Date: January 24, 2019

To: Distribution

From: Marianne Walck, Science and Technology Deputy Laboratory Director

Subject: FY-20 Annual LDRD Call for Proposals—**for limited external distribution**

Proposals are now being accepted for the Fiscal Year 2020 (FY-20) Laboratory Directed Research and Development (LDRD) call, the FY-20 Annual LDRD Call for Proposals. This call seeks high-quality proposals that address Idaho National Laboratory's (INL's) research priorities identified within the attached document, "LDRD FY-20 Research Priorities." We encourage the submittal of proposals that offer the potential for achieving breakthroughs in support of strategic objectives needed to advance our Laboratory Agenda:

1. Advance nuclear energy
2. Advance integrated energy systems
3. Advance design and manufacturing
4. Develop critical national and homeland security capabilities.

INL leadership will be reviewing proposals in the four major categories listed above with specified strategic intent of the LDRD FY-20 research priorities, detailed in the following pages.

Information and guidance for submitting a proposal is provided on the LDRD Program website.

The review process occurs in two-stages, allowing the consideration of a wide range of ideas while limiting the effort invested in preparing proposals. Preliminary short proposals (pre-proposals) must be entered into the Laboratory Overhead Investments–Electronic Submission System (LOI-ESS) by **February 28, 2019,** and full proposals by **May 13, 2019.**

Presentations of full proposals and renewal requests (for continuing LDRD projects) will be scheduled during **July 8–18, 2019**. The full schedule and a copy of this call are available on the LDRD Program website. **It is strongly encouraged that principal investigators (PIs) engage with their line management and division director early in the process (i.e., before submission of the pre-proposal), and that researchers discuss their proposal with points of contact identified for each area of the call.**

Please note: If staff members miss the annual call submission window and would like to submit their proposals for consideration for FY-20 investment, they may submit their proposals through INL's out-of-cycle LDRD proposal process or the seed LDRD proposal process. Questions related to the FY-20 Annual LDRD Call should be directed to the LDRD office (EROB Rm 161, 526-1378, *FY20AnnualLDRDCall@inl.gov*) or Dena Tomchak (EROB Rm 2EQ104, 526-1590, *Dena.Tomchak@inl.gov*).

-

Attachment: *LDRD FY-20 Research Priorities*

Laboratory Directed Research and Development Program

LDRD FY 2020 Research Priorities

Introduction

Our core mission at Idaho National Laboratory (INL) is to discover, demonstrate, and secure innovative nuclear energy solutions, clean energy options, and critical infrastructure. In anticipation of the world-class science and engineering research that must be performed to achieve INL's and the Department of Energy's (DOE's) mission. INL conducts Laboratory Directed Research and Development (LDRD) to engage researchers, leadership, and infrastructure stewards in converting the most innovative scientific and engineering ideas into future scientific discoveries, research capabilities, research and development (R&D) programs, and deployed technology solutions. LDRD is the primary INL research and development (R&D) investment in the successful development of the future core capabilities that assures achievement of our strategic objectives in science and technology (S&T): (1) advance nuclear energy, (2) advance integrated energy systems, (3) advance design and manufacturing, and (4) develop critical national and homeland security capabilities.

INL's Laboratory Agenda and Laboratory Plan are used to communicate to DOE the status of INL's core capabilities and our focus on future strategic S&T initiatives. Senior leadership and management have committed to following the Laboratory Agenda, which includes goals and milestones for our strategic objectives[a]. Fiscal Year 2020 (FY-20) discretionary investment through LDRD is, therefore, being made available to strengthen INL's core capabilities and to further integrate and apply our strengths in use-inspired basic and applied R&D to accomplish our mission and achieve our critical outcomes.

The objectives of the LDRD program are to (1) maintain INL's scientific and technical vitality, (2) enhance INL's ability to address current and future DOE missions, (3) foster creativity and stimulate exploration of forefront areas of S&T, (4) serve as a proving ground for new R&D concepts, and (5) support high-risk, potentially high-value R&D.

In FY-20, LDRD will be used to encourage INL's research staff to develop proposals focused on these four strategic objectives as they pertain to advancing the S&T leadership goals within the Laboratory Agenda, expanding our unique and differentiating research capabilities, enhancing peer recognition of our core capabilities, and advancing outcomes and achievement:

1. ***Advance nuclear energy.*** Advancing nuclear energy competitiveness and leadership, including ensuring the peaceful use of nuclear energy technology through innovations in nonproliferation technologies and developing integrated nuclear fuel-cycle solutions while advancing INL's nuclear science and technology (NS&T) computational and experimental capabilities.
2. ***Advance integrated energy systems.*** Integrating current and future nuclear energy products with renewable and fossil energy to create reliable, affordable, and sustainable energy commodities and to minimize rejected energy.
3. ***Advance design and manufacturing.*** Advancing secure design and manufacturing processes for nuclear energy; energy management; space and defense systems; and materials and components in extreme environments.
4. ***Develop Critical National and Homeland Security Capabilities.*** Developing secure and resilient cyber-physical systems in critical infrastructure and defense platforms.

Proposals should focus on transformative and/or breakthrough S&T that leads to impacts aligned with the success of DOE's and INL's missions. Proposals should discuss (1) new knowledge and innovations and how they extend the current state of the art, (2) approaches to communicating new knowledge and innovations (peer-reviewed publications, conferences, intellectual property, industry groups, etc.); (3)

a. INL's FY 2018 Laboratory Agenda

collaborations (university, industry, other national laboratories) and how they will enhance knowledge, leverage capabilities, build talent pipelines, and provide the foundation for building future programs; and (4) critical science and engineering skills development through engaging undergraduates, master's and doctoral candidates, and postdocs. Researchers are encouraged identify possible follow-on funding sources or, more generally, the S&T and business strategy that will continue and expand the work beyond the LDRD funding.

Researchers interested in responding to this call are strongly encouraged to engage with the identified point of contact or mission area point of contact (MAPOC) for the research areas in which they are interested, as well as engage their line management and/or division director early in the process. These individuals can provide guidance for tailoring proposals to best meet the needs of the strategic objective, help identify the appropriate area of the call in which to submit an idea, and help ensure that proposals do not duplicate work that is funded by existing R&D programs.

Partnerships with universities, industry, and other national laboratories are encouraged. When a proposal includes university students, the PI should plan for and encourage these students to spend time at INL to coordinate and collaborate with INL researchers. PIs are encouraged to consider investments in postdocs as much as is feasible and reasonable.

