

DOE-ID NEPA CX DETERMINATION

Idaho National Laboratory

SECTION A. Project Title: FY-22 Annual Laboratory Directed Research and Development

SECTION B. Project Description and Purpose:

Idaho National Laboratory's (INL's) core mission is to discover, demonstrate, and secure innovative nuclear energy solutions, clean energy options, and critical infrastructure. The INL Laboratory Directed Research and Development (LDRD) program engages researchers, leadership, and infrastructure to convert scientific and engineering ideas into scientific discoveries, research capabilities, research and development (R&D) programs, and deployed technology solutions. INL uses the LDRD program to develop core capabilities and achieve strategic initiatives in science and technology (S&T).

For the Fiscal Year (FY)-22, INL's LDRD program focuses on the laboratory's five strategic initiatives and two emerging core capabilities as described below. Appendix A lists and describes individual FY-22 LDRD proposals for these initiatives.

Nuclear Reactor Sustainment and Expanded Deployment: FY-22 LDRD research for this strategic initiative focuses on the following two areas:

Simplified Nuclear Systems Technologies: These projects assess, analyze, and develop digital and automated technologies for next generation nuclear reactors, including fission batteries to address life-cycle costs of nuclear systems. These LDRD proposals integrate approaches that address costs and risk in the areas of standardization and manufacturing processes, transportation, onsite deployment, and automating operation. Research focuses on validation and demonstration of sensors for measuring reactor parameters for remote monitoring and reliable autonomous operation. This may include (1) R&D of miniature sensors that can survive harsh operating environment and (2) integrating machine learning (ML) and artificial intelligence (AI) with modeling and simulation (M&S) to enable virtual sensors. Other activities develop security technologies to enable transportation, unattended operation, and remote monitoring of reactors. This may include approaches that integrate safeguards-by-design and security-by-design to secure critical infrastructure.

Transformational Approaches to Accelerate Nuclear RD&D: This research focuses on reducing time and cost associated with developing, demonstrating and licensing new nuclear technologies and covers the following:

- This effort evaluates methodology linking INL fuel and materials development efforts to reactor designs and the commercial market and includes (1) test methodologies for understanding evolution in physical properties, (2) nuclear fuels and materials research demonstrating important reactor performance attributes by integrating next generation approaches to M&S, and (3) concepts for linking multi-physics modeling and experiments to enable sensor virtualization.
- This area enables the use of new materials and fuels and is concerned with the design and discovery of new materials. This research studies the relationships between the microstructure, properties, processing, and material performance for advanced reactor applications.
- This research integrates experiments and M&S to improve nuclear energy RD&D efficiency and outcomes, reduce nuclear energy RD&D timelines and costs, and establish new methods and algorithms for M&S capabilities. This research uses INL-developed M&S capabilities and high-performance computing resources and also uses facilities at the Materials and Fuels Complex (MFC) (e.g., Irradiated Materials Characterization Lab (IMCL) and Analytical Laboratory (AL)), INL irradiation capabilities (e.g., TREAT, the Advanced Test Reactor (ATR), and the Neutron Radiography reactor (NRAD)), and other unique facilities (e.g., the High Temperature Test Laboratory).

Integrated Fuel Cycle Solutions: Research in this area focuses on the following:

- The goal of this research is to simplify the fuel cycle and improve the economics of special nuclear material recovery. The research establishes competitive advantages for advanced and microreactor designs by enabling fuel take-back, demonstrating integrated approaches to safeguards and security, and promoting used fuel recycling. These LDRD projects include smaller scale proof-of-concept proposals that study critical process attributes and larger scale comprehensive treatment of the fuel cycle for possible advanced and microreactor fuel forms (e.g., tristructural isotropic [TRISO], metal, liquid, and oxide fuels).
- Chemical understanding of complex multi-component and multi-phase systems supports the development of innovative high-level liquid waste treatment processes, design of advanced liquid reactors, and special nuclear material recovery. These experimental and modelling projects increase the chemical knowledge and predict the behavior of complex systems in highly radioactive environments.
- Augmented data analytics for nonproliferation enables AI research. These projects use AI, ML, and deep learning (DL) to detect and characterize chemical process operations within the BEARTOOTH facility to develop and deploy monitoring sensors and to develop data supporting data intake, manipulation, and archiving. This research addresses challenges related to proliferation detection and tracking and accounting of special nuclear material.

