DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-19-027

SECTION A. Project Title: Advanced Design and Manufacturing Equipment Procurement and Installation

SECTION B. Project Description and Purpose:

The advanced design and manufacturing for harsh environments research initiative at Idaho National Laboratory (INL) focuses on research and development (R&D) on advanced manufacturing solutions for materials used in demanding or harsh environments to mitigate risk in advanced nuclear reactors, design and operation of Integrated Energy Systems (IES), defense systems, and space applications. INL's advanced manufacturing effort encompasses advanced computer science, visualization and data, applied materials science and engineering, biological and bioprocess engineering, chemical and molecular science, chemical engineering, condensed matter physics and materials science, cyber and information science, large-scale facilities/R&D facilities/advanced instrumentation, mechanical engineering and design, and nuclear engineering.

The advanced manufacturing effort will use facilities at the Research and Education Campus (REC) and facilities at the Materials and Fuels Complex (MFC) to perform:

- process discovery and development
- R&D design
- mockup
- fabrication
- testing
- analysis
- intensification and scale-up studies.

To support advanced manufacturing techniques, INL will utilize computer-aided drawing, engineering and manufacturing, high performance computing, additive-manufacturing processes, novel fabrication and joining processes, advanced robotics and other intelligent production systems, control systems to monitor processes and advanced platform technologies to manufacture composite materials. The Advanced Manufacturing effort also includes the Process Demonstration Unit (PDU) as a carbon feedstock resource, the Transient Analysis Products (TAP) transient kinetics research facility, catalyst and fuel cell research laboratories, development, design and manufacturing, and polymer and membrane development.

This research area includes (1) nuclear, chemical, microstructural, and physical properties; (2) reduction or tailoring residual stresses, especially in complex geometries; (3) functionally graded materials targeted at eliminating dissimilar-metal welds in the joining process; and (4) increasing the instrumentation, control, and monitoring of advanced fabrication methods to systematically control and manipulate material compositions and microstructures down to the atomic level. The Advanced Manufacturing for Harsh Environments (ADMHE) initiative also develops and deploys in-pile sensors and instrumentation to support scientific and engineering data-return.

Materials Science and Engineering R&D involving nuclear materials evaluates radiation effects on thermal transport, mass transport, and mechanical behavior of materials. These efforts focus on material behavior in harsh environments like nuclear reactors and radiation, temperature extremes, and chemical environments such as exposure to corrosives. The materials science departments validate structural materials and computational models for existing and advanced nuclear systems to develop standards and codes. Nuclear materials R&D activities are generally performed at MFC or the INL Site, and these efforts have been evaluated in separate National Environmental Policy Act (NEPA) reviews.

To support the ability to develop and test advanced manufacturing techniques, equipment such as computer technologies (e.g., computer-aided drawing, engineering, and manufacturing), high performance computing for materials science and analysis; additive-manufacturing processes; novel fabrication and joining processes; advanced robotics and other intelligent production systems; control systems to monitor processes; and advanced platform technologies to manufacture composite materials needs to be procured and installed or relocated to other laboratories at REC.

Advanced Manufacturing R&D efforts at INL include the following:

<u>Welding and Joining</u>: MS&E performs physics-based creep simulations of thick section welds in high temperature and pressure applications and monitors and controls the Hybrid Laser-Gas Metal-Arc Welding process. Research efforts in this area evaluate 1) thermochemical material processing using rolling mill equipment and power metallurgy hot isostatic press (PM-HIP) capabilities for metal and composite materials, 2) spray forming, 3) composite materials (e.g., ultra-long chain carbon nano-tube), and 4) dissimilar metal joining capabilities (e.g., Al, Mg, Ti to steels), filler metal designs, hybrid laser welding, and friction stir welding.

<u>Thermal spray</u>: R&D evaluates metallic and ceramic coating on various size and geometry substrates and measures thermal sprayed particle velocity, size and temperature for correlation to spray parameters and coating characteristics.

<u>Nondestructive evaluation</u>: The advanced manufacturing program performs non-destructive materials evaluations using X-ray, ultrasonic, and eddy current methods. MS&E has developed quantitative capabilities in 3D materials characterization used by multiple fuels and high temperature materials programs. X-ray CT capabilities are scalable in resolution and X-ray energy.

<u>Chemical agent munitions and storage container inspection</u>: The MS&E department develops and operates field-portable X-ray inspections systems for the Army and non-stockpile material.

