DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-19-088 R1

SECTION A. Project Title: TREAT Sodium Loop Cartridge R1

SECTION B. Project Description and Purpose:

Revision 1:

The TREAT Facility will perform sodium loop testing on engineering-scale experiments scheduled to begin in fiscal year (FY) 2023. These experiments will simulate design basis accidents and beyond design basis accidents on both fresh and pre-irradiated fuel specimens. The sodium loop tests will provide a prototypic testing of thermal-hydraulic conditions in a liquid sodium environment for fuel safety research and licensing data to be obtained for advanced fuel designs. This sodium loop testing will require various support equipment and infrastructure modifications to be completed to re-establish the capabilities to load, handle, unload, and perform post-irradiation examination (PIE) on sodium loop test trains that are irradiated in the TREAT reactor. The various support equipment and infrastructure modifications are discussed below.

This project has been a joint effort between INL and TerraPower. TerraPower was responsible for the design, fabrication, and testing of 2 prototype loops originally named Test Loop and Prototype Loop.

INL is responsible for designing, fabricating, and testing the final version of the sodium loop (i.e., NLC) which was originally referred to as the Reactor-Ready Loop. During design of this final loop the name was changed to the Mk-IIIR Sodium Loop to avoid confusion.

Hot Fuel Examination Facility (HFEF) Handling Infrastructure Preparations to handle the NLC in HFEF are required to enable testing fuel specimens. These preparations include engineering fixtures, equipment, and remotely-operated machines and tools. These components would be used to load pre-irradiated test specimens into a new TREAT Sodium Loop Cartridge (NLC) Irradiation System, and then ship those tests to the TREAT facility for irradiation. These activities also include establishing the capabilities at HFEF to receive irradiated sodium loop tests from the TREAT facility and perform both non-destructive and destructive post-irradiation examination on these specimens. Highlighted components/equipment include a test train assembly machine that builds experiment test trains out of previously irradiated fuel pins, and a sectioning saw that enables examination of disrupted fuel pins and test trains.

Sodium Charging and Loop Checkout Station TerraPower is constructing (or has constructed) two sodium loops in support of the Mk-IIIR project. The first loop, a sodium Test Loop, is capable of testing non-fueled experiment test trains, sodium pumps, and instrumentation and control equipment (e.g., flowmeters and pressure transducers). The second loop is the Prototype Loop, which is a flowing sodium loop with geometry similar to the final Mk-IIIR sodium loop. Both loops support R&D activities for the Mk-IIIR loop, but have utility as testing (e.g., hydraulic testing) and training platforms for the Mk-IIIR loop. Following R&D activities, both loops will be shipped to INL. These loops will be installed and housed at the Idaho Engineering Demonstration Facility (IEDF) where out-of-pile testing of components can occur. The IEDF will require equipment and infrastructure to support this loop. This equipment and infrastructure would include loop stands, sodium holding tank, and a test train loading/withdrawal fixture. Also, the IEDF will be the location of sodium loop assembly and sodium loading for fresh fuel tests. Sodium handling equipment will be needed for these functions. Furthermore, procedures and training for the handling of the test loops and for general sodium handling will be developed.

HFEF-15 Cask Preparations Modifications to the HFEF-15 cask are required to allow the installation, transport, and removal of the newly designed TREAT NLC Irradiation System.

Commissioning Tests Commissioning tests at TREAT are needed to verify system performance in full integration and environmental conditions. The scope of the commissioning tests includes design of fuel test, test train hardware fabrication, hydraulic characterization of test train, test train assembly, loop insertion, transient irradiations, post-transient exams, and final reporting. These tests will to be performed with unirradiated and pre-irradiated fuel to fully commission the capability.

TREAT Facility Equipment and Hardware Various fixtures and equipment within the TREAT facility will be necessary to successfully operate the NLC Irradiation System. Some equipment is new and will require design and fabrication. Some of the equipment exists from legacy loop testing but will still require modification to accommodate the NLC Irradiation System. These pieces of equipment include:

- loop storage/inspection fixtures,
- sodium holding tank,
- loop control console,
- loop calibration test trains,
- test train handling and assembly fixture,
- test train loading/withdrawal fixture,
- sodium drain/fill flange,
- loop handling cask modifications,
- loop monitoring and safety equipment,

- storage hole fixtures,
- upgrade TREAT loop handling cask,
- sodium loop shipping container,
- sodium drain fill flange,
- cask/reactor alignment fixtures,
- cask rigging change station,
- loop lifting fixture,
- test pit,
- radiography stand,
- test train handling tube,
- sodium filter assembly, and
- a loop hold down mechanism.

This scope would also provide the ability for a fresh fuel test train to be loaded and removed at TREAT rather than HFEF, reducing experiment assembly and disassembly time and increasing throughput.

Original:

Researchers use the Transient Reactor Test (TREAT) facility at Idaho National Laboratory (INL) to induce nuclear heating in experiments to simulate power cooling mismatch conditions in nuclear reactors. These types of experiments, known as transient tests, expose engineering-scale specimens to conditions simulating postulated accidents in nuclear power plants.