The format for proposals and the procedure[b] for submittal are described on the LDRD Program website. Note that proposals must be submitted to one of the four strategic objectives outlined above and in the following pages. Pre-proposals and full proposals will be reviewed by the PI's division director and by a strategic objective committee comprising subject-matter experts and lab leadership. Full proposals will also undergo a technical review in addition to division director and strategic objective committee reviews. Questions related to the FY-20 LDRD Annual Call should be directed to the LDRD office (EROB Rm 161, 526-1378, *FY20AnnualLDRDCall@inl.gov*) or Dena Tomchak (EROB Rm 2EQ104, 526-1590, *Dena.Tomchak@inl.gov*).

b. Publications and reports are expected and are important outputs of LDRD investments. These outputs are managed, tracked, measured, and reported to DOE and also used to evaluate performance. To improve the S&T measures and quality, PIs and collaborators are expected to include their Open Researcher and Contributor Identification (ORCID) as part of their LDRD proposal package. ORCID will be used to track and report publications. The Laboratory Overhead Investment–Electronic Submission System (LOI-ESS) will automatically pull ORCID data from INL's Human Resources system if PIs and co-PIs are in INL systems. For external proposal collaborators, postdocs, and interns, PIs should obtain an ORCID and enter this in the LOI-ESS to complete the proposal submission process. Exceptions to this requirement may be obtained for classified LDRD project PIs, co-PIs, and collaborators.

1. ADVANCE NUCLEAR ENERGY

A mission of INL, and in particular the NS&T, Materials and Fuels Complex (MFC), and Advanced Test Reactor (ATR) directorates, is to advance nuclear energy as a resource capable of meeting the nation's energy, environmental, and national-security needs by resolving technical, cost, safety, proliferation-risk, and security barriers through research, development, and demonstration (RD&D). In support of this mission and DOE Office of Nuclear Energy priorities addressing the existing fleet, the advanced-reactor pipeline, and fuel-cycle infrastructure, INL has identified the following focus areas:

- Nuclear energy competitiveness and leadership
- Realization of the National Reactor Innovation Center
- Development and sustenance of core capabilities to support current and future nuclear missions
- Integrated nuclear fuel-cycle solutions.

To achieve these objectives and to support INL's mission, INL's nuclear energy strategic plan outlines five goals to be achieved for the period of 2019–2023; these include:

- Strengthen the domestic commercial nuclear energy enterprise
- Enable U.S. technological leadership in global nuclear energy markets
- Provide stewardship of national nuclear fuel-cycle strategic assets
- Apply core competencies across broad markets
- Create the next-generation research organization.

In support of DOE and INL missions, high-quality proposals that address the nuclear goals outlined above are sought for four Advance Nuclear Energy (ANE) focus areas outlined below. LDRD provides a unique opportunity for internal investment in innovation and exploration of new and bold ideas to significantly expand the laboratory's impact on the advancement of nuclear energy. Thus, proposals that reflect some of the following considerations are sought:

- Addressing the nuclear grand challenges (develop and demonstrate intelligent secure micro reactor systems and deploy the Materials Performance Center of Excellence)
- Challenging conventional thinking while potentially leading to a paradigm shift in development and licensing of new nuclear materials, concepts, and technologies
- Utilizing and/or expanding INL's core capabilities in nuclear systems analysis, design, and safety; nuclear fuels and materials; fuel cycle technologies; and computational engineering
- Combining theory development, experimentation, and modeling and simulation (M&S) into a unified approach to address key technical challenges
- Integrating novel use of the MOOSE framework to the extent applicable and possible
- Building multi-disciplinary, cross-organization teams that result in large, multi-year projects.

Topics could include:

- Innovative technological solutions to lower operating and maintenance costs for reactor plants
- Methodologies or technologies that enable secure, autonomous operation of advanced reactors
- Methods for experiment analysis and the compilation and assimilation of large amounts data to enhance value of experiments and measurements
- Determination of key characteristics and phenomena underlying the performance of nuclear energy systems.

The FY-20 Annual LDRD Call is focused on a prioritized set of RD&D objectives of current strategic importance. Researchers are encouraged to engage with the point(s) of contact designated after each research priority for additional information and/or clarification. Proposals must not duplicate work that is funded by existing R&D programs. Please refer to Section 2 for information on proposals sought to Advance Integrated Energy Systems, Section 3 for information on proposals sought to Advance Design and Manufacturing, and Section 4 for information on proposals sought to Develop Critical National and Homeland Security Capabilities.

Mission Area Points of Contact:
John Jackson, 208-526-0293, John.Jackson@inl.gov, Nuclear Science and Technology
Doug Crawford, 208-533-7942, Doug.Crawford@inl.gov, Materials and Fuels Complex
Kevin Smith, 208-533-4853, Kevin.Smith2@inl.gov, Advanced Test Reactor

1.1 Transformational Nuclear System Technologies

This area supports INL leadership in addressing key challenges associated with the cost and time to deploy advanced technologies to current and future commercial viability of nuclear energy systems.

Topics for consideration include supporting technology for novel reactor concepts and technologies with the potential to dramatically reduce capital and operating costs, as well as providing scalable technology options suitable for current and evolving energy-market applications. These include ideas and concepts that increase the technological readiness of small modular reactors, micro reactors, and other advanced reactor concepts:

- Technologies common to multiple concepts are desirable—for example, mechanisms for semi- or fully autonomous reactor control and protection, minimally intrusive yet robust reactor instrumentation, and multi-unit remote operation with end-use (e.g., grid) integration
- Technologies for specific reactor concepts, including mitigation of chemical compatibility concerns, alternate coolants, deployable passive safety systems (for current light-water plants as well as advanced concepts), and chemical and/or physical source term reduction methods
- Innovative concepts that enable cost and risk reduction in overall plant design, licensing, and deployment strategies, especially regarding utilization of advanced construction materials and techniques (including modularization), alternate (non-water) ultimate heat rejection, and external hazard mitigation.

Point of Contact:
Hans Gougar, 208-526-1314, Hans.Gougar@inl.gov

1.2 Transformational Approaches to Accelerate Nuclear RD&D

Proposals within this area seek to innovate nuclear RD&D approaches with the potential to greatly (i.e., by a factor of two or more) reduce time and cost associated with developing, demonstrating, and licensing new nuclear technologies with the potential to reduce time to market for current, new, and advanced nuclear reactors.

Proposals that integrate experimental work and M&S to improve nuclear energy RD&D efficiency and outcomes, reduce nuclear energy RD&D timelines and costs, and ultimately allow for predictive models and techniques within well-defined ranges that support performance evaluations to enable reduced reliance on measured data through development, demonstration, and application of predictive M&S capabilities are highly encouraged.

