

DOE-ID NEPA CX DETERMINATION

Idaho National Laboratory

SECTION A. Project Title: Light-Water Reactor Fuels Testing in Idaho National Laboratory's Advanced Test Reactor

SECTION B. Project Description and Purpose:

This proposal involves the irradiation testing and PIE of six Cr-coated Zr-alloy-clad LWR fuel rods in the existing pressurized water loop at Advanced Test Reactor (ATR). The proposal will take 7–8 years and cost \$10M US. Cost and schedule are subject to change, based on alterations to the scope (e.g., more or fewer irradiation cycles, added PIE). Again, note that formal cost estimates will be generated as part of the contracting processes applied to develop a CRADA between Idaho National Laboratory (INL) and Japanese Atomic Energy Agency (JAEA).

INL can offer space to Mitsubishi for six fuel pins, to be inserted into the ATR Loop 2A in March of 2022. Four of these six pins would be instrumented (either with fuel-temperature thermocouples or plenum-pressure bellows/ linear variable differential transducers [LVDTs]). (Note that the instruments are expected to cease operating due to irradiation exposure at moderate burnup levels.) The projected peak burnup levels for these four pins would be on the order of 14–22 MWd/kgU with peak cladding fast fluences of $2e25$ n/m² to $3.5e25$ n/m². In 2024, these four pins must be removed to allow for the insertion of burnup-extension experiments sponsored by the U.S. DOE Advanced Fuels Campaign. However, Mitsubishi could also insert two additional pins without online instrumentation into Loop 2A in March of 2022. It is likely that these pins could be irradiated up to Mitsubishi's burnup/dpa target of 55 MWd/kgU– $1e26$ n/m² after approximately 12–15 ATR cycles (anticipated completion in 2026–2027, depending on ATR's actual operating schedule). This testing strategy would allow Mitsubishi to receive early data on moderate burnup fuel rods as well as specimens irradiated to high burnup.

The metallic-clad fuel pins in the Loop-2A test train are ~76 cm long, with a fueled length of ~61 cm. Precise dimensions would be communicated to JAEA/Mitsubishi. JAEA/Mitsubishi would be responsible for supplying INL with the coated cladding segments (9.5 mm OD) and UO₂ fuel pellets required for this test by June 30, 2021. Additionally, all of the required material certifications for the materials would be required at that time. This will allow INL time to build the rods and assemble them into the test train for irradiations in March of 2022. Pellet enrichments are 4.9–4.95% in the center of the fuel pins, with 3–5 insulator pellets at the top and bottom of the fuel pin that are low or naturally enriched. JAEA/Mitsubishi shall also supply a target plenum pressure standard to which INL will initially fill the rods.

INL will also require a minimum commitment (~\$3M) to support PIE following irradiation. The specific scope for these examinations will be planned prior to the irradiation but could be modified with consent of both parties. These modifications are commonly requested in response to information collected during the irradiation or execution of PIE.

INL can perform a broad variety of PIE, summarized in Table 1.

Table 1. Overview of the main PIE capabilities at INL.

Baseline non-destructive	Baseline destructive	Advanced PIE
Neutron radiography	Fission-gas release	Scanning electron microscopy (SEM)/energy dispersive x-ray spectroscopy (EDS)/ wavelength dispersive x-ray spectroscopy (WDS)
Gamma scanning	Sectioning	Focus ion beam (FIB) sectioning
Visual examination	Metallography/Ceramography sample preparation	Transmission electron microscopy (TEM)
Profilometry and eddy-current measurements	Optical Microscopy	Electron-probe microanalysis (EPMA)
Any other nondestructive examination (NDE) requested	Burnup chemical analysis, cladding hydrogen-content analysis	Atom-probe tomography (APT)
	Fuel density measurement via pycnometry	X-ray diffraction (XRD) for samples with limited radiation fields
	Microhardness	Micromechanical testing
	Ring Compression Testing (RCT) Ring and Axial Tensile Testing (RTT and ATT)	Thermal properties measurements (laser flash analyzer and local thermal-conductivity measurements)

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Other customized cladding mechanical testing*

*As additional cladding mechanical testing capabilities come online, they will be part of the baseline destructive PIE category.

Based on input from JAEA, the following test matrix is proposed (Table 2).

Table 2. PIE test matrix.