Advanced Materials and Manufacturing for Extreme Environments: This research area develops advancements in control algorithms that integrate multi-physics model(s) with the Spark Plasma Sintering (SPS) control system to close the loop between the experimental system and multi-physics models.

The FY-22 LDRD proposals in this area are comprised of the following:

- Process informed design techniques applying AI and ML to the design of manufacturing materials
- Advanced control algorithms to integrate multi-physics to advanced manufacturing methods
- Comprehensive data analytics and computational techniques to predict material behaviors during manufacturing processes
- In-situ measurement techniques to verify and validate predictive manufacturing processes
- Verification and validation testing of advanced manufacturing products in harsh or extreme environment
- Efficient and sustainable manufacturing techniques to make materials used in harsh and extreme environments
- Chemical transformations in extreme environments.

Integrated Energy Systems: The FY-22 LDRD projects related to IES are described below:

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Integration of thermal energy storage (TES) with emerging microreactors: Future application of reactors may include microgrid applications. Technology options may include molten salts, sodium, and concrete that have low costs and high readiness levels. This research investigates fundamental TES design and efficient interface and coupling options. These projects leverage INL facilities such as the electrically heated Dynamic Energy Transport and Integration Laboratory (DETAIL) and, when available, microreactor capabilities.

Chemical energy carriers: This research focuses on new energy conversion systems and chemical kinetic mechanisms to produce energy carriers. Examples include (a) chemicals such as alcohols, organic or inorganic acids, and liquid hydrogen carriers, (b) products used as fuels, such as ammonia, dimethyl-ether, and dimethyl carbonate, and (c) molecules that use CO₂ as feedstock.

Heat augmentation approaches: Amplifying thermal energy from nuclear reactors allows for industrial uses of nuclear energy. One approach to heat augmentation uses chemical heat pumps based on looping reaction mechanisms. These LDRD efforts develop new reversible looping systems to upgrade nuclear-generated heat to replace energy-intensive processes with more energy-efficient solutions.

Systems integration crosscut: These LDRD proposals evaluate new uses and enhancements of INL's RAVEN, TEAL, HERON, and Hybrid simulation tools, as described below:

- Data and artificial intelligence. Novel algorithms for data acquisition, filtering, and data fusion for operational IES will be developed to perform active and continuous learning and model validation.
- Cybersecurity. This research develops digital twins for IES configurations to improve control system optimization while maintaining security. Digital twins for IES opens an opportunity to explore possible approaches for cyber security.
- Reliability and resilience. These LDRD proposals develop metrics and methodologies to assess the impact of IES on grid reliability and resilience.

This work uses integrated computational platforms and assets in the INL Energy Systems Laboratory (ESL).

Experimental demonstration: This research uses the Thermal Energy Distribution System (TEDS) within the DETAIL facility at ESL to demonstrate new and efficient designs for heat exchangers, components for chemical and industrial processes, and other applications within an IES configuration.

Secure and Resilient Cyber-Physical Systems: These FY-22 LDRD proposals focus on innovations leading to new national technical capabilities in the following areas:

Secure and Resilient Control Systems: Cybercore Integration produces science and engineering capabilities for proactive design, implementation, and operation of secure and resilient control systems. This research focuses on the following:

- Proactive Design and Validation Methods. The effort advances formal and AI methods that support the design and validation of new secure and resilient control systems, including architectures for real-time cyber-physical situational assessment and response.
- Reverse Engineering at Scale (RE@Scale): This work includes RE@Scale of software and hardware systems to discover and mitigate vulnerabilities and misconfigurations and performs automated malware analysis for reactive responses to threats.
- Polymorphic Deception: This research performs formal validation of dynamic deception mechanisms to prevent compromise and respond quickly to mitigate effects of compromise.
- Layered Detection & Response: This research develops advancements to complement polymorphic deception or for other advanced responses and cyber-physical sensing approaches to network intrusion or side channel indications of attacks for high confidence recognition and response.

