FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT

U. S. Department of Energy

Idaho Operations Office

Fiscal Year 2018 Consolidated Innovative Nuclear Research

Funding Opportunity Announcement:
DE-FOA-0001772

Announcement Type: Initial: 10/19//2017
CFDA Number: 81.121

Informational Webinar: August 8–10, 2017
(Video links and presentations are available at www.neup.gov)

Issue Date: October 19, 2017

NSUF Access Request (Mandatory only for NSUF Applications)
Due Date: November 8, 2017 at 7:00 PM ET

NSUF Statement of Work for NSUF-1 and NEAMS-2 workscopes (Mandatory only for NSUF Applications)
Due Date: January 12, 2018 at 7:00 PM ET

Full R&D/NSUF-1 Applications (Mandatory for R&D/NSUF-1 full submissions)
Due Date: January 23, 2018 at 7:00 PM ET

NSUF Statement of Work for NSUF-2 workscope (Mandatory only for NSUF Applications)

Due Date: April 26, 2018

Full NSUF-2 Applications (Mandatory for NSUF-2 full submissions)
Due Date: May 17, 2018 at 7:00 PM ET

NOTE: Deadlines are the dates/times by which DOE must receive the specified submittal

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LIST OF ACRONYMS

AR	NSUF Access Request
CFDA	Catalog of Federal Domestic Assistance
CFA	Call for Full Applications
CFR	Code of Federal Regulations
CINR	Consolidated Innovative Nuclear Research
COI	Conflict of Interest
CTD	Crosscutting Technology Development
DE	Department of Energy (FOA Number)
DOE	Department of Energy
DUNS	Data Universal Numbering System
FC R&D	Fuel Cycle Research and Development
FFATA	Federal Funding and Transparency Act of 2006
FFRDC	Federally Funded Research and Development Center
FOA	Funding Opportunity Announcement
FSRS	FFATA Subaward Reporting System
FWP	Field Work Proposal
FY	Fiscal Year
GAIN	Gateway for Accelerated Innovation in Nuclear
ID	Identification
IRP	Integrated Research Project
LWRS	Light Water Reactor Sustainability
M&O	Management and Operating
M&TE	Measuring and Test Equipment
MOOSE	Multiphysics Object Oriented Simulation Environment
MS	Mission Supporting
MSI	Minority Serving Institution
MSR	Molten Salt Reactor
NCE	No Cost Extension
NE	Office of Nuclear Energy
NEAMS	Nuclear Energy Advanced Modeling and Simulation
NEET	Nuclear Energy Enabling Technologies
NEUP	Nuclear Energy University Program
NSUF	Nuclear Science User Facilities

NNSA	National Nuclear Security Administration
PDF	Adobe Portable Document Format
PIE	Post-irradiation Examination
PI	Principal Investigator
POC	Point of Contact
PS	Program Supporting
QA	Quality Assurance
R&D	Research and Development
RC RD&D	Reactor Concepts Research, Development and Demonstration
SAM	System for Award Management
SF	Standard Form
SMR	Small Modular Reactors
SOW	Statement of Work
URG	Under Represented Group
U.S.	United States

Major Changes to the CINR FOA Format for FY 2018

Due to the delayed release of the FY 2018 CINR FOA there are some major deviations from typical policy and practice. The following items will be altered to allow for award announcement in the June timeframe. These changes are unique to FY 2018 and DOE-NE anticipates to return to a normal schedule in FY 2019. Multiple workscope titles have changed.

NSUF LOI and Pre-Application will be Combined in to a NSUF Access Request

The NSUF Access Request will replace the NSUF LOI and NSUF Pre-Application. The NSUF Access Request is a 4-page document that combines many elements of the LOI and Pre-Application. Applications to NSUF-1 and NSUF-2 workscopes will require a NSUF Access Request which is due on November 8, 2017.

R&D Pre-Application Process for NEUP & NEET (Non-NSUF) Workscopes is Cancelled

Due to time constraints, the R&D pre-application process will not take place. R&D full applications will be due on January 23, 2018. PIs are still subject to the same application limits as years past. A PI can only lead on projects that they could potentially win. A new eligibility flowchart is available on NEUP.gov if there are questions about eligibility.

NSUF-2 Full Applications Have a Late Phase Due Date

Due to feasibility review times for NSUF applications the NSUF-2 full application process will be phased to a later date than the rest of CINR's workscopes. NSUF-2 full applications are due on May 17, 2018 and it is anticipated that award announcements for NSUF-2 will occur later in the calendar year.

NSUF Statement of Work Submittals

NSUF Statements of Work must be submitted using the online application. The Statement of Work will be appended to an already submitted NSUF Access Request. NSUF-1 Statements of Work are due on January 12, 2018 and NSUF-2 Statements of Work are due on April 26, 2018.

Two New Workscope Areas in Reactor Concepts

Three additional workscopes have been added titled, "RC-1.3: Oxidation Behavior in HTGR TRISO Fuel Materials;", "RC-2.3: Understanding the Structure and Speciation of Molten Salt at the Atomic and Molecular Scale".

RC-4.3 and IRP-RC-1 Workscopes have been Cancelled

There will be no IRP's available in FY 2018.

An informational webinar will be held to discuss updates to the FY 2018 CINR FOA on October 25. More information on the webinar will be available at www.neup.gov.

PART I – FUNDING OPPORTUNITY DESCRIPTIONS

A. STATEMENT OF OBJECTIVES

This Funding Opportunity Announcement (FOA) is for Consolidated Innovative Nuclear Research (CINR) and is thus referred to in this document as the "CINR FOA".

A.1 Background and Objectives

The Department of Energy's (DOE) Office of Nuclear Energy (NE) conducts crosscutting nuclear energy research and development (R&D) and associated infrastructure support activities to develop innovative technologies that offer the promise of dramatically improved performance for advanced reactors and fuel cycle concepts while maximizing the impact of DOE resources.

The Gateway for Accelerated Innovation in Nuclear (GAIN) team has been working closely with the advanced nuclear design community to identify R&D objectives that may be appropriately addressed through DOE programs. Several of the work scopes contain explicit language as guidance, but there are many additional work scopes that at least tangentially address needs identified in technology specific workshops. Generally speaking, proposals that offer flexibility or provision for addressing measurements, materials, and conditions relevant to private sector developers of fast-spectrum reactors (Pb-cooled, sodium cooled, and gas cooled), molten salt reactors (MSR), or high-temperature gas-cooled reactors (HTGCR) are encouraged.

NE strives to promote integrated and collaborative research conducted by national laboratory, university, industry, and international partners under the direction of NE's programs, and to deploy innovative nuclear energy technologies to the market in order to meet the strategic goals and optimize the benefits of nuclear energy. NE funds research activities, through both competitive and direct mechanisms, as required to best meet the needs of NE. This approach ensures a balanced R&D portfolio and encourages new nuclear power deployment with creative solutions to the universe of nuclear energy challenges. This FOA addresses the competitive portion of NE's R&D portfolio as executed through the Nuclear Energy University Program (NEUP), Nuclear Energy Enabling Technologies (NEET) Crosscutting Technology Development (CTD), and the Nuclear Science User Facilities (NSUF). NEUP utilizes up to 20% of funds appropriated to NE's R&D program for university-based infrastructure support and R&D in key NE program-related areas: Fuel Cycle Research and Development (FC R&D), Reactor Concepts Research, Development and Demonstration (RC RD&D), and Nuclear Energy Advanced Modeling and Simulation (NEAMS). NEET CTD supports national laboratory- and university-led crosscutting research. By establishing the NSUF in 2007, DOE-NE opened up the world of material test reactors, beam lines, and post-irradiation examination facilities to researchers from U.S. universities, industry and national laboratories by granting no-cost access to world-class nuclear research facilities.

NE reserves the right to respond to potential shifts in R&D priorities during Fiscal Year (FY) 2018 that may be driven by events, policy developments, or Congressional/budget direction. Further, NE reserves the right to fund all or part of an application to this FOA.

A.2 Major NE Funded Research Programs

A.2.1 Fuel Cycle Research and Development (FC R&D) Program

The mission of the FC R&D program is to develop used nuclear fuel management strategies and technologies to support meeting the federal government responsibility to manage and dispose of the Nation's commercial used nuclear fuel and high-level waste and to develop sustainable fuel cycle technologies and options that improve resource utilization and energy generation, reduce waste generation, enhance safety, and limit proliferation risk.

The program's vision is that by mid-century, strategies and technologies for the safe, long-term management and eventual disposal of U.S. commercial used nuclear fuel and any associated nuclear wastes are fully implemented. Additionally, it is desired that advanced nuclear fuel and fuel cycle technologies that enhance the accident tolerance of light-water reactors and enable sustainable fuel cycles are demonstrated and deployed. Together, these technologies and solutions support the enhanced availability, affordability, safety, and security of nuclear-generated electricity in the United States.

Current challenges include the development of high burn-up fuel and cladding materials to withstand irradiation for longer periods of time with improved accident tolerance; development of simplified materials recovery technologies, waste management (including storage, transportation, and disposal), and proliferation risk reduction methods; and development of processes and tools to evaluate sustainable fuel cycle system options, and to effectively communicate the evaluation results to stakeholders.

A.2.2 Reactor Concepts Research, Development and Demonstration (RC RD&D) Program

The mission of the RC RD&D program is to develop new and advanced reactor designs and technologies that broaden the applicability, improve the competitiveness, and ensure the lasting contribution toward meeting our Nation's energy and environmental challenges. Research activities are designed to address the technical, cost, safety, and security issues associated with various reactor concepts. The four technical areas are Light Water Reactor Sustainability (LWRS), Small Modular Reactors (SMR), Advanced (Non-Light Water) Reactor Concepts, and Advanced SMRs.

A.2.3 Nuclear Energy Advanced Modeling and Simulation (NEAMS) Program

The mission of the NEAMS program is to develop and deploy the NEAMS ToolKit, comprised of advanced computational tools, for use by government, industry, and academia in nuclear R&D, design, and analysis. These advanced computational tools employ scalable simulation methods on high performance computing architectures in combination with a science-based, mechanistic approach to physics modeling to allow scientists and engineers to better understand reactor materials properties and coupled phenomena in nuclear energy systems. The NEAMS ToolKit spans length scales from atomic to mesoscale to continuum, and time scales from picoseconds to seconds to days. NEAMS tools are currently being used to help evaluate advanced nuclear fuels and reactor concepts, design and analyze nuclear fuel experiments, and explore potential breakthroughs in the use of transient test reactors.

A.2.4 Nuclear Energy Enabling Technologies (NEET) Crosscutting Technology Development (CTD)

The NEET CTD program conducts R&D in crosscutting technologies that directly support and enable the development of new and advanced reactor designs and fuel cycle technologies. These technologies will advance the state of nuclear technology, improve its competitiveness and promote continued contribution to meeting our Nation's energy and environmental challenges. The activities undertaken in this program complement those within the RC RD&D and FC R&D programs. The knowledge generated through these activities will allow NE to address key challenges affecting nuclear reactor and fuel cycle deployment with a focus on cross-cutting innovative technologies.

A.2.5 Nuclear Science User Facilities (NSUF)

DOE-NE funds access to world-class capabilities to facilitate the advancement of nuclear science and technology. This mission is supported by providing access, at no cost to the user, to state-of-the-art experimental irradiation testing and Post-Irradiation Examination (PIE) facilities as well as technical assistance including the design and analysis of reactor experiments. NSUF and its partner facilities represent a prototype laboratory for the future. This unique model is best described as a distributed partnership with each facility bringing exceptional capabilities and expertise to the relationship including reactors, beamlines, state-of-the-art instruments, hot cells and, most importantly, expert technical leads. Together, these capabilities and people create a nation-wide infrastructure that allows the best ideas to be proven using the most advanced capabilities. Through NSUF, researchers and their collaborators are building on current knowledge to better understand the complex behavior of materials and fuels under irradiation.

The NSUF allows research teams to obtain access to designated capabilities at the following facilities:

- Argonne National Laboratory Intermediate Voltage Electron Microscope (IVEM)
- Brookhaven National Laboratory National Synchrotron Light Source II (NSLS II)
- Center for Advanced Energy Studies Microscopy and Characterization Suite (MaCS)
- Idaho National Laboratory
- Illinois Institute of Technology
- Lawrence Livermore National Laboratory
- Los Alamos National Laboratory
- Massachusetts Institute of Technology
- North Carolina State University
- Oak Ridge National Laboratory
- Pacific Northwest National Laboratory
- Purdue University
- Sandia National Laboratories

- Texas A&M University
- The Ohio State University
- University of California, Berkeley
- University of Florida
- University of Michigan
- University of Nevada, Las Vegas
- University of Wisconsin, Madison
- Westinghouse Materials Center for Excellence

NSUF capabilities are described in detail at https://nsuf.inl.gov/

Part I, Section B.2 of this FOA describes application options for projects requiring NSUF capabilities.

NOTE: Applicants requesting R&D financial support with a joint request for NSUF access will be limited to the workscopes in NSUF-1 and NEAMS-2. Workscopes in eligible areas have been tailored to align NSUF capabilities with focused NE program and mission priorities. Applicants requesting NSUF Access Only will apply to the NSUF-2 workscope, a broader workscope focused on NE mission priorities and also tailored to align with NSUF capabilities.

A.2.6 NSUF Fuels and Materials Library

The NSUF Fuels and Materials Library is a cataloged collection of irradiated materials and is a critical component of the NSUF. The Library was established to reduce costs and take advantage of new ideas and future analysis techniques and equipment. Researchers are encouraged to use the Library materials to develop research concepts. The catalog of available materials is available at https://nsuf.inl.gov/. In order to continue the expansion of the Library, the NSUF Program Office may recommend irradiating a larger number of samples than required for the proposed research. These samples will be added to the Library. In addition, all specimens remaining after three years of PIE will be moved into the Library. Principal Investigators (PIs) of all future awarded applications to study specimens added to the Library from previous awarded irradiation tests will be put in contact with the PI(s) of the project that produced the specimens for potential collaboration. Although collaboration with past NSUF PIs is encouraged, permission to use previously generated materials currently in the NSUF Library is not required. DOE owns all materials in the Library.

B. FUNDING OPPORTUNITIES

DOE is seeking applications from U.S. universities, national laboratories, and industry to conduct Program Supporting (PS), Mission Supporting (MS), and NSUF-supported nuclear energy-related research to help meet the objectives of the major NE-funded research programs.

Specifically, this FOA contains three separate funding opportunity areas defined as follows:

B.1 U.S. University-led PS/MS R&D Projects

These funding opportunities are available to U.S. university-led teams. In general, PS R&D is focused more directly on programmatic needs and is defined by the statement of objectives developed by the responsible programs. PS R&D, and within NSUF affiliated workscopes, must be focused and responsive to the representative statement of objectives, which is not specific to a discipline but can be limiting as defined by the project objective. In comparison, MS R&D is generally more creative, innovative, and transformative than PS R&D, but it must also support the NE mission. MS R&D activities could also produce breakthroughs in nuclear technology or could include research in the fields or disciplines of nuclear science and engineering that are relevant to NE's mission but may not fully align with the specific initiatives and programs represented by PS objectives. U.S. university PIs are invited to propose research projects in response to this area of the FOA and the associated PS and MS workscopes contained in Appendix A.

B.2 U.S. University-, National Laboratory-, or Industry-led PS R&D Projects

These funding opportunities are available to teams led by U.S. university, national laboratory, or U.S.-incorporated industry PIs. U.S. university or national laboratory PIs can apply as lead PI to any workscopes in Appendix B. **Industry leads can only apply to the NSUF workscopes**. Proposed research projects in response to this area of the FOA should meet the objectives of the NEET CTD program, and within the NSUF workscopes, meet the identified objectives of the RC RD&D, FC R&D, and NEET CTD programs as described in the workscopes contained in Appendix B of this FOA.

B.2.1 Note for Nuclear Science User Facilities Access Projects

NSUF access project applications require a NSUF Access Request (AR) and, if invited (see Part V, Section B.1), a full application. NSUF access project applications will also require a feasibility review and readiness review in addition to the relevancy and technical reviews. Important aspects of NSUF access applications are described in Appendix C and should be seriously considered when preparing applications. It is strongly recommended that all potential proposers review the contents of the NSUF website for vital information at http://nsuf.inl.gov.

The NSUF does not provide funding to the PI to support salaries, tuition, travel, or other costs typically supported via NE Program R&D funds.

DOE intends to fully fund all awarded NSUF access projects for the entire duration of the project. NSUF access project attributes include:

- U.S. university PIs may apply for NSUF access with a joint request for R&D financial support as stated in the NEAMS-2 workscope.
- U.S. university, national laboratory and industry PIs may apply for NSUF access with a joint request for R&D financial support as stated in the NSUF-1 workscope.
- U.S. universities, national laboratory and industry PIs may apply for only NSUF access without a joint request for R&D financial support as stated in the NSUF-2 workscope.

NSUF R&D projects may have a R&D component that is complemented by the unique capabilities of NSUF. Eligible workscopes for a NSUF R&D project are found in Appendix A &

B, and applications must comply with the provisions of Appendix C. **Since NSUF projects involving reactor neutron irradiation and PIE combined may last up to seven years in duration, greater flexibility in the R&D funding distribution can be established in order to better accommodate the actual resource allocation requirements of the project.** Those applications requesting research support, though limited to a total of three years of funding, may request a project period of performance to spread the funding over the entire length of the project. For irradiation only, PIE only, and beamline applications, a standard continuous funding profile should remain adequate. The PIE phase of all NSUF projects is limited to three years in duration. R&D funding shall not be utilized to directly supplement activities funded by NSUF.

NOTE: Applicants must demonstrate readiness for NSUF access. In the NSUF Access Request, a summary of readiness is required. In the full application, a detailed description of readiness is required. Awarded projects that are found to not be ready for NSUF access may be cancelled.

The following items must be completed prior to requesting NSUF access:

- Development and qualification of fabrication techniques, processes and methods
- Pre-irradiation characterization (physical, mechanical, thermal, chemical and other applicable properties)
- Material interaction studies (at irradiation conditions)
- Corrosion studies (at irradiation conditions)

A plan for delivery of fuel or material must be addressed with specific attention to the following:

- Structural and cladding materials for neutron irradiation must be supplied to NSUF three months after project initiation (provide supplier commitments and lead times) in order for the material to be machined to proper sample configuration prior to encapsulation.
- For previously irradiated fuels and materials not residing in the NSUF Fuels and Materials Library, the location (as specific as possible), condition, provenience, pedigree, radioactivity levels, isotopic content, material composition, configuration, ownership, and any other available information that will be needed in order to ship and/or prepare the fuel or material for examination must be identified.
- For any fuels or materials supplied for the purpose of neutron irradiation, the applicant must own and have full authority to transfer ownership and title (free of any liens, claims of ownership, or other liabilities) to DOE.
- For fuels or materials coming from other DOE programs (not NSUF), a statement of program commitment is required.

NSUF will not support preliminary fuels, materials, or instrumentation development work, i.e. development must be at irradiation testing stage. Projects whose relevancy is based solely or primarily on fusion energy needs will not be considered. Applications must include a list of publications that resulted from previous NSUF supported projects (publications to be included in the Benefit of Collaboration document as described Part IV, C1.2).

Projects not requiring R&D financial support may apply for NSUF access only projects in response to this area of the FOA and the associated workscope contained in Appendix B of this FOA, wherein only access to capabilities are sought to perform research in nuclear science.

Additional information on the NSUF process is included in Appendix C.

NOTE: Access to NSUF capabilities will require agreement and final signature to the User Agreement (copy provided in Appendix D).**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 NSUF-1, NEAMS-2, or NSUF-2 applications.** In order to ensure compliance throughout the application review process, applicants must indicate during the NSUF Access Request and full application submission that the User Agreement has been read, understood, and the terms and conditions are accepted. Further, submission of a NSUF Access Request 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..

As described above, workscopes for the respective FOA areas may be found in the appendices to this FOA as follows:

- Appendix A: "Workscopes for U.S. University-led Program and/or Mission Supporting R&D Projects." R&D support and associated NSUF access can only be proposed in specific workscopes;
- Appendix B: "Workscopes for U.S. University-, National Laboratory-, or Industry-led Program Supporting R&D Projects" R&D support and associated NSUF access and NSUF Access Only can be proposed in specific workscopes.

PART II – AWARD INFORMATION

A. TYPE OF AWARD INSTRUMENT

DOE anticipates awarding cooperative agreements under this CINR FOA, with the exception of awards to national laboratories, which will be funded through field work proposals (FWP) and NSUF Access Awards which will be funded through a NSUF User Agreement.

B. ESTIMATED FUNDING

The estimated amounts identified for each of the FOA areas are specified below. Funding for all awards and future budget periods are contingent upon the availability of funds appropriated by Congress for the purpose of this program.

B.1 U.S. University-led PS/MS R&D Projects

DOE currently estimates that it will fund approximately $40 million in awards for this FOA area.

B.2 U.S. University- or National Laboratory-led PS R&D Projects

DOE currently estimates that it will fund approximately $7 million in awards for this FOA area.

B.2.1 Nuclear Science User Facilities Projects

DOE currently estimates that it will fund approximately $8 million in award value for this FOA area.

C. MAXIMUM AND MINIMUM AWARD SIZE

Maximum and minimum award sizes are identified for the four FOA areas below:

C.1 U.S. University-led PS/MS R&D Projects

Ceiling (i.e., the maximum amount for an individual award made under this area):

- PS: up to $800,000 (3-year project), except as explicitly noted in individual workscopes.
- MS: up to $400,000 (3-year project), except as explicitly noted in individual workscopes.

Floor (i.e., the minimum amount for an individual award made under this area): None.

C.2 U.S. University- or National Laboratory-led PS R&D Projects

Ceiling (i.e., the maximum amount for an individual award made under this area):

- PS: up to $1,000,000 (3-year project), except as explicitly noted in individual workscopes.
- NSUF: up to $500,000 (3-year project) for R&D funding, except explicitly noted in individual workscopes.

Floor (i.e., the minimum amount for an individual award made under this announcement): None.

C.2.1 Nuclear Science User Facilities Projects

Ceiling (i.e., the maximum amount for an individual award made under this area):
Irradiation/PIE Project: $4,000,000 NSUF Access Value (up to a 7-year project).

Floor (i.e., the minimum amount for an individual award made under this announcement): None.

D. EXPECTED NUMBER OF AWARDS

The number of awards for each of the four FOA areas is identified below. The number of awards is dependent on the size of the awards. DOE reserves the right to make more or fewer (or even no awards) depending on funding availability and/or the quality of the applications.

D.1 U.S. University-led PS/MS R&D Projects

DOE anticipates making approximately 50 awards under this area.

D.2 U.S. University- or National Laboratory-led PS R&D Projects

DOE anticipates making up to 7 awards under this area.

D.2.1 Nuclear Science User Facilities Projects

DOE anticipates making up to 10 awards under this area.

E. ANTICIPATED AWARD SIZE

The anticipated award size for each of the three FOA areas are identified below. (Amounts represent anticipated maximum per award.)

E.1 U.S. University-led PS/MS R&D Projects

DOE anticipates that awards will be up to $800,000/award for PS projects and up to $400,000/award for MS projects (except as explicitly stated in individual workscope areas).

E.2 U.S. University- or National Laboratory-led PS R&D Projects

DOE anticipates that R&D awards will be up to $1,000,000/award (except as explicitly stated in individual workscope areas).

E.2.1 Nuclear Science User Facilities Projects

DOE anticipates that award access value (funds not provided to the PI) will fall within the following ranges:

- Irradiation only: $500,000 to $1,500,000
- Irradiation /PIE: $500,000 to $4,000,000
- Beamline or PIE only: $50,000 to $750,000.

F. PERIOD OF PERFORMANCE

DOE anticipates making awards for up to three years for each area with the exception of ***NSUF-1, NEAMS-2 and NSUF-2 awards, which may take up to seven years if irradiation and PIE is***

requested. Assuming DOE makes awards under this FOA by September 2018, funded projects shall begin no later than October 1, 2018; additionally, each successive budget period within the project period of performance should begin on October 1st of each year during the overall project period of performance. Proposing different start dates for the project and budget periods may make the application ineligible for award; if a different project start date other than October 1, 2018, is absolutely necessary for the successful performance of the project, it must be fully documented and justified in the application for consideration by DOE.

G. TYPE OF APPLICATION

DOE will accept only new applications for each of the two areas defined in Part I, Section B of this FOA. Applications made to previous FOAs will not be considered.

PART III – ELIGIBILITY INFORMATION

A. ELIGIBLE APPLICANTS

This FOA is open to U.S. universities, national laboratories, and industry.

Research consortiums may be composed of diverse institutions including academia, national laboratories, non-profit research institutes, industry/utilities, and international partners. Research teams should strive to achieve the synergies that arise when individuals with forefront expertise in different methodologies, technologies, disciplines, and areas of content knowledge approach a problem together, overcoming impasses by considering the issue from fresh angles and discovering novel solutions.

DOE-NE strongly encourages diversifying its research portfolio through effective partnerships with industry, underrepresented groups, and MSI, which may receive funding support from the project. International partners are encouraged to participate, however no U.S. government funding will be provided to entities incorporated outside of the United States. DOE-NE will evaluate the benefit and contribution of any such proposed partnerships as part of its program relevancy evaluation and scoring.

In Appendix A, non-university collaborators in composite can have no more than 20% of the total funds provided by the government.

