
Repair of In-service Components will Enhance the Cost Competitiveness of LWRs Testing

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ABSTRACT:

The challenging environment (*i.e.*, radiation, thermal, corrosion) associated with a nuclear reactor, including light water reactors (LWRs), makes any needed repair and servicing of components in a nuclear power plant challenging, time intensive, and consequently expensive relative to other energy sectors. *The objective of this proposal is to improve the economic competitiveness of the LWR fleet compared to other energy sectors by using modern technology to develop tools and approaches to repair and heal reactor components while in service.* We aim to extend the lifetime of LWR components using laser-based heat treatments of reactor core components. Irradiation-assisted stress corrosion cracking (IASCC) is a critical degradation mechanism for reactor-internal components as the nuclear fleet ages in long-term operation. In the last ~30 years, IASCC has been observed in structural components such as PWR baffle former bolts and BWR core shrouds and top guides. The ability of any mitigation technique to access the region of interest is important and with a fiber optic laser approach will be amenable to miniaturization to enable access to locations currently regarded as inaccessible. This project will fund the development of heat treatment procedures using laser-based systems and further develop the concept of a remote repair device that allows the ‘healing’ of critical areas of interest of in-service components. This proposal will utilize expertise of three nuclear engineering departments across the USA (University of New Mexico; University of California, Berkeley; and University of Tennessee, Knoxville; as well as industrial experts at Electric Power Research Institute). Experimental efforts will identify laser annealing parameters that offer healing to irradiation-damaged components to mitigate crack formation by coupling modelling, experimental thrusts with ion beam damaged specimens, and specimens undergoing reactor-relevant irradiation and straining regimes. The experimental work will demonstrate the applicability of the newly developed technique on neutron irradiated specimens. The proposed effort will incorporate innovative economic analysis. A high throughput ion irradiated material testing portfolio will be used to rapidly explore a large range of commercially available laser parameters. The impact of the laser-based healing process will be characterized and deciphered using a range of multi-scale metallographic characterization approaches (optical microscopy (OM), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDS), Electron Backscatter Diffraction (EBSD), and Transmission Electron Microscopy (TEM)). We propose that the development of the technology, tools, and approaches that proposed here will enhance the cost competitiveness for the nuclear power industry by decreasing the downtime for service and providing an additional and innovative tool for lifetime extension of the current LWR fleet.