

Non-destructive Evaluation of Dry Storage Canisters Using Acoustic Sensing

PI: Bora Gencturk (USC)

Program: FC-4.2: Spent Fuel and Waste

Disposition: Storage & Transportation

Collaborators: Assad Oberai (USC);
Ryan Meyer (PNNL)

ABSTRACT:

The objective of this project is to develop a robust non-destructive evaluation (NDE) technique based on acoustic sensing to detect impurity gases in a sealed (welded) dry storage canister (DSC) using only measurements collected on the external surface of the DSC. The method is based on time-of-flight analysis of acoustic signals propagating through the fill gas of a DSC, which is influenced by the composition, density and temperature of the propagation medium. The promise of this approach has already been demonstrated in an ongoing NEUP Integrated Research Project (IRP) (16-10908). In this effort, we will focus on the following tasks. (1) Developing an active noise cancellation technique to eliminate the signal coupled into the canister wall by the transducers mounted on the same surface. The cancellation of this signal will enable a detection of the signal propagating through the fill gas with a low noise-to-signal ratio and allow for monitoring of the gas impurity. (2) Evaluate and calibrate the developed NDE approach under various spatial distributions of temperature within the DCS, different compositions and concentrations of the impurity gases, and potential obstructions from the different geometries of the upper tie structure of pressurized water reactor (PWR) and boiling water reactor (BWR) fuel assemblies. (3) Develop high fidelity computational models that represent the true physics of the wave propagation phenomenon to inform the development of the noise cancellation approach, as well as to study configurations that are beyond those that can be practically achieved in a lab environment.

This project directly aligns with the work scope described in FC-4.2: Spent Fuel and Waste Disposition: Storage and Transportation of the funding opportunity announcement. It meets the requirements that all sensors and equipment are external to the canister, the size and placement of sensors could easily allow for access through the outlet vents in the overpack while the DSC is in an overpack, and the results of the NDE measurements could provide invaluable information on monitoring the gas composition. Particularly, with the proposed approach, presence of air or moisture (an indication of the DSC leakage or insufficient drying), Xe or Kr (an indication of fuel rod cladding failures), and potentially hydrogen (an indication of radiolysis or corrosion) can be monitored. A successful development such an approach will drastically advance DOE's goal of safe transportation of DSC to interim or permanent storage facilities in the future. The research team intends to provide the DOE with a final report that has complete information on the validity of the approach, the theoretical formulations, the experimental setup including optimal parameters, and the accompanying computational tools and their predictive abilities. It is expected that with limited additional development, the proposed approach may be deployed for use in real DSC.

University of Southern California (USC) is the lead organization in this proposal. USC PIs bring both experimental and computational expertise and resources to the project including a physical mock-up of a DSC. Similarly, the Pacific Northwest National Laboratory (PNNL) PI has many years of research experience on acoustic sensing and related problems. USC and PNNL PIs have ongoing research projects and many years of successful research collaboration. These synergies will allow for an easy technology transfer to the DOE national labs and also train the future workforce on an important nuclear energy related problem of safe SNF storage and transportation.