Proposals for methods and approaches that can substantially reduce time, cost, and uncertainty for developing and qualifying new nuclear fuels (including liquid, particle, metallic, and ceramic fuels), materials, and technologies are sought. Utilization and adaptation of innovative approaches that have been employed in other fields (for example, combinatorial materials synthesis to reduce time to deployment of materials) and computational design methods are highly encouraged. Topics of interest include:

- Advanced instrumentation applied to experiments and to characterization of systems
- Automation of processes and measurements
- Development and demonstration of a means to achieve hundreds of displacements per atom per year in materials that are relevant/applicable to nuclear fission systems
- Methods for accelerated testing of nuclear fuels
- Reduction in the time required for post-irradiation examination by a factor of ten or more
- Reduction in required irradiation times for fuels or materials studies by a factor of two or more
- Development of an efficient framework for rapid analysis and assimilation of data
- Methods that couple modeling, experimental data, and stochastic techniques
- Methods to support, improve, and integrate reactor and reactor components, including balance of plant systems
- Methodology to link INL to reactor designs and the commercial market.

Emphasis on validation of models or tools through utilization of ATR, MFC and Transient Reactor Test Facility (TREAT), combined with advanced M&S, is highly desirable.

Point of Contact:
Matthew Kerr, 208-526-1293, Matthew.Kerr@inl.gov

1.3 Deployment of the Nuclear Fuels and Materials Performance Center of Excellence

Proposals are requested under the grand challenge of nuclear fuels and materials performance to expand both the depth and breadth of INL's strength in this core competency. This effort extends INL's reach into evolving new and advanced reactor designs and is consistent with INL's position as lead national laboratory for nuclear energy, with influence on reactor designs and the commercial market. Specific areas of interest are:

- Data synthesis and analytical techniques and approaches that enable better analysis of existing historic fuels and materials performance data (fabrication, irradiation, safety testing or post irradiation examination [PIE]) to reduce uncertainty, improve understanding, and/or enable prediction of similar materials from existing INL databases
- Development or application of new experimental techniques, environmentally-robust sensors[c], and approaches that can better interrogate irradiated nuclear fuels and materials to enhance irradiation, PIE, or safety testing of fuel systems and improve INL's performance assessment of these material systems
- Meta-models that couple models with probabilistic approaches that account for uncertainties in both the models and physical parameters. The benefit of this approach is to reduce modeling complexities and computational runtime for large-scale models and allow quicker response to operational events, especially unplanned and safety events

---

[c] Note that proposals involving the development of sensors that relate to the use of novel/advanced manufacturing processes should be submitted under Section 3.2, Innovative M&S of Materials under Extreme Conditions

- Development of experimental techniques and models with a focus on materials for micro reactor designs, materials for small modular reactor designs, and materials for non-traditional fuel design (e.g., liquid, particle, metallic and ceramic fuels)[d]
- Development of in situ inspection and in situ repair techniques for existing reactor systems and materials, as well as new and advanced reactors to improve safety and reduce reactor downtime and minimize maintenance stoppage.

Point of Contact:
Youssef Ballout, 208-526-1293, Youssef.Ballout@inl.gov

1.4 Integrated Nuclear Fuel Cycle Technologies and Solutions

Addressing the current and future inventory of civilian spent nuclear fuel (SNF) and associated high-level radioactive waste (HLW) is essential to the continued viability and long-term sustainability of nuclear energy.

An effective management and disposition strategy requires understanding (1) how SNF and HLW are generated, (2) what treatments are necessary to stabilize SNF and HLW for storage, transportation and disposal, (3) how SNF and HLW behave during short- and long-term storage and subsequent transportation, and (4) the long-term performance of SNF and HLW in deep geological disposal environments.

To better position INL's core capabilities in advanced instrumentation, radiochemistry, chemical engineering, and M&S, we seek proposals that would expand these core capabilities to address the S&T challenges to advance SNF-cycle solutions. Of specific interest are proposals that advance knowledge related to and maintain core competencies in:

- Modern real time instrumentation tools to detect spent-fuel integrity and canister behavior in different environments during storage, transportation and disposal
- New instrumentation tools or monitoring techniques to detect special nuclear material (SNM) during SNM recovery processes, utilizing the physical and chemical signals that are inherent to the relevant recovery technology
- Process chemistry applications that leverage advanced fuel-cycle processing technology for diversifying and expanding the customer base (e.g., the National Nuclear Security Administration, isotopes, industry, etc.)
- Developing innovative solutions to nonproliferation strategies for treaty verification, advanced nuclear fuel cycle processes and nuclear forensics, with a focus on prevention and detection of, and response to, misuse of nuclear materials and technologies, isotope production and/or recovery, and experiments utilizing unique INL capabilities such as gamma irradiator, solvent test loop, hot-fuel dissolution apparatus, etc.
- Prediction tools for the understanding of long-term storage behavior and processing of advanced LWR and non-LWR fuels, including all secondary wastes generated, such as off-gas and molten salts.

Proposals that would advance INL leadership relative to fundamental understanding and demonstration of salt properties, chemistry, and processes for molten salt reactors are of special interest.

[d] Proposals involving the development of materials using advanced manufacturing processes should be submitted under Section 3.2, Innovative M&S of Materials under Extreme Conditions

Points of Contact:
Terry Todd, 208-526-3365, Terry.Todd@inl.gov
Monica Regalbuto, 208-526-2319, Monica.Regalbuto@inl.gov

2. ADVANCE INTEGRATED ENERGY SYSTEMS

Consistent with INL's aim to encourage cross-cutting LDRD projects, this section of the LDRD FY-20 research priorities is primarily dedicated to enabling development of relevant and high-quality proposals that advance integrated energy systems. The main purpose of the Advance Integrated Energy Systems (AIES) strategic objective is to increase access to low-cost, reliable, and resilient electricity and other energy services. AIES has been divided into four priorities:

- Thermal systems, with the purpose of demonstrating the use of high-density energy products via industrial processes and microgrid infrastructure
- Power systems, which enable thermal energy products and nuclear energy attributes to balance generation and consumption to enhance the stability and economics of power systems
- Data systems, which optimize, advance, and design cyber-informed rapid systems monitoring capabilities, big-data analytics, and cyber-secure control systems to manage risk and complexity associated with tightly coupled energy systems
- Energy-to-molecules and materials (E2M2) systems, which use thermal energy and power from low-emissions energy resources to upgrade and transform natural resources, opportunity carbon-based feedstocks, waste streams, intermediate chemicals, and water sources into higher-value, building-block molecules, chemicals,or materials.

Because thermal and power systems have well developed programs at INL, the LDRD FY-20 research priorities will focus on less-mature areas of research that involve data systems and E2M2 systems. Researchers will note that the scope of AIES topics is more limited than in prior years, and future research priorities are expected to change as strategic objectives are achieved and new initiatives are added.

Researchers are encouraged to contact the designated point of contact for additional information or clarification. Please refer to Section 1 for information on proposals sought to advance nuclear energy, Section 3 for information on proposals sought to advance design and manufacturing, and Section 4 for information on proposals sought to develop critical national and homeland security capabilities.

