

SECTION A. Project Title: Investigating heat transfer in horizontally oriented HTGR under normal and PCC conditions – Kansas State University
--

SECTION B. Project Description

Kansas State University (KSU) proposes to conduct research to understand heat transfer from core to the vessel of horizontal microscale High Temperature Gas-cooled Reactors (HTGRs) or micro-HTGRs. The horizontally oriented micro-HTGRs are expected to be located inside a shipping or transport container and dissipate heat to the air of the container. The existing scaled high temperature test facilities at KSU and City College of New York (CCNY) will be used to emulate normal operation and Pressurized Conduction Cooldown (PCC) in micro-HTGRs. The focus of these experiments will be to generate flow and temperature benchmark data including the peak core temperature and peak vessel temperatures under normal operation and PCC conditions. At KSU, an existing horizontal high temperature (up to 1200°C) experimental facility, equipped with thermographic imaging and distributed temperature sensing, will be used to characterize the conduction-radiation heat transport within the prismatic graphite blocks and the heat transfer from outer boundary of the test set-up under loss of forced cooling (LOFC) or PCC scenarios. At CCNY, a high pressure and high temperature flow loop exists for HTGR related research; the test section of this facility will be oriented horizontally and operated under prototypical HTGR conditions to study – a) flow laminarization under normal operating flow conditions and b) PCC scenarios. Both experimental setups at two universities will be placed in the scaled model of Transport ISO Container with provisions to allow for container air flow and infra-red sensors for monitoring of surface temperatures and cooling rates. Thermal maps of the vessel outer surface will be obtained using IR camera. Detailed temperature and flow data inside and outside the vessel will be obtained at both facilities and used to characterize heat transfer paths for horizontal micro-HTGRs from the core to vessel surface and container environment. This project will be divided into 5 main tasks: 1) Scaling analysis will be conducted for a horizontal orientation of a generic micro-HTGR as the reference geometry; 2) Horizontal flow laminarization and natural convection experiments under prototypic conditions and comparison with existing vertical measurements; 3) Multi-mode heat transfer tests under LOFC using high fidelity instrumentation with scaled experiments with horizontal orientation geometry; 4) Integral tests with experimental facilities under different container air flow conditions in transport container; and 5) Uncertainty Quantification and Validation database.

SECTION C. Environmental Aspects / Potential Sources of Impact

The university (and its partner university) 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 assess the heat transfer for prototypical conditions in a horizontally oriented micro-HTGR design under normal operation and PCC conditions.

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.