A collaborator is an individual that makes a defined, material contribution that is critical to the success of the project. **Any individuals that do not meet these criteria should not be listed as collaborators on the application.**

Part IV, Section H outlines funding restrictions for this FOA.

1. Domestic Entities

For-profit entities, educational institutions, and nonprofits[1] that are incorporated (or otherwise formed) under the laws of a particular state or territory of the United States are eligible to apply for funding as a prime or subrecipient (only educational institutions may apply as a prime recipient for U.S. university-led PS and MS projects).

State, local, and tribal government entities are eligible to apply for funding as a subrecipient (for U.S. university-, national laboratory-, or industry-led PS and/or MS projects only).

DOE/National Nuclear Security Administration (NNSA) Federally Funded Research and Development Centers (FFRDCs) and DOE Government-Owned Government-Operated laboratories are eligible to apply for funding as a prime recipient (for PS or MS projects under NEET CTD), team member, or subrecipient. If an FFRDC is proposed as a team member or subrecipient, the requirements contained in Part III, Section C apply.

[1] Nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 2005, are not eligible to apply for funding.

Non-DOE/NNSA FFRDCs and non-DOE Government-Operated Government-Owned laboratories are eligible to apply for funding as a subrecipient but are not eligible to apply as a prime recipient.

Federal agencies and instrumentalities (other than DOE) are eligible to apply for funding as a subrecipient but are not eligible to apply as a prime recipient.

U.S. Incorporated Foreign Entities

Foreign entities, whether for-profit or otherwise, are eligible to apply for funding under this FOA as either a prime recipient or subrecipient subject the requirements in 2 Code of Federal Regulation (CFR) 910.124. Foreign entities are not eligibile to apply as lead in Appendix A.

Incorporated Consortia

Incorporated consortia, which may include domestic and/or foreign entities, are eligible to apply for funding as a prime recipient (U.S. university- or national laboratory-led PS and/or MS projects only) or subrecipient. For consortia incorporated (or otherwise formed) under the laws of a State or territory of the U.S., please refer to "Domestic Entities" above. For consortia incorporated in foreign countries, please refer to the requirements in "U.S. Incorporated Foreign Entities" above.

Unincorporated Consortia

Unincorporated consortia, which may include domestic and foreign entities, must designate one member of the consortium to serve as the prime recipient/consortium representative (U.S. university- or national laboratory-led PS and/or MS projects only). The prime recipient/consortium representative must be incorporated (or otherwise formed) under the laws of a State or territory of the U.S. The eligibility of the consortium will be determined by the eligibility of the prime recipient/consortium representative.

Application Restrictions

The following application restrictions apply to lead PIs:

- Applicants are ineligible to apply to any area of this FOA as a lead PI under any of the following circumstances:
    1. The PI has a currently funded IRP that will be active after December 31, 2018.
    2. The PI has three or more R&D projects that will still be active after December 31, 2018.
    3. The PI has a no-cost extension on any DOE-NE funded project (excluding Infrastructure) that will still be active beyond December 31, 2018.
- A PI cannot have more than three R&D projects funded at any time, and may not submit more full applications than would be allowed by these restrictions.
- PIs cannot submit the same application to multiple workscope areas.
- Applications submitted in response to research requested by Appendix B are limited to three applications per institution per workscope area.
- Applications requesting NSUF access and R&D support will be evaluated on a case-by-case basis with respect to these eligibility requirements.

- Access only requests for NSUF are not bound by these eligibility restrictions.

NOTE: Applications submitted to this FOA will be awarded to the applicant institution listed and will not be transferred pre-award to another if a lead PI changes institution. PIs that are moving from one institution to another during and/or after the CINR review process are subject to the DOE Changing Principal Investigator and Related Changes/Revisions Policy which is explained at www.neup.gov. Awards in this FOA are made to the applying institution and will remain at that institution for the entirety of the project. Any additional changes to partners/collaborators will need to be approved by the DOE contracting officer.

B. COST SHARING

For applications led by universities, cost sharing is not required, but may be proposed. If cost sharing is provided, see 2 CFR 200 for the applicable cost sharing guidance and Part VIII, Section H below. Cost sharing is **NOT** a scored review criteria.

For applications led by all other entities (i.e., other than universities and FFRDCs), the provisions of the Energy Policy Act of 2005, Section 988, apply and a cost share of at least 20% of the total allowable costs of the project (i.e., the sum of the government share, including FFRDC contractor costs if applicable, and the recipient share of allowable costs equals the total allowable costs of the project) and must come from non-Federal sources unless otherwise allowed by law. (See 2 CFR 200.29 for more information on the cost sharing requirements.)

Although the DOE/NNSA FFRDC contractor cost is not included in the total approved budget for the award, DOE/NNSA will pay the DOE/NNSA FFRDC contractor portion of the effort under an existing DOE/NNSA contract. Recipient is not responsible for reporting on that portion of the total estimated cost that is paid directly to the DOE/NNSA FFRDC contractor.

By accepting federal funds under this award, you agree that you are liable for your percentage share of allowable project costs, on a budget period basis, even if the project is terminated early or is not funded to its completion. After award, failure to provide the cost sharing required may result in the subsequent recovery by DOE of some or all the funds provided under the award.

Cost sharing requirements do not apply to the value of the NSUF access.

C. OTHER ELIGIBILITY REQUIREMENTS

C.1 FFRDC Contractors

FFRDC contractors may be proposed as a lead institution (except as otherwise prohibited by this FOA) or team member on another entity's application subject to the following guidelines:

- **Authorization for non-DOE/NNSA FFRDCs**. The Federal agency sponsoring the FFRDC contractor must authorize in writing the use of the FFRDC contractor on the proposed project and this authorization must be submitted with the application. The use of a FFRDC contractor must be consistent with the contractor's authority under its award.

- **Authorization for DOE/NNSA FFRDCs**. The cognizant contracting officer for the FFRDC must authorize in writing the use of a DOE/NNSA FFRDC contractor on the proposed project and this authorization must be submitted with the application. The following wording is acceptable for this authorization:

  > "Authorization is granted for the Fill-in 1: [Name] Laboratory to participate in the proposed project. The work proposed for the laboratory is consistent with or complimentary to the missions of the laboratory, will not adversely impact execution of the DOE/NNSA assigned programs at the laboratory."

NOTE: Individual Letters of Authorization may be submitted or submitted as blanket permission if all FFRDC/non-FFRDC management has been notified of all submissions and acknowledgment of all participants are identified. Identification of participants by name is to be included in the body or as a separate list.

NOTE: Letter of authorization is not required for NSUF Technical Leads unless the Technical Lead is requesting R&D funding support under this FOA.

- **Value/Funding**: The value of, and funding for, the FFRDC contractor portion of the work will not normally be included in the award to a successful applicant. Usually, DOE will fund a DOE FFRDC contractor through the DOE FWP system and other FFRDC contractors through an interagency agreement with the sponsoring agency.
- **Cost Share**: The applicant's cost share requirement will be based on the total cost of the project (excluding NSUF access value). FFRDC costs are included as part of the government cost share.
- **FFRDC Contractor Effort** (except for project(s) in support of NEET CTD and NSUF):
  - The scope of work to be performed by the FFRDC contractor may not be more significant than the scope of work to be performed by the prime applicant.
  - The FFRDC contractor effort, in aggregate, shall not exceed 20% of the total estimated costs of the projects.
- **Responsibility**: The applicant, if successful, will be the responsible authority regarding the settlement and satisfaction of all contractual and administrative issues including, but not limited to, disputes and claims arising out of any agreement between the applicant and the FFRDC contractor.

Table 1 provides a summary of Parts II and III of this FOA.

Table 1. Summary of Parts II and III.

		Applicable Workscope Appendix	Estimated Available Budget	Maximum Award Size	Project Duration	Cost Share	Collaboration
University-led NEUP Projects	PS	Appendix A	$40,000,000	$800,000	Up to 3 years	Permitted but not required	University, national laboratory, industry, and foreign collaborations are encouraged but no U.S. funding can go to entities that are not incorporated in the U.S.
	MS			$400,000			
University- or National Laboratory-led NEET CTD Projects	PS	Appendix B	$7,000,000	$1,000,000	Up to 3 years		
NSUF Projects	PS	Appendix A & Appendix B	R&D: $3,000,000 NSUF: $8,000,000	Refer to maximum award size of the project funding and NSUF funding.	Up to 7 years for Irradiation and PIE. Up to 3 years for PIE only or Irradiation only		

PART IV – APPLICATION AND SUBMISSION INFORMATION

NOTE: The following requirements apply to all three areas defined in Part I, Section B. of this FOA unless specific requirements are identified.

A. ADDRESS TO REQUEST APPLICATION PACKAGE

Electronic applications and instructions are available at the NEUP website. To access these materials, (1) go to www.NEUP.gov, (2) select "Sign In" from the top right hand corner of the screen, (3) enter your user credentials, (4) select "Applications" from the menu, and (5) click on "Create New Application" for the type of application you are creating. Apply at www.NEUP.gov.

Paper copies of the application package can be requested at:

INR Integration Office
Attn: Drew Thomas
PO Box 1625 MS 3730
Idaho Falls, Idaho. 83415

Telephone: 208-526-1602
Fax: 208-526-1844

B. DOCUMENT FORMAT REQUIREMENTS

All non-budget documentation (use templates where provided) is to be prepared using standard 8.5" × 11" paper with 1-inch margins (top, bottom, left, right), using a font size no smaller than Times New Roman 11 point. The preferred file format is Adobe Portable Document Format (PDF) for all documents except for spreadsheets. All spreadsheets are to be uploaded in Excel file format to the online application. Do **NOT** lock any cells in the spreadsheet.

C. NSUF Access Request (NSUF Only)

C.1 NSUF Access Request (AR) (Mandatory for NSUF Projects Only)

ARs must be submitted by the date and time specified in Part IV, Section F.1. **Full applications will not be accepted without submission of an AR identifying the Technical Lead and NSUF facility to be used by the date and time specified in Part IV, Section F.1.**

All NSUF applications must be (1) initiated with an AR and (2) generated in close collaboration with a Technical Lead from the NSUF facility to define scope and feasibility of the project. NSUF projects are to be fully funded for the entire duration of the project; thus, where applicable, a firm cost estimate must be prepared for the NSUF portion of the project in addition to the required budget for the R&D funding. Since the cost estimate for the NSUF provided workscope to be included in the full application must be obtained from the particular NSUF facility or facilities where the work is to be performed, the application must be generated in close collaboration with a Technical Lead from the NSUF facility wherein the scope and feasibility of the project are established. The scope of work and the cost estimate are important considerations during the feasibility review (outlined in Part V, Section A.2). It is imperative that all potential

applicants establish immediate contact with a Technical Lead when preparing the NSUF Access Request to produce the most accurate feasibility result.

ARs must include the following:

- Title of the project
- Identification of primary NSUF Technical Lead(s)
- Identification of NSUF facilities and equipment
- Proposing and associated institutions
- Co-PIs and associated institutions
- Type of project (irradiation/PIE, irradiation-only, PIE-only, or beamline)
- Applicable workscope: NEAMS-2, NSUF-1 for R&D support with NSUF Access (specify workscope subpart [e.g., 1.3c]) or NSUF-2 for NSUF Access Only
- A detailed relevancy statement including a description of why the project is relevant to DOE-NE misson
- A summary of the proposed project, including a description of the project and a clear explanation of its importance and relevance to the objectives.
- Major deliverables and outcomes the R&D will produce.
- Timeframe for execution of proposed project (specify if the R&D is for a one-, two-, or three-year period or up to seven years for NSUF).
- Source, scope and duration of R&D funding associated with request for NSUF Access Only (NSUF-2 only).
- A summary of the readiness of the project for NSUF access (as describe in Part I, Section B.2.1)

4-page limit. Name File: 2018 AR Narrative "Insert ID #"

Points of contact (POCs) for the NSUF facilities, as well as facility descriptions, are provided on the NSUF website at http://nsuf.inl.gov. For assistance in identifying a NSUF Technical Lead or facility POC, please contact NSUF staff members listed on the website.

C.1.1 AR Submittal Instructions

Online applications and instructions are available at the NEUP website. To access these materials, (1) go to www.NEUP.gov, (2) select "Sign In" from the top right hand corner of the screen, (3) enter your user credentials, (4) select "Applications" from the menu, and (5) Find "FY 2018 NSUF Access Request" and click on "Create New Application" for the type of application you are creating.

4-page limit. Name File: 2018 AR "Insert ID #"

C.1.2 Benefit of Collaboration

Applicant shall provide a narrative that includes an explanation of the contribution that will be made by the collaborating organizations and/or facilities to be utilized. It can contain brief biographies of staff and descriptions of the facilities wherein the research will be conducted. Please indicate within this section if the application has benefit or influence on other ongoing or proposed NE R&D projects (e.g., modeling and simulation in one application and effect validation in a separate application).

NSUF Applicants Only: Applications must include a list of publications that resulted from previous NSUF supported projects (publications to be included in the Benefit of Collaboration document).

4-page limit. Name File: 2018 RPA Benefit of Collaboration "Insert ID #"

C.1.3 Principal Investigator Vitae

The lead PI shall provide a brief vitae that lists the following:

- Contact information.
- **Education and Training**: Provide institution, major/area, degree, and year for undergraduate, graduate, and postdoctoral training.
- **Research and Professional Experience**: Beginning with the current position list, in chronological order, professional/academic positions with a brief description.
- **Publications**: Provide a list of up to 10 publications most closely related to the proposed project. For each publication, identify the names of all authors (in the same sequence in which they appear in the publication), the article title, book or journal title, volume number, page numbers, year of publication, and website address if available electronically.
- Patents, copyrights, and software systems developed may be provided in addition to or substituted for publications.
- **Synergistic Activities**: List no more than five professional and scholarly activities related to the effort proposed.

2-page limit. Name File: 2018 RPA "Last Name of Individual" "Insert ID #.pdf"

C.1.4 Agreement Requirements

Institutions will be expected to follow quality assurance (QA) principles and requirements in conducting R&D activities. The integrity of R&D products and their usability by NE is predicated on meeting QA requirements as they apply to a specific scope of work and associated deliverables if the application is successful. Further, each institution serving as a team member to the proposed project shall be identified in the application, with their commitment made to collaborate in the FOA process.

If applicable, access to NSUF capabilities will require agreement and final signature to the User Agreement (copy provided in Appendix D). **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 NSUF-1, NEAMS-2 or NSUF-2 applications. In order to ensure compliance throughout the application review process, applicants must indicate during the NSUF Access Request and full application submission that the User Agreement has been read, understood, and the terms and conditions are accepted. Further, submission of a NSUF Access Request and a full application indicates the applicant will comply 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.

D. CONTENT AND FORM OF ALL FULL APPLICATIONS

Applicants must provide all information requested and can use forms and optional templates to provide the information in accordance with the instructions below. Files that are attached must be in PDF format unless otherwise specified in this announcement. Optional document templates can be found on the NEUP website by clicking the 'Documents' button at the bottom of the front page (https://neup.inl.gov/SitePages/Related_Documents.aspx).

NOTE: The review process for full applications (PS/MS R&D) is a semi-blind process. A semi-blind process removes all identifiable PI and facility information from the technical narrative. The application is first reviewed on technical merit alone. After this evaluation has taken place, reviewers receive identifiable information to assess the competency of the team. Please be sure to review the requirements below carefully as non-compliant applications may be excluded from review.

D.1 Conflict-of-Interest (COI) Acknowledgement (Checkbox)

COI may exist due to previous efforts performed by the applicant or assistance provided in program direction and other mission related activities. Check the appropriate box on the application signifying whether a potential COI exists. If a COI has been identified (for the lead PI or a collaborator), a file that explains the conflict must be attached, which includes a statement on how the potential conflict will be avoided, neutralized, or mitigated. This document must be attached even if the conflict appears to be insignificant. If no COI exists, check the box and proceed.

Name File: 2018 CFA COI "Insert ID #.pdf"

D.2 SF-424 R&R

Applicants shall complete the SF-424 R&R form available at www.NEUP.gov and upload a completed PDF copy of the form with the application.

Name File: 2018 CFA SF424RR "Insert ID #.pdf"

D.3 Research and Related (R&R) Other Project Information

Applicants shall complete items 1–6 on the R&R Other Project Information form available at www.NEUP.gov and upload a completed PDF copy of the form. Items 7-12 will be completed in the application form and do not need to be completed here.

Name File: 2018 CFA R&R Other Project Information "Insert ID #.pdf"

D.4 Project Summary/Abstract

(Use Provided Template on Application Site)

The project summary/abstract must contain a summary of the proposed activity suitable for dissemination to the public. It should be a self-contained document that identifies the name of the applicant; the project director/PI(s); the project title; a list of major deliverables; the scope and objectives of the project; a description of the project, including major tasks (phases, planned approach, etc.) and methods to be employed; the potential impact of the project (i.e., benefits, outcomes); and major participants (for collaborative projects). This document must not include any proprietary or sensitive business information as DOE-NE may make it available to the public after awards are made.

- 1-page limit for R&D.

Templates can be downloaded at: https://neup.inl.gov/SitePages/Related_Documents.aspx

Name File: 2018 CFA Technical Abstract "Insert ID #.pdf"

D.5 Project Narrative

Applicant shall provide a written narrative addressing the strategy to execute R&D that supports the specified Technical Workscope. The documentation provided shall include the items specified below:

- Application title.
- Final Technical Workscope Identification (FC-1.1, RC-1, etc.).
- Project Objectives: Provide a clear, concise statement of specific objectives/aims of the proposed project.
- Proposed scope description.
- Logical path to accomplishing scope, including descriptions of tasks. This section will provide a clear, concise statement of the specific objectives/aims of the proposed project. This section should be formatted to address each of the merit review criterion and sub-criterion listed in Part V, Section A. Provide sufficient information so that reviewers will be able to evaluate the application in accordance with these merit review criteria. **DOE has the right to evaluate and consider only those applications that separately address each of the merit review criteria**.
- Relevance and Outcomes/Impacts: This section will explain the program relevance/priority of the effort to the objectives in the program announcement and the expected outcomes and/or impacts.
- Schedule: Define timelines for executing the specified workscope, including all important activities or phases of the project. Successful applicants must use this schedule when reporting project progress.
- Milestones and deliverables.
- Type/Description of facilities that will be used to execute the scope (if applicable).

- The roles and responsibilities of each partnering organization in the execution of the workscope. Describe the role and work to be performed by each participant/investigator, the business arrangements between the applicant and participants, and how the various efforts will be integrated and managed.
- Unique challenges to accomplishing the work and planned mitigations.
- Information, data, plans, or drawings necessary to explain the details of the application.
- Source, scope and duration of R&D funding associated with request for NSUF Access Only (NSUF-2 only)
- A detailed description of the readiness of the project for NSUF access (as described in Part I, Section B.2.1) (NSUF-1, NSUF-2, and NEAMS-2 only)

NOTE: References are included in the page limits.

The R&D technical narrative (including R&D applications requesting NSUF access) shall **NOT** include the following information:

- Project cost and pricing information.
- Identification, by individual name or name of institution, of any teaming partner or lead institution. Examples of acceptable ways of referring to partners are posted on the NEUP website.
- Official name or title of facilities used to execute scope. Describe the facility by function and/or technical attributes such as an accelerator, a test reactor, etc.

NOTE: For applications requesting NSUF access, NSUF facilities must be named.

Page limits include cover page, table of contents, charts, graphs, maps, photographs, tables, and other pictorial presentations while complying with the document format instructions in Part IV, Section B. **Evaluators will not review pages above the specified limit.**

- All R&D Projects: 10-pages
- All NSUF Projects: 15-pages

Do not include any internet addresses (URLs) that provide information necessary to review the application; information contained in these sites will not be reviewed.

Name File: 2018 CFA Technical Narrative "Insert ID #.pdf"

D.6 Vitae (Technical Expertise and Qualifications)

Applicant shall name all teaming partners by name and organization, as well as their proposed roles and responsibilities. For collaborators (including senior key person) who will contribute in a substantial, measurable way to the project (including for subrecipients and consultants), the applicant shall provide a brief vita that lists the following:

- Contact information.

- Education and Training: Provide institution, major/area, degree, and year for undergraduate, graduate, and postdoctoral training.
- Research and Professional Experience: Beginning with the current position list, in chronological order, professional/academic positions with a brief description.
- Publications: Provide a list of up to 10 publications most closely related to the proposed project. For each publication, identify the names of all authors (in the same sequence in which they appear in the publication), the article title, book or journal title, volume number, page numbers, year of publication, and website address if available electronically.
- Patents, copyrights, and software systems developed may be provided in addition to or substituted for publications.
- Synergistic Activities: List no more than five professional and scholarly activities related to the effort proposed.

2-page limit, Name File: 2018 CFA "Last Name of Individual" "Insert ID #.pdf"

Technical expertise and qualifications are to be provided for individual participants, whether the participant is receiving funding or not (including consultants or national laboratory personnel). All participants making a defined, material contribution that is critical to the success of the project must be listed on the online application.

NOTE: This would typically not include the NSUF support staff.

D.7 Benefit of Collaboration

The applicant shall provide a narrative that includes an explanation of the contribution that will be made by the collaborating organizations and/or facilities to be utilized. Please indicate within this section if the application has benefit or influence on other ongoing or proposed NE R&D projects (e.g., modeling and simulation in one application and effect validation in a separate application).

NSUF Applicants Only: Applications must include a list of publications that resulted from previous NSUF supported projects (publications to be included in the Benefit of Collaboration document).

4-page limit, Name File: 2018 CFA Benefit of Collaboration "Insert ID#.pdf"

D.8 Capabilities

Infrastructure Requirements: The applicant shall identify the infrastructure (e.g., facilities, equipment, instrumentation, and other resources) required to execute the proposed scope of work, including their location, availability, capabilities, and how they will be used in the project. Describe the non-labor (e.g., facilities, equipment, and instrumentation) resources that are available and accessible to the applicant and are required to execute the scope of work. Describe any unique equipment and facilities that are needed, are accessible, and will be used to execute the scope of work. Discuss the adequacy of these resources and identify any gaps and how these will be addressed.

See the electronic application submission instructions for document guidance. This FOA allows the applicant to propose the purchase of any needed equipment to conduct the proposed work. If equipment purchases are proposed, describe comparable equipment, if any, already at the institution and explain why it cannot be used.

2-page limit, Name File: 2018 CFA Capabilities "Insert ID#.pdf"

D.9 Budget Documents

D.9.1 R&R Lead Budget Form

(TOTAL FED & NON-FED) (Required for all lead institutions, not required for NSUF-2 applications)

Complete the Research and Related Budget (Total Fed & Non-Fed) form in accordance with the instructions on the form (Activate Help Mode to see instructions) and the following instructions. A separate budget for each year of support requested must be completed. The form will generate a cumulative budget for the total project period. Complete all the mandatory information on the form before the 'next period' button is activated. Funds may be requested under any of the categories listed as long as the item and amount are necessary to perform the proposed work, meet all the criteria for allowability under the applicable Federal cost principles, and are not prohibited by the funding restrictions in this announcement (see Part IV, Section H).

NOTE: Do **NOT** lock the cells when saving this document. Applications containing budget forms with **locked cells** may not be evaluated further.

Name File: 2018 CFA Budget "Insert ID #xls"

D.9.2 R&R Subaward Budget Form

(TOTAL FED & NON-FED) (Required for University and Industry collaborators, not required for NSUF-2 applications)

Budgets for subrecipients, other than DOE FFRDC Contractors. Applicant must provide a separate cumulative SF-424 budget for each subrecipient that is expected to perform work estimated to be more than $100,000 or 50% of the total work effort (whichever is less). Use up to 10 letters of the subrecipient institution's name as the file name.

NOTE: Do **NOT** lock the cells when saving this document. Applications containing budget forms with LOCKED CELLS may not be evaluated further.

Name File: 2018 CFA Subaward Budget "Insert ID #xls"

D.9.3 Budget for DOE/NNSA Federally Funded Research and Development Center (FFRDC) Contractor

(Required for National Laboratory participants, not required for NSUF-2 applications)

If a DOE/NNSA FFRDC contractor is applying, they must provide a DOE Field Work Proposal in accordance with the requirements in DOE Order 412.1A, Administrative (Admin) Change 1, Work

Authorization System dated 05/21/2014. FWPs can be obtained from respective laboratory financial administrators.

FFRDCs are permitted to propose costs in accordance with their established DOE contracts (e.g., overhead, fees, etc.).

Name File: 2018 CFA FWP "Insert ID #.pdf"

D.9.4 Budget Justification

(Required for all university and industry participants, not required for NSUF-2 applications)

The Budget Justification Supporting Documentation is available at NEUP.gov. Provide the required supporting information for all costs required to accomplish the project, including the following costs: labor; equipment; domestic and foreign travel; participant/trainees; material and supplies; publication; consultant services; automated data processing/computer services; subaward/consortium/contractual; equipment or facility rental/user fees; alterations and renovations; and indirect cost type. Provide any other information you wish to submit to justify the budget request.

Foreign travel must be included in the budget justification request. Any foreign travel not added to the budget justification will not be approved upon issuance of the cooperative agreement. Any non-approved foreign travel must go through DOE-NE's foreign travel authorization process.

If cost sharing is required or voluntarily proposed, provide an explanation of the source, nature, amount, and availability of any proposed cost sharing.