These efforts use the capabilities of the Cybercore Integration Center, INL Resilience Optimization Center (IROC), Cyber Manufacturing Innovation Institute (CyManII), MAGNET, and IES test beds.

Trustworthy Machine Learning and Resilient Data Systems: This R&D is described below:

- Develop explainable AI that provides transparency and clarity into how the AI models make decisions so outputs can be validated and challenged
- Perform systematic red teaming of ML to understand vulnerabilities by exposing and exploiting problems in the algorithm implementations and their unique computational platforms
- Perform data resilience research into models and methods for determining the validity of data used to train the algorithms and approaches to minimizing impact of bad data on learning algorithms.

These proposals leverage cybersecurity experimental capabilities at the Cybercore Integration Center, IROC, and laboratories at university partners.

Secure 5G and Beyond Wireless Communications: These LDRD Proposals involve the following three areas:

- Advancements in secured shared spectrum communications within congested or "zero trust" environments, including the use of unlicensed spectrum
- Applications of AI or ML methodologies for improving and predicting 5G performance and security within a diverse and multi-platform Internet-of-Things environment
- Innovations in the resiliency and assurance of continuity of government command and control communications during disruptions such as loss in network synchronization, reduction in infrastructure availability, or targeted cyber-physical attack.

Resilient Critical Infrastructures: These FY-22 LDRD proposals develop innovative concepts to transform and enhance the resiliency of critical infrastructure in the following research areas:

- Demonstrate proof-of-principle and innovative approaches that utilize and integrate multiple scale resources (e.g., M&S, bench-scale, full-scale), to enhance the resilience and survivability of critical infrastructure systems. This includes innovative application to cyber defense operations and

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incident response, systems architecture risk evaluation and mitigation, and hands-on immersive ICS cybersecurity workforce development. Proof-of-concept studies include using emerging technologies such as digital twins, virtual reality, and other relevant solutions.

- Develop and validate science-based approaches to gain efficiencies in assessing risk and informing decisions associated with the resiliency of national critical infrastructure functions. This includes innovative application to broad scale risk analysis, quantification and mitigation, emergency or crisis response, advanced situational awareness, operational planning, and supply chain resiliency.

Chemical and Molecular Science (emerging core capability): These LDRD projects focus on fundamental chemical in the following areas:

Molecular Interactions at Material Interfaces: This research develops innovative means for conducting reactivity and characterization studies. Examples of systems where interfacial processes are important include interactions of solute and solvent with membranes; metal coordination complexes with liquid-liquid interfaces; feed and product molecule interactions with electrodes and electrolytes in solid oxide electrolysis cells; electrolyte fluids with battery electrodes; and non-aqueous fluids with complex mixtures and solutions.

Chemical Reactivity and Transport in Electric Fields: This research fills gaps in understanding fundamental phenomena related to ion and molecular migration and reactivity in electric field environments.

Condensed Matter Physics and Materials Science (emerging core capability): These LDRD proposals advance fundamental science to understand, predict, and ultimately control matter and energy at the level of electrons, atoms, and molecules.

The proposed laboratory activities include reasonably foreseeable actions necessary to implement the proposed action, such as radiological control and safety support; sample, chemical, and material transport; project closeout; waste management, transport, treatment, storage and disposal; maintenance, development, and demonstration of processes, instruments and detection; maintenance, calibration, transport, and use of analytical and research equipment; consulting and planning with sponsors and collaborators; and award of grants and contracts.