Suggested examination	Scope	Notes
High magnification visuals with in-cell camera	Coating external appearance, axial growth	All six rods
Contact profilometry	Cladding diameter	All six rods
Eddy current	Cladding defects (internal and external). Oxide thickness if exceeds 5 μm	All six rods
Fission gas release and analysis	Determine % of FGR and composition	Three medium-burnup rods and one high-burnup rod
Sectioning and optical microscopy	Overview of cladding and fuel microstructure	Two medium-burnup rods and one high burnup rod
Cladding hydrogen content	Hydrogen quantification	Two medium-burnup rods and one high-burnup rod
Cladding RTT and ATT	Cladding strength and ductility	Two medium-burnup rods and one high-burnup rod
Burst/Creep testing		One medium-burnup rod
SEM/EDS	Detailed cladding and fuel/cladding chemical interaction microstructure	Samples selected from two medium-burnup rods and one high-burnup rod

Additional analyses or substitution of PIE analyses can be discussed based on initial NDE results and potential for different or additional needs. Additional testing can be performed resulting in an increase cost of the PIE portion of the proposal.

Irradiation will occur at ATR. Other work will occur at the Advanced Fuels Facility, Hot Fuel Examination Facility (HFEF), Irradiated Material Characterization Laboratory (IMCL) all located at the Material and Fuels Complex. Work will also take place at the INL Engineering Demonstration Facility.

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

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

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

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

The potential for transportation accidents was analyzed in the SNF EIS (Section 5.1.5 and Appendix I-5 through I-10) and in the FRR EIS (Sections 4.2.1 and 4.2.2).

In addition to disposal of the irradiated fuel that will be generated as described above, industrial, mixed, and low level waste will be generated throughout the R&D process. This waste will be classified and disposed in accordance with INL procedures and DOE regulations/requirements.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

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

Discharging to Surface-, Storm-, or Ground Water

N/A

Disturbing Cultural or Biological Resources

N/A

Generating and Managing Waste

Irradiated sample debris and PIE waste are expected to generate research and development-related TRU waste and mixed TRU waste. TRU waste generated for the ATF-2 experiments will be less than 1 kilogram. Categorizing this material as waste is supported under DOE O 435.1, Att. 1, Item 44, which states "... Test specimens of fissionable material irradiated for research and development purposes only...may be classified as waste and managed in accordance with this Order...".

Small amounts of low-level waste would be generated in the form of personal protective equipment (PPE) and towels used for cleaning and polishing.

Project activities would also result in the generation of small amounts of industrial waste.

Project personnel would work with WGS to properly package and transport regulated, hazardous or radioactive material or waste according to laboratory procedures.

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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 material will be reused and/or recycled where economically practicable. All applicable waste would be diverted from disposal in the landfill when possible.

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"

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

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

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

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

Final Environmental Assessment and Finding of No Significant Impact for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site (DOE/EA-1793, December 2011)

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."

Transportation, receiving, and storing used nuclear fuel, as well as, research and development for used nuclear fuel management is covered by DOE's Programmatic Spent Nuclear Fuel (SNF) Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement and Record of Decision (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996). The analysis includes those impacts related to transportation to, storage of, and research and development related to used nuclear fuel at the INL (see Tables 3.1 of the SNF Record of Decision (May 30, 1995) and Table 1.1 of the Amended Record of Decision [February 1996]. The EIS limits the number of shipments to the INL, and the proposed activities would fall within the limits of the EIS.

The potential for transportation accidents has already been analyzed in the SNF EIS (Section 5.1.5 and Appendix I-5 through I-10). NEPA coverage for the transportation and disposal of waste to WIPP are found in Final Waste Management Programmatic Environmental Impact Statement [WM PEIS] (DOE/EIS-0200-F, May 1997) and Waste Isolation Plant Disposal Phase Supplemental

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EIS (SEIS-II) (DOE/EIS-0026-S-2, Sept. 1997), respectively. The 1990 ROD also stated that a more detailed analysis of the impacts of processing and handling TRU waste at the generator-storage facilities would be conducted. The Department has analyzed TRU waste management activities in the Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) (DOE /EIS-200-F, May 1997). The WM PEIS analyzes environmental impacts at the potential locations of treatment and storage sites for TRU waste; SEIS-II addresses impacts associated with alternative treatment methods, the disposal of TRU waste at WIPP and alternatives to that disposal, and the transportation to WIPP.

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Onsite disposal of RH-LLW was analyzed in the Final Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site (DOE/EA-1793, 2011).

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

Approved by Jason Anderson, DOE-ID NEPA Compliance Officer on: 05/20/2021