- Third Parties Contributing to Cost Sharing Information (if applicable):

  At the time the application is submitted it must include a letter from each third party (i.e., a party other than the organization submitting the application). The letter must state that the third party is committed to providing a specific minimum dollar amount of cost sharing. Submitting the application provides assurance that the letters of commitment have been signed. In an appendix to the Budget Justification, the following information for each third party contributing to cost sharing must be identified: (1) the name of the organization; (2) the proposed dollar amount to be provided; (3) the amount as a percentage of the total project cost; and (4) the proposed cost sharing - cash, services, or property. This appendix will not count in the project narrative page limitation. Successful applicants must provide the signed letters of commitment within the number of days specified in Part IV.E, Submissions from Successful Applicants.

Name File: 2018 CFA Budget Justification "Insert ID #.pdf"

D.10 Additional Attachments

D.10.1 Current and Pending Support

(Required for all University and Industry Applicants)

As requested by the submission form, PI(s), subrecipients, and other senior/key persons for ongoing and pending applications shall identify all federal funding sources by agency source,

project name, monetary amount (total award amounts for entire project period, including indirect costs), and length of term, person-months per year to be devoted to the project by the senior/key persons that are pending or currently in place for the university PI or collaborators within the past five years.

Name File: 2018 CFA Current and Pending Support "Insert ID #.pdf"

D.10.2 Coordination and Management Plan

Multiple PIs: The applicant, whether a single organization or team/partnership/consortium, must indicate if the project will include multiple PIs. This decision is solely the responsibility of the applicant. If multiple PIs will be designated, the application must identify the Contact PI/Project Coordinator and provide a "Coordination and Management Plan" that describes the organization structure of the project as it pertains to the designation of multiple PIs. This plan should, at a minimum, include:

- Process for making decisions on scientific/technical direction
- Publications
- Intellectual property issues
- Communication plans
- Procedures for resolving conflicts
- PIs' roles and administrative, technical, and scientific responsibilities for the project.

Name File: 2018 CFA CMP "Insert ID #.pdf"

D.10.3 Letter of Authorization for DOE/NNSA FFRDCs

(Required for all national laboratory participants listed on the application regardless of funding level or tier)

The cognizant contracting officer for the FFRDC must authorize in writing the use of a DOE/NNSA FFRDC contractor on the proposed project and this authorization must be submitted with the application. The following wording is acceptable for this authorization.

> "Authorization is granted for the Fill-in 1: [Name] Laboratory to participate in the proposed project. The work proposed for the laboratory is consistent with or complimentary to the missions of the laboratory, will not adversely impact execution of the DOE/NNSA assigned programs at the laboratory, and will not place the laboratory in direct competition with the domestic private sector."

NOTE: Individual Letters of Authorization may be submitted or submitted as a blanket permission if all FFRDC/non-FFRDC management has been notified of all submissions and all participants are identified. Identification of participants by name is to be included in the body or as a separate list.

NOTE: Letter of authorization is not required for NSUF Technical Leads unless the Technical Lead is requesting R&D funding support under this FOA.

Name File: 2018 CFA CO Authorization "Insert ID #.pdf

D.10.4 Project/Performance Site Location(s)

Indicate lead and collaborating site(s) where R&D work will be performed. Note the Project/Performance Site Congressional District is entered in the format of the 2-digit state code, following by the 3-digit Congressional district code (e.g., AA-001).

Name File: 2018 CFA Site Location "Insert ID#.pdf"

D.10.5 Environmental Checklist

Applicants must provide information outlined in the optional Environmental Checklist template which is available here. The checklist will not include the NSUF capabilities. Any awards that require the use of government facilities will require a NEPA review performed by the government facility granting the access before physical work can begin.

Name File: 2018 CFA ENV "Insert ID #.pdf"

D.10.6 Certifications and Assurances

(Required for All University Leads) (Not required for NSUF-2 applications)

Applicants must complete and attach the Certifications and Assurances form found on the DOE Financial Assistance Forms Page at: http://energy.gov/management/downloads/certifications-and-assurances-use-sf-424.

File Name: 2018 CFA Cert & Assurances "Insert ID #.pdf"

Federal and Technical POCs for FY 2018 can be found at:
https://neup.inl.gov/SitePages/FY18_RD_Technical_Program_Contacts.aspx

D.11.7 SF-LLL Disclosure of Lobbying Activities (Required by all Lead Applicants)

If applicable, complete SF- LLL. Applicability: If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the grant/cooperative agreement, you must complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying."

D.11 NSUF Statement of Work (NSUF Applicants Only)

NSUF applicants are required to provide a statement of work prior to the submittal of their NSUF full application submission. Statement of work documents are submitted at NEUP.gov using the provided Statement of Work Template.

The statement of work is necessary to complete the NSUF feasibility review and determine a value (cost) for NSUF access. The Statement of Work will be appended to the already submitted Access Request.

File Name: 2018 FinalSoW"Insert ID#".pdf

NOTE: NSUF Final Statement of Work documents will be submitted as an additional document to the already submitted NSUF Access Request.

Table 2 contains a summary of the required information for full application submittals.

Table 2. Summary of Full Application Required Information.

Name of Document	Format	Required From
Conflict-of-Interest	Checkbox	Affirmed by Lead Applicant for all Participants
SF424 (R&R)	Form	Lead Applicant
Research and Related Other Project Information	Form	Lead Applicant
Project Summary/Abstract	PDF	Lead Applicant
Project Narrative	PDF	Lead Applicant
Other Attachments		
Vitae - Technical Expertise and Qualifications (2 pages each)	PDF	All Leads and Collaborators
Benefits of Collaborations (4 pages)	PDF	Lead Applicant
Capabilities (2 pages)	PDF	Lead Applicant
SF-424 Lead Budget Form (Total Fed + Non-Fed)	Form	Lead Applicant (Except NSUF-2 workscope applicants)
SF-424 Subaward Budget (Total Fed + Non-Fed), if applicable	Form	University and Industry Collaborators (Except NSUF-2 workscope applicants)
Budget for DOE National Laboratory Contractor or FFRDC, if applicable	PDF	National Laboratory Leads and Collaborators (Except NSUF-2 workscope applicants)
Budget Justification	PDF	University Leads and Collaborators (Except NSUF-2 workscope applicants)
Current and Pending Support	PDF	All University and Industry Applicants
Coordination and Management Plan	PDF	Lead Applicant
Authorization for DOE/NNSA FFRDCs	PDF	National Laboratory Applicants (including non-funded collaborators)
Project/Performance Site Location	PDF	All sites performing work
Environmental Checklist	PDF	All site performing work
SF-LLL Disclosure of Lobbying Activities	PDF	Lead Applicant
Certifications and Assurances	Form	University Leads (Except NSUF-2 workscope applicants)

E. SUBMISSION FROM SUCCESSFUL APPLICANTS

If selected for award, DOE reserves the right to request additional or clarifying information for any reason deemed necessary including, but not limited to, the following:

- Indirect cost information
- Other budget information
- Name and phone number of the Designated Responsible Employee for compliance with national policies prohibiting discrimination (See 10 CFR Part 1040.5)
- Representation of Limited Rights Data and Restricted Software, if applicable
- Commitment Letter from Third Parties Contributing to Cost Sharing, if applicable

F. SUBMISSION DATES AND TIMES

F.1 NSUF Access Request Due Date

(Mandatory for NSUF Projects)

ARs for NSUF access are required by November 8, 2017 at 7:00 p.m. Eastern Time (ET). The AR shall be submitted as required in Part IV, Section C.1.

F.2 NSUF Statement of Work Due Date

Applicants requesting NSUF access must submit a Statement of Work prior to the submission of the full application. The SOW shall be submitted as required in Part IV, Section D.12. Applicants who fail to submit a SOW will be determined non-responsive and ineligible for further consideration.

F.3 Full R&D/NSUF-1 Application Due Date

Full R&D/NSUF applications must be received by January 23, 2018, not later than 7:00 p.m. ET. Applicants are encouraged to transmit their applications well before the deadline. Applications received after the deadline will not be reviewed or considered for award.

F.4 Full NSUF-2 Application Due Date

Full R&D/NSUF applications must be received by May 17, 2018, not later than 7:00 p.m. ET. Applicants are encouraged to transmit their applications well before the deadline. Applications received after the deadline will not be reviewed or considered for award.

F.6 Late Submissions, Modifications, and Withdrawals of Access Requests, Applications, and NSUF Statement of Work

a) Applicants are responsible for submitting any/all required submissions specified in this FOA, including letters of intent, applications, statements of work and any modifications or withdrawals thereto, so as to reach the Government office designated in the FOA by the date/time specified in the FOA.

(b)

(1) Any required FOA submittal, modification, or withdrawal received at the Government office designated in the FOA after the exact time specified for receipt of that submittal is "late" and will not be considered unless it is received before award is made, the Contracting Officer determines that accepting the late submittal would not unduly delay the FOA award process; and—

(i) If it was transmitted through an electronic commerce method authorized by the FOA, it was received at the initial point of entry to the Government infrastructure not later than 5:00 p.m. one working day prior to the date specified for receipt of the submittal; or

(ii) There is acceptable evidence to establish that it was received at the Government installation designated for receipt of the submittal and was under the Government's control prior to the time set for receipt of the required submittal.

(2) However, a late modification of an otherwise successful submittal or application that makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

(c) Acceptable evidence to establish the time of receipt at the Government installation includes the time/date stamp of that installation on the required electronic submission, other documentary evidence of receipt maintained by the installation, or oral testimony or statements of Government personnel.

(d) If an emergency or unanticipated event interrupts normal Government processes so that the required submittal cannot be received at the Government office designated for receipt of the submittal by the exact time specified in the FOA and urgent Government requirements preclude amendment of the FOA, the time specified for receipt of the required submittal will be deemed to be extended to the same time of day specified in the FOA on the first work day on which normal Government processes resume.

(e) Applications and other submittals may be withdrawn by written notice (sent by electronically to www.NEUP.gov) received at any time before the exact time set for receipt of that submittal. A required submittal may be withdrawn in person by an applicant or its authorized representative if, before the exact time set for receipt of that submittal, the identity of the person requesting withdrawal is established and the person signs a receipt for the submittal.

If electronic applications cannot be submitted, applicants can contact:

INR Integration Office
Attn: Drew Thomas
PO Box 1625 MS 3730
Idaho Falls, Idaho. 83415

Telephone: 208-526-1602
Fax: 208-526-1844

G. INTERGOVERNMENTAL REVIEW

This program is not subject to Executive Order 12372, "Intergovernmental Review of Federal Programs."

H. FUNDING RESTRICTIONS

Funding for all awards and future budget periods is contingent upon the availability of funds appropriated by Congress for the purpose of this program in current and future fiscal years.

H.1 Cost Principles

Costs must be allowable, allocable, and reasonable in accordance with the applicable Federal cost principles referenced in 2 CFR 200, as adopted and amended by 2 CFR 910. The cost principles for for-profit organizations are in FAR Part 31.

H.2 Pre-Award Costs

Recipients may charge to an award resulting from this announcement pre-award costs that were incurred within the ninety (90) calendar day period immediately preceding the effective date of the award if the costs are allowable in accordance with the applicable Federal cost principles referenced in 2 CFR 200, as adopted and amended by 2 CFR 910. Recipients must obtain the prior approval of the contracting officer for any pre-award costs that are for periods greater than this 90-day calendar period.

Pre-award costs are incurred at the applicant's risk. DOE is under no obligation to reimburse such costs if for any reason the applicant does not receive an award or if the award is made for a lesser amount than the applicant expected.

I. OTHER SUBMISSION AND REGISTRATION REQUIREMENTS

I.1 Where to Submit

NOTE: Submit applications through www.NEUP.gov to be considered for award.

Submit electronic applications through the "Applications" function at www.NEUP.gov. For problems with completing the registration process or submitting your application, call 208-526-1602 or 208-526-8178 or send an email to NEUP@inl.gov.

I.2 Application Validity Timeframe

By submitting an application in response to this FOA applicants agree that their applications are valid for at least one year from the date set forth for receipt of applications to this FOA. DOE reserves the right (with concurrence of the applicant) to use the submitted application(s) to make additional awards for up to a one year valid time-frame, even after DOE's initial selection announcement has occurred.

PART V – APPLICATION REVIEW INFORMATION

NOTE: The following requirements apply to all FOA areas unless specific requirements are identified.

A. CRITERIA

A.1 NSUF Access Request Review

Selection of applying institutions invited to provide full applications shall be based on how well the Access Request meets or exceeds the technical and program relevancy and program priority evaluation criteria provided below and as weighted as described in Table 3. All applications submitted under this FOA will be reviewed and scored as described below.

First, programmatic experts will assess each Access Request's program relevancy and program priority to NSUF workscopes. Scores will be assigned according to the following program relevancy and program priority attributes:

A.1.1 Relevancy Attributes

- **High Relevance:** The project is fully supportive of, and has significant, easily recognized and demonstrable ties to mission and relevant workscope area. The project builds on synergies with ongoing direct- or competitively-funded projects or meets a critical mission need. The project focuses on critical knowledge gaps where limited work is currently being performed.
- **Moderate Relevance:** The project is supportive of, and has significant, recognized and demonstrable ties to mission and relevant workscope area. The project recognizes synergies with ongoing direct- or competitively-funded projects and identifies areas for improvement to current, or recently completed, work. The project has ties to knowledge gaps where limited work is currently being performed.
- **Some Relevance:** The project is somewhat supportive of, and has some ties to mission and relevant workscope area. The project recognizes ongoing direct- or competitively-funded projects and identifies limited improvements to current work. The project addresses some knowledge gaps, although there is a moderate amount of work currently being performed in the area.
- **Low Relevance:** The project is minimally supportive of, and has limited ties to mission and relevant workscope area. The project does not recognize ongoing work and does not identify areas for improvement to current, or recently completed work. Substantial work is currently being performed in the area to address knowledge gaps.
- **No Relevance:** The project is not supportive of mission or the relevant workscope area.

A.1.2 Program Priority

Application relevancy scores will be weighted in consideration of program priority which is established and influenced by factors such as balance of portfolio, funding constraints, and anticipated program needs. The categories for program priority are listed below:

- **High Program Priority:** The project is critical to program objectives and/or the workscope area and will provide unique results that can be effectively integrated with other currently funded work (direct and/or competitively funded).
- **Moderate Program Priority:** The project is important to program objectives and/or the workscope area and will provide complementary results to currently funded work (direct and/or competitively funded).
- **Low Program Priority:** The project is somewhat important to program objectives and/or the workscope area but results may be duplicative of currently funded work (direct and/or competitively funded) or unnecessary for current program objectives.
- **No Program Priority:** The project is not important to program objectives and/or the workscope area. The project may also be duplicative of ongoing R&D efforts.

Note that the program relevancy score may be increased by up to 5 points based on evaluators' determination of the degree to which an application effectively partners with MSIs, international or industrial partners, and/or underrepresented groups.

Second, designated technical reviewers assigned by NSUF will assess the technical basis of the application, assigning it a merit category. Applications will then be judged as meeting all, most, or some expectations for that merit category.

After considering the overall evaluation scores, available funding, and the other selection factors (see Part V, Section A.7) as needed, DOE will make a final determination of applicants who will be invited to provide full applications.

A.1.3 Merit Categories

- **High Merit:** The project unquestionably advances the technical state of knowledge and understanding of the mission or relevant workscope area, and is creative and based largely on original concepts. The scope can be executed fully in the facilities available.
- **Moderate Merit:** The project advances the technical state of knowledge and understanding of the mission or relevant workscope area, and is based on some established concepts, although several creative and original concepts are presented. The scope may be executed fully in the facilities available.
- **Some Merit:** The project incrementally advances the technical state of knowledge and understanding of the mission or relevant workscope area, and is based predominately on established concepts, with some creative, original concepts. The scope may be difficult to execute fully in the facilities available.
- **Low Merit:** The project recognizes the technical state of knowledge and understanding of the mission or relevant workscope area, and is only marginally creative and contains few original concepts. The scope will require resources not named in the project or will require additional facilities or resources to execute.
- **No Merit:** The project does not advance or recognize the technical state of knowledge and understanding of the mission or relevant workscope area, and is not creative or original. The scope cannot be executed fully in the facilities available.

The individual scores determined by evaluating each application against the above criteria will then be weighted as defined in Table 3 to determine an overall evaluation score for each application.

NSUF Access Requests that do not receive an invitation to submit are not permitted to submit a full application.

A.2 Feasibility Review (NSUF Projects Only)

The feasibility review is a very important part of the NSUF full application preparation process. Many factors will be taken into account as part of the feasibility review including type of project, duration of project, experimental degree of complexity, types of samples, number of samples, needed shipping and containment, potential needed capability or facility enhancement or upgrade, project schedule, and cost. In order to ensure that the application is submitted with the highest possible degree of feasibility, it is imperative that potential proposers establish contact with an NSUF Technical Lead at the earliest possible time. The NSUF Technical Lead will have knowledge of and direct access to the facility or facilities where the work will be performed. It is intended that the Technical Lead should be an integral collaborator on the project and contribute strongly to the application preparation. The Technical Lead will provide guidance in establishing the scope of the project in negotiation with the facility to produce a cost estimate. Should the project be awarded, the Technical Lead will be the primary POC to best ensure the project is performed on schedule and within budget.

Applications deemed not feasible by the NSUF Program Office will not be considered.

A.3 Readiness Review (NSUF Projects Only)

Prior to final selection, both Access Requests and applications for NSUF access will be reviewed by the NSUF Program Office to verify the project is ready for NSUF access as discussed in Part 1, Section B.2.1. Access Requests and applications deemed not ready for NSUF access will not be considered.

A.4 Initial Review Criteria of Full Applications

Prior to a comprehensive merit evaluation, DOE will perform an initial review to determine that (1) the applicant is eligible for an award; (2) the named PI(s) and collaborators have not changed from the Access Request to the full application (NSUF only) or, if they have, DOE's Contracting Officer has provided signed approval; (3) the information required by the announcement has been submitted; and (4) all mandatory requirements are satisfied. Only applications meeting these initial review criteria will be considered during the merit review and award selection decision.

A.5 PS/MS/NSUF R&D Merit Review Criteria: Full Applications

Selection will be made in accordance with the review criteria identified for each area and the program policy factors (other selection factors) listed in Part V, Section A.7 of this FOA. The criteria for the respective FOA areas are identified below along with the relative importance of each criterion or sub-criterion, if applicable. All applications will be point scored and ranked. Applications must be fully responsive to each of the following criteria.

Review of full applications shall be based on how well the applications meet or exceed the technical and program relevancy/priority evaluation criteria provided below and as weighted as described in Table 3. All invited full applications submitted under this FOA will be reviewed and scored as described in this FOA. A panel of programmatic experts will assess each full application's program relevancy/priority to NE's R&D mission and workscope area and multiple technical peer reviewers will evaluate the project for technical merit. Effective partnerships will be incorporated into the program relevancy/priority evaluation.

A.5.1 Program Relevancy/Priority Attributes

Same criteria used for PS/MS/NSUF Access Request evaluation phase applies to full applications. See Part V, Section A.1.1.

A.5.2 Technical Merit Attributes

Applications will be subjected to formal merit review and will be evaluated against the following criteria.

- **Criterion 1 – Advances the State of Scientific Knowledge and Understanding and Addresses Gaps in Nuclear Science and Engineering Research**: The technical merit of the proposed R&D project will be evaluated, including the extent to which the project advances the state of scientific knowledge and understanding and addresses gaps in nuclear science and engineering research. Evaluation will consider how important the proposed project is to advancing knowledge and understanding within the area selected and how well the proposed project advances, discovers, or explores creative, original, or potentially transformative concepts.
- **Criterion 2 – Technical Quality of the Proposed R&D Project**: DOE will evaluate the overall quality/acceptability of the proposed R&D project. In evaluating this criterion, DOE may consider the (1) merit, feasibility, and realism of the proposed methodology and approach to the project; (2) schedule, including sequence of project tasks, principle milestones, and times for each task; (3) planned assignment of responsibilities; (4) proposed project efficiencies; and (5) technical expertise available to the applicant in carrying out the project.
- **Criterion 3 – Applicant Team Capabilities, Risks, and Experience**: The extent to which the applicant team provides objective evidence that it has the resources and abilities to successfully complete the R&D project in a technically defensible manner will be evaluated. Current activities, relevance and depth of the organization's experience and capabilities, together with that of the PI, and the adequacy of the requested resources and their supporting justification will all be evaluated as they relate to the likely successful completion of the R&D objectives.

  In evaluating this criterion, DOE will consider the extent to which the application demonstrates the following:

  - That the capabilities and qualifications of engineering and scientific personnel, PI, and other key contributors are such that they can successfully accomplish the technical scope of the proposed project.

- That the applicant or respective team members have demonstrated successful experience/past performance, knowledge, and understanding of the business and regulatory requirements for projects of similar size, scope, and complexity in achieving project technical success on time with no significant, unresolved safety and quality issues.
- The applicant team's identification of and work with industry to gain industry perspective and technical knowledge important to project decisions, and how the applicant will work with industry to best achieve the objectives of this FOA and the project.

Table 3. PS/MS R&D and NSUF Access Only Access Requests and Full Applications - Weighting of Evaluation Scores.

Criterion	
Technical Application – Peer Review	Percentage of Peer Review Score
Access Request	
Technical Merit Category	100%
Full Applications	
Criterion 1: Advances the State of Scientific Knowledge and Understanding and Addresses Gaps in Nuclear Science and Engineering Research	35%
Criterion 2: Technical Quality of the Proposed R&D Project	35%
Criterion 3: Applicant Team Capabilities, Risks, and Experience	30%
Peer Review Score	Sum of ratings x weights
Access Requests and Full Applications	
Program Relevance/Priority[1] (Separate Review Process, Used for Both Letters of Intent and Full Applications)	Percentage of Program Relevancy/Priority Review Score
Relevancy	100%
Program Priority	Multiplier based on program priority rating
Diverse Partnerships	Up to 5 points, not to exceed the maximum relevancy points available.
Program Relevancy/Priority Score	Sum of ratings[2] x program priority multiplier
Weighting	Weighted Score Ratio (Technical : Relevancy) Program Supporting: 65:35 Mission Supporting: 80:20 NSUF Access Only: 65:35 Access Request: 40:60

[1] Supports Program Relevance: This element will be scored by the Program Offices, not by peer review.

Criterion	
[2] Total program relevancy/priority points cannot exceed 100% of points available from the program relevancy/priority criteria.	

A.6 Other Selection Factors

Program Policy Factors. The Selection Official may consider the following program policy factors in the selection process:

- Degree to which proposed project optimizes/balances/maximizes use of available DOE funding to achieve DOE program goals and objectives. This includes how those R&D projects support DOE research; it may also include research portfolio diversity, geographic distribution and/or how the projects support other complementary efforts which, when taken together, will best achieve program research goals and objectives.
- Application selection may optimize appropriate mix of projects to best achieve DOE research goals objectives.
- Cost/Budget considerations, including availability of funding.
- Readiness of the project for NSUF access
- The extent that the applicant has awards in progress, or not completed, from DOE, from a previous year's FOA, or has existing no cost extensions.
- The demonstrated ability of the applicant to successfully complete projects (including relevant prior projects) and do so within budget and within the specified timeframe of the award.

Any of the above factors may be independently considered by the Selection Official in determining the optimum mix of applications that will be selected for support. These factors, while not indicators of the application's merit, may be essential to the process of selecting the application(s) that, individually or collectively, will best achieve the program objectives. Such factors are often beyond the control of the applicant. **Applicants should recognize that some very good applications might not receive an award because of program priorities and available funding.** Therefore, the above factors may be used by the Selection Official to assist in determining which applications shall receive DOE funding support.

For applications requesting R&D support with NSUF access, DOE reserves the right to decouple the R&D element from the NSUF access element and consider either portion for a provisional award dependent on confirmation from the applicant that the portion selected for award can be executed independently.

B. SUMMARY OF THE REVIEW AND SELECTION PROCESS

B.1 PS/MS/NSUF Access Request

NSUF projects will be evaluated against the technical and program relevancy/priority criteria described in this FOA. This technical and program evaluation process will produce a list of recommended projects for each NSUF workscope. DOE will consider the overall evaluation

results and subjective programmatic factors to select a final set of invited projects to provide a full application.

NOTE: Applicants requesting NSUF access who are not specifically invited by DOE to submit full applications will NOT be allowed to submit full applications. Due to resource limitations within the NSUF, the feasibility review, a critical element of NSUF access, will continue only for applications that are specifically invited. An uninvited NSUF application without a complete NSUF feasibility review is incomplete and cannot be re-reviewed for program relevancy/priority.

B.2 PS/MS/NSUF Full Applications

Multiple peer reviewers will independently employ a semi-blind process to evaluate the applications in accordance with the technical review evaluation criteria described in this FOA. Also, DOE will complete a program relevancy/priority review process in accordance with the criteria described above. These results will be weighted in accordance with the ratio described above. DOE will consider the overall evaluation results and subjective programmatic factors to ultimately recommend a final set of applications for approval by the Selection Official.

B.3 Selection Official Considerations

The Selection Official will consider the merit review recommendations, subjective factors such as program policy considerations, and the amount of funds available to make final project selections.

B.5 Reporting of Matters Related to Recipient Integrity and Performance

DOE, prior to making a Federal award with a total amount of Federal share greater than the simplified acquisition threshold, is required to review and consider any information about the applicant that is in the designated integrity and performance system accessible through SAM (currently FAPIIS) (see 41 U.S.C. 2313).

The applicant, at its option, may review information in the designated integrity and performance systems accessible through SAM and comment on any information about itself that a Federal awarding agency previously entered and is currently in the designated integrity and performance system accessible through SAM.

