DOE-ID NEPA CX DETERMINATION

CX Posting No.: DOE-ID-21-080

SECTION A. Project Title: Multiscale Modeling and Experiments for Investigating High Burnup LWR Fuel Rod Behavior Under Normal and Transient Conditions – Texas A&M University

SECTION B. Project Description

Texas A&M University proposes to achieve a mechanistic understanding of and to develop a predictive model for fuel rod behavior at high burn-up (HBU) under both normal and transient conditions. By combining multiscale modeling and quantitative characterization and measurements, this project will investigate the effects of the pellet heterogeneous microstructure and transients on the performance of fuel rods at HBU. The research outcomes are expected to i) provide novel data on the pellet microstructure at HBU, ii) develop an experimentally validated multiscale model that accounts for the effect of microstructure on the enhanced fission gas release and fuel fragmentation at HBU, iii) advance the fundamental understanding of the change of fuel rod internal pressure with burnup, and iv) advance the fundamental understanding of the change of fuel fragment size with burnup. The predictions of this multiscale approach will be validated using data generated in this project and from open literature on same HBU fuel rods before and after loss-of-coolant accident (LOCA) testing. These outcomes will improve the predictions of existing fuel relocation and dispersion models and cladding ballooning and rupture models. Hence, this study will be able to provide the nuclear industry with validated, physics-based criteria for fuel fragmentation thresholds and rod mechanical integrity limits. While this project will mainly focus on the current UO_2 and Zircaloy fuel-clad system, primary investigations of the Cr_2O_3-doped UO_2 and Cr-coated Zircaloy accident tolerant fuel (ATF) concept will also be conducted. In this project, the researchers will focus on three critical factors, e.g., pellet non-uniform microstructure, fuel cracking and fragmentation, and fission gas release (FGR), which are considered critically important for advancing the current understanding of fuel rod behavior at HBU.

SECTION C. Environmental Aspects / Potential Sources of Impact

During the experimental phase of this work, which will occur at Oak Ridge National Laboratory, radioactive samples will be examined and will result in the generation of a small amount of radioactive waste. The kinds of wastes generated by this project are typical for the facility and will be disposed using established procedures. No legacy waste will be generated by this project. All the samples used in this work are loaned by DOE NE-4's Advanced Fuels Campaign and will remain the responsibility of that program at the conclusion of this program.

SECTION D. Determine the Level of Environmental Review (or Documentation) and Reference(s): Identify the applicable categorical exclusion from 10 CFR 1021, Appendix B, give the appropriate justification, and the approval date.

Note: 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, including requirements of DOE orders; 2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities; 3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; 4) adversely affect environmentally sensitive resources. In addition, no extraordinary circumstances related to the proposal exist which would affect the significance of the action, and the action is not "connected" nor "related" (40 CFR 1508.25(a)(1) and (2), respectively) to other actions with potentially or cumulatively significant impacts.

References: 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). For purposes of this category, "demonstration actions" means actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment. Demonstration actions frequently follow research and development and pilot projects that are directed at establishing proof of concept.

Justification: The activity consists of an investigation to advance the fundamental understanding of fuel rod behavior at high burnup (HBU) under both normal and transient conditions and provide a predictive modeling tool for deriving physics-based criteria to the thresholds for fuel fragmentation and clad ballooning and rupture phenomena for current and accident tolerant fuel concepts.

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 09/17/2021.