Welding & Repair Technology Center (QA)

Program Overview

Program Description
High-quality repair methodologies, mitigation processes, and dependable welds are critical to safe nuclear plant operation. The safety significance of component repairs and replacements emphasizes the need for a high degree of confidence in the integrity of joining processes and implementation techniques. Productivity improvements and new technology development can lead to cost savings in maintenance and repair activities while maintaining a commitment to quality and safety.

The Welding & Repair Technology Center develops and tests advanced materials, joining, and repair technologies for nuclear plant applications, contributing to improved safety, higher plant availability, and reduced operation and maintenance costs. The program also supports technical interactions with code and regulatory entities to inform the development and modification of new and existing requirements.

Research Value
Research results from the Welding & Repair Technology Center help nuclear power plants deploy safe, effective, less costly repairs using novel welding techniques or by applying existing techniques in new situations. Research results also are used to support technical interactions with regulators regarding code requirements. Program participants gain access to the following:

- Materials, welding, and repair experts across the Electric Power Research Institute (EPRI) and the nuclear industry
- Strategic roadmaps outlining research gaps associated with key issues—such as advanced nickel-based filler metals, welding of irradiated materials in boiling and pressurized water reactors, and advanced welding processes—and the collaborative actions needed to address these gaps
- Demonstrated repair techniques and technologies that can improve material performance, enable component life extension, increase plant availability, and reduce repair costs
- Benchmarking information from welding programs at nuclear power plants
- Advanced welding techniques such as laser welding and friction stir welding that may be necessary to provide repair solutions for irradiated materials and high-chromium nickel-base filler metals
- Repair options for key components, supplemented by application guidelines, procedures, and training
- Support during implementation of plant repair applications involving material interactions, weld process control, and code requirements
- Forums for continuous sharing of operating experience, weld program issues, and industry emerging issues

Approach
The Welding & Repair Technology Center combines extensive laboratory capabilities with detailed familiarity with industry and regulatory needs to investigate and evaluate welding and repair techniques. EPRI can replicate welding setups in the field—power supplies, weld heads, and other equipment—to create realistic welding environments in the laboratory. Through participation in many American Society of Mechanical Engineers (ASME) and industry technical committees, the program also ensures that the research results inform code requirements.

There are both base and supplemental components of the Welding & Repair Technology Center Program. The base portion focuses on repair and replacement research, code and standards support, and effective transfer of EPRI technology. This project supports access to EPRI expertise through meetings and various information products, including unique repair/replacement applications, a database of welding procedures, repair/welding program assessments, and benchmarking activities.
Regular engagement with code organizations and other technical bodies helps inform the implementation of new repair methods, welding procedures, and weld materials within acceptable safety limits. Base research supports EPRI interactions with ASME and other code and regulatory bodies regarding code cases, revisions, and technical interpretations impacting a wide range of component repairs. Examples include boiling water reactor control rod leakage repair, pre-emptive dissimilar metal weld overlays to address Alloy 600 mitigation applications, and use of specialized methods to seal leakage while under power. Finally, recognizing that the evolutionary nature of repair and replacement requires continuous sharing of experience among nuclear plants, vendors, and research organizations, the Welding & Repair Technology Center compiles best practices, experience information, and benchmarking data.

To address strategic objectives established for each of its programs, EPRI has developed roadmaps to plan, coordinate, and execute needed research among multiple entities. For the Welding & Repair Technology Center, roadmaps have been developed for the following issues: welding of irradiated materials for reactor internals; weldability assessment of Alloy 52/52M weld metals; development of a new high-chromium welding alloy with improved weldability and superior resistance to weld cracking; advanced welding process development in the nuclear power industry; and incorporation of fabrication, repair and joining technologies in nuclear codes and standards. Additional roadmaps will be developed as conditions warrant.

The supplemental portion of the program evaluates welding material performance in power plant environments to assess the life of nuclear components and investigates advanced welding and repair technologies to potentially reduce time and cost of repairs. The supplemental portion also provides access to case histories, lessons learned data, and technical support in the form of materials and joining evaluations, program benchmarking, and procedure development.

Through a separately funded project, participants can participate in the Weld Mitigation Interest Group, which evaluates emerging repair options that address dissimilar weld metal mitigation. The project supports expanded repair and mitigation options that reduce the time, cost, and radiation exposure associated with inspection and mitigation activities, including mechanical stress improvement, inlays, onlays, and overlays.

Accomplishments

EPRI’s Welding & Repair Technology Center supports nuclear power industry efforts to develop and apply welding and repair techniques that enhance safety, inform regulatory issues, reduce maintenance costs, and improve productivity.

- Supported development of realistic code rules, including new code cases to reduce post-weld examination hold times and use dissimilar metal weld overlays for stress corrosion cracking mitigation.
- Provided annual update to the Repair Welding Handbook and ASME Code activities, which assists nuclear power plants in choosing appropriate repair techniques and complying with regulatory and code processes.
- Evaluated nickel high-chromium weld filler materials for resistance to typical welding related defects, such as direct digital control, hot cracking, and general weldability. Alloy-52-type materials and derivatives have been evaluated to support alloy selection and grading to distinguish heat-to-heat variations.
- Conducted technical analysis to evaluate temperbead welding applications that could be used for component replacement, mitigation and repair, thereby supporting code compliance and utilization of new welding processes.
- Demonstrated the feasibility of in-vessel underwater laser beam weld repair of critical nickel alloy welds, eliminating the need to drain the reactor vessel. Areas that have been addressed include seal welding capabilities, temperbead welding, and hot cracking susceptibility.
- Provided technical support for implementing new technologies, including application guides for advanced welding methods, guidelines for installing and examining dissimilar metal weld overlays, and repair/mitigation of socket weld fatigue failures.
- Developed guidance for overlay applications based on lessons learned, best practices, and weld studies to support current technology. Also supported development of new and higher production welding processes such as gas-metal arc welding and dual wire feed gas tungsten arc welding.
- Evaluated the application of new repair techniques for non-metallic repairs for high-density polyethylene piping, which is gaining traction as an alternative to steel in low-energy applications.

**Current Year Activities**

Welding & Repair Technology Center research and development for 2014 will focus on developing safe repair and fabrication technologies to reduce outage time and expand the availability of repair options that may be performed during plant operation. Specific efforts include:

- Establish welding criteria for repair and mitigation of irradiated material
- Evaluate advanced filler/welding materials (Alloy 52M) for critical plant repair applications
- Develop training for new repair and replacement engineers addressing code, welding fundamentals and advanced welding topics
- Evaluate welding methods for small-bore piping and alternative joining methods for socket welded joints
- Provide benchmarking support for utility welding Risk & Reliability (R&R) programs
- Identify repair/mitigation options that address buried piping issues, fuel pool leakage, and components susceptible to stress corrosion cracking

Selected reports and products may be prepared in whole or in part in accordance with the EPRI Quality Program Manual that fulfills the requirements of 10CFR50 Appendix B and 10CFR21. The QA status of reports and products will be marked and identified.

**Estimated 2014 Program Funding**

$3.3 million

**Program Manager**

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