

SECTION A. Project Title: Quantifying the Dynamic and Static Porosity/Microstructure Characteristics of Irradiated Graphite through Multi-technique Experiments and Mesoscale Modeling – North Carolina State University

SECTION B. Project Description

North Carolina State University proposes to utilize a host of experimental methods and computational modeling to uncover the pertinent microstructural features and mechanisms at the mesoscale that control the macroscopic mechanical behavior in different nuclear graphite grades. Of primary importance is the characterization of pores/cracks and defect structures, which needs a multi-technique approach as no single method can access the relevant scales or has the fidelity to probe the details at different length scales. The project will use a joint experimental-computational approach to probing and quantifying the porosity and microstructure characteristics of irradiated nuclear graphite grades, and their influence on dimensional changes, turnaround behavior and mechanical properties. The central focus of the project is to quantify both the static and dynamic porosity/crack characteristics in various graphitic phases (filler particles, binders, quinoline insoluble particles) in medium, fine, and super/ultra-fine grained irradiated graphite grades and HOPG (highly oriented pyrolytic graphite) through several experimental techniques. HOPG is included as a highly ordered/oriented reference grade while the POCO grades, which do not have a binder phase, serve as an intermediate form between HOPG and other nuclear grades. The selected graphite grades span a wide range of porosity, grain size, and constituents. The samples are neutron-irradiated at temperatures ranging from 300°C to 1200°C, and doses from 1 to 21 displacements per atom (dpa), approximately. Additionally, graphite grades that are oxidized will be investigated – thus a spectrum of irradiated, thermal, and oxidative conditions will be covered in this project.

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 a joint experimental/computational approach for probing, quantifying, and analyzing the microstructural/mesoscale characteristics of several grades of nuclear graphite and exploring their correlation to macroscopic mechanical behavior.

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 09/02/2021.