Mission Area Point of Contact:
Anne Gaffney, 208-526-6110, Anne.Gaffney@inl.gov

Points of Contact:
Richard Boardman, 208-526-3083, Richard.Boardman@inl.gov
Richard Hess, 208-526-0115, JRichard.Hess@inl.gov

2.1 Data Systems: A Computer-aided Cognitive System with Risk Assessment and Integration in support of AIES

Data systems support AIES in achieving the goal of increasing the contribution of nuclear products to the national energy mix. Among nuclear products, heat is a useful resource if properly integrated to enhance energy efficiency and diversify national energy utilization. Electric energy and power systems are critical to provide the balance of energy use in the national energy mix, robust resilience in our utility infrastructure, and energy and power distribution and utilization. Many concepts and deployments of

AIES, as they progress in the transformation of our infrastructure, require better understanding of the operational and integration issues and validation of outcomes. Developing new concepts to advance, optimize, and enable high-throughput, cyber-informed, and robust monitoring capabilities through big-data analytics and cyber-secure control systems are highly encouraged, specifically:

- *Novel ideas that create a holistic approach to data collection, analytics, and validation to improve workflow, processes, environment, and operations*. This might include a computer-aided, self-aware, and self-healing cognitive system through explainable artificial intelligence (AI). In this case, cognitive systems are defined as intelligent assets (e.g., an edge sensor, edge devices) to sense, communicate, and self-diagnose; cognitive processes and operations to analyze workflow, process, environment so as to drive quality and to enhance operations and a smarter system of systems resources and optimization. This area of research might include machine-learning techniques or algorithms to analyze and control data platforms through data identification and classification and algorithm development.
- *Novel ideas that change the holistic concept of data collection, analytics, and validation to improve utilization and efficiency in data systems and reduce risks*. This area might include the detection and prediction of anomalies within a big-data network. It might evaluate a network to establish cyber- and physical-vulnerability assessment of complex; interconnected systems (e.g., hybrid energy systems, integrated power systems, material processing systems, and manufacturing processes), improving the resiliency of these systems by making predictive analytics of the potential outcome scenarios, avoiding cascading failures, and enhancing advanced control and situational awareness. In addition, areas of interest might include simulation of cyber-informed systems, such as hardware-in-the-loop simulation.
- *Concepts that can simplify and streamline the data collection, analytics, and validation processes to improve efficiency and effectiveness of transforming information for decision making*. This would include big-data analytics (e.g., cloud or local Hadoop cluster) and physics-based simulation (local high performance computing [HPC]), which would include risk assessment and management of non-MySQL databases, streaming platforms (data intensification, a high-throughput collection of high-quality data), and cloud platforms.
- *Concepts that can provide proper infrastructure to allow data quality assessment, data analytics, and validation*. This framework includes heterogeneous computational architecture of Internet-of-things (IoT) edge sensors (sensors, special-purpose devices without an operating system), IoT edge devices (battery powered, operating systems), and IoT edge gateways (unlimited power, operating systems), cloud, local, and HPC.

Points of Contact:
Tammie Borders, 208-526-3992, Tammie.Borders@inl.gov
Dan Herway, 208-526-2362, Dan.Herway@inl.gov
Wayne Austad, 208-526-5423, Wayne.Austad@inl.gov

2.2 Energy to Molecules and Materials

Conceptually, E2M2 systems are innovative, out-of-the-box approaches that harness energy derived from low-emissions energy resources, such as nuclear, to upgrade and transform natural resources, carbon-based feedstocks, waste streams, chemicals intermediates, and water resources into higher-value molecules, chemicals, and materials. Energy products derived from low-emissions power systems may be in the form of high-value heat, electrons, photons, ionizing radiation, or intermediate energy carriers. The primary goal of E2M2 is to integrate reliable, secure, low-cost energy products with domestic natural resources and opportunity feedstocks that include waste streams for their valorization through transformation to building-block molecules, modification of chemicals or chemical processes, or process re-invention. Waste streams could include agriculture residues, process by-products, and municipal solid wastes, liquid waste steams (including municipal and process effluents), process off-gas fugitive gas species (e.g., CO, CO_2, CH_4, H_2, and H_2O), and water sources (e.g., brackish or sea water, produced water, and municipal and industrial wastes waters). To focus on enabling capabilities and innovations, proposals are sought that focus on: (1) novel methods or processes that apply low-emissions energy to convert carbon-based molecules or complex materials and resources into chemicals, pure-energy carriers that can be rapidly stored and recovered within a tightly-coupled integrated energy system, commodity-grade feedstocks, and target molecules for the production of significantly higher-value consumer products, and (2) novel development of methods for processes that produce energy carriers and can be stored and used in AIES to add value to the system—including the electrical grid—and produce high-value consumer products. Consideration may be given to intermittent use of low-emissions energy sources, such as nuclear, participating in electricity production when such cases increase the value of the whole energy systems as measured by cost-benefit tradeoff of energy that would otherwise be curtailed or lost.

2.2.1 Innovative Ways to Produce Commodity Feedstocks and Chemicals using Low-emissions Energy Sources

Proposals under this topic area should focus on upgrading and valorizing carbon-based materials in various forms (i.e., solid, liquid, and gas forms, as listed above) through utilization of low-emissions energy provided by a primary source, such as a nuclear reactor, solar plant, geothermal source, excess heat or electrons, or stored energy sources. Proposals should include re-inventing how a process uses thermal and electrical energy from a nuclear system or a renewable source. Innovations or approaches may include any thermal, electrical, catalytic, biological or a combination of motive forces that utilize the energy from primary sources; for example, high-value heat may be employed for thermal modification of waste streams or renewable resources while excess electrons available during low usage energy cycles can be captured for reduction of CO_2 or other waste streams for molecule synthesis. Example pathways for E2M2 reduction could include electron transfer to CO_2 for production of low carbon number compounds through (bio)electrochemistry or electrocatalysis or integration of high-value energy from micro and/or small modular nuclear reactors with molecule synthesis through low-pressure thermal processes. Other applications might include radiation energy as a resource for chemical conversions, which could consist of reprocessing and utilization of carbon-rich waste streams (i.e., plastics, municipal solid wastes, carbon materials) to products such as composites, nano-cellulosic materials, wood adhesives, and phenolic resins. The approach should improve the thermodynamic and financial efficiencies of the system through innovative heat- and mass-transport processes and chemical processes to improve performance of the overall energy system. Proposals should consider how energy products derived from carbon-based materials can be rearranged or harnessed to synthesize, separate, or manipulate materials for alternative uses in association with energy sources available at various locations in a grid or microgrid. Proposals submitted to this area may focus on innovations that can competitively upgrade water resources for process utilization. Justification may include demonstrable improvement to AIES resiliency, reliability, costs, sustainability, security, and safety.