DOE will consider any written comments by the applicant, in addition to the other information in the designated integrity and performance system, in making a judgment about the applicant's integrity, business ethics, and record of performance under Federal awards when completing the review of risk posed by applicants as described in 2 CFR 200.205 - Federal awarding agency review of risk posed by applicants.

C. ANTICIPATED NOTICE OF SELECTION

DOE anticipates making selection announcements no later than July 31, 2018 with the exception of NSUF-2 selections which will be announced no later than September 30, 2018.

PART VI – AWARD ADMINISTRATION INFORMATION

A. AWARD NOTICES

A.1 Notice of Selection

DOE will notify applicants selected for award. This notice of selection is not an authorization to begin performance. (See Part IV, Section H.2 with respect to the allowability of pre-award costs.) Organizations whose applications have not been selected will be advised as promptly as possible. This notice will explain why the application was not selected.

A notice of Federal award signed by the DOE Contracting Officer is the authorizing award document for any cooperative agreements awarded as a result of this FOA. A post-selection/pre-award process will occur prior to issuing the actual award; this includes such activities as a responsibility review/review of risk posed by the selected applicant, a technical and budget review of the selected applicant's proposed budget, etc. Once approved, the actual award notice will be provided by DOE to the recipient by electronic means.

A.2 Nondisclosure and Confidentiality Agreements Representations

In submitting an application in response to this FOA the Applicant represents that:

(1) It does not and will not require its employees or contractors to sign internal nondisclosure or confidentiality agreements or statements prohibiting or otherwise restricting its employees or contactors from lawfully reporting waste, fraud, or abuse to a designated investigative or law enforcement representative of a Federal department or agency authorized to receive such information.

(2) It does not and will not use any Federal funds to implement or enforce any nondisclosure and/or confidentiality policy, form, or agreement it uses unless it contains the following provisions:

a. ''These provisions are consistent with and do not supersede, conflict with, or otherwise alter the employee obligations, rights, or liabilities created by existing statute or Executive order relating to (1) classified information, (2) communications to Congress, (3) the reporting to an Inspector General of a violation of any law, rule, or regulation, or mismanagement, a gross waste of funds, an abuse of authority, or a substantial and specific danger to public health or safety, or (4) any other whistleblower protection. The definitions, requirements, obligations, rights, sanctions, and liabilities created by controlling Executive orders and statutory provisions are incorporated into this agreement and are controlling.''

b. The limitation above shall not contravene requirements applicable to Standard Form 312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.

Notwithstanding provision listed in paragraph (a), a nondisclosure or confidentiality policy form or agreement that is to be executed by a person connected with the conduct of an intelligence or intelligence-related activity, other than an employee or officer of the United States Government, may contain provisions appropriate to the particular activity for which such document is to be

used. Such form or agreement shall, at a minimum, require that the person will not disclose any classified information received in the course of such activity unless specifically authorized to do so by the United States Government. Such nondisclosure or confidentiality forms shall also make it clear that they do not bar disclosures to Congress, or to an authorized official of an executive agency or the Department of Justice, that are essential to reporting a substantial violation of law.

A.3 Notice of Award

An assistance agreement issued by the Contracting Officer is the authorizing award document (excludes NSUF access only awards). It normally includes, either as an attachment or by reference, the following: (1) special terms and conditions; (2) applicable program regulations, if any; (3) application as approved by DOE; (4) DOE assistance regulations at 2 CFR part 200, as amended by 2 CFR 910; (5) National Policy Assurances To Be Incorporated As Award Terms; (6) Budget Summary; and (7) Federal Assistance Reporting Checklist, which identifies the reporting requirements.

Grants and cooperative agreements made to universities, non-profits, and other entities subject to Title 2 CFR are subject to the Research Terms and Conditions located on the National Science Foundation website at http://www.nsf.gov/bfa/dias/policy/rtc/index.jsp.

If award is made to a DOE national laboratory, it will be made against their existing prime contract with the DOE through the work authorization system as outlined in DOE O 412.1A, Admin Change 1. DOE O 481.1C., Work for Others, is not applicable. DOE national laboratories remain bound by the terms and conditions of their contract with DOE.

B. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

B.1 Administrative Requirements

The administrative requirements for DOE grants and cooperative agreements are contained in 2 CFR 200, as amended by 2 CFR 910 (See: http://ecfr.gov). Grants and cooperative agreements made to universities, non-profits, and other entities subject to Title 2 CFR are subject to the Research Terms and Conditions located on the National Science Foundation website at http://www.nsf.gov/bfa/dias/policy/rtc/index.jsp.

B.1.1 DUNS and SAM Requirements

Additional administrative requirements for DOE grants and cooperative agreements are contained in 2 CFR, Part 25 (see http://www.ecfr.gov/cgi-bin/ECFR?page=browse). Prime awardees must be registered in the System for Award Management (SAM) before submitting an application, and must continue to maintain an SAM registration with current information at all times during which it has an active Federal award or an application or plan under consideration by DOE under this FOA. Primes and subawardees at all tiers must obtain Data Universal Numbering System (DUNS) numbers and provide the DUNS to the prime awardee before the subaward can be issued. The prime will provide this valid unique entity identifier in its application. DOE may not make a Federal award to an applicant until the applicant has complied with all applicable unique entity identifier and SAM requirements and, if an applicant has not fully complied with the requirements by the time DOE is ready to make the award, DOE may

determine that the applicant is not qualified to receive an award and use that determination as a basis for making an award to another applicant.

B.1.2 Subaward and Executive Reporting

Additional administrative requirements necessary for DOE grants and cooperative agreements to comply with the Federal Funding and Transparency Act of 2006 (FFATA) are contained in 2 CFR, Part 170 (see http://www.ecfr.gov/cgi-bin/ECFR?page=browse). Prime awardees must register with the new FFATA Subaward Reporting System (FSRS) database and report the required data on their first tier subawardees. Prime awardees must report the executive compensation for their own executives as part of their registration profile in the SAM.

B.2 Special Terms and Conditions and National Policy Requirements

The DOE special terms and conditions for use in most grants and cooperative agreements are located at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms under Award Terms.

If the Federal share of any Federal award may include more than $500,000 over the period of performance, post award reporting requirements reflected in 2 CFR 200, Appendix XII—*Award Term and Condition for Recipient Integrity and Performance Matters,* may also apply to any resultant award made under this FOA.

The National Policy assurances to be incorporated as award terms are located at http://www.nsf.gov/bfa/dias/policy/rtc/appc.pdf and at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms under Award Terms.

Quality Assurance to be incorporated as award terms (applicable to educational institutions only).

While DOE will normally rely on the institution's quality assurance (QA) system, below are general guidelines that those systems should adhere to, as applicable, for the type of work being done. No separate deliverable is required by this provision, unless the institution's existing QA systems are not compliant with these guidelines, or in the case that the institution identifies that the work to be performed has any special or unique QA requirements. The DOE has the right of access to the university facilities and records for surveillance or inspection. Any surveillance or inspections will be coordinated with the PI.

- **Test Planning, Implementation, and Documentation (Research Planning)**
  - Test methods and characteristics shall be planned and documented, and the approaches and procedures recorded and evaluated. Characteristics to be tested and test methods shall be specified. The test results shall be documented and their conformance to acceptance criteria evaluated.
  - Documentation shall be developed to ensure replication of the work. The researcher/developer shall document work methods and results in a complete and accurate manner. The level of documentation shall be sufficient to withstand a successful

peer review. Protocols on generation and safeguarding of data and process development from research shall be developed for consistency of R&D work.

- Laboratory notebooks shall be controlled by a university documented procedure/process. Also, the process for development of intellectual property documentation shall be controlled under university document control procedures/processes.
- If the university identifies any special or unique QA requirements for Test Planning, Implementation, and Documentation, the university shall submit a Test Plan/Research Plan to the funding organization for review and concurrence prior to use if requested.

- **Equipment Calibration and Documentation**

  The researcher shall specify the requirements of accuracy, precision, and repeatability of measuring and test equipment (M&TE). Depending upon the need for accuracy, precision, and repeatability of M&TE used in research, standard university documented procedures shall be implemented. During the process development stage and for all R&D support activities, M&TE shall be controlled. The degree of control shall be dependent on the application of the measurement. The university shall have available calibration records documenting instrument calibration to a national standard.

- **Procurement Document Control**

  University documented procurement document control procedures/processes shall be implemented if results of initial research work are expected in the next stage of work, and if the pedigree of materials being used could influence the usefulness of the research work results. Procurement document specifications shall be controlled. For development and support activities, the level of procurement document control shall be applied to support a design basis, i.e., engineering design system criteria. If procurement document control requirements apply, the university shall have a documented procedure/process for control of suspect/counterfeit items (S/CI), and have available for submission for DOE review material pedigree records.

- **Training and Personnel Qualification**

  Personnel performing research activities shall be trained per university documented requirements to ensure work is being conducted properly to prevent rework or the production of unacceptable data. The university shall have available—for submission for DOE review—personnel training records.

- **Records**

  In many cases, the notebook or journal of the researcher is the QA record. These documents shall be controlled in accordance with university documented procedure/process, e.g., maintain notebook as a controlled document, maintain copies of critical pages or access-controlled filing when not in use to preserve process repeatability and the QA record. Electronic media may be used to record data and shall be subject to documented administrative controls for handling and storage of data. Work activity records shall be maintained by the university and available for DOE review, upon request, within 60 days of completion of the work scope.

- **Data Acquisition/Collection and Analysis**

  When gathering data, the researcher shall ensure that the systems and subsystems of the experiment are operating properly. Software systems used to collect data and operate the experiment requires verification that it meets functional requirements prior to collection of actual data. Data anomalies require investigation. When performing data analysis, define (1) assumptions and the methods used; (2) the results obtained so that independent qualified experts can evaluate how data was interpreted;(3) methods used to identify and minimize measurement uncertainty; (4) the analytical models used; and (5) whether the R&D results have been documented adequately and can be validated.

- **Peer Review**

  Peer reviews shall be performed in accordance with peer review best practices as described in Part V. The peer reviews shall be documented and maintained by the university. Peer review documentation and results shall be provided to DOE.

B.3 Intellectual Property Provisions

The standard DOE financial assistance intellectual property provisions applicable to the various types of recipients are located at http://energy.gov/gc/standard-intellectual-property-ip-provisions-financial-assistance-awards.

B.4 Lobby Restrictions

By accepting funds under this award, the applicant agree that none of the funds obligated on the award shall be expended, directly or indirectly, to influence congressional action on any legislation or appropriation matters pending before Congress, other than to communicate to Members of Congress as described in 18 U.S.C. 1913. This restriction is in addition to those prescribed elsewhere in statute and regulation.

B.5 Corporate Felony Conviction and Federal Tax Liability Representations

In submitting an application in response to this FOA the applicant represents that:

- It is not a corporation that has been convicted (or had an officer or agent of such corporation acting on behalf of the corporation convicted) of a felony criminal violation under any Federal law within the preceding 24 months.
- It is not a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

  For purposes of these representations the following definitions apply:

  A corporation includes any entity that has filed articles of incorporation in any of the 50 states, the District of Columbia, or the various territories of the United States (but not foreign corporations). It includes both for-profit and non-profit organizations.

B.6 Statement of Substantial Involvement

DOE anticipates having substantial involvement during the project period, through technical assistance, advice, intervention, integration with other awardees performing related activities,

and technical transfer activities. The recipient's responsibilities are listed in the first bulleted section and DOE's responsibilities are listed in the second bulleted section:

- Recipient's responsibilities. The recipient is responsible for:
  - Complying with all award requirements, including performing the activities supported by this award, including providing the required personnel, facilities, equipment, supplies and services;
  - Defining approaches and plans as may be required by this award, submitting the plans to DOE for review, and incorporating DOE's comments;
  - Managing and conducting the project activities, including coordinating with DOE management and operating (M&O) contractor(s) as required and as proposed in the recipient's project plan on activities performed under the M&O contract(s) that are related to the project;
  - If requested by the program, attending annual program review meetings and reporting project status;
  - Submitting technical reports as stated in the Federal Assistance Reporting Checklist, and incorporating DOE comments;
  - **DOE-NE Program Information Collection System (PICS:NE):** NE CINR R&D award PIs are required to complete reporting requirements as outlined in the instructions provided in the awards Attachment B "Federal Assistance Reporting Checklist and Instructions". Information provided in required award reporting will be utilized to populate PICS:NE (PICS:NE data entry will be done by DOE using information provided by the PI). PIs may be asked by the DOE PICS:NE representative for additional information during the initial work package setup process to accurately document the project plan, as well as through the award's project period to populate information in PICS:NE. PIs may be requested to provide additional assistance for clarification purposes in assuring accuracy of the information being entered into PICS:NE.
  - **DOE-NE Program Accrual Information:** DOE policy requires the monthly tracking of uncosted obligations on financial assistance awards in the DOE accounting system to assist DOE in accomplishing more accurate project management and to more accurately recognize Department liabilities to the recipient. DOE personnel do this internally by subtracting paid costs and any costs accrued (yet to be paid incurred costs of the recipient) from the amounts obligated on the financial assistance award. In accomplishing this, DOE may request the recipient provide additional cost accrual information to accurately estimate/document the accrual in the DOE accounting system. If such information is needed, it will typically be done on awards over $1M and DOE will normally do this using an e-mail to the recipient requesting the recipient identify the dollar value of work it has performed each month but not yet invoiced (or done a Treasury system draw on) as of month end. Recipients will cooperate with DOE in providing the needed cost accrual information.
- DOE responsibilities. DOE is responsible for:
  - Reviewing in a timely manner project plans, including technology transfer plans, and redirecting the work effort if the plans do not address critical programmatic issues;

- Conducting annual program review meetings to ensure adequate progress and that the work accomplishes the program and project activities. Redirecting work or shifting work emphasis, if needed;
- Promoting and facilitating technology transfer activities, including disseminating program results through presentations and publications; and
- Serving as scientific/technical liaison between awardees and other program or industry staff.

NOTE: There are limitations on recipient and DOE responsibilities and authorities in the performance of the project activities. Performance of the project activities must be within the scope of the Statement of Objectives, the terms and conditions of the Cooperative Agreement, and the funding and schedule constraints.

C. REPORTING

Reporting requirements are identified on the Federal Assistance Reporting Checklist, DOE F 4600.2, attached to the award agreement. A sample checklist is available at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms under Award Forms.

NOTE: The DOE F 4600.2 identifies in box 4.E "Other Reporting" a checkbox titled "Other (see special instructions)". For NEUP and NEET/NSUF awards, the other box is checked and the following is requested.

Work Package Template (one time submission) – Completed and submitted by the PI to assist DOE with populating general award information in the PICS:NE system. The template is due no later than 10/31/2018 for awardees in the above listed areas.

Quad Chart (quarterly submission) – The chart is completed and submitted by the PI to provide DOE-NE program managers and technical leads with a quick "snap-shot" look at R&D progress.

Research Performance Progress Report Template (quarterly submission) – The DOE F 4600.2 identifies in box 4.A "Management Reporting" a checkbox titled "Research Performance Progress Report (RPPR)(RD&D Projects)". The PI will complete and submit this template which asks for information that satisfies the RPPR.

PART VII – QUESTIONS/AGENCY CONTACTS

A. QUESTIONS

Questions regarding the content of this CINR FOA must be submitted to the Agency Contact listed in Part VII, Section B. Questions regarding workscopes may be submitted to the DOE federal and technical POCs listed in Appendices A, B, and C. PIs are not allowed to contact Federal or Technical Points of Contact after the full application due date with the exception of discussion supporting NSUF feasibility assessments. Answers to questions submitted that contain information about the FOA or the FOA process that would be necessary for the preparation of applications will be posted to www.NEUP.gov as soon as practical. Information provided to a potential applicant in response to its request will not be disclosed if doing so would reveal the potential applicant's confidential business strategy and/or is otherwise protected. DOE will try to respond to a question within three (3) business days, unless a similar question and answer have already been posted on the website.

Interested parties are encouraged to ask Q&A as early in FOA process as possible. Questions and comments concerning this FOA shall be submitted not later than five (5) business days prior to the application due date. Questions submitted after that date may not allow the Government sufficient time to respond.

Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to NEUP@inl.gov.

B. AGENCY CONTACT

Name: Ms. JoAnne Hanners
E-mail: hannerj@id.doe.gov

C. INFORMATIONAL WEBINAR

DOE holds a webinar each year to discuss the structure and execution of this FOA, including major updates from previous years, including workscopes. Applicants can watch and participate in the live webinars and submit questions through the GoToWebinar interface to be answered in real time. Registration information and webinar presentations are available on www.NEUP.gov for review by applicants.

PART VIII – OTHER INFORMATION

A. MODIFICATIONS

Notices of any modifications to this announcement will be posted on www.FedConnect.net and www.Grants.gov and will also be posted as a courtesy on www.NEUP.gov. It is recommended that the website is checked frequently at www.NEUP.gov to ensure you receive timely notice of any modifications or other announcements.

B. GOVERNMENT RIGHT TO REJECT OR NEGOTIATE

DOE reserves the right, without qualification, to reject any or all applications received in response to this announcement and to select any application, in whole or in part, as a basis for negotiation and/or award.

C. COMMITMENT OF PUBLIC FUNDS

The Contracting Officer is the only individual who can make awards or commit the Government to the expenditure of public funds. A commitment by anyone other than the Contracting Officer, either explicit or implied, is invalid.

Funding for all awards is contingent upon the availability of funds appropriated by Congress for the purpose of this program.

D. PROPRIETARY APPLICATION INFORMATION

Patentable ideas, trade secrets, proprietary or confidential commercial or financial information, disclosure of which may harm the applicant, should be included in an application only when such information is necessary to convey an understanding of the proposed project. The use and disclosure of such data may be restricted, provided the applicant includes the following legend on the first page of the project narrative and specifies the pages of the application which are to be restricted:

> "The data contained in pages [Insert pages] of this application have been submitted in confidence and contain trade secrets or proprietary information, and such data shall be used or disclosed only for evaluation purposes, provided that if this applicant receives an award as a result of or in connection with the submission of this application, DOE shall have the right to use or disclose the data herein to the extent provided in the award. This restriction does not limit the government's right to use or disclose data obtained without restriction from any source, including the applicant."

To protect such data, each line or paragraph on the pages containing such data must be specifically identified and marked with a legend similar to the following:

> "The following contains proprietary information that (name of applicant) requests not be released to persons outside the Government, except for purposes of review and evaluation."

E. EVALUATION AND ADMINISTRATION BY NON-FEDERAL PERSONNEL

In conducting the merit review evaluation, the Government may seek the advice of qualified non-Federal personnel as reviewers. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The applicant, by submitting an application, consents to the use of non-Federal reviewers/administrators. Non-Federal reviewers must sign COI and non-disclosure agreements prior to reviewing an application. Non-Federal personnel conducting administrative activities must sign a non-disclosure agreement.

F. INTELLECTUAL PROPERTY DEVELOPED UNDER THIS PROGRAM

Patent Rights. The Government will have certain statutory rights in an invention that is conceived or first actually reduced to practice under a DOE award. 42 U.S.C. 5908 provides that title to such inventions vests in the United States, except where 35 U.S.C. 202 provides otherwise for nonprofit organizations or small business firms. However, the Secretary of Energy may waive all or any part of the rights of the United States subject to certain conditions. (See "Notice of Right to Request Patent Waiver" in Section G below.)

Rights in Technical Data. Normally, the Government has unlimited rights in technical data created under a DOE agreement. Delivery or third-party licensing of proprietary software or data developed solely at private expense will not normally be required except as specifically negotiated in a particular agreement to satisfy DOE's own needs or to insure the commercialization of technology developed under a DOE agreement.

Special Protected Data Statutes. This program is covered by a special protected data statute. These special protected data statutes apply to only those applicants who cost share. The provisions of the statute provide for the protection from public disclosure, for a period of up to five (5) years from the development of the information, of data that would be a trade secret, or commercial or financial information that is privileged or confidential, if the information had been obtained from a non-Federal party. Generally, the provision entitled, Rights in Data - Programs Covered Under Special Protected Data Statutes (Item 4 under 2 CFR 910, Appendix A to Subpart D), would apply to an award made under this announcement. This provision will identify data or categories of data first produced in the performance of the award that will be made available to the public, notwithstanding the statutory authority to withhold data from public dissemination, and will also identify data that will be recognized by the parties as protected data.

G. NOTICE OF RIGHT TO REQUEST PATENT WAIVER

Applicants may request a waiver of all or any part of the rights of the United States in inventions conceived or first actually reduced to practice in performance of an agreement as a result of this announcement, in advance of or within 30 days after the effective date of the award. Even if an advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver of the rights of the United States in identified inventions, i.e., individual inventions conceived or first actually reduced to practice in performance of the award. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784 at http://energy.gov/gc/services/technology-transfer-and-procurement/office-assistant-general-counsel-technology-transf-1 under the Patent Waivers.

Domestic small businesses and domestic nonprofit organizations will receive the patent rights clause at 37 CFR 401.14, i.e., the implementation of the Bayh-Dole Act. This clause permits domestic small business and domestic non-profit organizations to retain title to subject inventions. Therefore, small businesses and non-profit organizations do not need to request a waiver.

H. UNDERSTANDING COST SHARING REQUIREMENTS (Cost sharing is not required for Universities and FFRDCs)

Department-wide cost sharing requirements are established by Section 988 of the Energy Policy Act of 2005. The DOE Financial Assistance Rules at 2 CFR 200 and 2 CFR 910 implement cost sharing requirements (see 2 CFR 200.306 and 2 CFR 910.130). The FOA requires a minimum of 20% cost sharing by awardees, except for applications led by U.S. non-profit educational institutions/universities. The applicant's cost share requirement will be based on the total cost of the project. FFRDC costs are included as part of government cost share.

In accordance with section 988 (d), Calculation of Amount, when calculating the amount of the non-Federal contribution, the Government:

1. May include the following costs as allowable in accordance with the applicable cost principles:
   a. Cash.
   b. Personnel costs.
   c. The value of a service, other resource, or third party in-kind contribution determined in accordance with the applicable circular of the Office of Management and Budget [**Note**: In-kind contributions, like any other cost, need to be incurred during the award project period, e.g., cannot give credit for costs incurred prior to the award, including prior development costs, unless otherwise authorized by the applicable cost principles].
   d. Indirect costs or facilities and administrative costs.
   e. Any funds received under the power program of the Tennessee Valley Authority (except to the extent that such funds are made available under an annual appropriation act).

Shall not include:

   a. Revenues or royalties from the prospective operation of an activity beyond the time considered in the award.
   b. Proceeds from the prospective sale of an asset of an activity.
   c. Other appropriated Federal funds.

The terms and conditions of the cooperative agreement will include appropriate provisions on allowable costs.

The Federal share shall not be required to be repaid as a condition of award. Royalties should not be used to repay or recover the Federal share, but may be used as a reward for technology transfer activities.

Cost share is often confused with some form of cost matching. The key to understanding how cost share works is to understand the base from which the cost share percentage is calculated. Cost share percentage is a percentage of the total allowable costs of the project. Note that it is NOT a percentage of the DOE funds, but rather the entire project, including all awardee funds, DOE funds, and all FFRDC requirements.

When determining the cost share requirement in dollars, it is first necessary to determine the entire project cost. Initially, no consideration would be given as to where the funds would come from. An applicant would determine that a certain cost (e.g., hours, travel, supplies, etc.) would be needed to complete the project as proposed in the application. Once the project cost is determined, an applicant can then calculate the cost share requirement by multiplying the cost share percentage by the project cost. The resulting dollar figure would be the dollar requirement that the applicant must provide as cost share.

Below are several examples of how the cost share amount would be calculated:

Example 1

The applicant determines that the following budget requirements are needed to carry out the work described in its application to DOE:

Direct Labor	$100,000
Travel	$3,000
Equipment	$17,000
Supplies	$10,000
Subcontract	$20,000
Total Project Cost	**$150,000**

A cost share requirement of 20% was specified in the funding announcement.
Cost Share = (cost share percentage) × (***total project cost***)
Cost Share = (20%) × ($150,000)
Cost Share = $30,000

The applicant must now identify $30,000 of $150,000 as Cost Share.
The applicant would then request DOE funding in the amount of $120,000.

DOE Share = $120,000 **Awardee Share = $30,000**

Example 2

The applicant determines that the following budget requirements are needed to carry out the work described in its application to DOE:

Direct	$200,000
Labor	$10,000
Travel	$20,000
Equipment	$10,000
Supplies	$60,000
Total Project	**$300,000**

A cost share requirement of 20% was specified in the funding announcement.

Cost Share = (cost share percentage) × (total project cost)
Cost Share = (20%) × ($300,000)
Cost Share = $60,000

The applicant must now identify $60,000 of $300,000 as Cost Share. DOE would pay $60,000 directly to the FFRDC. The applicant would then request DOE funding in the amount of $180,000.

DOE Share = $180,000 (funds to Awardee) + $60,000 (FFRDC) = $240,000

Awardee Share = $60,000

NOTE: FFRDC funds are paid directly to the FFRDC by DOE. The work provided by the FFRDC is still considered part of the total project cost; therefore, it is included in the base from which the awardee cost share is calculated.

In all cases, the applicant must specify the individual costs that make up each part of the total project cost and indicate whether DOE or non-DOE funds will be used to cover the cost.

