

**SECTION A. Project Title: Multi-scale Effects of Irradiation Damage on Nuclear Graphite Properties – The Pennsylvania State University****SECTION B. Project Description**

The Pennsylvania State University (PSU) proposes to elucidate the (a) microstructural changes in nuclear graphite when exposed to radiation and high temperature and (b) their influence on elastic modulus, strength, toughness, and creep. Nuclear graphite has pre-existing defects spanning atomic to sub-mm scales along with non-uniform constituents. Identifying the micro-mechanisms across the length-scales is difficult with the conventional practice of ‘post-mortem’ microscopy. PSU proposes a multi-scale, in-situ experimental approach to visualize the mechanisms and simultaneously measure the properties. PSU’s hypothesis is that the interaction radiation defects with the pre-existing ones will govern the dimensional and property changes. To test this hypothesis, PSU will perform the following research: 1) In-situ TEM (transmission electron microscopy) and Xray CT (computed tomography) experiments will generate qualitative data (microstructural information from atomic to mm scale) corresponding to quantitative properties for various temperature and displacement damage levels; 2) In-situ TEM ion irradiation experiments will allow for real-time visualization of defect generation due to irradiation and their interaction with pre-existing defects; 3) PSU’s finite element model, when validated with experiments, will result in a virtual specimen that can be further studied under various loading (e.g., creep, fracture) to predict both localized and global behavior; and 4) The outcome from ion irradiation will be connected with existing knowledge on neutron irradiation with correspondence established along the length-scales, starting from vacancy and dislocation generation in the crystallographic length-scale to pore stress localization to crack propagation and catastrophic fracture.

**SECTION C. Environmental Aspects / Potential Sources of Impact**

The university has 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 university.

**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 explore the microstructural mechanisms that govern mechanical properties of nuclear-grade graphite.

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 09/07/2021.