LWRS LIGHT WATER REACTOR SUSTAINABILITY

LWRS Program Research Pathway Fact Sheet

Materials Research Pathway

Construction of the large concrete test blocks to evaluate alkali-silica reaction effects on concrete.

December 2018

Project summary and objectives

The Light Water Reactor Sustainability (LWRS) Program has two objectives with respect to long-term operations: (1) to provide science-based solutions to the industry to implement technology to exceed the performance of the current labor-intensive business model; and (2) to manage the aging of plant systems, structures, and components (SSCs) so that nuclear power plant lifetimes can be extended and the plants can continue to operate safely, efficiently, and economically. The LWRS Program does this through three pathways: (1) Materials Research; (2) Plant Modernization; and (3) Risk-Informed Systems Analysis.

The objective of the Materials Research Pathway is to develop the scientific basis for understanding and predicting the long-term environmental degradation behavior of materials and to provide data and methods to assess performance of systems, structures, and components essential to the safe and economical operation of nuclear power plants.

Accomplishments

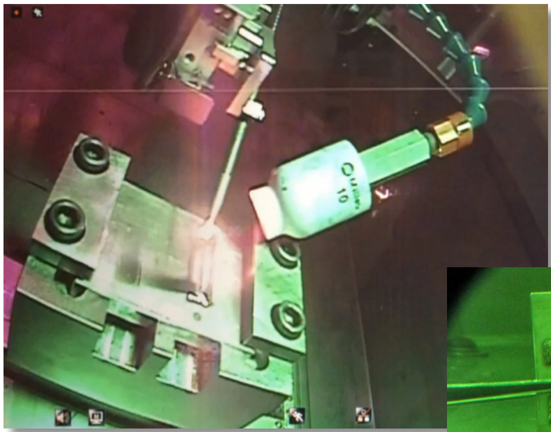
- Development and continued increase in functionality of computational models for aged reactor pressure vessel (RPV) performance under operating and pressurized thermal shock accident conditions.
- Computational code for predicting radiation induced swelling of metal alloys.
- Identification of the mechanisms controlling crack nucleation and growth in alloys 600 and 690.
- Increased understanding of the influence of alloy condition and water chemistry on Irradiation-assisted stress corrosion cracking (IASCC) in steels.
- Construction of a large-scale experimental test facility to assess the impact of alkali-silica reaction on the structural capacity of concrete.
- Developed numerical mesoscale radiation induced volumetric expansion model for concrete.
- Improved nondestructive evaluation (NDE) techniques for examination of thick, heavily reinforced concrete structures.
- Improved understanding of age related degradation in cables and NDE techniques to assess condition of cable properties.
- Demonstrated advanced welding techniques on irradiated materials.

Current work

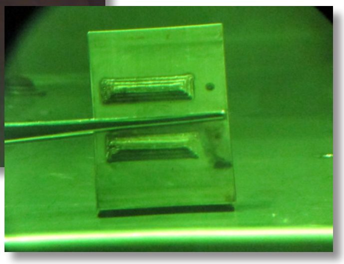
- Modeling age related property changes in RPV alloys; validating through experimental, surveillance and ex-service materials; and exploring mitigation efforts.
- Developing a fully mechanistic fatigue life evaluation model for nuclear reactor components.
- Testing and analysis of RPV material harvested form the Zion nuclear power plant and aged cable systems from various operating plants.
- Understanding mechanisms for IASCC initiation in stainless steel to develop better predictive models and mitigation strategies.
- Development of a fully coupled thermo-hydro-mechanical- chemical model for reliably predicting the performance of concrete structures.
- Establishing condition monitoring techniques for cable systems and concrete structures.
- Experimental testing and modeling of aged properties of cast, wrought and welded austenitic stainless steels alloys aged under light water reactor conditions.
- Testing and evaluation of alloys with superior properties to conventional in-core alloys.
- Developing procedures, techniques, and computational modeling for weld repair of highly irradiated materials.

Summary

Materials research provides an important foundation for licensing and managing the long-term safe and economical operation of nuclear power plants. Predicting aging mechanisms with confidence supports planning, investment, licensing, and necessary component repair and replacement for relicensing.



Advanced laser welding (Top) and the welded irradiated coupon (Bottom)



Advanced Laser Welding

Advanced laser welding using auxiliary beam stress improved technique on irradiated 304 stainless steel

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