DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-22-073

SECTION A. Project Title: (JAEA) Drop-In Capsule Light-Water Reactor Fuels Testing in Idaho National Laboratory's Advanced Test Reactor

SECTION B. Project Description and Purpose:

The Japan Atomic Energy Agency (JAEA – Participant 1) is an independent administrative institution within the government of Japan. The mission of JAEA is to contribute to the welfare and prosperity of human society through nuclear science and technology as Japan's sole comprehensive nuclear research and development institution. Hitachi-GE, plant provider, and Global Nuclear Fuel-Japan (GNF-J), fuel vender, are currently developing FeCrAl-ODS cladding for use in its light water reactor fuel assemblies under the cooperation of Nippon Nuclear Fuel Development (NFD). Hitachi-GE is the representative of this development conducted by HGNE, GNF-J and NFD as a Hitachi-Consortium.

INL is the nation's lead laboratory for nuclear energy research, development, demonstration, and deployment, controlled by DOE. The purpose of this Cooperative Research and Development Agreement (CRADA) is to support collaboration between INL JAEA and Hitachi-Consortium, on the development of the FeCrAl-ODS cladding. INL will principally support JAEA and Hitachi-Consortium by conducting irradiation experiments and post irradiation examinations on the FeCrAl-ODS cladding in INL. Collaboration on the project in this CRADA furthers the goals of the U.S. DOE's Accident Tolerant Fuel (ATF) Program as well as the U.S. – Japan Civil Nuclear Working Group (CNWG) agreement.

Three rodlets containing Uranium dioxide (UO2) fuel with FeCrAl-ODS cladding will be irradiated in the Advanced Test Reactor (ATR) of INL. The ATR is a water-cooled plate-type materials test reactor that first achieved criticality in 1967. The fuel plates are curved and placed in a serpentine arrangement that create nine flux traps. The reactor is approximately 1.3 meters tall and 1.3 meters in diameter and is cooled with a top-down flow of pressurized water at approximately 4-5 bars of pressure and an inlet temperature of 55°C. Power in each of the four quadrants is controlled independently, with a maximum power split between any of the four quadrants of 3:1. Normal reactor cycles consist of 60-day runs with a nominal power of ~150 MW, with limited power splits between the four quadrants. Peak flux levels during these cycles are 4e14 n/cm2-s thermal and 2e14 n/cm2-s fast (>1MeV).

Following irradiation, the cladding will be non-destructively and destructively examined at INL's Hot Fuels Examination Facility (HFEF). HFEF is a large open hot cell with a single division between an air side which is mostly used for decontamination and a larger fully inert side. Various stations in the inert hot cell provide for a wide range of nondestructive and destructive examinations to take place on irradiated materials.

Project Management, Reporting, and Administration:

- INL will provide oversight, project management and administrative support.
- INL will provide interim progress reports and a final report with PIE results.

Experiment Design and Analysis:

- INL will perform design and analysis of the experiment.
- GNF-J will perform thermal-mechanical analysis and review for design of rodlets.
- NFD and GNF-J will summarize datasets of material properties for analysis.

Procurement, Fabrication and ATR Waste Disposition:

- INL will procure the UO2 fuel per JAEA/Hitachi-Consortium request.
- Hitachi-GE will provide 10 meters of FeCrAl-ODS cladding and 5 meters of round bar for the welding development and final assembly.
- INL will perform waste disposition.

Weld Development and Rodlet Assembly:

- INL will perform weld development for final assembly.
- NFD will provide background experimental data of welding and review the weld development.
- INL will perform final assembly and qualification of the rodlets.

ATR Cycle-Specific Analyses:

- INL will irradiate the experiment in ATR and perform cycle specific analyses.

Irradiated Rodlet Shipments:

- INL will ship the irradiated rodlets upon reaching the target burnup to Materials and Fuels Complex (MFC).

Post-Irradiated Examinations (PIE):

- INL will perform Post-Irradiated Examinations (PIE), both non-destructive and destructive testing in HFEF.
- JAEA and NFD will review the plan and results of the PIE and, if necessary, provide suggestions of PIE methods.

Tasks

The irradiation testing and PIE of the FeCrAl-ODS cladding project is broken down into five principal tasks each of which are articulated below.

Task 0. Project Management, Reporting, and Administration

INL will provide project management and reporting through the life cycle of the project.

Task 1. Design of JAEA/ Hitachi-Consortium Experiment

The FeCrAl-ODS cladding to be provided by Hitachi-GE has an outer diameter that is slightly larger than the Pressurized Water Reactor (PWR) specimens that have been irradiated in the Acceptance Test Facility (ATF)-2 program. The design will be analyzed to establish the operating limits that meet ATR Safety Analysis Report (SAR) requirements. The NFD and GNF-J will summarize datasets of material properties of FeCrAl-ODS to be necessary for analysis to be conducted in Task 1. By using the datasets, the GNF-J will identify adequate pellet-clad gaps to meet the goal of this irradiation test by the thermal-mechanical analysis. GNF-J will review the rodlets design prior to the final approval of INL.

Task 2. JAEA/Hitachi-Consortium Experiment Fabrication, Weld Development, Experiment Assembly, and Waste Disposition

Hitachi-GE will supply INL with fuel cladding and bar segments of the appropriate dimension and all paperwork necessary to establish material traceability. INL will use this material for:

- Mechanical and chemical testing of both materials
- Weld development
- Weld qualification samples
- Rodlet hardware including adequate mockup and spare parts

NFD will provide background experimental data of welding and review the weld development to be conducted by INL.