The TREAT reactor-ready sodium loop cartridge (RR-NLC) supports configurations for conducting liquid metal-cooled fuel safety research experiments with up to seven uranium or plutonium-bearing fresh or pre-irradiated fuel pins. The RR-NLC offers prototypic liquid metal-cooled fast reactor thermal-hydraulic conditions, supplies heating and sodium re-melt capabilities, facilitates using test fuel motion diagnostics, supports test instrumentation, and contains experiment associated hazards.

The RR-NLC will serve multiple missions. However, this environmental checklist (EC) covers one experiment module configuration to house the seven fuel pin bundle. This bundle configuration serves as the limiting dimension for the loop test section. This bundle holder can be readily replaced with several different experiment holder configurations. This EC only covers designing, fabricating, prototype testing, and installing the RR-NLC. Projects using the RR_NLC require project specific ECs. The RR-NLC enables integral effects irradiation tests pertaining to fuel safety research for liquid metal cooled reactor specimens. In-situ instrumentation and post irradiation examination (PIE) deliver test data. TerraPower, LLC will design, fabricate, and test the prototype of the RR-NLC. The prototype NLC will be operated at TerraPower facilities and will be tested to show compliance to design requirements, aid in defining operating procedures for the RR-NLC, create an operator training platform, and demonstrate expected performance characteristics. The project will then move the functional loop cartridge to INL facilities after completing prototype testing. Testing the prototype loops involves developing and finalizing operating procedures and includes shakedown testing, which involves a variety of system and component tests on the test loop. Design activities and operating procedures incorporate these test results. Shakedown testing includes the following activities:

- Filling the loop, including sodium cleanup
- Pre-heating the loop
- Checking loop instrumentation
- Starting (including restart), controlling (including flowrate transients), and shutting down the pump
- Managing loop enclosure heat, including pump cooling if applicable
- Operating the loop over a range of temperatures and flows
- Checking loop data acquisition
- Demonstrating loop safety interlock (loop pressure, loop temperature, pump temperature, electric load, etc.)
- Shutting down and cooling the loop
- Inserting and withdrawing the test section from the loop.

Successful testing contributes to producing the equipment specification needed for procuring and deploying a fully capable RR-NLC.

The original EC covers designing and fabricating the functional RR-NLC including activities listed below:

- Procuring critical components
- Fabricating safety-grade loop for TREAT insertion

- Sodium conditioning of reactor-ready loop
- Delivering reactor-ready loop to TREAT.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

The proposed action has the potential to generate radiological emissions from irradiation in TREAT. Air emissions are anticipated to be minor, and emissions from this project are not likely to cause an increase above the currently monitored air emissions. An Air Permit Applicability Determination (APAD) would not be required.

Discharging to Surface-, Storm-, or Ground Water

N/A

Disturbing Cultural or Biological Resources

The proposed action is a federal undertaking defined in 36 CFR 800.16(y), and although it is the type of activity that has the potential to cause effects to historic properties, it is excluded from Section 106 review per MCP-8008, Appendix B. The proposed action is excluded under Activity Type 8: Internal Reconfiguration of Active Laboratories, because the proposed scope of work includes several small modifications to HFEF (MFC-785; eligible) and TREAT (MFC-720; eligible) to accommodate sodium loop testing on engineering-scale experiments. Therefore, there are no further obligations under Section 106. No CRR is required.

Generating and Managing Waste

The proposed action will generate a variety of waste streams, including industrial, radioactive and/or mixed waste. Industrial waste may include scrap metal, wiring, adhesives, and common trash. Scrap metal will be recycled to the extent possible. Demolition of existing equipment will result in the generation of contaminated waste, which could include mixed hazardous waste (i.e., lead paint). Operating the RR-NLC will generate radioactive waste, including radioactive sodium. The total quantity of sodium inside the NLC is estimated at 2 liters. The waste streams generated have the potential to be remote handled or contact handled low-level waste and remote handled and contact handled mixed waste. It is estimated that approximately 192 cubic feet of radiological waste could be generated, which could include hazardous waste based on waste determination of lead-based paint. Remote handled or contact handled mixed waste is estimated to be approximately 0.1 cubic feet (~2 liters) of sodium contaminated waste. Project personnel will consult the INL Waste Management Program and MFC Waste Generator Services staff for characterization and disposition pathway analysis for all waste prior to generation. The waste generated during the project is expected to be dispositioned using mature pathways in quantities that are readily manageable by WGS.

Releasing Contaminants

Whenever chemicals are used there is a potential to spill to soil, water, or the air.

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.

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 B1.24, "Property transfers", B1.31, "Installation or relocation of machinery and equipment", and B3.6, "Small-scale research and development, laboratory operations, and pilot projects."

Justification:

The proposed R&D activities are consistent with CX 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;"

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;" and

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); and 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 or developed 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."

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

Approved by Jason L. Anderson, DOE-ID NEPA Compliance Officer on: 08/26/2022