The budget from **Example 1** might look something like the following:

		DOE	**Non-DOE**
Direct Labor	$100,000	$70,000	$30,000
Travel	$3,000	$3,000	$0
Equipment	$17,000	$17,000	$0
Supplies	$10,000	$10,000	$0
Subcontract	$20,000	$20,000	$0
Total Project Cost	**$150,000**	**$120,000**	**$30,000**

The application forms in this FOA will facilitate the identification of funding sources.

I. NOTICE REGARDING ELIGIBLE/INELIGIBLE ACTIVITIES

Eligible activities under this program include those which describe and promote the understanding of scientific and technical aspects of specific energy technologies, but not those which encourage or support political activities such as the collection and dissemination of information related to potential, planned, or pending legislation.

J. NO-COST TIME EXTENSIONS

Unilateral no-cost time extensions will NOT be permitted to awards made under this FOA. All no-cost time extensions must provide adequate justification and receive approval from the Contracting Officer. No-cost time extensions should be requested as soon as the need is identified and normally no later than three months before the original project end date.

No-cost time extensions on existing DOE-NE funded projects ending in the current fiscal year should be requested by April 15. Any request beyond this date should be submitted after October 1. One no-cost time extension request may be granted for up to 12 months pending review and approval. No more than one no cost time extension will be allowed. No-cost time extensions must be submitted to NEUP@inl.gov.

K. CONFERENCE SPENDING

The recipient shall not expend any funds on a conference not directly and programmatically related to the purpose for which the grant or cooperative agreement was awarded that would defray the cost to the United States government of a conference held by any executive branch department, agency, board, commission, or office for which the cost to the United States government would otherwise exceed $20,000, thereby circumventing the required notification by the head of any such executive branch department, agency, board, commission, or office to the inspector general (or senior ethics official for any entity without an inspector general), of the date, location, and number of employees attending such conference.

PART IX – APPENDICES/REFERENCE MATERIAL

Appendix A: Workscopes for U.S. University-led Program and/or Mission Supporting R&D Projects

Appendix B: Workscopes for U.S. University-, National Laboratory-, or Industry-led Program and/or Mission Supporting R&D Projects

Appendix C: Accessing Nuclear Science User Facilities

Appendix D: Draft Nuclear Science User Facilities User Agreement

Appendix A: Workscopes for U.S. University-led Program and/or Mission Supporting R&D Projects

PROGRAM SUPPORTING: NUCLEAR REACTOR TECHNOLOGIES

MATERIALS FOR ADVANCED REACTOR TECHNOLOGIES (RC-1)

The Office of Nuclear Energy (NE) supports the Department of Energy's HPC4 Materials (High Performance Computing for Materials) initiative to accelerate "industry discovery, design, and development of materials for severe environments by enabling access to computational capabilities and expertise in the DOE laboratories". NE's high-performance computing capabilities include Falcon at the Idaho National Laboratory. More information on computational resources can be found at NSUF.inl.gov. NE is seeking proposals for the development of innovative materials or material concepts for the extreme operating and accident environments expected in advanced reactor and fuel cycle technologies using the high-performance computing capabilities at the INL.

RC-1.1: DOWN-SELECTION OF CLADDING MATERIALS FOR STRUCTURAL COMPONENTS IN LIQUID-FUELED MOLTEN SALT REACTORS (FEDERAL POC – BILL CORWIN & TECHNICAL POC – SAM SHAM) (ELIGIBLE TO LEAD: UNIVERSITIES ONLY) (UP TO 3 YEARS AND $800,000)

Current metallic alloys permitted for the construction of elevated temperature Class A components contained in Section III Division 5 of the ASME Boiler and Pressure Vessel Code are limited, and may not be considered optimum for molten salt reactors (MSRs) that operate under the extreme environments of high temperatures, corrosive salts and neutron irradiation (including fission products.) The development of new alloys that can meet the structural integrity challenges of MSR components under these extreme environments and the desired lifetimes will be challenging, and their subsequent Code qualification will require comprehensive and very long-term test data.

Before such new structural alloys are developed and qualified, use of integral cladding on existing Division 5 Class A base metals would be an alternative approach to support near-term deployment of MSRs. Design rules and acceptance criteria are being developed for cladded components with weld overlaid clad on Division 5 Class A base metals so that testing requirements of the cladding materials could be much less demanding than the load bearing base metals, and hence shortening the deployment time lines of MSRs. To support such a strategy, appropriate cladding materials that have the necessary corrosion and irradiation resistance in molten salt reactor systems need to be down-selected.

The objective of this project is to use innovative scoping test techniques with integrated computation materials engineering to down-select a collection of existing alloys, or to develop new classes of alloys, that can be applied as cladding for structural components in thermal and fast spectrum MSRs using liquid fuels. Characteristics of the cladding materials to be considered include, but not limited to, ductility, compatibility with different fuel salts, irradiation damage resistance, fission product embrittlement resistance, and weldability on Division 5 Class A base metals.

The outcome of the project is to demonstrate the favorable characteristics outlined above for the down-selected cladding materials under the salt and irradiation environments of liquid-fueled MSRs. A plan should also be developed for intermediate term testing to confirm the favorable characteristics observed during the relatively short time frame of the NEUP project and to close any gaps that might exist, e.g., confirmatory neutron irradiation testing.

PROGRAM SUPPORTING: NUCLEAR REACTOR TECHNOLOGIES

RC-1.2: INNOVATIVE NEW ALLOYS FOR MOLTEN SALT REACTOR STRUCTURAL APPLICATIONS
(FEDERAL POC – BILL CORWIN & TECHNICAL POC – SAM SHAM)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Metallic structural components of Molten Salt Reactors (MSRs) have significant structural integrity challenges due to the extreme environments of high temperatures, corrosive coolants and neutron irradiation (including fission products.) The selection of metallic alloys for structural applications is further complicated by the variety of MSR systems that are being considered, e.g., fast versus thermal spectrum reactor core, solid versus liquid fuel, and fluoride versus chloride salts. Existing ASME code qualified metallic alloys do not meet the challenges imposed by these extreme environments.

The objective of this project is to evaluate existing or propose and develop new metallic alloy(s) that can be used for welded construction of structural components of thermal or fast spectrum MSR design that uses liquid fuel. Characteristics of the new metallic alloy(s) to be considered include, but not limited to, high temperature strength, fuel salt compatibility, irradiation damage resistance, fission products embrittlement, and weldability, all for the desired life times of the components. While not specifically a part of this activity, the long-term goal of alloys developed under this effort would be their qualification for nuclear service under ASME Section III, Division 5, hence the long-term stability, fabricability, and potential capability for commercialization of any alloys developed are important.

Novel application of high-value experiments with integrated computation materials engineering for the development and testing of new metallic alloy(s) is highly encouraged. Non-traditional alloys such as high entropy alloys that would meet the requirements could also be considered. The outcome of the project is to demonstrate the potential of the developed alloy(s) to meet the challenges under these extreme environments for liquid-fueled MSR and a plan for fabrication scale up and intermediate term testing to further demonstrate the capability of the developed alloy(s) to meet these challenges.

While not required, interaction with MSR designers on their system requirements is highly encouraged.

RC-1.3: OXIDATION BEHAVIOR IN HTGR TRISO FUEL MATERIALS
(FEDERAL POC – MADELINE FELTUS & TECHNICAL POC – PAUL DEMKOWICZ)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

While high-temperature gas-cooled reactors (HTGRs) and very high temperature gas-cooled reactors (VHTRs) use pure helium as a reactor coolant, there are certain circumstances when oxidants may be introduced into the helium coolant. Trace quantities of moisture, carbon monoxide and carbon dioxide may be present as impurities in the coolant during normal operation. Large amounts of moisture can be introduced into the helium coolant and reactor core as a result of a steam generator tube leak and significant amounts of air can be introduced following depressurization of the helium cooling loop in some accident scenarios. The effects of oxidants on tri-structural isotropic (TRISO) fuel integrity and fission product transport in the core are essential considerations that are part of HTGR safety analysis, and data are needed to more accurately understand fuel oxidation and model core behavior.

Studies of "chronic oxidation" of nuclear graphite because of these oxidizing impurities have already been performed. Previous studies have tested fuel matrix material (graphitic material composed of multiple types of graphite and carbonized phenolic resin) in air, but reaction kinetic parameters have not been collected for the oxidation of fuel matrix material in water vapor. In parallel, analyses that consider the effect of TRISO fuel matrix burnoff on the rate of oxidation are also sought. Recent work has tested the silicon carbide layer of surrogate (non-uranium bearing) coated particles at high temperatures (approximately 1600°C) in high steam partial pressures. There is a need to understand the transition from active to passive (and passive to active) oxidation of chemical vapor deposition (CVD) SiC in TRISO particles at the temperatures of interest (between

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approximately 1000 and 1600°C) under relevant atmospheres (e.g., those containing O_2 or, especially, H_2O vapor), with the ultimate goal of determining the level of SiC damage that could potentially occur during accidents.

Proposals are sought that will explore these phenomena experimentally using the most prototypic materials available (e.g., SiC and matrix materials available from US Advanced Gas Reactor program sample archives). Analysis of SiC and matrix oxidation properties should also consider the effect of irradiation using irradiated specimens, if possible. While the emphasis is on carefully designed experiments, comparison of results with computational models of oxidation behavior is beneficial. The most useful results are those that can be used in computational models of reactor fuel and core behavior during air or moisture ingress accidents, such as those used to predict the rate of reaction for core materials and partial pressures of oxidants reaching the fuel specimens. Any data collected or equations developed should permit application to a realistic range of HTGR temperatures, gas flow rates, core geometries, oxidant partial pressures, etc. Oxidation model(s) specific to graphitic matrix and TRISO CVD SiC could later be coupled to a thermal hydraulic model of the reactor (not part of this call).

All experiments must be performed to NQA-1 standards. Data, experiments, and calculations shall be submitted to the Idaho National Laboratory's NGNP Data Management and Analysis System (NDMAS). Assistance shall be provided by the INL (or ANL for experiments related to NSTF) to ensure NQA-1 standards are properly established. Investigators are strongly urged to coordinate with AGR TRISO Fuel Program staff to obtain appropriate irradiated and un-irradiated materials for these oxidation effects experiments. While not required, interaction with HTGR/VHTR fuel and reactor designers on their system requirements is highly encouraged.

SALT BEHAVIOR IN MOLTEN SALT REACTORS (RC-2)

RC-2.1: PREDICTING THE CHEMICAL SPECIATION, STRUCTURE, AND DYNAMICS OF SALTS SOLUTIONS FOR MOLTEN SALT REACTORS
(FEDERAL POC – STEPHEN KUNG & TECHNICAL POC – DAVID HOLCOMB)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

With the ongoing development of Molten Salt Reactors there is a significant need for understanding the thermochemical behavior of salt compositions. Thermodynamic models and values are needed to predict critical fuel salt characteristics such as melting points, heat capacity, free energies for potential corrosion reactions, and solubilities for fission and corrosion products as function of temperature and composition. The atomic composition and redox condition of the salt may change as a function of time as a result of fission product formation and irradiation effect. Proposals are requested to advance the understanding the thermochemical behavior of molten salts to support reactor design and safety evaluation activities. Potential activities supporting fuel salt database development should include consolidating existing databases and data mining for use with standard thermodynamic minimization codes. The goal is to develop and use first-principles molecular dynamics simulations and computational electronic structure method to extend the limited experimental data sets in covering a broad range of chemical evolution and environments. Targeted experimental efforts should include validating literature data and plans for benchmarking new data against existing information and verified with targeted measurements.

RC-2.2: DEVELOPMENT OF MOLTEN SALT REACTOR FUEL SALT IRRADIATION CAPABILITIES
(FEDERAL POC – STEPHEN KUNG & TECHNICAL POC – DAVID HOLCOMB)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Fuel salt capsule irradiation and PIE capabilities to evaluate radionuclide release and transport mechanisms are needed to support MSR fuel salt qualification and source term evaluation efforts. While traditional fuel salt

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capsule irradiation is expensive and time consuming, liquid fuels samples and scale could be significantly reduced decreasing the difficulty and expense for handling radioactive materials. Currently, microscale salt thermophysical and radionuclide transport property measurement techniques are not available. Proposals are requested to accelerate and decrease the cost of fuel salt irradiation while providing validated salt thermo-physical property and radionuclide transport information. Topics could include the following: (1) understanding materials compatibility in Molten Salts Reactor Environment; (2) Understanding degradation processes at the material–salt interface; (3) Understanding the combined effect of chemistry and radiation at the interface; and (4) Predicting liquid-solid and liquid-gas interfacial interactions.

RC-2.3: UNDERSTANDING THE STRUCTURE AND SPECIATION OF MOLTEN SALT AT THE ATOMIC AND MOLECULAR SCALE
(FEDERAL POC – STEPHEN KUNG & TECHNICAL POC – DAVID HOLCOMB)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

To understand how the structure and dynamics of molten salts impact their physical and chemical properties—such as viscosity, solubility, volatility, and thermal conductivity—it is necessary to determine the speciation of salt components as well as the local and intermediate structure at operationally relevant temperatures. Proposals are requested to use advanced spectroscopic and scattering methods to provide information at the atomic or molecular scale. The goals are to determine the local structure and bonding of chemical species in salt solution and to develop innovative real-time analytical methods for microscopic and macroscopic property measurements to underpin and support molten salt reactor design and development. Proposed experimental work must be closely interfaced with first-principles computational and data analysis approaches to establish validated predictive models for system performance.

RC-3: EXPERIMENTAL INVESTIGATION OF RADIOISOTOPE RETENTION CAPABILITY OF LIQUID METAL COOLANTS (SODIUM AND LEAD)
(FEDERAL POC – TOM SOWINSKI & TECHNICAL POC – TANJU SOFU)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

The U.S. NRC has indicated an expectation for advanced reactor vendors to utilize a mechanistic source term (MST) assessment as an integral part of their future licensing efforts. The hope is that MST analyses will provide a realistic representation of the potentially reduced offsite consequences associated with advanced reactor transients through the utilization of best-estimate models and tools. For liquid metal-cooled reactors in particular, the radionuclide retention characteristics of the coolant may be a vital mechanism to lessen the offsite consequences of core damage accidents. However, the use of an MST analysis as part of licensing will likely require substantial data and a high level of confidence in the radionuclide transport models employed. Recent DOE efforts have acknowledged a potential inadequacy in the current knowledgebase and have sought to identify and characterize gaps (See ANL-ART-3, ANL-ART-38, ANL-ART-49).

This workscope seeks experimental programs to provide the data necessary to achieve adequate confidence in sodium- and lead-cooled reactor MST analyses. Specifically of interest are the data required to properly model the following phenomena for metal-fueled sodium fast reactors and oxide-fueled lead fast reactors:

- Radionuclide interactions with the coolant (compounds formed, solubility, etc.)
- Radionuclide behavior within the coolant (mixing, surface effects, plate-out, etc.)
- Vaporization of radionuclides from the coolant
- The transport of radionuclide gas/vapor bubbles through the coolant

As the phenomena of interest are chemical in nature, it is assumed that non-radioactive isotopes can be utilized for the experiments. In addition, many DOE facilities exist that may be leveraged for the experimental program,

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such as the SNAKE sodium loop at Argonne National Laboratory. It is important for the proposer to properly characterize how the experimental program will resolve gaps in the knowledgebase while not repeating past efforts.

ADVANCED REACTOR DEVELOPMENT (RC-4)

RC-4.1: HIGH TEMPERATURE GAS REACTORS (HTGR)
(FEDERAL POC – DIANA LI & TECHNICAL POC – HANS GOUGAR)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Experimental validation of HTGR simulations is focused on providing data of high temperature gas-cooled reactor (prismatic or pebble bed) phenomena for the validation of system and computational fluid dynamics models. These phenomena are relevant to core safety and performance. The phenomena are important during loss of forced cooling transients in which decay heat is transported by natural circulation, conduction, and radiation within and from the reactor vessel. This may occur in conjunction with the loss of pressure and coolant inventory resulting from a break in piping or a component (e.g. a relief valve). Under these conditions, coolant flow within the vessel is driven by natural circulation and may exhibit complex behavior involving mixing of streams of different temperatures (and cooler air after depressurization), reversed flow, and stratified flow.

Proposals that will investigate the following phenomena are desired:

-Natural circulation of hot helium plumes and jets within the reactor vessel during an extended loss of forced circulation

-Partitioning of water in the primary loop after a steam generator tube rupture with sensitivity to rupture location

Investigations of interest should include experimental and computational studies of separate and mixed effects associated with HTGR accident phenomena. Validation of models that capture these phenomena requires coordinated completion of a number of fundamental, separate (SET), mixed (MET), and integral tests. Tests must be properly scaled to reproduce the thermal fluid conditions bounding gas-cooled reactors under nominal and accident scenarios. The General Atomics 350 MWt MHTGR and 600 MWt GT-MHR serve as reference designs for scaling of existing experiments and should also be used for new experiments. High resolution measurements of complex fluid flows can be used to validate CFD models, contribute to greater understanding of phenomena, and quantify uncertainties inherent in the lower order models. To provide consistent and complementary sets, new separate and mixed effects experiments should be scaled to the design used for the corresponding integral effects experiment.

Integral testing facilities are generally large, long-term investments beyond the scope of NEUP awards. However, a few have been built using other funding sources. The High Temperature Test Facility (HTTF) at Oregon State University and the Natural circulation Shutdown Test Facility (NSTF) at Argonne National Laboratory (ANL) are examples of integral testing facilities that have been scaled and constructed based on the MHTGR design. The NSTF is transitioning from an air-based to a water-based configuration. Additionally, Texas A&M and UltraSafe Nuclear corporation are investigating reactor building atmospheric response to primary leaks through an industry award and was scaled and constructed based on the GT-MHR design.

All experiments must be performed to NQA-1 standards. Data, experiments, and calculations shall be submitted to the Idaho National Laboratory's NGNP Data Management and Analysis System (NDMAS). Assistance shall be provided by the INL (or ANL for experiments related to NSTF) to ensure NQA-1 standards are properly established.

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RC-4.2: FLUORIDE SALT COOLED HIGH TEMPERATURE REACTORS
(FEDERAL POC – DIANA LI & TECHNICAL POC – DAVID HOLCOMB)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

The Fluoride Salt-Cooled High-temperature Reactor (FHR) describes the reactor concept containing a liquid fluoride salt coolant and graphite-matrix coated-particle fuel. The attractive features of this concept include low-pressure liquid fluoride salt cooling, a high-temperature power cycle, and fully passive decay heat rejection. There has been significant effort in developing this reactor design over the past decade with several funded research projects as well as design development efforts by Oak Ridge National Laboratory.
This funding opportunity aims to build upon previous research efforts and further close gaps to the FHR design concept. Proposals are desired in the following areas:

Flow loop testing: ORNL has a functional high temperature forced-flow FLiNaK salt loop. Additionally, a forced flow FLiBe loop is expected to be available at the beginning of FY19 at ORNL. Proposals are requested to design and execute experiments related to 1) corrosion, 2) instrumentation demonstration, 3) thermal-hydraulic data, and/or 4) dynamic system model verification using the loop. The facility would be operated with programmatic funding. Proposals would propose any needed hardware additions to the loop, collect and analyze data, and document the results.

Reactor core and plant modeling capabilities: Proposals for reactor core and plant modeling capability that is affordable, yet accurate, and easily shared among collaborating institutions is requested. Methodologies that provide accurate results while requiring modest computational capability are desirable. Alternate methodologies that provide independent comparison of commonly used methods is highly desirable. Areas of interest include, but are not limited to 1) Core neutronics and 2) thermal hydraulics, and 3) dynamic system level modeling.

All work should be performed to NQA-1 standards. Models that will provide data in a form that can interface with the NEAMS toolkit will be considered with higher priority.

RC-5: DATA SCIENCE AND BIG DATA ANALYTICS TO IMPROVE NUCLEAR POWER PLANT EFFICIENCY
(FEDERAL POC – TREVOR COOK & TECHNICAL POC – BRUCE HALLBERT)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

The call is seeking research proposals to enhance operational efficiency and productivity of current light water reactors using data science, especially big data analytics. Current and emerging technologies related to wireless communication, wireless sensors, and digital systems will enable plants to collect data that were previously unavailable to them. Proposals should address novel approaches to integrate and analyze heterogeneous data streams to extract insights and develop associated rules to significantly impact the operational efficiencies in managing and protecting (i.e., from unplanned failure, wear, and other modes of degradation and failure). Transformation of large volumes of heterogeneous data into useful information including data visualization is valuable because it could enable plant operators to make informed decisions related to a variety of plant engineering, maintenance, economics of operation, and asset management. The outcomes of research are expected to provide input to a more agile and modular big data analytic framework that can be leveraged by nuclear power plant owner operators and their suppliers.

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RC-6: EVALUATION OF POTENTIAL IMPROVEMENTS TO RISK AND ECONOMICS RESULTING FROM ACCIDENT TOLERANT PLANT DESIGNS
(FEDERAL POC – TREVOR COOK & TECHNICAL POC – CURTIS SMITH)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

The focus of this research is to evaluate current light water reactor plants for design enhancements including the possibility for accident-tolerant fuel (ATF); accident-tolerant core structures; incorporation of backup safety systems such as FLEX and new passive cooling systems; improved operational control; and accident-tolerant instrumentation. In 2013, a report (INL/EXT-13-30195) considered how an evaluation of ATF might be performed in a risk-informed fashion. This report looked at initial evaluation of ATF through a risk-informed lens. In summary, it noted:

- There is no particular reason to believe that regulatory acceptance criteria (e.g., peak clad temperature < 2200°F) will be the same for new cladding types as for the traditional cladding type.
- It is clear a priori that a meaningful analysis must analyze plant-level behavior for each cladding type, as opposed to simply looking at the physical properties of cladding.
- In order to compare plant-level behavior keeping all but cladding the "same," it is necessary to exercise considerable care in formulating inputs to the simulation of time histories.

The concept of "accident tolerance" has been ingrained in the light water reactor design and operation for decades. For example, the Regulatory Guide 1.155: Station Blackout produced by the U.S. Nuclear Regulatory Commission note "…a method acceptable to the NRC staff for complying with the Commission regulation that requires nuclear power plants to be capable of coping with a station blackout for a specified duration." The method provides an informed way to select a minimum acceptable station blackout coping duration capability from 2 to 16 hours. The principle behind this approach is that the coping capability that is required is related to the likelihood of challenging that capability.

The research in this call will be to evaluate plant scenarios to determine potential applicability of the different coping times using risk-informed approaches. This analysis will focus on determination of "response surface" of coping time versus potential economic savings. The research will leverage the RISMC tools (described in INL-EXT-11-22977, Rev. 4) and the LOTUS framework (described in INL/EXT-17-42461) in order to consider coping time issues related to both fuel/cladding and plant/system-level integrity issues. Once the possible positive risk implications are identified, these will be evaluated against 10CFR 50.69 considerations to better understand potential regulatory relaxations that are possible for the specific components of interest.

RC-7: INNOVATIVE METHODS FOR INCREASING SAFETY RESPONSE FOR EXISTING PLANTS
(FEDERAL POC – TREVOR COOK & TECHNICAL POC – MITCH FARMER)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Although research and development on severe accidents is important for formulating mitigation strategies, an equally important question is whether there are any relatively simple and non-intrusive ways to increase the ability of existing nuclear power plants to passively respond to beyond design basis events. Within the LWRS Program, two approaches are currently being considered for achieving this objective: (1) utilization of Accident Tolerant Fuel (ATF) performance coupled with extended emergency core cooling equipment performance (i.e., reactor core isolation cooling pump performance for boiling water reactors and auxiliary feedwater pump performance for pressurized water reactors) to delay or prevent core damage, and (2) examination of concepts for utilizing existing structures and equipment within containment for extending or augmenting long-term containment heat sink. One example of a possible heat sink approach would be exterior flooding of the drywell

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head in Mark I and II containments. Research is sought to define innovative concepts for increasing the passive safety capability for existing nuclear power plants with the goal of demonstrating a passive concept for achieving a 72-hour coping period for an existing plant using existing equipment. Specific elements of this work may include the utilization of system level severe accident codes for examining potential synergistic effects of ATF and extended reactor core isolation cooling / auxiliary feedwater operation on providing additional margin for safe shutdown during a beyond design basis accident, coupled with innovative ways for increasing passive heat sink in containment in order to avoid the need to vent within the 72-hour coping period.

PROGRAM SUPPORTING: FUEL CYCLE TECHNOLOGIES

MATERIAL RECOVERY AND WASTE FORM DEVELOPMENT (FC-1)

This program element develops innovative methods to separate reusable fractions of used nuclear fuel (UNF) and manage the resulting wastes. These technologies, when combined with advanced fuels and reactors, form the basis of advanced fuel cycles for sustainable and potentially growing nuclear power in the U.S.

FC-1.1: ELECTROCHEMICAL SEPARATIONS
(FEDERAL POC – STEPHEN KUNG & TECHNICAL POC – MARK WILLIAMSON)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Recovery of fission products from the molten salt employed in the electrochemical treatment of used nuclear fuel allows for salt recycle thus minimizing high-level waste production and potentially reducing fuel cycle costs. The Nuclear Technology R&D program is soliciting proposals focused on developing innovative fission product recovery processes that yield high recovery efficiencies and minimize secondary waste production. The processes could employ electrochemical, reductive extraction or other techniques to recover fission product elements, present as chlorides in the electrolyte salt, in a form suitable for encapsulation in robust waste forms. In addition to the proposed R&D plan, the proposal should address the chemical basis for the recovery process, fission product elements targeted by the process, expected recovery efficiencies, final form of fission product elements for encapsulation in waste forms, and waste generation estimates.

