DOE-ID NEPA CX DETERMINATION

CX Posting No.: DOE-ID-21-056

SECTION A. Project Title: Wireless Multifunctional Ultrasonic Arrays with Interdigital and Airborne Transducers for Monitoring Leakage and Corrosion Conditions of Welded Dry Storage Canisters – Mississippi State University

SECTION B. Project Description

Mississippi State University (MSU) proposes to develop innovative, wireless, multifunctional, ultrasonic sensor arrays that enable on-demand, quantitative interrogation, and real-time monitoring of both the canister leakage indicators (helium, helium/air mixture, internal pressure loss, and temperature change) and corrosion conditions (free and/or vapor water). Moreover, the ultrasonic sensor arrays will be fully integrated, wirelessly powered and communicated, easy to use, and compact (smaller than a quarter). To develop the proposed ultrasonic sensor arrays, MSU will fuse the merits of the following three critical fundamental innovations: 1) Wirelessly powered and communicated, multifunctional, on-chip interdigital transducer (IDT)-based ultrasonic sensors that also incorporate critical techniques such as chirped concentric interdigital electrodes, ultrasonic Bragg reflectors, ultrasonic delay lines, and phononic crystals; 2) Wirelessly communicated, airborne ultrasonic transducer arrays that enable critical functions such as detecting helium leakage as well as quantitative evaluation and monitoring of the helium/air volume ratio based on ultrasonic velocity change and a pitch-catch sensing configuration; and 3) Validated theoretical and multi-physics numerical models that can predict the effects of multiple conditions (such as free/vapor water, helium/air ratio, internal pressure, and temperature) on ultrasonic wave properties (such as speed, transmission, amplitude, phase, and frequency band gap). Three tasks are proposed: In Task 1, MSU will develop on-chip, small-size, wirelessly, IDT-based sensors to monitor multiple dry storage container (DSC) conditions including internal pressure, temperature, free water, and vapor water. MSU will also develop airborne ultrasonic arrays to monitor potential helium leakage and evaluate the helium/air ratio. In Task 2, MSU will further improve and characterize the ultrasonic arrays by fundamentally investigating the effects of combined DSC conditions on the sensors utilized, decoupling the combined effects, testing the sensor survivability, and performing characterization tests on a small-scale canister mockup. In Task 3, MSU will develop a fully integrated prototype based on the ultrasonic method as well as validate the prototype through onsite experiments on both the ORNL full-scale vertical canister mockup and the Orano NUHOMS horizontal system.

SECTION C. Environmental Aspects / Potential Sources of Impact

General lab chemicals to be used in this project include isopropyl alcohol (3 gallons), acetone (1 liter), and boric acid (1 liter). All the chemicals will be properly labeled, stored, inventoried, and used following their protocols. The researchers will also follow the appropriate handling and storage practices (https://www.ehs.msstate.edu/safety/chemical/storage/) required by the Mississippi State University Environmental Health & Safety Office (EHS), which annually audits the PI's lab space and practices. The researchers will follow the chemical and hazardous waste disposal procedures (https://www.ehs.msstate.edu/safety/chemical/disposal/) required by the Mississippi State University EHS Office.

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 develop innovative methods for interrogation of dry storage container (DSC) internal conditions to provide assurance that safety functions continue to be met.

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.