, nuclear materials control and accountability, cybersecurity, safety analysis methods, regulatory frameworks, and systems engineering and integration of these areas. Topics of interest include, but are not limited to, enhancing the applicability, usability and efficiency of PRA tools or other innovative risk assessment methodologies; combined hazard PRA models; cost-effective MC&A methods and tools for advanced reactors, and fuel fabrication and recycling processes; cost-effective means of managing advanced cybersecurity threats; enabling the cyber-secure deployment of advanced digital technologies; and addressing specific gaps in licensing technical requirements for advanced reactors.

For investigators applying to Topic area 7, incremental funding is potentially available through participation in the Department of Energy's interactions with the Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) Nuclear Education, Skills and Technology (NEST) program. NEST ties together university research projects across multiple countries to provide students a fuller professional experience as they pursue their degree. NEST funds are provided to allow travel for students to interact with colleagues in other NEST countries in accordance with NEST program rules. Applications submitted to this work-scope do not require NEST participation. Access to NEST funds do require investigators to agree to participate in NEST. Investigators must clearly indicate in their application if they are willing to join as a NEST project or not.

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**TOPIC AREA 11 – ADVANCED NUCLEAR MATERIALS**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

Identification, investigation, and research and development of revolutionary technologies in crosscutting materials science areas have the potential for radical improvement in reactor or fuel cycle performance, safety, and economics. NE is seeking proposals for R&D to better understand core and structural materials, to qualify and/or test existing materials, and to explore and develop new classes of materials for identified applications. Topics of interest under this are include, but are not limited to, environmental, thermal and irradiation effects on materials, materials to efficiently immobilize fission products and off-gas capture species, development of comprehensive frameworks to characterize and model degradation or key materials, components and structures such as concrete or polymers, development of relevant advanced metal alloys for core materials and cladding, and development of materials to support waste minimization and management, such as sorbents and transmutation targets.

**TOPIC AREA 12 – ADVANCED MANUFACTURING TECHNOLOGIES**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $1,000,000)

The emerging fleet of advanced reactors, of virtually all types and sizes, is supported by its strongest business case when coupled with advanced manufacturing techniques that allow for significant reductions to the costs of original construction and major component replacement. The concepts under consideration range from advanced manufacturing of components through complete factory fabrication of reactors for delivery and installation at the site. NE is seeking proposals for R&D that support the development, nuclear qualification, and/or regulatory acceptance of advanced manufacturing processes, methods, equipment, and/or materials or components manufactured using such techniques. Topics of interest include, but are not limited to, processing and fabrication methods for composites, concrete, and metals; joining and repair; and specific applications to components, sub-systems, systems, and structures.

**TOPIC AREA 13- STRATEGIC NEEDS BLUE SKY**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $500,000)

NE is seeking proposals to advance foundational models, methods, and theory. Maintaining fundamental skills and knowledge in key nuclear engineering topics is important to maintaining and establishing research excellence and expertise. Areas of interest could include, but are not limited to, thermal hydraulics, heat transfer, reactor physics, and nuclear chemistry. A response should address innovative research in the identified area and could include any aspect (experiments, modeling, etc.) that is necessary to accomplish the proposed scope.

## INTEGRATED RESEARCH PROJECTS

### IRP-1: Grand Challenge IRP – ACCELERATING REACTOR DEVELOPMENT

(FEDERAL POC – JANELLE EDDINS)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $3,000,000)

NE's goal of demonstrating several advanced reactor types within this decade resulting in advanced reactor deployment in the 2030s, is a core aspect of addressing U.S. clean energy climate change goals. One of the primary challenges is reducing overall capital and operating and maintenance (O&M) costs while also de-risking the technologies for more rapid adoption by industry. NE solicits applications for this scope that take a holistic, multi-disciplinary approach to reactor deployment considerations for specific reactor technologies. Applications can cover a wide variety of topics including innovative component, instrumentation, and fuel handling systems; design optimization including integrated systems or reducing the size of the core or number of components; technologies to reduce the cost and schedule for construction; and siting infrastructure considerations for remote applications and transition from fossil generation sources, including environmental justice considerations. Proposals that suggest innovative ideas for cost reduction or shortening the deployment timeline by developing a holistic, multi-faceted approach, including a focus on key technical needs areas, like nuclear economics, accelerated testing, and reactor/plant design expertise, are desired.

For investigators applying to this work scope, incremental funding is potentially available through participation in the Department of Energy's interactions with the Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) Nuclear Education, Skills and Technology (NEST) program. NEST ties together university research projects across multiple countries to provide students a fuller professional experience as they pursue their degree. NEST funds are provided to allow travel for students to interact with colleagues in other NEST countries in accordance with NEST program rules. Applications submitted to this work-scope do not require NEST participation. Access to NEST funds do require investigators to agree to participate in NEST. Investigators must clearly indicate in their application if they are willing to join as a NEST project or not.