Points of Contact:
Chenlin Li, 208-526-5714, Chenlin.Li@inl.gov
Boryann Liaw, 208-526-3238, Boryann.Liaw@inl.gov

2.2.2 Innovative Ways to Manage, Store, and Utilize Energy in AIES

Proposals in this topic area should focus on novel development of methods or processes that involve energy carriers that can be stored and used in AIES to add value to the system, including the electrical grid, the transportation sector, and production of high-value consumer products. Proposals are sought that focus on the idea of harnessing excess thermal energy and power derived from low-emissions resources (possibly heat derived from solar or geothermal sources). The excess thermal energy and power may be in the form of high-value heat or electrons derived from nuclear power plants or renewable energy resources. Proposals are sought that include coordination with other AIES components, which might consist of power systems controls, hydrogen generation, energy storage, electrochemical conversion to design targeted applications or other processes that are incorporated in a new integrated energy system. Proposals will be considered that invent pathways that can store and convert various forms of energy into electricity to support electric grid ramping for services such as load management/curtailment on short time scales (i.e., less than 15 minutes transition to steady-state energy dispatch). Proposals submitted within this area may also focus on improving efficiency and manipulating chemicals and materials to accept excess energy from a distributed energy resource or a microgrid when justified by appropriate cost-tradeoff benefits of energy that would otherwise be curtailed or lost. Consideration may be given to intermittent use of the nuclear and low-emissions energy sources participating in electricity production when such cases increase the value of the whole energy systems as measured by cost-benefit tradeoff of energy that would otherwise be curtailed or lost.

Points of Contact:
Chenlin Li, 208-526-5714, Chenlin.Li@inl.gov
Boryann Liaw, 208-526-3238, Boryann.Liaw@inl.gov

3. ADVANCE DESIGN AND MANUFACTURING

Novel functional, multi-role, and integrated materials systems (i.e., a combination of materials for a function role) and technologies for a wide range of applications have cross-cutting applications to a variety of industries, which range from nuclear power to cybersecurity applications. Materials systems and technologies that use advanced manufacturing for service in extreme environments include in-pile reactor applications[e] and high-temperature, corrosive, abrasive environments, and those subjected to high-energy impact. Nuclear fuels and systems, energy conversion, energy efficiency, power and thermal management distribution and utilization, and defense and space technologies all utilize materials and products from advanced design and manufacturing (ADM) systems. INL is becoming a leading laboratory in ADM and is expanding into applications that support INL missions, including nuclear power, integrated systems, homeland security, and cybersecurity.

Proposals are sought that focus on applied R&D, engineering and manufacturing concepts and demonstration of proof-of-principle for new materials and integrated components that are co-manufactured or joined using novel approaches. Proposals should focus on ideas that have transformational performance characteristics, such as improvements in system weight, efficiency, hardness, strength, toughness, and cost-effectiveness on a relevant scale. These proposals should address the following challenge areas:

- *Pilot and production scale-up ADM development*. Develop and establish a methodology for pilot and production scale-up ADM testing for new or high-value materials.
- *Innovative modeling and simulation of materials under extreme conditions*. Development of innovative M&S capabilities of materials and product fabrication via ADM processes and performance prediction of products in service.
- *M&S and experiments designed using machine learning to support combinatorial science exploration of new materials for extreme environments. e*.g., new nuclear fuel alloys or systems that suppress fuel cladding chemical interactions; armor materials systems; thermal-electrical conversion devices.

---

[e] Proposals involving the development of sensors for nuclear applications that do not relate to the use of novel/advanced manufacturing processes should be submitted under Section 1.3, Deployment of the Nuclear Fuels and Materials Performance Center of Excellence

Making traditionally-accidental materials discoveries a deliberate act by engaging machine learning / AI used in conjunction with M&S informed experiments.

- *Multi-role and integrated materials systems*. Development of armor and materials that have survivability and protection capabilities.
- *Intersection between manufacturing machine code and AI controlled cybersecurity capabilities*. Development and integration of new or modified manufacturing machine codes and enabling of future integration with AI-controlled cybersecurity capabilities.

Researchers are encouraged to contact the designated technical point of contact for additional information and/or clarification. Please refer to Section 1 for information on proposals sought to advance nuclear energy, Section 2 for information on proposals sought to advance integrated energy systems, and Section 4 for information on proposals sought to develop critical national and homeland security capabilities.

Mission Area Point of Contact:
Anne Gaffney, 208-526-6110, Anne.Gaffney@inl.gov

Point of Contact:
Robert O'Brien, 208-533-7580, Robert.OBrien@inl.gov

3.1 Process and Production Scale-up

ADM seeks to develop and establish innovative modeling or experimentation methodologies and systems leading to future unique pilot-testing capabilities or to proof-of-concept demonstration of the scalability of production processes for new or high-value advanced materials. Proposals in this area should focus on obtaining credible science-based data that supports ADM-based fuel designs in anticipation of licensing and commercialization; Energy Systems Laboratory expansion to accommodate ADM at-scale demonstration development; characterization and comparison of property differences between additive manufacturing and conventional methods for fuels and components; and expanded industrial ADM processes through engagement of intensification of throughput and size or format scaling. Example areas of examination might include intensification of field-assisted sintering processes (e.g., spark plasma sintering (SPS) and flash sintering); novel, high-performance nuclear-fuels production and application-specific control strategies and methodologies; mass production of advanced energy materials and products, including supercapacitors, dielectric materials, and capacitive components; production of high-temperature oxidation-resistant and infra-red-reflective or ablative materials; feedstocks, processes, and applications relevant to at-scale production of lightweight, hard, incompressible, and functional graded or joined hybrid material systems for highly abrasive, explosive, shock, or high-impact service; and thermal-energy management materials and devices (e.g., components and integrated assemblies for advanced heat-pipe technologies).

Point of Contact:
Robert O'Brien, 208-533-7580, Robert.OBrien@inl.gov

3.2 Innovative M&S of Materials under Extreme Conditions

Development of innovative M&S of materials and products fabrication via ADM processes is another ADM goal. The continual development of innovative M&S of materials and product fabrication is essential for advancing parts to build from ADM processes. M&S to predict the performance of products in service under operational and postulated abnormal conditions are of extreme interest. The goal of these types of prediction models is to enable process-informed digital design. In addition, these M&S capabilities can be used to predict manufacturing process parameters and determine physical and performance characteristics. The optimization of process parameters can potentially be determined by molecular-scale heat flow dynamics; kinetics approaches to advance insights into chemical, interfacial, and physical interactions; transient electrokinetics to obtain information in electrochemical systems; and time-resolved kinetic spectroscopies to study the behavior of materials under dynamic conditions in real-time and advancing multi-scale M&S and data science.