INL will supply fuel pellets which it will procure from a U.S. commercial fuel vendor. The fuel pellets will be loaded into the cladding and all endcaps will be fitted onto the pins at INL. While the experiment will only irradiate three pins, four pins will be fabricated to mitigate risk. Pins will undergo various inspections (including radiography and helium leak checks) prior to insertion to ensure acceptability of the welds and that the fuel pin is holding the back pressure with no leaks. Pins will then be loaded into the test assembly for irradiation.

INL shall dispose of waste as required through all phases of the project, including FeCrAl-ODS cladding and round bar provided by Hitachi-GE.

Task 3. Irradiation

JAEA and Hitachi-Consortium has requested irradiating 3 pins, which will inform and/or aid viability determination of a UO2 FeCrAl-ODS LWR fuel systems and provide the measurements necessary for fuel performance code verification. Note that only 2 pins will be irradiated at a time. This proposed testing strategy will irradiate three different pins with three different target irradiation days. Two pins will be inserted at Cycle 175A. One of those pins will be removed after Cycle 175C, and this low burnup rodlet should reach its expected 10-15 GWd/MTU burnup target after approximately 180 days of irradiation at full power. A third pin will be added starting in Cycle 177A, replacing the one removed after 175C. These remaining pins will be irradiated through Cycle 179C. It is likely that after cycle 177C the rods will be moved to a different loop to finish irradiation. The target burnup of 20-30 GWd/MTU for the pin irradiated during cycles 177A through 179C should be reached after approximately 360 days of irradiation at full power. Finally, a target burnup of 30-40 GWd/MTU for the third pin irradiated during cycles 175A through 179C should be reached in 540 days of irradiation at full power.

Task 4. Shipment to INL Hot cells

Following irradiation, the JAEA/Hitachi-Consortium experiment rodlets will be shipped from ATR to HFEF at INL's Materials and Fuels Complex (MFC). Shipments normally occur a minimum of 90 days following the conclusion of the last full power cycle.

Task 5. Post Irradiation Examination (PIE)

Three fuel experiment rodlets will be subject to nondestructive and destructive examinations at HFEF. INL can perform a broad variety of PIE. The change of PIE analyses can be proposed and modified if agreed. The change will be made based on the assumption that the main objective is the collection of data to validate predictions of fuel performance codes for this rod system.

JAEA and NFD will review the PIE plan and the results of PIE and, if necessary, provide suggestions of PIE methods.

INL will share the plan and results of the PIE with Hitachi-GE and GNF-J when JAEA and NFD receive those reports for review.

The work will take place at ATR, HFEF, Fuels and Applied Science Building (FASB), Advanced Fuels Facility (AFF), or Experimental Fuels Facility (EFF), and Irradiated Materials Characterization Laboratory (IMCL). At IMCL, there will be testing/characterization runs such as optical microscopy, microhardness, Scanning electron microscopy (SEM)/ energy dispersive x-ray spectroscopy (EDS), Focused ion beam (FIB) sectioning, Transmission electron microscopy (TEM). Fuel and cladding material assembly, would be in either FASB/AFF/EFF, depending on the finalized welding technique. The rodlet includes cladding and fuel material. The cladding material is the main target for testing and characterization in this project and will be sampled for mechanical and microstructure characterization. The fuel will be treated as waste after the testing. The total waste generation of radioactive materials is 3 capsules of fuel

which are ~ 0.15 x 10-4 m3, about one cubic inch. PIE will generate transuranics but the final waste package will likely be low-level waste. The project lifetime is from October 2022 to April 2028.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Fuel fabrication activities in FASB (MFC-787) are not a modification in accordance with Idaho Administrative Procedures Act (IDAPA) 58.01.01.201 and 40 Code of Federal Regulation (CFR) 61 Subpart H. The dose from this facility is tracked based on inventory on a quarterly basis by Operations and Environmental personnel.

Experiment irradiation will be performed at the ATR. The irradiation in the ATR is not a modification in accordance with Idaho Administrative Procedures Act (IDAPA) 58.01.01.201 and 40 Code of Federal Regulation (CFR) 61 Subpart H. ATR radionuclide emissions are sampled and reported in accordance with Laboratory Wide Procedure (LWP)-8000 and 40 CFR 61 Subpart H. All experiments will be evaluated by ATR Environmental Support and Services staff, prior to insertion in the ATR. All radionuclide release data (isotope specific in curies) directly associated with this experiment will be calculated and provided to ATR Programs Environmental Support organization.

The irradiated specimens will be delivered to the MFC HFEF for disassembly and then undergo routine PIE. All radionuclide release data associated with the PIE portion of this experiment will be recorded as part of the HFEF continuous stack monitor. The PIE examination in HFEF is not a modification in accordance with Idaho Administrative Procedures Act (IDAPA) 58.01.01.201 and 40 Code of Federal Regulation (CFR) 61 Subpart H.

Discharging to Surface-, Storm-, or Ground Water

N/A

Disturbing Cultural or Biological Resources

The ATR Reactor Building (TRA-670) is over 50 years old. No structural or aesthetic changes will be made to the building.

Generating and Managing Waste

Generation of radioactive waste of UO_2 fuel. The total volume of the fuel from 3 capsules are ~ 0.15 x 10-4 m^3.

Hazardous/Radioactive Material or Waste Handling and Transportation: Project personnel would work with Waste Generator Services (WGS) to properly package and transport regulated, hazardous or radioactive waste according to laboratory procedures.

Releasing Contaminants

When chemicals are used during the project there is the potential for spills that could impact the environment (air, water, soil).

Using, Reusing, and Conserving Natural Resources

All materials will be reused and recycled where economically practicable. All applicable waste will be diverted from disposal in the landfill where conditions allow.

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."

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

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

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."

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

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: 08/24/2022