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### IRP -2: Grand Challenge Research and Development at MINORITY SERVING INSTITUTIONS (MSI)

(FEDERAL POC – JENNA PAYNE)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 3 YEARS AND $3,000,000)

NE's mission is to advance nuclear energy science and technology to meet U.S. energy, environmental, and economic needs. Toward this mission, NE has identified goals to address challenges in the nuclear energy sector, to help realize the potential of advanced technology, and to leverage the unique role of the government in spurring innovation:

1. Enable continued operation of existing U.S. nuclear reactors
2. Enable deployment of advanced nuclear reactors
3. Develop advanced nuclear fuel cycles and spent nuclear fuel management options

This opportunity is restricted to MSI lead institutions, including historically black colleges and universities (HBCUs), tribally controlled colleges and universities, (TCCUs), Asian American and Native American Pacific Islander-serving institution (AANAPISI) and Hispanic-serving institutions (HSIs), as defined in Title III and Title V of the Higher Education Act. This scope solicits applications that address one or more NE mission related technical areas that advance nuclear engineering research and development at MSI institutions.

**NUCLEAR SCIENCE USER FACILITIES (NSUF) JOINT R&D AND ACCESS (NSUF-1)**
Applicants interested in utilizing a joint R&D and Nuclear Science User Facilities (NSUF) capabilities should submit under this topic area (NSUF-1). Projects requiring NSUF Access only (see NSUF-2, Appendix C) or "R&D funding only" must be submitted under other appropriate topic areas. In this topic area, R&D support will be provided to university led projects to support their research directly associated with the proposed irradiation and/or post irradiation examination including compilation and interpretation of results. All applications submitted under this topic area will be projects coupling funding with NSUF access.

Proposals with NSUF access can include ion, neutron, and gamma irradiation, x-ray synchrotron beam or neutron beam interrogation, post-irradiation examination, advanced materials characterization, and high-performance computing. Applicants can access the full list of NSUF capabilities at https://nsuf.inl.gov/. NSUF may have additional capabilities online by FY25 that can be included in the FY24 CINR applications. Users should contact the NSUF directly with questions prior to submitting an application.

NOTE: Access to NSUF capabilities will require agreement and final signature to the User Agreement (copy provided in Part IX, Appendix E). The terms and conditions of the User Agreement are non-negotiable, and failure to accept the terms and conditions of the User Agreement will terminate processing and review of the application. To ensure compliance throughout the application review process, applicants must indicate in the Letter of Intent (LOI) and full application submission that the User Agreement has been read, understood, and the terms and conditions are accepted. Further, submission of a pre-application and a full application indicates the applicant will comply with and agree to the terms and conditions of the User Agreement. Upon award of an NSUF supported project, the User Agreement must be signed before activities will begin on the project. Failure to sign the non-negotiable User Agreement within 30 days of receipt of the User Agreement may result in cancellation of an awarded project.

**NSUF-1.1: Core and Structural Materials Behavior Development**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 7 YEARS AND $1,000,000)
(NSUF READINESS REQUIREMENTS APPLY)

This NSUF topic is focused on fundamental understanding of irradiation effects in core and structural materials. This includes the behavior of nuclear fuels (including cladding) in reactor and research into advanced nuclear fuels and improving the performance of current fuels. For the core and structural materials aspect of the topic, areas of interest include materials aging and degradation mechanisms, testing alternate and/or radiation resistant materials for application in current and future fission reactors, and innovative materials from alternate or advanced joining and manufacturing techniques. For the nuclear fuel's aspect of the topic, areas of interest include the fundamental physics and chemistry of nuclear fuels, irradiation and thermal effects on microstructure development, and thermophysical and thermomechanical properties. Proposed projects may involve research in the areas of fuels and materials irradiation performance and combined effects of irradiation and environment on fuels and materials. Advanced fuel types extend to fast spectrum transmutation systems, coated particle fuels for high-temperature reactor systems, robust fuels for light water reactors including accident tolerant fuels, and innovative

fuel for small modular, micro-, and other advanced reactor concepts. Activities can be aimed at irradiation experiments (neutron steady state or transient, ion, and gamma) and post irradiation examination that explore fundamental aspects of fuel performance such as radiation damage, amorphization, fuel restructuring, species diffusion and migration, and fission product behavior. Separate effects testing focused on validation of specific modeling and simulation issues is encouraged. Applications coupling experimental methods with modeling and simulation are strongly encouraged.