FC-1.2: MATERIALS RECOVERY
(FEDERAL POC – JIM BRESEE & TECHNICAL POC – TERRY TODD)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Solvent Extraction Chemistry and Radiation Chemistry- Critical gaps exist in our knowledge underlying advanced aqueous separation processes being considered currently for used fuel recycle for the separation of Actinides/Lanthanides. The current reference process: Actinides/Lanthanides Separation Process (ALSEP), combines a neutral donor extractant with an acidic extractant to yield a hybrid solvent system for separating minor actinides (MA) from acidic HLW.

Understanding the stability of ALSEP process and other advanced actinide solvent extraction systems to chemical and radiolytic degradation is indispensable. Information is needed on the different degradation pathways and the formation of by-product species due to chemical or radiolytic degradation. Some of these new by-products species can potentially impede the process, so investigation on concept for solvent cleanup should be developed based on the resulting insights.

FC-1.3: WASTE FORMS DEVELOPMENT
(FEDERAL POC – KIMBERLY GRAY & TECHNICAL POC – JOHN VIENNA)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

FC-1.3a: Off Gas Capture- Iodine Capture from Vessel Off Gas Streams – The capture of iodine from vessel off-gas streams (VOG) is a high priority research area. It is estimated that only 1 to 6 % of the total iodine is found in this stream. However, capture of 99.9+% of this iodine is required to achieve the overall plant iodine abatement requirements. This capture is complicated by three factors: 1) The iodine concentration is 100 to

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1000 times more diluted than in the dissolver off-gas stream (DOG), resulting in VOG iodine concentrations between 5 and 100 ppb. 2) The VOG gas stream is ~10 times the volume of the DOG resulting in the need for larger equipment. 3) The primary form of the iodine in the VOG is a mixture of organic iodine species. Proposals are sought to determine the reaction pathways and kinetics for the adsorption of iodine on a silver-containing sorbent over the range of anticipated organic iodide compounds (C1 [methyl-iodide] to C12 [iodo-dodecane]). The effects of temperature and associated VOG constituents on the reaction pathways and rates should also be determined.

FC-1.3b: Waste-Form Development- Zeolite Formation Thermodynamics and Kinetics – The nucleation and growth of zeolite secondary phases during borosilicate waste glass degradation is believed to couple with the dissolution kinetics of the glass and increase the dissolution rate under certain conditions. Identifying solution conditions conducive to the formation of rate-affecting phases will allow the long-term behavior of borosilicate waste glasses to be modeled more accurately. Threshold concentrations required to generate zeolites must be determined to support modeling behavior over temperature ranges of 25 to 90 °C and pH 8 to 13. Proposals are sought to determine the composition/temperature/pH boundaries for the formation of alumino-silicate zeolites that have been identified to impact borosilicate waste glass corrosion rate and to determine the rates of precipitation as functions of the same parameters.

ADVANCED FUELS (FC-2)

FC-2.1: BENCHMARKING MICROSCALE MECHANICAL PROPERTY MEASUREMENTS (FEDERAL POC – JANELLE EDDINS & TECHNICAL POC – STUART MALOY) (ELIGIBLE TO LEAD: UNIVERSITIES ONLY) (UP TO 3 YEARS AND $800,000)

Recent research has shown the benefits of microscale mechanical testing and has significantly advanced the field for nuclear materials. However, more research is needed to correlate microscale measurements to the macroscale (particularly for ductility measurements). Techniques including micro tensile, micro compression, micro bending and nano hardness have been developed and have demonstrated that mechanical properties can be evaluated on nm and µm length scales. These techniques have extensive applications as they enable the nuclear materials community to generate mechanical property data even on heavy ion beam irradiated materials as well as on radioactive materials. With the excellent progress made on developing these microscale techniques, more research is needed to standardize these practices and benchmark the results against those from macroscale measurements. Issues including effects of artefacts from preparation, scale of the microstructure, multiphase materials, microscale segregation, and local texture on results need to be studied. Thus, proposals are sought on correlating microscale mechanical testing data with macroscale data for testing of irradiated nuclear materials for high dose applications. In addition, there has been very little development of microscale ductility measurement techniques which is particularly important for some of the more advanced alloys. Hence, priority will be given to proposals that include a method for microscale ductility measurement and comparison to macroscale measurements.

FC-2.2: ADVANCED FABRICATION METHODS FOR METALLIC FAST REACTOR FUELS (FEDERAL POC – JANELLE EDDINS & TECHNICAL POC – STEVE HAYES) (ELIGIBLE TO LEAD: UNIVERSITIES ONLY) (UP TO 3 YEARS AND $800,000)

The Advanced Fuels Campaign is currently investigating advanced casting and extrusion processes for the fabrication of metallic transmutation fuels. Proposals are sought for novel fabrication methods for metallic fast reactor fuels having the potential for economic, fuel performance, or manufacturability improvements over existing fabrication techniques for future commercial applications. Fabrication methods having the potential to meet the 0.1% loss goal for the metallic fast reactor fuel systems currently under study by the Advanced Fuel Campaign are also desired for future commercial applications.

PROGRAM SUPPORTING: FUEL CYCLE TECHNOLOGIES

FC-2.3: DAMAGE AND FAILURE MECHANISMS FOR SIC/SIC COMPOSITE FUEL CLADDING AND MITIGATION TECHNOLOGIES
(FEDERAL POC – FRANK GOLDNER & TECHNICAL POC – YUTAI KATOH)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Failure of SiC/SiC composite fuel cladding occurs under a complex operating environment involving hydrothermal corrosion, radiolysis, radiation damage, and mechanical loading. Proposals are solicited for fundamental to applied research and development in one or more of the following areas: **1) Multi-axial failure criteria for SiC/SiC composites**: complex stress states develop in SiC/SiC composites during services in nuclear systems. While the design criteria and test methods have been reasonably established for uniaxial or simple hoop loading to the ceramic matrix composite tubular test articles, insufficient work has been performed for multi-axial failure and testing, limiting the ability of qualification for ceramic matrix composite (CMC) components. Establishing the multi-axial failure criteria and development of appropriate test methods to support the experimental investigation and validations of nuclear-grade SiC/SiC composites are required; **2) Understanding radiolytically assisted hydrothermal corrosion of SiC:** dissolution of SiC in operating environments combining oxidative water chemistries and water radiolysis is a critical feasibility issue for SiC-based fuel and core components in LWRs. While various mitigation strategies are actively studied, it is important to establish scientific understanding of the detailed corrosion kinetics of the radiolytically assisted hydrothermal corrosion of SiC and the factors that determine the rate of corrosion. The ultimate goal of the solicited project on this topic is to enable mapping of SiC corrosion rate in the multi-dimensional space involving water chemistry, radiolysis intensity, and temperature. A technical approach combining experiments and computational modeling is highly encouraged; **3) Corrosion barrier technologies for SiC/SiC composites:** for widespread applications of SiC-based materials in water reactor systems, environmental barrier coating technologies or novel matrix/surface modification technologies that provide protection against radiolytically assisted hydrothermal corrosion in multiple LWR water chemistries need to be developed. On this topic proposals are solicited for research toward development of such technologies. Technical approaches that recognize the existing state-of-the art, and are scalable to industrial production of full length fuel rods and core components such as inside coating/modification of LWR channel boxes are encouraged.

ADVANCED DATA INTEGRATION FOR DOMESTIC NUCLEAR SAFEGUARDS (FC-3)

(FEDERAL POC – DAN VEGA & TECHNICAL POC – MIKE MILLER)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Methods and approaches for integrative advanced process monitoring to enhance nuclear material control and accounting in used nuclear fuel reprocessing facilities. This area includes integrating radiation based and non-radiation based data with the goal of providing quantitative analysis and error propagation to supplement traditional nuclear material control and accounting measures resulting improved performance of the safeguards system to meet NRC Material Control and Accountability (MC&A) requirements.

USED NUCLEAR FUEL DISPOSITION (FC-4)

FC-4.1: USED NUCLEAR FUEL DISPOSITION: DISPOSAL
(FEDERAL POC – JOHN ORCHARD & TECHNICAL POC – PETER SWIFT)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

PROGRAM SUPPORTING: FUEL CYCLE TECHNOLOGIES
Assessments of nuclear waste disposal options start with the degradation of waste forms and consequent mobilization of radionuclides, reactive transport through the near field environment (waste package and engineered barriers), and transport into and through the geosphere. Science, engineering, and technology improvements may advance our understanding of generic deep geologic environments (e.g., salt, clay, tuff, granite geologic repository) and will facilitate the characterization of the natural system and better enable analysis of expected natural system performance during the post-closure period. DOE is required to provide reasonable assurance that the disposal system isolates the waste for an extended time period (i.e., engineered and natural systems work together to prevent or delay migration of waste components to the accessible environment). Demonstration of isolation generates business or R&D opportunities supportive of the mined repository and ongoing generic disposal system investigations. DOE invites proposals involving novel materials, testing methods, and modeling concept and capability enhancements that support the program efforts to design, develop, and characterize the barrier systems and performance (i.e., to assess the safety of a nuclear waste repository). DOE will consider proposals addressing applications of state-of-the-art uncertainty quantification and sensitivity analysis approaches to coupled-process modeling and performance assessment contributing to a better understanding of barrier system performance and the optimization of repository performance. Research proposals are sought to support the development of materials, modeling tools, and data relevant to permanent disposal of spent nuclear fuel and high-level radioactive waste for a variety of generic mined disposal concepts in clay/shale, salt, crystalline rock, and tuff. Key university research contributions for the disposal portion of this activity may include one or more of the following: • Improved understanding of the degradation processes (i.e. corrosion) for heat generating waste containers/packages considering direct interactions with buffer materials in a repository reducing environment leading to the development of improved models to represent the waste container/package long term performance • Improved understanding of the degradation processes for engineered barrier materials (i.e., waste containers/packages, buffers, seals) under evolving repository thermal conditions and radionuclide transport processes through these materials leading to and including the development of improved models to represent these processes • Improved understanding of coupled thermal-mechanical-hydrologic-chemical processes in the near-field of relevant disposal model environments, leading to the development of improved engineered barrier materials and models to represent these processes • Improved understanding of large-scale hydrologic and radionuclide transport processes in the geosphere of relevant disposal repository environments, leading to the development of improved methodologies and models to represent these processes • Development of new techniques for in-situ field characterization of hydrologic, mechanical, and chemical properties of host media and groundwater in an excavated tunnel • Development of pertinent data and relevant understanding of aqueous speciation and surface sorption at elevated temperatures and geochemical conditions (e.g., high ionic strength) relevant to the disposal environments being considered • Development of new and innovative concepts (in different geologic media -- argillite, crystalline, salt, tuff) for sealing repository openings (e.g., shafts, tunnels, wells) to facilitate repository closure and provide required long-term waste isolation and performance • Improved understanding of how spent nuclear fuel waste forms degrade and perform in different disposal environments using theoretical approaches, models and/or experiments, with quantitative evaluations including uncertainties of how the long-term performance of spent nuclear fuel waste forms, waste package materials and fluids can be matched to different geologic media and disposal

PROGRAM SUPPORTING: FUEL CYCLE TECHNOLOGIES

concepts

- Experimental and modeling investigations for the effect of radiolysis on spent fuel, high-level waste, and barrier material degradation at temperatures and geochemical conditions relevant to potential disposal environments

- Identification and assessment of novel buffer materials, new methods and tools for multi-scale integration of flow and transport data, new methods for characterization of low permeability materials, state-of-the-art tools and methods for passive characterization and monitoring of engineered system component properties and failure modes

- Other innovative or novel proposals with potential to advance understanding of materials or systems, characterization, monitoring, and / or performance of engineered and natural system barriers and their capability to isolate and contain waste may also be considered by the department.

FC-4.2: USED NUCLEAR FUEL DISPOSITION: STORAGE & TRANSPORTATION (FEDERAL POC – JOHN ORCHARD & TECHNICAL POC – PETER SWIFT) (ELIGIBLE TO LEAD: UNIVERSITIES ONLY) (UP TO 3 YEARS AND $800,000)

The possibility of stress corrosion cracking (SCC) in welded stainless steel dry storage canisters (DSC) for spent nuclear fuel (SNF) has been identified as a potential safety concern. The welding procedure introduces high tensile residual stress and sensitization in the heat-affected zone (HAZ), which may drive the initiation of pitting and transition to SCC growth when exposed to an aggressive chemical environment. Analysis of samples surface deposited on in-service DSCs at three near-marine ISFSIs sites have demonstrated the presence of chloride-rich salts on the outer canister surfaces (Enos et al. 2013, Bryan and Enos, 2014, EPRI, 2014, Bryan and Enos, 2015). As portions of the canister surfaces cool sufficiently, the marine atmospheric salts may deliquesce and generate an aqueous brine layer on the surface of the canisters at various locations. This aggressive environment may lead to pitting, SCC, and potentially a through-wall failure in the weldments of the canisters.

To prevent the potential for a through-wall crack, it is necessary to develop repair and mitigation technologies for the identified pitting and cracks. The main incentive of development repair technology is to avoid the enormous cost of canister replacement, and significant safety related issues during the replacement process. The cost-effective repair technologies would ensure the continuation of long-term safety performance of dry storage casks at ISFSIs. Development of crack repair techniques using advanced welding repair technologies in combination with mitigation technologies to prevent or minimize future pitting or SCC would be essential to maintain and/or restore the mechanical integrity of the canisters under extended service conditions. Both the repair and mitigation techniques must be capable of in-service repair on loaded systems, which requires low heat input, no spark source, and acceptable external forces to avoid significant reduction in mechanical strength, ignition of potential hydrogen gas inside the canister, and deformation of the canister during the repair process.

Potential repair techniques include friction stir welding (FSW) technology, or additive FSW. FSW is a solid-state welding technique that could potentially introduce compressive residual stress to the surface of the components or canisters, which might suppress the possibility of future crack initiation. The lower heat input introduced by FSW would also avoid or mitigate the microstructure sensitization, which would further suppress the susceptibility to SCC and thus contribute to the long-term safety performance of the canisters. Potential mitigation techniques include peening or burnishing of the welds (the original fabrication welds, or the subject repair welds, or both) to reduce tensile stress or coatings or inhibitors to minimize corrosion are of interest. In addition to development of the techniques, verification of the incubation time for pitting and crack initiation as well as crack growth rates for the treated welds compared to traditional welds is necessary.

PROGRAM SUPPORTING: FUEL CYCLE TECHNOLOGIES
Research proposals are sought to support the development of repair and mitigation technologies for the identified pitting and cracks.

MISSION SUPPORTING: FUEL CYCLE TECHNOLOGIES
MS-FC-1: FUEL CYCLE R&D **(FEDERAL POC – BILL MCCAUGHEY & TECHNICAL POC – JACK LAW)** **(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)** **(UP TO 3 YEARS AND $400,000)** The Fuel Cycle Research & Development program conducts generic (not site specific) research and development related to spent nuclear fuel, nuclear waste management and disposal issues. The program also conducts R&D on advanced fuel cycle technologies that have the potential to improve resource utilization and energy generation, reduce waste generation, enhance safety, and limit proliferation risk. Applications are sought for advanced fuel treatment or material recovery processes, innovative fuel designs, and innovative fuel cycle analysis tools. Areas of interest include "blue sky" concepts for advanced methods of managing used nuclear fuel, such as innovative recycling, transport, storage, and disposal concepts. Areas of interest for fuel R&D include, but are not limited to, advanced concepts for existing LWR and other thermal spectrum reactors and advanced transmutation fuels for fast or mixed spectrum systems. Advanced fuel concepts may also include LWR fuel with improved performance benefits and fast reactor fuel with improved cladding performance (e.g., ability to withstand 400 dpa). **This call excludes nuclear reactor technologies.**

PROGRAM SUPPORTING: NUCLEAR ENERGY ADVANCED MODELING AND SIMULATION

NUCLEAR ENERGY ADVANCED MODELING AND SIMULATION (NEAMS-1) (FEDERAL AND TECHNICAL POC'S – SEE SUB-SCOPES BELOW)

The Nuclear Energy Advanced Modeling and Simulation (NEAMS) program aims to take advantage of scalable simulation methods on high performance computing architectures in combination with a science-based, mechanistic approach to model multi-physics phenomena for predictive assessments of the performance and safety in a broad class of nuclear reactors. To ensure the accuracy of computational solutions, the NEAMS program also aims to validate underlying models (materials science, thermal-hydraulics, neutronics, and structural mechanics), through both separate effects as well as integral analyses. Such validation is essential to helping government and industry integrate predictive simulation-based high-performance computing models into their nuclear R&D activities. To support this integration, NEAMS also seeks to improve the convenience of using the tools for end users, demonstrate the use of the tools through advanced studies and benchmark analyses, and demonstrate improved results realized with high-fidelity tools over conventional methods.

The NEAMS program is seeking applications that contribute to improving the mechanistic models, computational methods, validation basis, and code integration and deployment for the NEAMS tools and their components in following six topical areas. Collaboration with members of the NEAMS development team residing at DOE laboratories as well as end users in industry or regulatory authorities is strongly encouraged.

NEAMS-1.1: ATOMISTIC AND MESOSCALE MODELING AND SIMULATION OF NUCLEAR FUELS, CLADDING, AND REACTOR STRUCTURAL MATERIALS (FEDERAL POC: DAN FUNK & TECHNICAL POC: STEVE HAYES) (ELIGIBLE TO LEAD: UNIVERSITIES ONLY) (UP TO 3 YEARS AND $800,000)

The NEAMS mesoscale nuclear materials simulation tool MARMOT simulates the evolution of microstructure and the consequent change in material properties in fuel and cladding materials under irradiation. The microstructure evolution is described using the phase field method coupled to solid mechanics and heat conduction and solved within the finite element-based Multiphysics Object Oriented Simulation Environment (MOOSE). MARMOT is dependent on free energies, diffusivities, and other data for material systems from experiments and atomistic simulations such as molecular dynamics and density functional theory. To date, MARMOT has primarily focused on LWR fuel (UO_2) and cladding materials (zirconium-based alloys), but in principle can be employed for studies of a broad range of materials. Proposals are sought which improve predictive capabilities for additional phenomena of interest in nuclear materials impacting their in-reactor performance, extend the capabilities of MARMOT to a broader range of fuel and cladding materials (e.g., metallic fuels and stainless steel claddings for fast reactors), and improve the validation basis of the code. Examples of additional phenomena of interest include mechanistic models for corrosion, creep, chemical interaction, swelling, and phase separation in multi-phase, multi-component systems in reactor materials including current and future reactors. Validation should involve closely correlated experiments and modeling using MARMOT, as well as uncertainty quantification. Proposals on atomistic simulations to enable and inform development of mechanistic models for MARMOT are also encouraged.

NEAMS-1.2: MACROSCALE FUEL PERFORMANCE (FEDERAL POC: DAN FUNK & TECHNICAL POC: STEVE HAYES) (ELIGIBLE TO LEAD: UNIVERSITIES ONLY) (UP TO 3 YEARS AND $800,000)

The NEAMS macroscale fuel performance simulation tool BISON provides capabilities for 1-D, 2-D and 3-D predictions of changes in thermal and structural response of nuclear fuel and cladding materials from beginning of life, through irradiation to high burnup, and even including wet and dry storage of used fuel. To date, BISON has primarily focused on LWR fuel (UO_2) and cladding materials (zirconium-based alloys), but in principle can

PROGRAM SUPPORTING: NUCLEAR ENERGY ADVANCED MODELING AND SIMULATION

be employed for studies of a broad range of nuclear fuel systems. BISON's material and behavior models are being continuously improved through hierarchical and concurrent coupling activities with MARMOT and through coordination with MARMOT development. NEAMS encourages proposals that aid in the development of mechanistic models for material properties and irradiation behaviors, propose more robust and efficient numerical algorithms, extend capabilities of BISON to relevant fuel forms that are currently under supported or not supported at all (e.g., metallic fuels and stainless steel claddings for fast reactors), or improve the validation basis of the code, particularly for 3-D problems (here, a proposal to enhance 3-D multiphysics BISON validation using a method of manufactured solutions approach would be encouraged). Proposals that employ coupling of BISON and MARMOT simulations using hierarchical, concurrent, or hybrid approaches are encouraged.

NEAMS-1.3: CORE NEUTRONICS
(FEDERAL POC: DAN FUNK & TECHNICAL POC: TANJU SOFU)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

NEAMS' investment in neutronics methods is driven by the need to provide much more detailed spatial and temporal descriptions of reaction rates and isotopic densities to the NEAMS fuels performance modules than can be achieved with more conventional methods. The NEAMS ToolKit uses the PROTEUS neutronics code which provides tools for second order discrete ordinates transport and kinetics. PROTEUS is integrated with ORIGEN for depletion. The MC2-3 code is used in conjunction with PROTEUS for multi-group cross section generation and it requires a whole-core ultrafine-group transport calculation (currently using TWODANT) to obtain realistic region-wise spectra for group condensation.

Recently, capabilities of 3-D MOC transport calculation and thermal cross sections have been added to MC2-3, which still needs significant effort for performance improvement as well as verification and validation. Proposals are sought to improve solution accuracy, computational performance and efficiency, and verification and validation of MC2-3 for various fast and thermal reactor applications, by introducing Monte Carlo approaches, coherent coupling with PROTEUS, efficient parallelization and numerical algorithms, and advanced uncertainty evaluation techniques.

NEAMS-1.4: THERMAL HYDRAULICS
(FEDERAL POC: DAN FUNK & TECHNICAL POC: ELIA MERZARI)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

The NEAMS program is supporting the development of a novel system code (SAM) and a computational fluid dynamics (Nek5000) tool. Nek5000 provides capabilities for high resolution Direct Numerical Simulation (DNS), Large Eddy Simulation (LES), Unsteady Reynolds Average Navier-Stokes (URANS) simulation, and reduced order distributed resistance modeling. SAM is an advanced system code that leverages the MOOSE framework to deliver advances in software environment, and design, numerical methods, and physical models. It features flexible multi-scale multi-physics integration with other high-fidelity tools, including Nek5000.

To support the development of these tools, contributions are sought for modeling the mixing and thermal-stratification in large volumes (e.g., upper plena) and its influence on natural circulation flow rates and decay heat removal in a pool type LMRs. In fact, mixing and heat transfer in reactor inlet/outlet plena can be modeled reasonably accurately using various CFD techniques but the computational resource requirements make the use of such high fidelity approaches prohibitively expensive within the context of system analyses. With the system analysis codes, the reactor plena are typically modeled as perfectly mixed 0-D volumes, often leading to inaccurate estimate of the natural circulation flow rates for decay heat removal.

This call seeks the development of Reduced-order modeling (ROM) approaches to be implemented in the System Analysis Module (SAM) to support conceptual design studies and license applications. In order to generate the

PROGRAM SUPPORTING: NUCLEAR ENERGY ADVANCED MODELING AND SIMULATION

ROM, simulations performed with high fidelity tools are strongly encouraged to obtain the necessary data to mine. Techniques to construct the reduced order model may involve POD [1], other structure recognition methods or machine learning. Experimental contributions will not be considered, but coordination with existing experimental efforts is encouraged. High-fidelity simulations performed with Nek5000 will be primarily considered.

[1] Elia Merzari, W. David Pointer and Paul Fischer, "A POD-Based Solver for the Advection-Diffusion Equation", ASME-JSME-KSME 2011 Joint Fluids Engineering Conference, Hamamatsu, Japan, July 24–29, 2011

NEAMS-1.5: INTEGRATION AND DEMONSTRATION
(FEDERAL POC: DAN FUNK & TECHNICAL POC: BRAD REARDEN)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

To enhance integration of NEAMS tools into a wider range of R&D activities, NEAMS employs a model and workflow interface called the NEAMS Workbench (B. T. Rearden, et al, "Introduction to the Nuclear Energy Advanced Modeling and Simulation Workbench," *M&C 2017 – International Conference on Mathematics & Computational Methods Applied to Nuclear Science and Engineering*, Jeju, Korea, April 16–20, 2017.) The NEAMS Workbench was created in response to the needs of design and analysis communities to enable end users to apply high-fidelity simulations to inform lower-order models for the design, analysis, and licensing of advanced nuclear systems.

The NEAMS Workbench provides a common user interface for model creation, review, execution, and visualization for many codes and provides the ability to run many codes from a common user input by templating engineering scale specifications to code-specific input requirements, enabling multi-fidelity analysis of a system from a common input using a variety of codes. Expansion of the codes integrated under the Workbench as well as the creation of templates for many practical systems and established benchmarks will facilitate the use of high-fidelity tools to improve confidence in faster running design calculations, accelerating the development of future nuclear energy systems.

Proposals are sought to integrate high-fidelity as well as conventional tools into the Workbench, automate analysis workflows used in design studies, provide convenient access to uncertainty quantification, develop and demonstrate templates of complex system models, provide automated meshing and mesh refinement, and demonstrate the use of the Workbench for practical studies. Proposals that demonstrate the value of the high-fidelity NEAMS tools as applied to collaborative benchmarks, validation, and industrial systems as well as the use of NEAMS tools to inform the improved use of conventional tools within the Workbench are strongly encouraged. Partnerships with the developers of the tools as well as industrial and/or regulatory users of the tools are strongly encouraged.