Environmental Effects Lab: Advanced Manufacturing R&D efforts at the Environmental Effects Laboratory evaluate hydriding and de-hydriding neodymium based magnet materials under the Critical Materials Institute (CMI) and study the effects of corrosive environments on various materials. Environmental effects testing capabilities include a Q-fog cyclic corrosion chamber, environmental chamber, and Q-UV accelerated weathering chamber.

The Advanced Manufacturing program maintains the following capabilities:

- Nine Electro-Mechanical Load Frames for tensile testing and stress corrosion cracking testing.
- Four Servo-Electric Load Frames for crack growth monitoring
- Eleven Servo-Hydraulic Load Frames
- Environmental chamber with high vacuum and controlled chemistry
- Different extensometers and gripping methods
- Three-zone and induction coil heating systems
- Twenty-one Lever Arm Creep Load Frames equipped with three zone resistance furnaces capable of reaching 1200 °C
- Up to 20:1 lever arm for high stresses
- Two INL Rebuilt Stress-Relaxation Systems
- Geeble System to evaluate tensile, torsion loading (and variants) with heating rates up to 1000 °C/s
- Electron backscatter diffraction (EBSD), scanning electron microscopy (SEM), and transmission electron microscopy (TEM).

The additive-manufacturing processes for metal (powder, rod, wire, sheet, block and other forms, e.g., stainless steels, aluminum, steel, brass, copper, bronze, titanium, platinum and their oxide forms), ceramics (e.g., $La_{0.7}$, $Sr_{0.3,}$ MnO_3- and YBa_2Cu3O_7−x-based) and polymers (fundamental chemical species ethane to polyethylene polymeric materials) joining include these possible options:

- 3 D Three-dimensional additive manufacturing/printing systems
- Field assisted sintering
- Direct digital manufacturing systems
- Direct metal laser sintering systems
- Electron beam powder bed systems
- Electron beam free form fabrication systems
- Free form fabrication systems
- Hot isotactic press systems
- Laser additive manufacturing systems
- Laser beam powder bed systems
- Laser engineered net shaping systems
- Plasma transferred arc selected free form fabrication systems
- Selective laser melting
- Selective laser sintering
- Shaped metal deposition
- Wire and arc additive manufacturing
- Wire fed laser beam
- Capillary spinning.

Fabrication and joining processes require intelligent quality control using advanced robotics and control systems to monitor processes, creating novel powders, wire feed options, and feedstocks development.

Post fabrication and joining uses a broad array of analytical and characterization instrumentation at the Materials and Fuels Complex and Research and Education Campus (REC). Other analytical equipment that may be needed includes:

- Molecular mass spectrometry and chromatography
  - Electrospray Ionization Quadrupole Time-of-flight mass spectrometer (QTOFMS)
  - Triple quad mass spectrometer (TQMS)
  - Ion trap mass spectrometer (ITMS)
  - High and Ultra High-Pressure Liquid Chromatography (HPLC and UHPLC)
  - Ion chromatography with conductivity, UV-Vis, and electrochemical detection
  - HPLC/UPLC with UV-Vis, refractive index, and mass spectrometric detection
  - Gas Chromatography with FID, TC, mass spectrometric and other detectors.
- Molecular spectroscopy
  - Fourier Transform Infrared and Raman (FTIR and FT Raman)
    - Attenuated total reflectance (ATR)
    - Photoacoustic
    - IR and Raman Microscopy
    - Gas cells
  - Ultraviolet-visible-near infrared (UV-Vis-NIR)
  - Fluorescence
  - Nuclear Magnetic Resonance (NMR)
    - 400 and 600 MHz multinuclear spectrometers

        - Liquid and solids probes
- Elemental analysis
    - Inductively coupled plasma optical emission and mass spectrometry (ICPOES and ICPMS)
    - Microwave digestion
    - LIBS
    - CHNSO
- Radioanalytical chemistry
    - Elemental separations
    - Alpha spectroscopy
    - Liquid scintillation counting (LSC)
    - Gas-proportional counting (i.e. gross alpha/beta)
- Radiation measurements
    - Gamma spectroscopy
    - Neutron dosimetry
    - Gross Alpha-Beta Measurements
- Other
    - Scanning electron microscopy (SEM)
    - X-Ray diffraction (XRD)
    - Thermal analysis suite (TGA, DSC, DTA, DMA)
    - Particle size analysis
    - Bomb calorimetry
    - Pycnometry.

