DOE-ID NEPA CX DETERMINATION

CX Posting No.: DOE-ID-21-052

SECTION A. Project Title: Experimental thermofluidic validation of TCR fuel elements using distributed temperature and flow sensing – Kansas State University

SECTION B. Project Description

Kansas State University (KSU) proposes to experimentally measure the performance of additively manufactured components of the Transformational Challenge Reactor (TCR). This goal will be accomplished using the existing high-temperature helium flow loop facilities at KSU and the City College of New York (CCNY). Thermal transport capabilities of the 3D-printed ceramic core structures will be experimentally measured, and the data generated will be used to qualify computational physics models. KSU has developed an infrared thermal imaging-based measurement technique that will be used to obtain a high-fidelity temperature scan of the TCR fuel elements. Advanced Bragg grating-based flow and temperature sensors will be embedded in the additively manufactured TCR fuel elements provided by ORNL. Data from specific sensor locations will be overlaid and mapped to the rest of the fuel domain using a graph-based machine learning method previously developed by the KSU team. There is a growing need to produce high-quality experimental data to support verification and validation efforts for modeling TCR components. The high-fidelity data—including local turbulence and mixing characteristics, velocity profiles, temperature distribution, heat transfer coefficients, pressure drops, and loss coefficients—will be essential for qualifying the computational models. The research proposed here will directly address this gap and will provide experimentally measured datasets using the team's unique test facilities following best practices according to the NQA-1 standards. The objective of the TCR program is to demonstrate an advanced nuclear reactor which can be rapidly designed and deployed using additive manufacturing methods. By removing the constraints imposed by conventional manufacturing, advanced manufacturing makes it possible to design and develop more complex core designs with a variety of materials while ensuring rapid production. These methods also allow for incorporation of alternative materials, embedded sensors, and optimal topology.

SECTION C. Environmental Aspects / Potential Sources of Impact

The university (and its partner universities) have procedures in place to handle any waste that will be generated through this project. The action would not create additional environmental impacts above those already occurring at the universities.

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 experimentally measure the performance of additively manufactured components of the Transformational Challenge Reactor.

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 08/31/2021.