Proposals are sought for:

- Scaling and fabrication processes, as discussed above
- Testing and characterization of nuclear materials and extreme environments systems manufactured by advanced techniques (e.g., additive or field assisted sintering) with the expanded deployment of advanced nuclear fuels, hardened materials systems, and in-pile sensors[f] to enhance science and engineering data return
- Development and demonstration of a new direct energy conversion instrument or device(s) at TREAT
- Beamline and radiography experiments to determine and process parameters and kinetics to support scaled optimization of multi-role (reactor shielding and ballistic protective) super-hard ultra-incompressible ceramic materials production via SPS electric-field sintering.

Point of Contact:
Richard Martineau, 208-526-2938, Richard.Martineau@inl.gov

3.3 Multi-role and Integrated Materials Systems

Armor and materials that have survivability and protection capabilities are developed to satisfy a growing demand for lighter weight and stronger materials that can protect personnel, vehicles, and infrastructure against emerging threats, including ballistic and explosive threats, to national interests. Revolutionary advancements in manufacturing techniques and material processes are needed to make innovative materials in a cost-competitive manner that enables market adoption. Proposals are sought in the areas of materials science, material process science, large-scale manufacturing methods, and experimentation, including:

- *Functionally graded materials (FGMs) design and manufacturing method*. Functionalities sought include hardness, strength, and toughness, while mechanical features sought would have strongly bonded, variable-thickness multilayers with smooth transitional interfaces between layers and high flexural stiffness.
- *Titanium alloys and related processing science research areas*.
  - Explore and determine whether titanium alloys besides the currently favored Ti-6Al-4V and Ti-10V-2Fe-3Al might be suitable for defense applications. Alternate titanium alloy investigation should include exploring alpha/near-alpha, alpha-beta, beta/near or metastable beta titanium alloys; determining a correlation between specific crystalline microstructure, phases fraction and dynamic behavior, and developing an appropriate thermomechanical process to transform alternate alloys into suitable armor-grade materials.
  - Develop novel welding methods for titanium alloys to prevent ballistic performance degradation due to contamination. Welding process characteristics sought would be suitable for use in a field environment and for fabrication of large complex-shape structures.

[f] Proposals involving the development of sensors for nuclear applications that do not relate to the use of novel/advanced manufacturing processes should be submitted under Section 1.3, Deployment of the Nuclear Fuels and Materials Performance Center of Excellence.

- *High-entropy alloy (HEA) composition design and manufacturing method, applicable for ballistic impact application*. Characteristics sought are high hardness and strength and high toughness combined with low density.
- *Equal-channel angular extrusion (ECAE) process science in manufacturing material with a preferred crystalline/grain or molecular chain orientation to control, deflect or disperse shock wave and/or projectile flight path*.
- Novel designs and manufacturing methods of metamaterial systems capable of absorption, dispersion, or diversion of severe shock created under extreme loading condition.

Point of Contact:
Henry Chu, 208-526-7514, Henry.Chu@inl.gov

3.4 Intersection between Manufacturing Machine Code and AI-controlled Cybersecurity Capabilities

Development and integration of new or modified manufacturing machine codes and enabling future integration with AI-controlled cybersecurity capabilities are sought-for outcomes. Advanced manufacturing technologies are rapidly evolving to high-precision, autonomously controlled process instrumentation that relies on advanced in-process sensors, real-time data acquisition, and physics-based intelligent algorithms—all capable of high-quality performance within application-specific time scales, precision quality, and extreme process environments. Assurance of this high-quality performance will be viable through RD&D breakthroughs that enable high-value, cost-effective protection against cybersecurity and physical threats across the supply chain, process communication networks, and process instrumentation and data. Research of most significant interest will lead to unique M&S methodologies or innovative experimental systems that enable the measurement of the value added from cybersecurity-informed designs, preferably those relevant at the highest-consequence stages of ADM processes. Proposals should address how research will create the critical science-based data for a scaled system or method involving both hardware and software that validate further research in cybersecurity-informed principles and standards.

Proposals are encouraged that address the following areas:

- The combination of cyber intrusion and process-interference detection, coupled to AI-controlled M&S product-performance consequence analysis and part accept-repair-or-terminate action
- Integration with machine code and future integration with AI-controlled cybersecurity capabilities
- Ties to cyber detection that protects the characteristics and process designs
- A holistic approach to cybersecurity-informed design, control, and protection of the input and output of each manufacturing device or instrument
- Unique communication protocols (such as Modbus, BACnet, TCP, etc.)
- Unique application programming interfaces (APIs)

Point of Contact:
Wayne Austad, 208-526-5423, Wayne.Austad@inl.gov

4. DEVELOP CRITICAL NATIONAL AND HOMELAND SECURITY CAPABILITIES

INL's Laboratory Agenda includes the strategic objective "Develop critical national and homeland security capabilities." Achievement of this strategic objective will be dependent upon discovering scientific breakthroughs, developing innovative engineering, and/or demonstrating proof-of-principle of unique technical capabilities or national-security solutions that are aligned with the following:

- *Advance security solutions that prevent, detect, and counter nuclear and radiological threats and support the peaceful use of nuclear energy* - achieved though RDD&D in international safeguards and security of nuclear and radiological materials within nuclear energy production and nuclear fuel lifecycle and detection systems and deterrence methodologies that support national policies for countering the prohibited development and use of weapons of mass destruction.
- *Develop innovative solutions for security and resilience of critical infrastructure that enable government and industry to safely and securely reap the benefits of automation, networked communications, and artificial intelligence across all sectors of critical infrastructure* - achieved through RDD&D in cybersecurity-informed advanced digital instrumentation, controls, and processes; assured wireless communications within dynamic sharing and contested radio frequency spectrum environments; resilient and state-aware energy-delivery systems; and highly skilled, threat-informed, and exercised operators.
- *Enable defense, intelligence, and public-safety organizations with next-generation technologies that support them* - achieved through RDD&D in advanced materials and engineered designs for ballistic and blast protection and threat analyses, detection systems, mission planning, and full-spectrum special-application tools for preparation and execution of mission operations and international agreements.

This section describes LDRD FY-20 research priorities for developing the science foundations and new research capabilities that will prepare INL to conduct the future national security RDD&D needed by DOE, National Nuclear Security Administration, Department of Defense, Department of Homeland Security, intelligence community, and public-safety and emergency-response organizations. The topical areas in this section are primarily dedicated to RD&D that advances the strategic initiatives of INL's lab-wide Cybercore Integration Center, with an understanding that many cyber- and physical security and resilience priorities are also integral to the successful achievement of all of INL's strategic objectives. As a result, proposals addressing topics within this section are encouraged to include multidisciplinary, cross-organizational teams and to describe, when applicable, how the proposed research can enable future innovations in nuclear energy, integrated energy systems, advanced manufacturing, electric-grid modernization, or advanced scientific computing. To optimize a proposal's strategic alignment with the topical areas, it is strongly recommended that researchers discuss concepts with the designated point(s) of contact.