The proposed LDRD projects leverage facilities across INL – the Advanced Test Reactor (ATR) Complex, Central Facilities Area (CFA), Critical Infrastructure Test Range Complex (CITRC), Materials and Fuels Complex (MFC), and the Research and Education Campus (REC). These facilities each host complementary resources and infrastructure to support research.

The primary focus of the ATR Complex is continued fuels and materials irradiation testing, nuclear safety research and nuclear isotope production. The ATR subjects experiments to a wide range of temperatures, pressures and exposure to high levels of neutrons and gamma rays to determine how the materials will react in high-radiation environments. The ATR-Critical Facility (ATR-C) is a full-size, low-power, pool-type nuclear replica of the ATR, designed to evaluate prototypical experiments before the actual experiments are irradiated in the ATR.

CFA supports the Wireless Test Bed network, operations center, and the site-wide protection, emergency response, network and communications, transportation, and warehousing services for the Site campuses.

CITRC supports INL National & Homeland Security (N&HS) missions in developing solutions for security and resilience of critical infrastructure and advancing security solutions that prevent, detect and counter nuclear and radiological threats. This mission engages strategic partnership projects that include other federal agencies, national and international programs and the energy industry.

MFC has facilities for fabricating, examining, and characterizing nuclear fuel and materials, as well as remotely handling and processing spent fuel and radioactive wastes. Projects at MFC primarily focus on developing innovative solutions for nuclear power technology, including nuclear fuel development, separations development, post-irradiation examination (PIE), and fast reactor development. The Analytical Laboratory (AL) houses shielded hot cells, air and inert atmosphere glove boxes, casting laboratories and related assets used for nuclear fuels and materials characterization, environmental sampling and analysis and other examination tasks. The Fuel Conditioning Facility (FCF) contains two adjacent hot cells, a mock-up area and shielded decontamination and repair area that support legacy spent fuel treatment, remote equipment development, cask receipt and related activities. The Fuel Manufacturing Facility (FMF) features a highly secure vault and two work rooms with glove boxes that allow for the receipt, storage, handling and inspection of fissionable material and the development of advanced nuclear fuels. The Transient Reactor Test Facility (TREAT) is an air-cooled, thermal test reactor maintained in standby status to support radioisotope dispersal device exercises, recovered spent fuel storage and potential future transient testing needs.

The Research and Education Campus is located in Idaho Falls and includes laboratories where researchers work on a wide variety of R&D projects. The campus includes numerous office, lab and support facilities, including the Bonneville County Technology Center (BCTC), the Center for Advanced Energy Studies (CAES), the Information Operations and Research Center (IORC), the INL Research Center (IRC), the Energy Systems Laboratory (ESL), Energy Innovation Laboratory (EIL), the Collaborative computing Center (C3), Cybercore integration Center (CIC), and National and Homeland Security's University Boulevard (UB) 2 and 3. Activities in these facilities are highlighted below:

- The BCTC offers a blend of low- and high-bay work areas and wet and dry lab space for technologies close to commercial deployment.
- CAES is a research and education consortium between INL, Boise State University, Idaho State University, University of Idaho and University of Wyoming and provides a collaborative, multi-mission environment focusing on research including nuclear and materials science, geothermal energy systems, advanced manufacturing, and energy policy.
- The IORC is a secure building that serves as a centralized location for industry, vendors and government agencies to work together to reduce cyber vulnerabilities in control systems.
- The IRC houses more than 60 laboratories and was designed to allow easy lab space modification as research needs change over time. Scientists and engineers at the IRC conduct research in a number of different fields including materials science, biology, analytical chemistry, nondestructive battery evaluation, autonomous systems and geochemistry.