NEAMS-1.6: ADVANCED TWO-PHASE SIMULATION FOR LIGHT WATER REACTORS
(FEDERAL POC: DAN FUNK & TECHNICAL POC: ELIA MERZARI)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

The NEAMS program is supporting the development of the next generation of nuclear reactor system safety analysis code at the Idaho National Laboratory (INL). The RELAP-7 (Reactor Excursion and Leak Analysis Program) development is taking advantage of the progress made in the past several decades to achieve simultaneous advancement of physical models, numerical methods, and software design. The RELAP-7 code utilizes the INL's MOOSE (Multi-Physics Object-Oriented Simulation Environment) framework. The five major improvements in RELAP-7 over traditional approaches are 1) A well-posed seven-equation two-phase flow model (liquid, gas, with two phasic pressures); 2) Improved numerical approximations resulting in second-order accuracy in both space and time; 3) Implicit tightly coupled time integration for long duration transients; 4) the

PROGRAM SUPPORTING: NUCLEAR ENERGY ADVANCED MODELING AND SIMULATION

ability to tightly couple to higher fidelity physics, such as the NEAMS BISON nuclear fuels performance application; and 5) the ability to easily couple to multi-dimensional core simulators being developed (NEAMS TREAT simulator and CASL VERA).

To support the development of RELAP-7, contributions are sought for developing a native three-dimensional sub-channel capability in RELAP-7 based upon the seven-equation two-phase flow model. The sub-channel capability will be required to be tightly coupled to the BISON nuclear fuels performance code, taking into account continuous heat flux across the fluid structure interface and the effect of fuel pin cladding displacement on the sub-channel geometry over the life of the fuel. Specific experiments are also sought to validate RELAP-7's seven-equation flow model, specifically regarding its advanced features that distinguish it from traditional two-phase models. This will require consideration that the seven-equation model assumes that there are distinct phasic pressures for steam and water. Measurement of the distinct phasic pressures and their rate of relaxation toward a common pressure under transient flow conditions are necessary to validate the pressure relaxation coefficients of the seven-equation model.

SEPARATE EFFECTS IRRADIATION TESTING FOR VALIDATION OF MICROSTRUCTURAL MODELS IN MARMOT (NEAMS-2)
(FEDERAL POC: DAN FUNK & TECHNICAL POC: STEVE HAYES)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(NSUF ACCESS REQUEST REQUIRED)
(UP TO 3 YEARS AND $500,000)

Requests are sought for innovative, separate effects irradiation tests of nuclear fuels and/or materials that would provide data important to informing and validating mechanistic, microstructure-based models of fuel behavior under development using MARMOT, the NEAMS tool for simulating microstructure evolution under irradiation. MARMOT models under active development are summarized under NEAMS 1.1 and in the MARMOT Assessment Report. Fuel systems of interest for which separate effects experiments are desired are the LWR fuel system (*i.e.*, both the historic UO_2 fuel and Zirconium-based cladding, as well as emerging Accident Tolerant Fuel concepts) and the SFR fuel system (*i.e.*, U-Zr and U-Pu-Zr metallic fuel and steel-based cladding).

NOTE: Access to NSUF capabilities will require agreement and final signature to the User Agreement (copy provided in Appendix D and at https://atrnsuf.inl.gov/documents/ATRNSUFStandardNon-PropUserAgreement.pdf). **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 NEAMS-2, NSUF-1, or NSUF-2 applications.** In order to ensure compliance throughout the application review process, applicants must indicate during the Access Request and full application submission that the User Agreement has been read, understood, and the terms and conditions are accepted. Further, submission of an Access Request and a full application indicates the applicant will comply 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.

PROGRAM SUPPORTING: NUCLEAR ENERGY

NUCLEAR ENERGY-CYBERSECURITY RESEARCH TOPICS AND METRICS ANALYSES (NE-1)
(FEDERAL POC: TREVOR COOK & TECHNICAL POC: STEVEN HARTENSTEIN)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Cost-effectively preventing, detecting, and mitigating cyber threats to nuclear energy systems is the subject of this research. Understanding the risks associated with each design decision is fundamental to cyber protection. With the increasing application of digital instrumentation, control, and communication systems and the constant evolution of cyber security threats and technologies, there is a need for comprehensive analytical capability to model and simulate control systems and their vulnerabilities.

Proposals are sought for modeling, and simulation capabilities that can inform researchers, designers and operators when assessing cyber security risks. Research of most interest will addresses characteristics and behaviors of components within embedded instrumentation and control (I&C) systems that are used within the nuclear enterprise. Models shall capture the behavior of an I&C system, to 1) simulate characteristics of an I&C system under cyber-attack; 2) study the cyber risk impacts of upgrades and maintenance on such systems; 3) enable future nuclear energy cyber security research, and 4) facilitate nuclear facility operation education and training.

HYBRID ENERGY SYSTEMS DESIGN AND MODELING (NE-2)
(FEDERAL POC – CARL SINK & TECHNICAL POC – SHANNON BRAGG-SITTON)
(ELIGIBLE TO LEAD: UNIVERSITIES ONLY)
(UP TO 3 YEARS AND $800,000)

Advanced nuclear-renewable hybrid energy systems (NHES) composed of nuclear and renewable energy sources, industrial energy users, and energy storage systems are being evaluated for their economic benefit. Proposals are sought to support development of modeling and simulation tools to analyze NHES. Tools must be able to link with Modelica component models and RAVEN optimization tools under development by the DOE national laboratory team. Proposals are requested in the following areas:

- Development of detailed component models to support integrated system concept evaluation within the HES modeling and simulation framework and within specific regions (with consideration to regional energy markets, policies, siting, etc.), beyond the current set of component models developed by the national laboratory team. Component models might include energy storage systems, industrial processes, etc., translating mathematical models into compatible Modelica models.
- Evaluation of the economic potential and advantage of new process designs with heat storage over baseload electricity production.
- Characterization of dynamic energy system behavior to determine impact of thermal cycling of components and subsystems on component and system robustness, resiliency, response rates, etc.

Low TRL system components and/or subsystems that can be demonstrated at reduced scale to show technical feasibility, economic potential of integration, etc. are also of interest. Proposals are requested in the following areas:

- Scaled studies of energy storage concepts, e.g. a scaled down demonstration of thermal energy storage concepts that could later be integrated in the INL Dynamic Energy Transport And Integration Laboratory (DETAIL) for integrated systems testing.
- Efficient temperature amplification technologies, such as chemical heat pumps, that can allow conventional LWRs and near term SMRs to support a wider range of industrial applications. Options could include upgrading of "waste heat" or primary heat from the systems. Concepts should give consideration to operational, regulatory, and safety constraints associated with an operating nuclear plant.

MISSION SUPPORTING: NUCLEAR ENERGY

INTEGRAL BENCHMARK EVALUATIONS (MS-NE-1)
(FEDERAL POC: DAN FUNK & TECHNICAL POC: JOHN BESS)
(UP TO 3 YEARS AND $400,000)

The International Reactor Physics Experiment Evaluation Project (IRPhEP) and International Criticality Safety Benchmark Evaluation Project (ICSBEP) are recognized world-class programs that have provided quality-assured (peer-reviewed) integral benchmark specifications for thousands of experiments. The Project produces two annually updated Organization for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) Handbooks that are among the most frequently quoted references in the nuclear industry. Applications are sought, within the scope of these two projects, to provide complete benchmark evaluations of existing experimental data that would be included in IRPhEP and ICSBEP handbooks, and would support current and future R&D activities.

The IRPhEP and ICSBEP Handbooks are the collaborative efforts of nearly 500 scientists from 24 countries to compile new and legacy experimental data generated worldwide. Without careful data evaluation, peer review, and formal documentation, legacy data are in jeopardy of being lost and reproducing those experiments would incur an enormous and unnecessary cost. The handbooks are used worldwide by specialists in reactor safety and design, criticality safety, nuclear data, and analytical methods development to perform necessary validations of computational models. Proposed benchmark evaluations should be of existing experimental data. Measurements of interest include critical, subcritical, buckling, spectral characteristics, reactivity effects, reactivity coefficients, kinetics, reaction-rate and power distributions, and other miscellaneous types of neutron and gamma transport measurements. A growing area of interest includes evaluation of transient benchmark experiment data for light water reactor systems, such as PWRs and BWRs.

All evaluations must be completed according to the requirements, including peer review, in the IRPhEP and the ICSBEP. DOE currently invests tens of millions of dollars each year to develop the next generation of nuclear engineering modeling & simulation tools. These tools need ad-hoc evaluated and quality-assured experimental data for validation purposes and, consequently, benchmark evaluations in support of DOE programs such as, but not limited to, TREAT, LWRS, FCT, ART, and NE's Advanced Modeling and Simulation Program (which combines application of computational capabilities from the NEAMS ToolKit and the VERA suite developed by the Energy Innovation Hub for Reactor M&S) are of particular interest to this call. To avoid duplication, please take into account ongoing work in these recent projects:

- An Integrated Research Project awarded under IRP-NE-1 in FY15 to prepare one or more TREAT transient testing benchmarks;
- Integral Benchmark Evaluation Projects awarded under MS-NE-1 in FY16 for a Molten Salt Reactor Experiment Benchmark Evaluation; and,
- In FY17 for Reactor Physics Benchmark Evaluations for Power Burst Facility Experiments.

NUCLEAR DATA NEEDS FOR NUCLEAR ENERGY APPLICATIONS (MS-NE-2)
(FEDERAL POC: DAN FUNK & TECHNICAL POC: BRAD REARDEN)
(UP TO 3 YEARS AND $400,000)

The Evaluated Nuclear Data File (ENDF) maintained by the National Nuclear Data Program (NNDC) at Brookhaven National Laboratory (BNL) provides the most reliable and commonly used nuclear data for nuclear energy applications. However, a close and critical examination of the existing nuclear data often finds that it is inadequate for current and emerging applications.

Proposals are sought that address nuclear data needs in NE mission areas, provided that these needs are clearly demonstrated to be a limiting factor in nuclear fuel and reactor design, analysis, safety, and licensing calculations. Use of sensitivity and uncertainty analysis methods in proposed efforts is encouraged to demonstrate these needs.

Many nuclear data needs for NE may be found in the NEA Nuclear Data High Priority Request List (HPRL) (https://www.oecd-nea.org/dbdata/hprl/, which includes a broad spectrum of needs encompassing light water reactors (LWRs) as well as sodium fast reactors. Other emerging needs not yet listed on the HPRL include continued investigations of thermal scattering data in high-temperature graphite, thermal scattering data for fluorine-based molten salt reactors, and chlorine reactions for fast spectrum molten salt reactors. Additional nuclear data needs that meet documented needs for industry and DOE-NE missions are also encouraged especially as aligned with the Gateway for Accelerated Innovation in Nuclear (GAIN), Nuclear Energy Advanced Modeling and Simulation (NEAMS), Consortium for Advanced Simulation of LWRs (CASL), Advanced Reactor Technologies (ART), Fuel Cycle Research and Development (FCR&D), Transient Test Reactor (TREAT), Light Water Reactor Sustainability (LWRS) and others.

Proposals are sought that provide relevant improvements in nuclear data that address one or more stated needs by developing and demonstrating the enhancements through the entire nuclear data pipeline, from 1) new nuclear data measurements; 2) evaluation in the appropriate format (e.g. ENDF); 3) inclusion of nuclear data covariances; 4) processing into usable forms for application codes; 5) confirmation of improved predictions and uncertainties through application studies and validation; and 6) deployment through the National Nuclear Data Center at BNL for inclusion by external users in quality-assured design, analysis, safety, and licensing calculations. Partnerships with national laboratories and especially industry to clearly articulate the need for the data and to demonstrate the use of improved data in production applications are strongly encouraged.

Appendix B: Workscopes for U.S. University-, National Laboratory-, or Industry-led* Program Supporting R&D Projects

*Industry may only lead in NSUF workscopes

PROGRAM SUPPORTING: NUCLEAR ENERGY ENABLING TECHNOLOGIES (NEET)

ADVANCED METHODS FOR MANUFACTURING (NEET-1)
(FEDERAL POC – ALISON HAHN & TECHNICAL POC – BRUCE LANDREY)
(ELIGIBLE TO LEAD: UNIVERSITY OR NATIONAL LABORATORY)
(UP TO 3 YEARS AND $1,000,000)

The Advanced Methods for Manufacturing program seeks proposals for research and technology development to improve the methods by which nuclear equipment, components, and plants are manufactured, fabricated, and assembled. Most importantly, reducing the cost and time of manufacturing here in the U.S. for advanced reactors, including SMRs, is an important goal for any proposed research. Specific goals include:

- Manufacturing innovations that accelerate deployment schedules by at least 6 months compared to current new plant construction estimates;
- Reduce component fabrication costs by 20% or more;
- Increase installation of key subsystems without cost increase or schedule delay.

The program seeks to develop manufacturing innovation that supports the "factory fabrication" and expeditious deployment of reactor technologies. Potential areas for exploration include:

- Factory and field fabrication techniques that include improvements in manufacturing technologies such as advanced (high speed, high quality) welding technologies; practical (shop floor) applications of electron beam welding for fabricating heavy sections; surface modification, metal spraying, and advanced cladding techniques that reduce erosion, corrosion and wear on component surfaces.
- Additive manufacturing techniques that build upon previous program success including advanced materials and multi-material components.
- Advances in manufacturing processes for reactor plant components, reactor internals, fuel cladding and fuel support assemblies. Research could include advanced manufacturing methods for individual components or fabrication of assemblies.
- Advances in non-destructive examination (NDE) methods for components manufactured using additive manufacturing techniques.
- Development of in-situ quality control techniques to ensure quality high speed manufacturing.

Details of several areas for innovation can be found in the NEET 2010 Workshop report (http://www.ne.doe.gov/pdfFiles/Neet_Workshop_07292010.pdf).

The most up-to-date information on active AMM projects can be found in the 2017 NEET Advanced Methods for Manufacturing Awards Summaries (https://energy.gov/ne/downloads/2017-neet-advanced-methods-manufacturing-award-summaries).

Through innovation in manufacturing, significant advancements in nuclear technology quality, performance and economic improvements will be achieved. One of the key success criteria for the program is the development of manufacturing methods that will gain acceptance by the appropriate regulatory or standard-setting bodies and licensing for commercial nuclear plant deployment.

PROGRAM SUPPORTING: NUCLEAR ENERGY ENABLING TECHNOLOGIES (NEET)

ADVANCED DIGITAL MONITORING AND CONTROL TECHNOLOGY (NEET-2)
(FEDERAL POC – SUIBEL SCHUPPNER & TECHNICAL POC – BRUCE HALLBERT)
(ELIGIBLE TO LEAD: UNIVERSITY OR NATIONAL LABORATORY)
(UP TO 3 YEARS AND $1,000,000)

The Advanced Sensors and Instrumentation program seeks applications for innovative digital technology for use in improving monitoring and control of nuclear energy systems. Technology should demonstrate greater accuracy, reliability, resilience, higher resolution, and ease of replacement/upgrade capability for applications in the nuclear environment and also reduce operations and maintenance costs and address regulatory concerns.

The proposal should indicate whether and how the proposed technology is or may be applicable to multiple reactors or fuel cycle applications, i.e. crosscutting.

Research topics:

1. State of the art control rooms, control systems, and plant control technologies, including automated work management systems.

2. Big data analytics and applications to improve plant operation and control.

3. Sensors and instrumentation to generate data needed to support improved plant control and data analytics applications for improved plant operations.

PROGRAM SUPPORTING: NUCLEAR SCIENCE USER FACILITIES (NSUF)

NUCLEAR ENERGY-RELATED R&D SUPPORTED BY NUCLEAR SCIENCE USER FACILITIES CAPABILITIES (NSUF-1)
(ELIGIBLE TO LEAD: UNIVERSITY, NATIONAL LABORATORY, OR INDUSTRY)
(UP TO 3 YEARS AND $500,000)

NOTE: NEAMS-2: Separate Effects Irradiation Testing For Validation of Microstructural Models in Marmot requires NSUF access but can only be led by universities. That workscope can be found on page 75.

This workscope solicits applications for nuclear energy-related research projects focused on the topical areas described below. It is intended that these focused topical areas will change with each future CINR FOA. The focused topical areas are selected by NE's R&D programs (e.g. Nuclear Reactor Technologies, Fuel Cycle Technologies, and Nuclear Energy Enabling Technologies) with the explicit purpose to leverage the limited R&D funding available with access to NSUF capabilities. All applications submitted under this workscope will be projects coupling R&D funding with NSUF access. Projects requiring "NSUF access only" (see NSUF-2 below) or "R&D funding only" must be submitted under other appropriate workscopes. Applications submitted under this workscope must support the Department of Energy Office of Nuclear Energy mission. Information regarding the current Nuclear Energy R&D Roadmap as well as specific research areas can be found at http://energy.gov/ne/mission. Capabilities available through the NSUF can be found on the website at nsuf.inl.gov.

The Office of Nuclear Energy (NE) supports the Department of Energy's HPC4 Materials (High Performance Computing for Materials) initiative to accelerate "industry discovery, design, and development of materials for severe environments by enabling access to computational capabilities and expertise in the DOE laboratories". NE's high-performance computing capabilities include Falcon at the Idaho National Laboratory. More information on computational resources can be found at NSUF.inl.gov. NE is seeking proposals for the development of innovative materials or material concepts for the extreme operating and accident environments expected in advanced reactor and fuel cycle technologies using the high-performance computing capabilities at the INL.

NSUF 1.1: TESTING OF ADVANCED MATERIALS OR ADVANCED SENSORS FOR NUCLEAR APPLICATIONS
(FEDERAL POC: SUIBEL SCHUPPNER & TECHNICAL POC: BRUCE HALLBERT)
(ELIGIBLE TO LEAD: UNIVERSITY, NATIONAL LABORATORY, OR INDUSTRY)
(UP TO 3 YEARS AND $500,000)

Proposals are sought for irradiation testing and post-irradiation examinations that support the development of advanced materials for sensors, and development of advanced sensors themselves. This funding does not support research and development activities to develop materials or sensors, but rather the irradiation of sensors and materials as described below.

1) Advanced Materials for Sensors: Successful irradiation testing and post irradiation examination of candidate materials proposed for advanced sensors applications will include: a description of the materials; irradiation and post irradiation examination needs; the role of the materials in new sensors, controls, communications or associated applications.

2) Advanced Sensors: Successful irradiation and post irradiation examination of sensors and associated instrumentation will include: a description of the sensor and associated instrumentation and materials requiring irradiation and post irradiation examination; irradiation and post irradiation examination needs; and the purpose and application of the developed sensor in nuclear energy systems.

PROGRAM SUPPORTING: NUCLEAR SCIENCE USER FACILITIES (NSUF)

NSUF 1.2: IRRADIATION TESTING OF MATERIALS PRODUCED BY INNOVATIVE MANUFACTURING TECHNIQUES
(FEDERAL POC: ALISON HAHN & TECHNICAL POC: BRUCE LANDREY)
(ELIGIBLE TO LEAD: UNIVERSITY, NATIONAL LABORATORY, OR INDUSTRY)
(UP TO 3 YEARS AND $500,000)

Products from advanced and innovative manufacturing techniques that offer lower cost and higher performance can be proposed for irradiation testing to demonstrate performance. Coupling to modeling mechanisms predicting performance enhancements is encouraged.

NUCLEAR SCIENCE USER FACILITIES ACCESS ONLY (NSUF-2)
(FEDERAL POC: ALISON HAHN & TECHNICAL POC: RORY KENNEDY)
(ELIGIBLE TO LEAD: UNIVERSITY, NATIONAL LABORATORY, OR INDUSTRY)

Applicants interested in utilizing Nuclear Science User Facilities (NSUF) capabilities only should submit "access only" applications under this workscope. Applications must support the Department of Energy Office of Nuclear Energy's mission. Information regarding the current Nuclear Energy Research and Development Roadmap as well as specific research areas can be found at http://energy.gov/ne/mission. Capabilities available through the NSUF can be found on the website at nsuf.inl.gov.

The Office of Nuclear Energy (NE) supports the Department of Energy's HPC4 Materials (High Performance Computing for Materials) initiative to accelerate "industry discovery, design, and development of materials for severe environments by enabling access to computational capabilities and expertise in the DOE laboratories". NE's high-performance computing capabilities include Falcon at the Idaho National Laboratory. More information on computational resources can be found at NSUF.inl.gov. NE is seeking proposals for the development of innovative materials or material concepts for the extreme operating and accident environments expected in advanced reactor and fuel cycle technologies using the high-performance computing capabilities at the INL.

NSUF-2.1: CORE AND STRUCTURAL MATERIALS

This element is primarily focused on understanding material aging and degradation mechanisms (e.g. fatigue, embrittlement, void swelling, fracture toughness, IASCC processes and mitigation), developing alternate and/or radiation resistant materials for application in current and future fission reactors, and materials from alternate or advanced manufacturing techniques. Proposed projects may involve R&D in the areas of material irradiation performance and combined effects of irradiation and environment on materials. Projects whose relevancy is based solely or primarily on fusion energy needs will not be considered.

NSUF-2.2: NUCLEAR FUEL BEHAVIOR AND ADVANCED NUCLEAR FUEL DEVELOPMENT

This program element is primarily focused on increasing our fundamental understanding of the behavior of nuclear fuels (including cladding) in reactor and research and development activities for advanced nuclear fuels and improving the performance of current fuels. Areas of interest include irradiation and thermal effects on microstructure development and the effects on, for example, thermophysical and thermomechanical properties as well as chemical interactions. Advanced fuels applicability extends to fast spectrum transmutation systems, coated particle fuels for high-temperature reactor systems, and robust fuels for light water reactors including accident tolerant fuels. Activities should be aimed at irradiation experiments and post irradiation examination that investigate 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 specific V&V issues are encouraged.

PROGRAM SUPPORTING: NUCLEAR SCIENCE USER FACILITIES (NSUF)

NSUF-2.3: ADVANCED IN-REACTOR INSTRUMENTATION

This program element includes development of advanced in-reactor instrumentation for characterization of materials under irradiation in test reactors and for on-line condition monitoring in power reactors. Applications should address the development of radiation resistant sensors for measurement of thermal conductivity, dimensional changes (specifically diameter and volume), crack propagation in materials, and internal fission gas release, composition, and pressure. Development of practical techniques that are non-intrusive with respect to irradiation specimens is encouraged, as are concepts that examine the feasibility and practical use of nontraditional methods such as optical fibers and ultrasonic techniques as well as other incorporated wireless transmission techniques. Proposals that also support the GAIN initiative, such as those involving development of advanced instrumentation, sensors, and measurement techniques for use in advanced reactors including molten salt reactors, sodium cooled fast reactors, lead cooled fast reactors, or high temperature gas reactors are encouraged. For MSR with dissolved fuel, an important and challenging problem is the ability to measure local chemical composition in real time at critical locations.

NSUF-2.4: EXPERIMENTS WITH SYNCHROTRON RADIATION

Proposed research includes the use of facilities at the Materials Research Collaborative Access Team (MRCAT) beamline located in the Advanced Photon Source Facility at Argonne National Laboratory (ANL) and, new to this year's FOA, the X-ray Powder Diffraction (XPD) beamline at the National Synchrotron Light Source – II (NSLS-II) facility at Brookhaven National Laboratory (BNL). Proposals requesting the use of these facilities should focus on post-irradiation examination or concurrent use with ongoing irradiations by NSUF. Experiments conducted at MRCAT will be facilitated by the Illinois Institute of Technology that can include x-ray diffraction (XRD), x-ray absorption (XAS), x-ray fluorescence (XRF), and 5 µm spot size fluorescence microscopy. Experiments conducted at the NSLS-II XPD will be facilitated by the Nuclear Science and Technology Department at BNL.

Research Areas for Experiments with Synchrotron Radiation - The research areas listed here represent promising applications of synchrotron x-ray techniques in characterizing microstructural evolution and associated physical and mechanical properties of materials under irradiation.

- Fundamental Aspects of Radiation Damage
- Phase Stability and Phase Transformation under Irradiation
- Surfaces and Grain Boundaries in Irradiated Materials
- Deformation and Fracture of Irradiated Materials
- Physics and Chemistry of Nuclear Fuels

NOTE: Access to NSUF capabilities will require agreement and final signature to the User Agreement (copy provided in Appendix D. 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 NEAMS-2, NSUF-1, or NSUF-2 applications. In order to ensure compliance throughout the application review process, applicants must indicate during the Access Request and full application submission that the User Agreement has been read, understood, and the terms and conditions are accepted. Further, submission of an Access Request and a full application indicates the applicant will comply 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.

Appendix C: Accessing Nuclear Science User Facilities

As previously described in this document, the NSUF provides access, at no cost to the user, to DOE, University, and Industry facilities. The access to these facilities also includes the support of the technical staff at each facility to ensure that the applicant is able to successfully complete their research. Requesting NSUF is more complex than requesting R&D funding through this FOA. Figure C-1 depicts the process for requesting NSUF access. Note that NSUF rapid turn-around experiments are not part of this FOA.

Unlike the other workscopes in this FOA, the applicant will not be able to provide cost information without the involvement of the NSUF facilities and staff. The effort to develop a firm cost estimate requires effort on the applicant's part as well as the NSUF facilities and staff and must be started at the earliest possible date in order to have the information available for inclusion in the full application. In order to get this process started, the applicant may need to contact the NSUF Program Office to identify a NSUF technical lead(s) and is required to submit a NSUF Access Request to apply for the FOA. The applicant will work with the NSUF Technical Lead(s) to prepare the Access Request. If invited to submit a full application, the applicant and NSUF Technical Lead(s) will work together to develop the application and define the scope of the application and estimate the cost.