Mission Area Point of Contact:
Steve Hartenstein, 208-526-1967, Steven.Hartenstein@inl.gov

4.1 Cybercore Integration Center (Cybercore)

The ubiquitous implementation of digital command, control, communication, and computing capabilities throughout critical infrastructure, military systems, public-safety systems, and personal devices provides significant economic, safety, and security benefits. As a result of the demand for digital technologies, many of the nation's most vital and critical systems are subject to high-consequence risks from sophisticated, persistent, and high-speed cyberattack. The cyberattacks on the Ukraine power grid demonstrate that attacks on energy infrastructure can move very fast and impact a wide variety of interdependent systems across a region. Also, high-profile events within the U.S. cause increased burdens for utilities and regulators, who must have the capabilities to detect and respond to an attack before it causes unacceptable consequences.

INL, as the recognized lead nuclear energy national laboratory and the national leader in control systems cybersecurity, is advancing Cybercore as integral to INL's critical outcome of "enduring control systems cybersecurity innovation capability for the nation and global transformation to cyber-informed science and engineering.” To achieve the strategic initiatives of this critical outcome, proposals are encouraged in the following areas:

- Near-term needs for experimentation that enables implementation of cyber-informed engineering (CIE) methodologies
- Long-term needs for discovery science and engineering innovations that advance capabilities for reverse engineering
- Research gaps in the development of a risk indicators.

Point of Contact:
Wayne Austad, 208-526-5423, Wayne.Austad@inl.gov

4.1.1 Cyber-informed Engineering

CIE is an INL-developed concept intended to create a paradigm shift to mitigate cyber risk by making cybersecurity an inherent component of the formal engineering design processes and operational culture - beyond the application of market technology too late in the deployment phases. CIE principles seek to establish the basis and methods for enhancing engineering decision making, enabling engineers to design with a cybersecurity-informed perspective. CIE is based upon acknowledgement that: a) cyber-physical processes in a plant or infrastructure are inherently engineered systems, b) for a persistent, targeted attack by a top-tier adversary, all current digital systems can be compromised, and c) CIE solutions are holistic and not limited only to ‘bits and bytes.’ INL intends to develop, experimentally validate, and publish formal CIE methods that optimize the full lifecycles of new cyber-informed designs and operations. Proposals should describe innovative approaches to successfully validate and demonstrate CIE method(s) effectiveness. Proposals of most interest should describe how the resulting research publications will accelerate the transfer of methodologies into academic partners’ engineering education and training curriculum; and how the experimentation will support future longer-term research. Future longer-term research of interest includes and is not limited to: a) experimentation that innovatively collects the science-based data supporting the formal methods and tools that enable CIE engineering standards; and b) innovations in the integration of CIE methods into physics-based and/or risk assessment modeling and simulation applications.

Point of Contact:
Wayne Austad, 208-526-5423, Wayne.Austad@inl.gov

4.1.2 Reverse Engineering

INL seeks to develop automated techniques for reverse engineering of embedded systems and malware at scale, including the integration of the human and computer techniques resulting in knowledge repositories, predictive data analytics, immersive visualization methods, and decision-sciences methodologies. To advance beyond the current general-use, blunt-tools (i.e., manual) methods to perform binary analysis, INL seeks proposals describing research that advances scalable solutions for binary analysis. Proposals might consider leveraging new approaches to cluster-based computation, machine learning, and symbolic execution.

Point of Contact:
Wayne Austad, 208-526-5423, Wayne.Austad@inl.gov

4.1.3 Digital Supply Chain

To pilot and expand formal supply-chain test operation processes, Cybercore seeks innovations with systematic component and critical function analysis, reverse engineering of layered hardware and software, and methods and tools for formal testing environments. Proposals are sought to develop innovations in data analytics with structured repositories for open-source information, test results, threat information, intellectual property, tools, and reporting.

Point of Contact:
Virginia Wright, 208-526-7021, Virginia.Wright@inl.gov

4.1.4 Modeling and Simulation

Cybercore seeks solutions to create innovative scenario-based experimentation environments in which actual designed or fielded systems can be virtualized and combined with high-fidelity cyberattack scenarios generated from realistic malware. With the understanding that there are strengths and limitations in the environments under development or deployed among national laboratories and industry, proposals should address: (1) how the proposed environment's performance functionality is different from other approaches, and (2) the experimentation that will validate the enhanced performance functionality of the proposed environment relative to these other systems. Proposals should describe the collaborative partnerships needed to advance the novelty of the concept and strategies for transitioning the environment for scaled deployment. When applicable, proposals also should describe how the approach will leverage and extend INL strengths in physics-based effects modeling, critical engineering risk analysis, interdependency analysis, and the unique protocols and behaviors of control-system networks and physical sensors. Proposals of most interest will describe systems that can eventually be integrated with the learning environments of the new Idaho Research and Education ecosystem that will link to Cybercore's regional and national partners and network with data from experimentation systems (e.g., INL's Critical Infrastructure Test Range Complex).

Point of Contact:
Shane Cherry, 208-526-1438, Shane.Cherry@inl.gov

4.1.5 Resilience and Cyber Risk Analysis

4.1.5.1 Resilience metrics

For the advancement of resilient systems, Cybercore seeks novel approaches focused on the development of situational- and state-awareness systems and human-machine methods for maximizing cyber- and physical performance of resilient systems. This research area explores discoveries and solutions that advance cyber- and physical-resilience metrics for the various hierarchies and control architectures in complex systems of systems and advances appropriately defined performance measures that can be validated and integrated into larger architectures and technology innovations (e.g., modern grid architecture). Proposals of most interest will leverage out-of-band cyber-physical sensing techniques for critical-field protection devices and develop new interfaces for integration into well-defined resilient-response architectures.

Point of Contact:
Craig Rieger, 208-526-4136, Craig.Rieger@inl.gov

4.1.5.2 Integrated all-hazards vulnerability assessments and impact analysis

Critical infrastructure stakeholders require advanced knowledge-discovery tools and reliable decision-support methodologies to improve capabilities to conduct vulnerability assessments, to identify infrastructure interdependencies, and to perform consequence analyses of natural and manmade threats to operational technology systems. Proposals are sought for concepts leading to advances in decision-science areas related to vulnerability discoveries and consequence analyses that simplify and improve predictive and real-time decision support in response to all-hazards security and situational awareness. Proposals of most interest will include experimentation that demonstrates measurable improvements in effective stakeholder decisions in response to multiple threats and potential cascading impacts.