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- The ESL supports R&D to reduce technical and economic risks associated with the deployment of new energy technologies in the areas of bioenergy research, energy storage and advanced vehicles, and energy systems integration.
- EIL houses INL researchers affiliated with Energy & Environment Science & Technology, Nuclear Science & Technology, and the Nuclear Science User Facilities. Laboratories at EIL support chemical sciences, nanotechnology, water chemistry, advanced microscopy, control systems, high-temperature testing, thermal hydraulics, materials testing and characterization, separations technology and advanced instrument training.
- The C3 is a facility where INL researchers, Idaho universities and industry can explore computer modeling and simulation to develop new nuclear materials, advance nuclear energy concepts and conduct a broad span of scientific research.
- The CIC supports research on security and resilience of the nation's critical infrastructure, including the power grid. The research focuses on developing the partnerships, people and innovations required to meet emerging threats from persistent, capable, well-resourced and highly motivated cyber adversaries.
- University Boulevard 2 and 3 (UB2/3) contain engineering space that supports a wide range of work-for-others customers including programs for the departments of Defense and Homeland Security.

One of the proposals listed in Appendix A involve work locations outside of INL as listed below:

- 22A1059-031FP, *An Innovative Secure & Energy Efficient Sub-Terahertz Wireless System for 6G*, involves research with analysis and M&S in collaboration with North Carolina State University (NCSU) in accordance with NCSU Standard Operating Procedures found at <https://ehs.ncsu.edu/home-page-info/environmental-affairs/>.

The proposed projects could result in emissions to the atmosphere of both chemicals and radionuclides; generating hazardous, mixed, radioactive low-level, transuranic (TRU), and industrial wastes. Samples for analysis or R&D work may be received from outside the INL or originate within the INL. Laboratory activities may result in excess samples or sample residues that project personnel must return to the generator or to INL personnel to manage and dispose. Project activities may retain wastewater from laboratory operations for characterization and management by Waste Generator Services (WGS) or may be disposed to laboratory drain systems in accordance with the appropriate sewage disposal regulations.

To complete some of the proposed work activities, it is necessary for projects to use the HFEF hot cell which contains both defense and nondefense related materials and contamination. Project materials will come into contact with defense related materials. It is impractical to clean out defense related contamination, and therefore, waste associated with project activities is eligible for disposal at the Waste Isolation Pilot Plant (WIPP). National Environmental Policy Act (NEPA) coverage for the transportation and disposal of waste to WIPP are found in *Final Waste Management Programmatic Environmental Impact Statement [WM PEIS] (DOE/EIS-0200-F, May 1997)* and *Waste Isolation Plant Disposal Phase Supplemental EIS (SEIS-II) (DOE/EIS-0026-S-2, Sept. 1997)*, respectively. The 1990 ROD also stated that a more detailed analysis of the impacts of processing and handling transuranic (TRU) waste at the generator-storage facilities would be conducted. The Department has analyzed transuranic (TRU) waste management activities in the *Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) (DOE/EIS-200-F, May 1997)*. The WM PEIS analyzes environmental impacts at the potential locations of treatment and storage sites for TRU waste; SEIS-II addresses impacts associated with alternative treatment methods, the disposal of TRU waste at WIPP and alternatives to that disposal, and the transportation to WIPP.

After PIE, irradiated test pin segments and PIE remnants will be stored with other similar DOE-owned irradiated materials and experiments at MFC, most likely in the HFEF or the Radioactive Scrap and Waste Facility (RSWF) in accordance with DOE's Programmatic SNF Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (FEIS) and ROD (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996). Ultimate disposal of the irradiated test pin segments and PIE remnants will be along with similar DOE-owned irradiated materials and experiments currently at MFC. Categorizing this material as waste is supported under Department of Energy Order (DOE O) 435.1, Att. 1, Item 44, which states "... Test specimens of fissionable material irradiated for research and development purposes only... may be classified as waste and managed in accordance with this Order..."

Packaging, repackaging, transportation, receiving, and storing used nuclear fuel and R&D for used nuclear fuel management is covered by DOE's *Programmatic Spent Nuclear Fuel (SNF) Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (EIS)* and Record of Decision (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996). The analyses include those impacts related to transportation to, storage of, and research and development related to used nuclear fuel at the INL (see Tables 3.1 of the SNF Record of Decision (May 30, 1995) and Table 1.1 of the Amended Record of Decision [February 1996]).