Equipment proposed includes additive processes based on Laser direct energy deposition, Hybrid Laser Tig-wire fed systems, Spark Plasma Sintering and high temperature reaction synthesis including bakeout and carborization of materials at temperatures up to 3000K at REC. The following materials will be processed:

- High temperature and refractory metals (W,Ta,Mo, Re, Zr Ti)
- Stainless steels and steel alloys (316, 304, Inconel 718)
- Ceramics (ZrO_2, B_6O, WB_4, Al_2O_3, SiC, B_4C).

Quantities of each material to be processed is anticipated to be less than 500Kg each.

The strategy for Advanced Manufacturing at INL builds and improves core competencies and introduces new and revitalized R&D capabilities. The scope of work maintains and improves infrastructure and equipment needed for safe operations and supplies state-of-the-art research instrumentation and capabilities. This environmental checklist (EC) covers mission enabling infrastructure improvements, and procurement, installation, and operation of the items listed above. Equipment and instrumentation not listed may require program or project specific ECs or revision of this EC. The scope of work does not include activities that generate TRU waste. Activities that generate TRU waste must have project specific NEPA review.

To support these efforts, INL must address infrastructure needs. Upgrades to the Energy Innovation Laboratory (EIL), Energy Systems Laboratory, and CAES capabilities may be needed. Heating, Ventilation, and Air Conditioning (HVAC) ducting may need reconfiguring, and air conditioning systems for cooling electronic equipment may be required. Equipment installation includes electrical system modifications, installing sound proofing materials, and installing supply and return air ductwork. The scope of work includes removal and disposition of old equipment and facility components. Sources contributing to air emissions require an air permitting applicability determination (APAD).

Based on INL priorities, some activities in this environmental checklist (EC) will not be completed or funded and other activities could be added. Individual projects will be reviewed by the Program Environmental Lead (PEL) and/or the NEPA Technical Lead to verify scope is covered by this NEPA analysis. In addition, this EC will be reviewed and updated on an annual basis.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Project activities have the potential to release hazardous and chemical contaminants into the air. Regulatory requirements will be determined prior to commencing modification of facilities using the APAD process.

Subcontractors may bring mobile generators, welders and compressors on-site during construction. Equipment must meet the visible emissions/opacity requirements or will be shut down and repaired or removed from the facility. These non-road sources will be used at project locations for less than a year.

Work may result in the disturbance or removal of asbestos.

Project activities have the potential to release refrigerants and greenhouse gases.

Generating and Managing Waste

Industrial waste in the form of scrap wood, scrap metal, packaging material, Resource Conservation and Recovery Act (RCRA) empty chemical containers, rags, insulation, wire, carpet scrap, tile scrap, drywall, pipe scrap, etc., will be generated during the project.

Hazardous waste generation has the potential to be generated from paint waste, adhesive waste, cleaning solvents, and spill material.

All waste generated during the project will be characterized, stored, and disposed at the direction of Waste Generator Services (WGS).

Releasing Contaminants

Chemicals will be used and will be submitted to chemical inventory lists with associated Safety Data Sheets (SDSs) for approval prior to use. The Facility Chemical Coordinator will enter these chemicals into the INL Chemical Management Database. All chemicals will be managed in accordance with laboratory procedures. When dispositioning surplus chemicals, project personnel must contact the facility Chemical Coordinator for disposition instructions.

Although not anticipated, there is a potential for spills when using chemicals. In the event of a spill, notify facility PEL. If the PEL cannot be contacted, report the release to the Spill Notification Team (208-241-6400). Clean up the spill and turn over spill cleanup materials to WGS.

Using, Reusing, and Conserving Natural Resources

All applicable waste would be diverted from disposal in the landfill when possible. Program personnel would use every opportunity to recycle, reuse, and recover materials and divert waste from the landfill when possible. The program would practice sustainable acquisition, as appropriate and practicable, by procuring construction materials that are energy efficient, water efficient, are bio-based in content, environmentally preferable, non-ozone depleting, have recycled content, and are non-toxic or less-toxic alternatives.

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, items B3.6, "Small-scale research and development, laboratory operations, and pilot projects" and B1.31 "Equipment installation."

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;" and

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 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."

Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) ☐ Yes ☒ No

Approved by Jason Sturm, DOE-ID NEPA Compliance Officer on: 4/30/2019