Point of Contact:
Ron Fisher, 208-526-5630, Ron.Fisher@inl.gov

4.1.6 Advanced Learning Methodologies and Capabilities

Many organizations within the U.S. government, industry, national laboratories, and universities are seeking novel capabilities to conduct research and testing on transformational approaches that accelerate human skills-development and operational-response capabilities through highly relevant and effective cybersecurity training and education. To develop an INL science base for future design and implementation of effective training and learning environments, proposals should focus on research or proof-of-principle demonstration of live, virtual, constructive, or gaming innovations that optimize capabilities for cybersecurity skills development. Proposals of greatest interest will describe how the research advances capabilities to develop, observe, and assess highly effective behavior patterns of personnel under simulated situations of cybersecurity crisis response.

Point of Contact:
Ralph Ley, 208-526-4551, Ralph.Ley@inl.gov

4.2 Electric Grid and Energy Infrastructure Protection

INL has unique capabilities through the integration of powered wireless industrial control systems and cybersecurity research expertise, together with modeling, experimentation equipment, and full-scale testing. These capabilities enable researchers to understand interoperability, failure, resilience, and recovery, all to protect the power grid from natural phenomena and physical and cyberattack. Proposals are sought that focus on novel approaches to facilitate stakeholder decisions by characterizing and prioritizing relevant cyber- and physical threats to the grid, to secure mission-critical energy assets, to verify and validate solutions that improve dynamic grid resiliency, disaster recovery, and grid stability, or to integrate innovative grid data-analytics methods with operational data for predicting and responding to new grid behaviors that mitigate cyber- and physical vulnerabilities. Proposals of most interest will describe cyber- and physical experimentation utilizing INL's test-scale facilities and will improve the accuracy and fidelity of physics-based M&S tools.

Point of Contact:
Scott McBride, 208-526-5878, Scott.McBride2@inl.gov

4.3 Improved Connectivity through Wireless Communications

The nation's critical infrastructure systems increasingly rely on secure and resilient wireless connectivity. This requires RD&D of next-generation communications systems for advancing throughput, quality-of-service, system integration, compatibility, information integrity, and security. Proposals in this area should focus on novel approaches for analyzing, detecting, evaluating, and improving future-generation wireless communications through novel advances in wireless communications for large-scale infrastructure (including systems such as smart-grid installations, drones, remote sensors, massively distributed IoT, etc.). Proposals of most interest will address radio-frequency-spectrum modeling, system prototyping, and testing of secure spectrum technologies applicable to the 5G wireless standards and beyond in a frequency range above 6 GHz.

Point of Contact:
Arup Bhuyan, 208-526-2460, Arupjyoti.Bhuyan@inl.gov

RECOMMENDATIONS FOR SUCCESSFUL LDRD PROPOSALS

Submitted proposals should address specific scientific and technical challenges within the topic areas described above. Proposals should also describe how the proposed work may fill gaps in INL's current-mission research portfolio, strengthen INL's core capabilities and recognized position within the scientific and engineering field, lead to publications and intellectual property, strengthen strategic collaborations, ensure programmatic growth, and increase our market share. The proposals should clearly describe how the proposed work takes advantage of capabilities and resources across INL and builds on INL's long-standing strengths of interdisciplinary research and use-inspired basic and applied science.

Researchers are strongly encouraged to discuss their proposal concept with their division director and the point of contact identified in the proposal for the applicable topic area early in the process (i.e., before submission of the pre-proposal.) The points of contact are identified to guide researchers in developing their concepts into pre- and full proposals that are optimally aligned with strategic objectives and research priorities, providing PIs with the best opportunities for success.

PIs are encouraged to build on INL strengths and facilities (MFC, ATR/ATR-Critical, TREAT, Critical Infrastructure Test Range Complex, etc.,) and integrate, when and where appropriate, advanced scientific computational and data-analysis methods. Successful LDRD proposals will (1) address a specific scientific and application area challenge, considering requirements from mission stakeholders and the scientific community, (2) describe how the proposed approach is innovative and how successful outcomes will position INL for a leadership role (e.g., enhancing core capabilities, knowledge, partnerships, intellectual property, etc.), and (3) provide a plan for developing future RD&D proposals that will sustain and grow the effort beyond the initial LDRD investment period.

FY-20 ANNUAL LDRD CALL FOR PROPOSALS—KEY DATES

The full calendar, including information for continuing projects, is available on the LDRD website.

Date (2019)	Task
January 24	**FY-20 Annual LDRD Call for Proposals opens.** **8–11 am, INL meeting room, EIL A102: Deputy Laboratory Director for Science and Technology (DLD-ST) and Associate Laboratory Directors (ALDs) communicate FY-20 call, proposal requirements, process changes, etc.**
February 28	**Deadline for submittal of pre-proposals by principle investigators (PIs) to LOI-ESS.**
February 28–March 8	Administrative review comments to PIs for revised pre-proposal data/input.
March 8–28	Strategic objective committee reviews pre-proposals, and committees meet to discuss pre-proposal scores and recommendations. PIs may be asked to provide additional information to answer questions from the strategic objective committees. **Committee reviews for pre-proposals will not include a presentation by the PI.**

Date (2019)	Task
April 01–05	Strategic objective committees develop recommendations of a short list of pre-proposals for full proposal development.
By April 5th	Chairs of strategic objective committees, MAPOCs, and LDRD program director finalize recommendations and complete entering comments into LOI-ESS.
April 9	**ALDs, strategic objective committee chairs, and LDRD program director meet with DLD-ST to review committee recommendations and get approval for the list of pre-proposals selected for full proposal development.**
April 10–11	LDRD Office notifies PIs of selections and invites those selected to develop full proposals.
May 13	**Deadline for submittal of full proposals by PIs to LOI-ESS.**
May 23–July 1	LDRD Office releases full proposal comments to PIs and strategic objective committee review members.
July 8–18	**New proposals review:** Presentations take place for each new proposal. Reviews are set up for proposals within each strategic objective. After presentations are complete, strategic objective committees finalize scores and summary comments for new proposals.
July 22–26	LDRD program director and strategic objective committee chairs develop recommendations for FY-20 investment, decision package, and presentation for investment portfolio.
July 30	**Strategic objective committee chairs, ALDs, and LDRD program director meet with the DLD-ST to review FY-20 recommendations and develop final list of approved FY-20 projects with associated budgets.**
July 31–August 8	LDRD Office communicates FY-20 **funding decisions** to PIs and also requests proposal revision (if necessary) based on review comments. MAPOCs and committee members provide feedback to PIs.
August 15	Deadline for PIs to submit revised proposals to LOI-ESS (if so instructed by strategic objective committee). LDRD office submits FY-20 projects for DOE-ID concurrence review.
October 1–15	Meet FY-20 PIs and begin opening FY-20 LDRD project accounts.