The environmental impacts of transferring LLW from the INL Site to the Nevada National Security Site were analyzed in the 2014 *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada* (DOE/EIS-0426) and DOE's *Waste Management Programmatic EIS* (DOE/EIS-200). The fourth Record of Decision (ROD) (65 FR 10061, February 25, 2000) for DOE's *Waste Management Programmatic EIS* established the Nevada National Security Site as one of two regional LLW and MLLW disposal sites.

The potential for transportation accidents was analyzed in the SNF EIS (Section 5.1.5 and Appendix I-5 through I-10).

SECTION C. Environmental Aspects or Potential Sources of Impact:

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Air Emissions

Air Emissions (Describe Impact): Note: If this project or activity produces or causes air emissions, and it is not stated in this ECP how those emissions caused by this project or activity are exempt, then an APAD is required for documentation.

INL LDRD projects have the potential to generate small amounts of air emissions containing a variety of constituents. Due to the nature of these LDRD projects, INL anticipates emissions will be minor and covered by existing APAD's for the individual facilities. Air emissions include minor amounts of radionuclides and toxic air pollutants. Air emissions may also include fugitive emissions and emissions from non-road mobile generators at locations such as the National Security Test Range. Emissions from mobile generators are not regulated if the generator will be in place less than one year.

Activities may result in chemical and radiological emissions from vents, stacks, and hoods. Each activity must meet state and Federal air emission regulations. General APADs may be used to cover independent projects. The APAD establishes the appropriate maximum 24-hour and maximum annual emission limits for toxic pollutants used at the laboratory. Administrative controls based on inventory limits and independent Hazard Reviews for new programs would then be implemented to assure that these limits would not be exceeded.

Where biological materials or nanoparticles are involved, HEPA filtration will be installed as required.

Experiment irradiation and PIE may be performed at the ATR, HFEF, NRAD, and TREAT facilities. The proposed irradiations are not modifications in accordance with Idaho Administrative Procedures Act (IDAPA) 58.01.01.201 and 40 Code of Federal Regulation (CFR) 61 Subpart H. APADs will be completed to document these exemptions. Normal operation of sealed experiments in ATR primary coolant and NRAD and TREAT irradiations are not expected to contribute to or cause an increase in air emissions. ATR radionuclide and TREAT emissions are sampled and reported in accordance with Laboratory-wide Procedure (LWP)-8000 and 40 CFR 61 Subpart H. The irradiated experiments will be delivered to the MFC HFEF for disassembly and then undergo routine PIE. All radionuclide release data associated with the PIE portion of the proposed activities will be recorded as part of the HFEF continuous stack monitor and calculated and provided to Programs Environmental Support organization by January 31 of each year for the preceding calendar year as part of the INL Annual National Emission Standards for Hazardous Air Pollutants (NESHAPs) report to DOE. Releases of radioactive airborne contaminants from this process are not expected to result in an increase to the annual HFEF dose to the Maximum Exposed Individual (MEI). Therefore, no Air Permit Applicability Determination is required for the project. All experiments will be evaluated by ATR Environmental Support and Services staff, prior to insertion in the ATR. All radionuclide release data (isotope specific in curies) directly associated with this experiment will be calculated and provided to the ATR Programs Environmental Support organization by January 31 of each year for the preceding calendar year.

For calendar year 2020 the effective dose equivalent to the MEI member of the public was $6.17E-02$ millirem (mrem) per year, which is 0.62 percent of the 10 mrem per year standard for the INL Site. The additional increment in emissions from the proposed action would not significantly change the total site-wide MEI dose.

Discharging to Surface-, Storm-, or Ground Water

This ECP does not authorize direct discharge to ground water, surface water, or the ground surface. Storm water runoff may occur from parking lots.

Proposed activities have the potential to discharge chemicals to the Idaho Falls Sewer System. No discharges are planned to occur out at the INL Site.