**NSUF-1.2: Testing of Advanced Materials for Sensors**
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY; UP TO 7 YEARS AND $1,000,000)
(NSUF Readiness Requirements Apply)

Applications are sought for irradiation testing and post-irradiation examination that support the development of advanced sensor materials, and the development of advanced instrumentation or measurement systems to support NE's mission to enhance the long-term viability and competitiveness of the existing fleet, and to develop an advanced reactor pipeline, and to implement and maintain national strategic fuel cycle and supply chain infrastructure. For this topic, areas of interest include irradiation testing and post irradiation examination of candidate sensor materials and candidate instrumentation systems. Proposed projects can include irradiations and post-irradiation examination to address fundamental and applied technology gaps.

**NUCLEAR SCIENCE USER FACILITIES (NSUF) ACCESS ONLY (NSUF-2)**
Applicants interested in utilizing Nuclear Science User Facilities (NSUF) capabilities only should submit "access only" applications under this topic areas. **This topic does not provide R&D support**. Applications under the NSUF-2 work scope must support the Department of Energy Office of Nuclear Energy's mission. Capabilities available through the NSUF can be found on the website at https://nsuf.inl.gov/.

Proposals with NSUF access can include ion, neutron, and gamma irradiation, x-ray synchrotron beam or neutron beam interrogation, post-irradiation examination, advanced materials characterization, and high-performance computing. Applicants can access the full list of NSUF capabilities at https://nsuf.inl.gov/. NSUF may have additional capabilities online by FY25 that can be included in the FY24 CINR applications. Users should contact the NSUF directly with questions prior to submitting an application.

NOTE: Access to NSUF capabilities will require agreement and final signature to the User Agreement (copy provided in Part IX, Appendix E). The terms and conditions of the User Agreement are non-negotiable, and failure to accept the terms and conditions of the User Agreement will terminate processing and review of the application. To ensure compliance throughout the application review process, applicants must indicate in the Letter of Intent (LOI) and full application submission that the User Agreement has been read, understood, and the terms and conditions are accepted. Further, submission of a pre-application and a full application indicates the applicant will comply with and agree to the terms and conditions of the User Agreement. Upon award of an NSUF supported project, the User Agreement must be signed

before activities will begin on the project. Failure to sign the non-negotiable User Agreement within 30 days of receipt of the User Agreement may result in cancellation of an awarded project.

**NSUF-2.1: Core and Structural Materials Behavior and Development**
(ELIGIBLE TO LEAD: UNIVERSITY, NATIONAL LABORATORY, AND INDUSTRY)
(LIMITED TO 7 YEARS)
(NSUF READINESS REQUIREMENTS APPLY)

This NSUF topic is focused on fundamental understanding of irradiation effects in core and structural materials. This includes the behavior of nuclear fuels (including cladding) in reactor and research into advanced nuclear fuels and improving the performance of current fuels. For the core and structural materials aspect of the topic, areas of interest include materials aging and degradation mechanisms, testing alternate and/or radiation resistant materials for application in current and future fission reactors, and innovative materials from alternate or advanced joining and manufacturing techniques. For the nuclear fuel's aspect of the topic, areas of interest include the fundamental physics and chemistry of nuclear fuels, irradiation and thermal effects on microstructure development, and thermophysical and thermomechanical properties. Proposed projects may involve research in the areas of fuels and materials irradiation performance and combined effects of irradiation and environment on fuels and materials. Advanced fuel types extend to fast spectrum transmutation systems, coated particle fuels for high-temperature reactor systems, robust fuels for light water reactors including accident tolerant fuels, and innovative fuel for small modular, micro-, and other advanced reactor concepts. Activities can be aimed at irradiation experiments (neutron steady state or transient, ion, and gamma) and post irradiation examination that explore fundamental aspects of fuel performance such as radiation damage, amorphization, fuel restructuring, species diffusion and migration, and fission product behavior. Separate effects testing focused on validation of specific modeling and simulation issues is encouraged. Applications coupling experimental methods with modeling and simulation are strongly encouraged.

**NSUF-2.2: Testing of Advanced Materials for Sensors**
(ELIGIBLE TO LEAD: UNIVERSITY, NATIONAL LABORATORY, AND INDUSTRY)
(LIMITED TO 7 YEARS)
(NSUF READINESS REQUIREMENTS APPLY)

Applications are sought for irradiation testing and post-irradiation examination that support the development of advanced sensor materials, and the development of advanced instrumentation or measurement systems to support NE's mission to enhance the long-term viability and competitiveness of the existing fleet, and to develop an advanced reactor pipeline, and to implement and maintain national strategic fuel cycle and supply chain infrastructure. For this sub-topic, areas of interest include irradiation testing and post irradiation examination of candidate sensor materials and candidate instrumentation systems. Proposed projects can include irradiations and post-irradiation examination to address fundamental and applied technology gaps.