Irradiation of Sensors and Adhesive Couplants for Application in LWR Primary Loop Piping and Components

PI:

Dr. James J. Wall, Electric Power Research Institute

Program: NSUF 1.1

Collaborators:

Dr. Luke Breon, Electric Power Research Institute

Dr. Maria Guimaraes, Electric Power Research Institute

Dr. Joshua Daw, Idaho National Laboratory

Dr. Pradeep Ramuhalli, Oak Ridge National Laboratory

ABSTRACT:

The Electric Power Research Institute (EPRI) Nuclear Sector and US Department of Energy Light Water Reactor Sustainability (DOE-LWRS) Program are committed to engaging in research and development programs to address materials aging issues specific to long term operation of light water power reactors. To this effect, in 2020 EPRI launched an industry initiative to develop nondestructive evaluation systems for online monitoring of existing cracks in light water reactor primary coolant loop piping and components. One of the goals of this initiative is to develop a sensor system or systems that can determine if cracks are growing or arrested and, in the case of the former, to characterize their growth rates. A missing component of this initiative is an experimental assessment of how sensors and adhesive couplants will perform in service when exposed to neutron radiation, particularly at the primary coolant loop hot and cold leg dissimilar metal welds, which join the primary loop piping to the reactor pressure vessel. As such, the objective of the proposed NSUF experimental study is to determine how ultrasonic transducers and adhesive couplants will perform when exposed to irradiation in a test reactor. To achieve this objective, the signal stability of piezoelectric transducers and performance of adhesive couplants as a function of accumulated fast neutron fluence will be characterized by collecting ultrasonic data in-situ during irradiation. Of particular interest are the piezoelectric response and signal to noise ratio as a function of fast neutron fluence. Subsequent post-irradiation examination (PIE) will be used to characterize microstructural changes in the transducers and couplants due to irradiation. NSUF funding and facility access are being requested to perform the sensor irradiation and PIE studies. The proposed NSUF study will be critical to the overall success of the industry initiative. What is proposed here is a joint EPRI / US DOE partnership to achieve the objectives of the initiative. The insights gained from the proposed NSUF study on irradiation of sensors and adhesive ultrasonic couplants as well as synergistic EPRI-funded work on elevated temperature performance of sensors and couplants will be of immediate use to the nuclear power generation industry. Pilot plants for demonstration of the developed technology are being identified by EPRI starting in 2020. Successful implementation of crack online monitoring technology in one or more pilot plants should lead to significant industry utilization.