For all full applications, the NSUF Technical Lead(s) will work with the applicant to define the scope in the form of a Statement of Work (SOW). The SOW will be submitted after the Access Request. As a minimum, the SOW will include the following (as applicable):

- Facilities and equipment required to conduct the experiment
- Specific requirements for specimen acquisition (e.g., material location, material condition, and fabrication or preparation requirements)
- Specific requirements for irradiation or beam-time (e.g., neutron or beam energy spectrum, target temperature, flux and fluence [or burn-up/dpa] for each specimen, in-pile instrumentation, etc.) including a detailed test matrix
- Specific requirements for post-irradiation examination (PIE) of each specimen (e.g., visual examination, dimensional examinations, tensile testing, radiography, microscopy, etc.) including a detailed test matrix

The approved SOW will be utilized by the NSUF facility technical staff to develop an execution plan and cost estimate for the SOW (Statement of Work Template). The execution plan will typically address the following elements (as applicable):

- Concept for the irradiation device including fabrication and assembly plans
- Irradiation position and duration
- Experiment shipping
- Disassembling and cataloging the experiment
- Specimen preparation and shipping
- Specimen examination details

- Waste disposal
- Resource loaded schedule.

The information in the SOW and execution plan will then be used by the NSUF facility to develop a cost estimate for the proposed scope of work.

After award announcement, several steps will be required prior to initiation of work. The successful applicant's institution will be required to sign a Non-Proprietary User Agreement with Battelle Energy Alliance. Appendix D contains the standard User Agreement. The User Agreement is not negotiable. The SOW will be an appendix in the User Agreement in order to bind the PI to the SOW and to define the NSUF policies applicable to the scope of work. A subcontract(s) or work authorization(s), with a total value equal to the previously developed cost estimate, will be placed with NSUF facilities performing the work defined the in SOW and experiment execution plan.

NSUF Quality Assurance Requirements

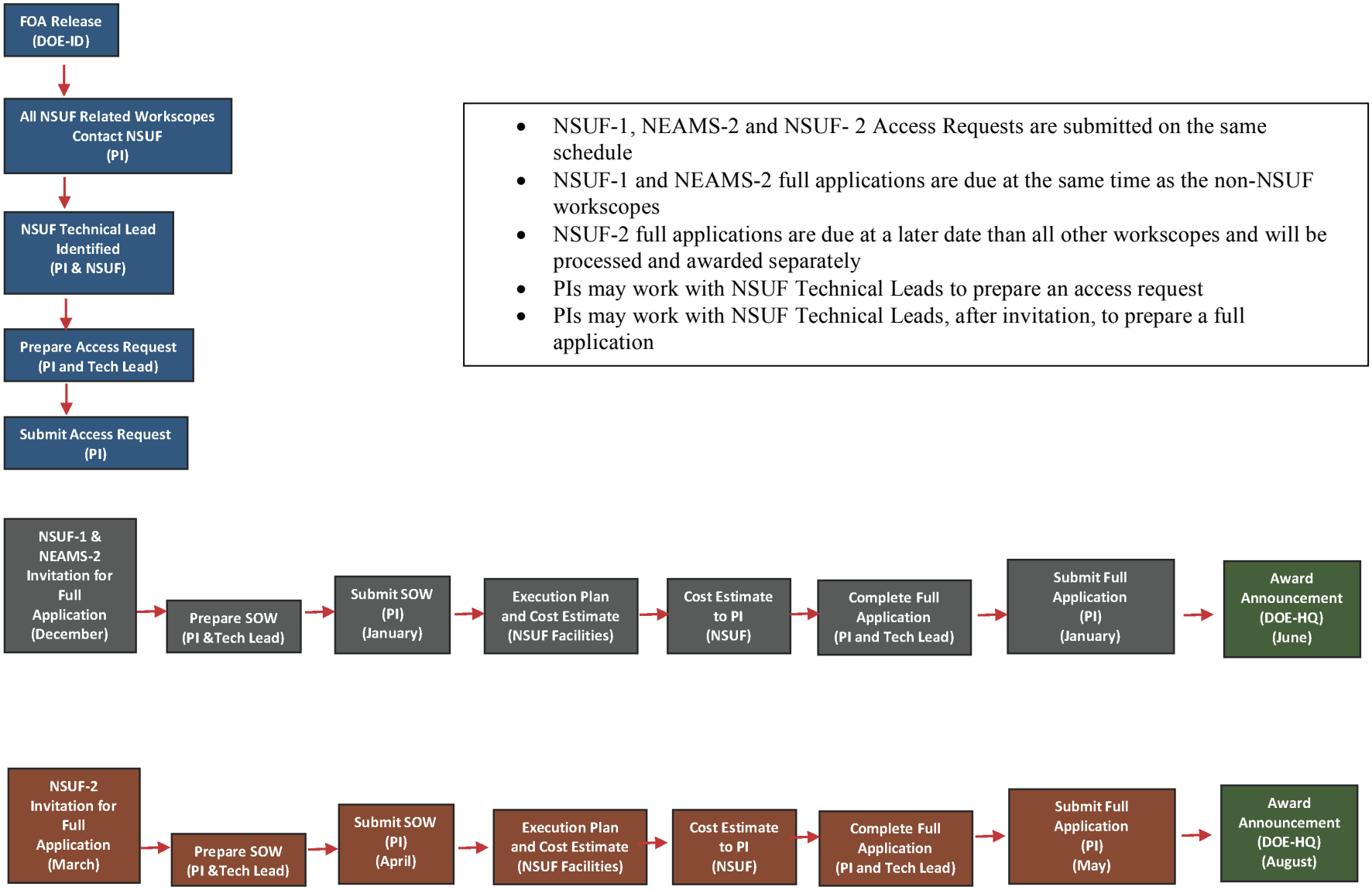
Irradiation of materials in test reactors requires additional rigor and quality assurance requirements beyond those described in other sections of this FOA. Specific requirements will depend on the reactor license, the irradiation vehicle design and specimen constituents. NSUF Technical leads will assist the PI in understanding the specific requirements early in the process.

Budget Development for NSUF Applications

As previously described, applicants may apply for NSUF access with or without R&D support from other works scopes in this FOA. Applicants need to ensure that the following cost elements are covered within the R&D budget for NSUF-1 in this FOA or via another fund source for NSUF-2:

- Travel costs to NSUF facilities for facility access training, technical meetings, examinations, experiment loading, etc.
- Applicant salary support
- Graduate student support
- Post-doctoral or other researcher support
- Materials and supplies support at the PI's work location

Figure C-1. NSUF Access Process



Appendix D: Draft Nuclear Science User Facilities User Agreement

NOTE: For Public Institutions residing in the State of Colorado, a version of the User Agreement, compliant with Colorado statute, is available. Contact the NSUF program office for more information.

Non-Proprietary User Agreement

User Facility Agreement No. xxxxx BETWEEN

BATTELLE ENERGY ALLIANCE, LLC

(" CONTRACTOR")
Operator of The Idaho National Laboratory (hereinafter "Laboratory") under U.S. Department of Energy (DOE) Contract No. DE-AC07-05ID14517

AND

XXXXXXXXXXXXXXXXXX

("USER")

(Collectively, "the Parties")

The obligations of the above-identified DOE Contractor may be transferred to and shall apply to any successor in interest to said Contractor continuing the operation of the DOE Non-Proprietary User Facility involved in this User Agreement.

ARTICLE I. FACILITIES AND SCOPE OF WORK

Subject to the terms and conditions of this Agreement, CONTRACTOR will make available to employees, consultants and representatives of USER (hereinafter called "Participants") certain Laboratory Non-Proprietary User facilities, which may include equipment, services, information and other material, with or without Laboratory scientist collaboration, for purposes as described in the attached Scope of Work and in accordance with the attached Funding Statement, both of which are incorporated by this reference and are made a part of this Agreement. Amendments to the attached Scope of Work and Funding Statement may be submitted by USER for identifying facilities and purposes during the term of this Agreement (see Article II). Such amendments will be considered to be part of this Agreement upon written acceptance by CONTRACTOR. The attached Scope of Work sets forth a specific project, including deliverables, to be performed pursuant to this Agreement. The Scope of Work and abstracts thereof, shall not be

considered proprietary information and shall be publicly releasable. The Parties agree that an initial abstract of the work to be performed shall be deliverable under this Agreement.

ARTICLE II. TERM OF THE AGREEMENT

This Agreement shall have a term of X years from the effective date. The term of this Agreement shall be effective as of the date on which it is signed by the last of the Parties.

ARTICLE III: COST

Each Party will bear its own costs and expenses associated with this Agreement unless otherwise agreed to by the Parties or as may otherwise be agreed to by the User and DOE.

ARTICLE IV: ADMISSION REQUIREMENTS

USERs and Participants are subject to the administrative and technical supervision and control of CONTRACTOR; and will comply with all applicable rules of CONTRACTOR and DOE with regard to admission to and use of the User facility, including safety, operating and health-physics procedures, environment protection, access to information, hours of work, and conduct. Participants shall execute any and all documents required by CONTRACTOR acknowledging and agreeing to comply with such applicable rules of CONTRACTOR. Participants will not be considered employees of CONTRACTOR for any purpose.

ARTICLE V: PROPERTY AND MATERIALS***

USER may be permitted by Contractor to furnish equipment, tooling, test apparatus, or materials necessary to assist in the performance of its experiment(s) at the USER facility. Such items shall remain the property of USER, except as otherwise provided in this Article. Unless the Parties otherwise agree, all such property furnished by USER or equipment and test apparatus provided by USER will be removed by USER within sixty (60) days of termination or expiration of this Agreement or will be disposed of as directed by USER at User's expense. Any equipment that becomes integrated into the facility shall be the property of the Government. USER acknowledges that any material supplied by USER may be damaged, consumed or lost. USER will return facilities and equipment utilized in their original condition except for normal wear and tear.

CONTRACTOR shall have no responsibility for USER's property in CONTRACTOR's possession other than loss or damage caused by willful misconduct or gross negligence of CONTRACTOR or its employees.

Personal property produced or acquired during the course of this Agreement shall be disposed of as directed by the owner at the owner's expense.

USER represents that it owns and has full authority to transfer ownership and title to any materials

it supplies for the purpose of irradiation under this Agreement and that said materials are free of any liens, claims of ownership, or other liabilities. Transfer of materials for irradiation and/or examination under this Agreement, shall constitute a transfer of title of said materials from User to DOE upon delivery of the materials at the Nuclear Science User Facility (NSUF) unless otherwise specified.

After the material has been irradiated, transferred to an examination facility and extracted from the encapsulation and/or holders, the USER will be notified by the CONTRACTOR that the irradiated material is available for examination. The USER will have exclusive research rights to the irradiated material for a period of three (3) years from the date of notification. After the three (3) years, DOE and CONTRACTOR have full discretion to make the irradiated material available to the general research community, maintain possession, transfer possession, or dispose of the irradiated material. DOE may transfer title to the material at its discretion.

ARTICLE VI: SCHEDULING***

USER understands that CONTRACTOR will have sole responsibility and discretion for allocating and scheduling usage of the User Facilities and equipment needed for or involved under this Agreement.

ARTICLE VII: INDEMNITY AND LIABILITY***

A. **Personnel Relationships -** USER shall be responsible for the acts or omissions of Participants.

B. **Product Liability** - To the extent permitted by US and US State law, if USER utilizes the work derived from this Agreement in the making, using, or selling of a product, process or service, then USER hereby agrees to hold harmless and indemnify CONTRACTOR and the United States Government, their officers, agents and employees from any and all liability, claims, damages, costs and expenses, including attorney fees, for injury to or death of persons, or damage to or destruction of property, as a result of or arising out of such utilization of the work by or on behalf of USER, its assignees or licensees.

C. **General Indemnity** - To the extent permitted by US and US State law, USER hereby agrees to indemnify and hold harmless CONTRACTOR and the United States Government, their officers, agents and employees from any and all liability, claims, damages, costs and expenses, including attorney fees, for injury to or death of persons, or damage to or destruction of property, to the extent such liability, claims, or damages is caused by or contributed to the negligence or intentional misconduct of USER or its employees or representatives during the performance of the work under this Agreement.

D. ***Patent and Copyright Indemnity—Limited -*** *To the extent permitted by US and US State law, USER shall fully indemnify the Government and CONTRACTOR and their officers, agents, and employees for infringement of any United States patent or copyright arising out of any acts required or directed or performed by USER under the Agreement to the extent such acts are not normally performed at the facility.*

E. The liability and indemnity provisions in paragraphs B, C and D above shall not apply unless USER shall have been informed as soon as practicable by CONTRACTOR or the Government of the suit or action alleging such infringement, and such indemnity shall not apply to a claimed infringement that is settled without the consent of USER unless required by a court of competent jurisdiction.

F. General Disclaimer -
THE GOVERNMENT AND CONTRACTOR MAKE NO EXPRESS OR IMPLIED WARRANTY AS TO THE CONDITIONS OF THE USER FACILITY FURNISHED HEREUNDER. IN ADDITION, THE GOVERNMENT, CONTRACTOR AND USER MAKE NO EXPRESS OR IMPLIED WARRANTY AS TO THE RESEARCH OR ANY INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE OR DEVELOPED UNDER THIS AGREEMENT, OR THE OWNERSHIP, MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE OF THE RESEARCH OR RESULTING PRODUCT; THAT THE GOODS, SERVICES, MATERIALS, PRODUCTS, PROCESSES, INFORMATION, OR DATA TO BE FURNISHED HEREUNDER WILL ACCOMPLISH INTENDED RESULTS OR ARE SAFE FOR ANY PURPOSE INCLUDING THE INTENDED PURPOSE; OR THAT ANY OF THE ABOVE WILL NOT INTERFERE WITH PRIVATELY OWNED

RIGHTS OF OTHERS. THE GOVERNMENT, CONTRACTOR AND/OR USER SHALL NOT BE LIABLE FOR SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES ATTRIBUTED TO USE OF SUCH FACILITIES, RESEARCH OR RESULTING PRODUCT, INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE OR DELIVERED UNDER THIS AGREEMENT.

ARTICLE VIII: PATENT RIGHTS***

A. Definitions

1. "Subject Invention" means any invention or discovery conceived or first actually reduced to practice in the course of or under this Agreement.
2. "USER Invention" means any Subject Invention of USER.
3. "CONTRACTOR Invention" means any Subject Invention of CONTRACTOR.
4. "Patent Counsel" means the DOE Counsel for Intellectual Property assisting the DOE Contracting activity.

B. Subject Inventions

CONTRACTOR and USER agree to disclose their Subject Inventions, which includes any inventions of their Participants, to each other, concurrent with reporting such Subject Inventions to DOE.

C. CONTRACTOR's Rights

Except as provided below in the case of joint inventions, CONTRACTOR Inventions will be governed by the provisions of CONTRACTOR'S Prime Contract for operation of the User facility.

D. USER's Rights

Subject to the provisions herein, USER may elect title to any USER Invention and in any resulting patent secured by USER within one year of reporting the subject invention to DOE. The USER shall file a US patent application within a reasonable period of time. Where appropriate, the filing of patent applications by USER is subject to DOE security regulations and requirements.

E. Joint Inventions

For Subject Inventions conceived or first actually reduced to practice under this Agreement that are joint Subject Inventions made by CONTRACTOR and USER, each Party shall have the option to elect and retain title to its undivided rights in such joint Subject Inventions.

F. Rights of Government

1. USER agrees to timely assign to the Government, if requested, the entire right, title, and interest in any country to each USER Invention where USER:

a. Does not elect to retain such rights; or

b. Fails to timely have a patent application filed in that country on the USER Invention or decides not to continue prosecution or not to pay the maintenance fees covering the Invention; or

c. At any time, no longer desires to retain title.

2. USER shall provide the Government a copy of any application filed by USER promptly after such application is filed, including its serial number and filing date.

3. USER hereby grants to the Government a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States the USER Invention made under said project throughout the world.

4. USER acknowledges that the DOE has certain March-in Rights to any USER Inventions elected by the USER in accordance with 48 C.F.R. 27.304-1(g) and that the USER is

subject to the requirements with respect to preference for U.S. industry pursuant to 35 U.S.C. § 204 to any USER Inventions elected by the USER.

5. The USER agrees to include, within the specification of any U.S. patent applications and any patent issuing thereon covering a USER Invention, the following statement: "The Government has rights in this invention pursuant to a USER Agreement (specify number) between (USER name) and (CONTRACTOR Name), which manages and operates (name of Laboratory) for the US Department of Energy."
6. USER agrees to submit on request periodic reports to DOE no more frequently than annually on the utilization of USER Inventions or on efforts to obtain such utilization that are being made by USER or its licensees or assignees.
7. Facilities License: USER agrees to and does hereby grant to the Government a nonexclusive, nontransferable, irrevocable, paid-up license in and to any inventions or discoveries, regardless of when conceived or actually reduced to practice or acquired by USER, which are incorporated in the User Facility as a result of this Agreement to such an extent that the facility is not restored to the condition existing prior to the Agreement (1) to practice or to have practiced by or for the Government at the facility, and (2) to transfer such licenses with the transfer of that facility. The acceptance or exercise by the Government of the aforesaid rights and license shall not prevent the Government at any time from contesting the enforceability, validity or scope of, or title to, any rights or patents herein licensed.

G. Invention Report and Election

USER shall furnish the Patent Counsel a written report concerning each USER Invention within six months after conception or first actual reduction to practice, whichever occurs first. If USER wishes to elect title to the Invention, a notice of election should be submitted with the report or within one year of such date of reporting.

ARTICLE IX: RIGHTS IN TECHNICAL DATA***

A. Definitions:

1. "Technical Data" means recorded information regardless of form or characteristic, of a scientific or technical nature. Technical Data as used herein does not include financial reports, costs analyses, and other information incidental to Agreement administration.
2. "Proprietary Data" means Technical Data which embody trade secrets developed at private expense, outside of this agreement, such as design procedures or techniques, chemical composition of materials, or manufacturing methods, processes, or treatments, including minor modifications thereof, provided that such data:
    - **a.** Are not generally known or available from other sources without obligation concerning their confidentiality.
    - **b.** Have not been made available by the owner to others without obligation concerning their confidentiality

c. Are not already available to the CONTRACTOR or the Government without obligation concerning their confidentiality.

d. Are marked as “Proprietary Data.”

3. "Unlimited Rights" means right to use, duplicate, or disclose Technical Data, in whole or in part, in any manner and for any purpose whatsoever, and to permit others to do so.

B. Allocation of Rights

1. The Government shall have Unlimited Rights in Technical Data first produced or specifically used in the performance of this Agreement except as otherwise provided in this Agreement.

2. USER shall have the right to use for its private purposes, subject to patent, security or other provisions of this Agreement, Technical Data it first produces in the performance of this Agreement provided the data delivery requirements of this Agreement have been met as of the date of the private use of such data; and Technical Data first produced by CONTRACTOR, if any, under this Agreement. USER agrees that to the extent it receives or is given access to Proprietary Data or other technical, business or financial data in the form of recorded information from DOE or a DOE contractor or subcontractor, USER shall treat such data in accordance with any restrictive legend contained thereon, unless use is specifically authorized by prior written approval of the Contracting Officer.

C. Deliverables

1. USER agrees to furnish to DOE or CONTRACTOR those data, if any, which are (a) specified to be delivered in Appendices, (b) essential to the performance of work by CONTRACTOR personnel or (c) necessary for the health and safety of such personnel in the performance of the work. Any data furnished to DOE or CONTRACTOR shall be deemed to have been delivered with unlimited rights unless marked as "Proprietary Data" of USER.

2. Upon completion or termination of the project, USER agrees to deliver to DOE and CONTRACTOR a nonproprietary report describing the work performed under this Agreement.

D. Legal Notice

The following legal notice shall be affixed to each report or publication resulting from this Agreement which may be distributed by USER:

DISCLAIMER NOTICE

This document was prepared by __ as a result of the use of facilities provided through the U.S. Department of Energy (DOE) Nuclear Science User Facilities program, which is managed by Battelle Energy Alliance, LLC, acting under Contract No.DE-AC-07-05ID14517. Neither Battelle Energy Alliance, LLC, DOE, the U.S. Government, nor any government contractors, nor other persons and facilities performing work under this Agreement or acting on behalf of any of the above: (a) make any warranty or representation, express or implied, with respect to the information contained in this document; or (b) assume any liabilities with respect to the use of, or damages resulting from the use of any information contained in the document.

E. Copyrighted Material

1. USER agrees to, and does hereby grant to the Government, and to its officers, agents, servants and employees acting within the scope of their duties:

a. A royalty-free, nonexclusive, irrevocable license to reproduce, translate, publish, use, and dispose of and to authorize others so to do, all copyrightable material first produced or composed in the performance of this Agreement by USER, its employees or any individual or concern specifically employed or assigned to originate and prepare such material; and

b. A license as aforesaid under any and all copyrighted or copyrightable works not first produced or composed by USER in the performance of this Agreement but which are incorporated in the material furnished or delivered under the Agreement, provided that such license shall be only to the extent USER now has, or prior to completion or final settlement of the Agreement may acquire, the right to grant such license without becoming liable to pay compensation to others solely because of such grant.

2. USER agrees that it will not knowingly include any copyrightable material furnished or delivered under this Agreement without a license as provided for in subparagraph 1(b) hereof, or without the consent of the copyright owner, unless it obtains specific written approval of the Contracting Officer for the inclusion of such copyrighted materials.

F. Disclosure of Proprietary Data

In the absence of a properly executed and effective non disclosure agreement between USER and CONTRACTOR, the USER shall not bring Proprietary Data into the USER facility except at USER's own risk and any such data, regardless how it is marked, shall be deemed Technical Data and shall be treated according to this article of this Agreement.

ARTICLE X: <u>LABORATORY SITE ACCESS, SAFETY AND HEALTH</u>***

As a precondition to using CONTRACTOR facilities, Participants must complete all CONTRACTOR Site Access documents and requirements. USER and participant shall take all reasonable precautions in activities carried out under this Agreement to protect the safety and

health of others and to protect the environment. Participants must comply with all applicable safety, health, access to information, security and environmental regulations and the requirements of the Department and CONTRACTOR, including the specific requirements of the User Facility covered by this Agreement. In the event that USER or Participant fails to comply with said regulations and requirements, CONTRACTOR may, without prejudice to any other legal or contractual rights, issue and order stopping all or any part of USER's activities at the User Facility.

ARTICLE XI: PERSONNEL RELATIONSHIPS***

Participants will remain employees or representatives of the USER at all times during their participation in the work under this Agreement, and shall not be considered employees of CONTRACTOR or DOE for any purpose. Participants shall be subject to the administrative and technical supervision and control of CONTRACTOR during and in connection with the Participant's activities under this Agreement.

ARTICLE XII: EXPORT CONTROLS***

USER acknowledges that the export of goods or Technical Data may require some form of export control license from the U.S. Government and that failure to obtain such export control license may result in criminal liability under the laws of the United States.

ARTICLE XIII: PUBLICATIONS***

- **A.** USER and CONTRACTOR will provide each other copies of articles of any publication of information generated pursuant to this Agreement for review and comment 14 days prior to publication.
- **B.** USER will not use the name of CONTRACTOR or the United States Government or their employees in any promotional activity, such as advertisements, with reference to any product or service resulting from this Agreement, without prior written approval of the Government and CONTRACTOR.

ARTICLE XIV: DISPUTES***

The parties will attempt to jointly resolve all disputes arising under this agreement. If the parties are unable to jointly resolve a dispute within a reasonable period of time, either party may contact the laboratory's Technology Transfer Ombudsman (TTO) to provide assistance. The TTO may work directly to resolve the dispute or, upon mutual agreement of the parties, contact a third party neutral mediator to assist the parties in coming to a resolution. The costs of the mediator's services will be shared equally by the parties. In the event that an agreement is not reached with the aid of the ombudsman or mediator, the parties may agree to have the dispute addressed by neutral evaluation. The decision rendered by the neutral evaluator shall be nonbinding on the parties, and any costs incurred there from shall be divided equally between the parties. Upon mutual agreement, the parties may request a final decision by the DOE Contracting Officer. Absent resolution, either party may seek relief in a court of competent jurisdiction.

ARTICLE XV: CONFLICT OF TERMS***

This Agreement constitutes the primary document which governs the work described in the attached Appendices. In the event of any conflict between the terms of this document and any other document issued by either Party, the terms of this document shall prevail.

ARTICLE XVI: TERMINATION***

Either Party may terminate this Agreement for any reason at any time by giving not less than thirty (30) days prior written notice to the other Party. Notice will be deemed made as of the day of receipt. The obligations of any clause of this Agreement, which by their nature extend beyond its termination, shall remain in full force and effect until fulfilled.

BATTELLE ENERGY ALLIANCE, LLC (CONTRACTOR):

BY: _____
Signature

NAME: _____
Printed

TITLE: Deputy Laboratory Director, Science & Technology

DATE: _____

User's Formal Name (USER):

BY: _____
Signature

NAME: _____
Printed

TITLE: _____

DATE: _____

ADDRESS: _____

TELEPHONE: _____

User Principal Investigator Acknowledgment

I, XXXXXXXX, have read and hereby acknowledge the above terms and conditions.

BY: _____
Signature

TITLE: _____

DATE: _____

ADDRESS: _____

TELEPHONE: _____

***** Any changes to the *** or substantive changes to the non *** provisions will require formal written approval by DOE.**