No discharges are planned for off-site locations.

Disturbing Cultural or Biological Resources

It is not likely that LDRD projects would result in adverse impacts to sensitive biological or cultural resources. However, when project circumstances warrant it, biological and cultural resource reviews would be conducted to assure that impacts to sensitive resources are avoided and minimized. Resource review recommendations would be followed to assure there are no adverse impacts to sensitive species and resources.

Generating and Managing Waste

LDRD projects will generate waste, including office waste, industrial waste (e.g., gloves, non-hazardous hardware, ceramic-type pellets, machining scrap, lab pipettes, wipes, etc.), low-level waste (LLW), mixed LLW (e.g., from irradiated fuel salt and salt-facing components), hazardous waste from chemical solutions and solvents, and transuranic (TRU) waste from certain activities at the INL Site. The total estimated sum of the generated TRU waste is less than 1 m³.

Off-Site Locations: Locations off-site will have the potential to generate industrial waste, office waste, hazardous waste, and LLW. No TRU waste will be generated at off-site locations. From LWP-20000, research performed by INL personnel at offsite (non INL) locations must be performed with the same rigor as on-site work. To ensure such rigor is applied, an analysis must occur between the work performer and research line management using Form 420.15, "Off-Site Work Request." If it is determined that the work controls are consistent with INL standards, research by the INL performer at the offsite location may be allowed. In the absence of a defined and structured work-control process, INL work-control processes should be applied.

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Physical modeling of geotechnical centrifuge tests at the UCSD will be performed in compliance with UCSD research safety policies, procedures, and services for research and teaching laboratories available at <https://blink.ucsd.edu/safety/research-lab/index.html>.

Research in collaboration with NCSU will be performed in accordance with NCSU Standard Operating Procedures found at <https://ehs.ncsu.edu/home-page-info/environmental-affairs/>.

Research activities at DOE laboratories outside of INL comply with the environmental and other requirements applicable to the laboratory where work is being performed.

Releasing Contaminants

When chemicals are used, there is the potential the chemicals could be spilled to air, water, or soil.

Using, Reusing, and Conserving Natural Resources

All materials will be reused and recycled where economically practicable. All applicable waste will be diverted from disposal in the landfill where conditions allow. Project description indicates materials will need to be purchased or used that require sourcing materials from the environment. Being conscientious about the types of materials used could reduce the impact to our natural resources. Project activities may release known greenhouse gases (GHGs) to the atmosphere and increase INL's energy use.

SECTION D. Determine Recommended Level of Environmental Review, Identify Reference(s), and State Justification: Identify the applicable categorical exclusion from 10 Code of Federal Regulation (CFR) 1021, Appendix B, give the appropriate justification, and the approval date.

For Categorical Exclusions (CXs), the proposed action must not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, or similar requirements of Department of Energy (DOE) or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment or facilities; (3) disturb hazardous substances, pollutants, contaminants, or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources (see 10 CFR 1021). In addition, no extraordinary circumstances related to the proposal exist that would affect the significance of the action. In addition, the action is not "connected" to other action actions (40 CFR 1508.25(a)(1)) and is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1608.27(b)(7)).

References: 10 CFR 1021 Appendix B to subpart D, Item B3.6, "Small-scale research and development, laboratory operations, and pilot projects", B1.24 "Property Transfers" and B1.31 "Installation and relocation of machinery and equipment".

Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement and Record of Decision (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (1996)

Final Environmental Impact Statement for the Waste Isolation Pilot Plant (DOE/EIS-0026, October 1980) and Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant (SEIS-I) (DOE/EIS-0026-FS, January 1990)

Final Waste Management Programmatic Environmental Impact Statement [WM PEIS] (DOE/EIS-0200-F, May 1997) and Waste Isolation Plant Disposal Phase Supplemental EIS (SEIS-II) (DOE/EIS-0026-S-2, September 1997)

Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE/EIS-0426, December 2014).

Justification: The proposed R&D activities are consistent with CX B3.6 "Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment."

B1.31, "Installation or relocation and operation of machinery and equipment (including, but not limited to, laboratory equipment, electronic hardware, manufacturing machinery, maintenance equipment, and health and safety equipment), provided that uses of the installed or relocated items are consistent with the general missions of the receiving structure. Covered actions include modifications to

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an existing building, within or contiguous to a previously disturbed or developed area, that are necessary for equipment installation and relocation. Such modifications would not appreciably increase the footprint or height of the existing building or have the potential to cause significant changes to the type and magnitude of environmental impacts." and,

B1.24, "Transfer, lease, disposition, or acquisition of interests in personal property (including, but not limited to, equipment and materials) or real property (including, but not limited to, permanent structures and land), provided that under reasonably foreseeable uses (1) there would be no potential for release of substances at a level, or in a form, that could pose a threat to public health or the environment and (2) the covered actions would not have the potential to cause a significant change in impacts from before the transfer, lease, disposition, or acquisition of interests."

To complete some of the proposed work activities, it is necessary for projects to use the HFEF hot cell which contains both defense and nondefense related materials and contamination. Project materials will come into contact with defense related materials. It is impractical to clean out defense related contamination, and therefore, waste associated with project activities is eligible for disposal at the Waste Isolation Pilot Plant (WIPP). National Environmental Policy Act (NEPA) coverage for the transportation and disposal of waste to WIPP are found in Final Waste Management Programmatic Environmental Impact Statement [WM PEIS] (DOE/EIS-0200-F, May 1997) and Waste Isolation Plant Disposal Phase Supplemental EIS (SEIS-II) (DOE/EIS-0026-S-2, Sept. 1997), respectively. The 1990 ROD also stated that a more detailed analysis of the impacts of processing and handling transuranic (TRU) waste at the generator-storage facilities would be conducted. The Department has analyzed transuranic (TRU) waste management activities in the Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) (DOE/EIS-200-F, May 1997). The WM PEIS analyzes environmental impacts at the potential locations of treatment and storage sites for TRU waste; SEIS-II addresses impacts associated with alternative treatment methods, the disposal of TRU waste at WIPP and alternatives to that disposal, and the transportation to WIPP.

After PIE, irradiated test specimens and PIE remnants will be stored with other similar DOE-owned irradiated materials and experiments at MFC, most likely in the HFEF or the Radioactive Scrap and Waste Facility (RSWF) in accordance with DOE's Programmatic SNF Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (FEIS) and ROD (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996). Ultimate disposal of the irradiated test pin segments and PIE remnants will be along with similar DOE-owned irradiated materials and experiments currently at MFC. Categorizing this material as waste is supported under Department of Energy Order (DOE O) 435.1, Att. 1, Item 44, which states "...Test specimens of fissionable material irradiated for research and development purposes only...may be classified as waste and managed in accordance with this Order..."

Packaging, repackaging, transportation, receiving, and storing used nuclear fuel and R&D for used nuclear fuel management is covered by DOE's Programmatic Spent Nuclear Fuel (SNF) Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (EIS) and Record of Decision (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996). The analyses include those impacts related to transportation to, storage of, and research and development related to used nuclear fuel at the INL (see Tables 3.1 of the SNF Record of Decision (May 30, 1995) and Table 1.1 of the Amended Record of Decision [February 1996]).

The environmental impacts of transferring LLW from the INL Site to the Nevada National Security Site were analyzed in the 2014 Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE/EIS-0426) and DOE's Waste Management Programmatic EIS (DOE/EIS-200). The fourth Record of Decision (ROD) (65 FR 10061, February 25, 2000) for DOE's Waste Management Programmatic EIS established the Nevada National Security Site as one of two regional LLW and MLLW disposal sites.

The potential for transportation accidents was analyzed in the SNF EIS (Section 5.1.5 and Appendix I-5 through I-10).

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Approved by Jason L. Anderson, DOE-ID NEPA Compliance Officer on: 09/29/2021