EPRI ELECTRIC POWER RESEARCH INSTITUTE

Success Story

D.C. Cook Avoids Costly Outage with Overlay Repair of Socket Welded Piping

EPRI testing and analysis supports code case that enabled American Electric Power to repair a leaking socket weld without undergoing a lengthy and disruptive outage.

American Electric Power's D.C. Cook Unit 1, a pressurized water reactor, repaired a cracked and leaking socket welded joint in the reactor coolant system by applying a fast and economical weld overlay. EPRI testing and analysis demonstrated that a socket welded joint repaired by the weld overlay has equal or superior fatigue strength to that of a standard socket weld. The first-of-its-kind repair, performed in accordance with an EPRI-supported American Society of Mechanical Engineers (ASME) Code Case (N-666), enabled D.C. Cook to:.

- Overlay repair the leaking socket weld to obtain a joint with strength and vibration resistance equal to a standard socket weld.
- Avoid an extended plant shutdown that would have required draining the reactor vessel, removing the reactor vessel head, and performing other disruptive activities.
- Save an estimated $1 million in maintenance and downtime costs.

A new approach for repairing socket welded joints by overlay welding can reduce plant downtime and outage costs by eliminating the need for joint removal and replacement.

A Common and Growing Problem

Socket weld failures due to high-cycle vibration fatigue have become an increasing concern at nuclear power plants. Socket welds are commonly used for fabrication of small-diameter piping systems. D.C. Cook and other nuclear power plants contain thousands of socket welds.

During plant heatup following a refueling outage, D.C. Cook personnel discovered a leak in an ASME Class 1 socket weld between an elbow fitting to a ¾-inch pipe. The leaking socket weld was located in a section of the reactor coolant system.

Traditional Repair Has Costly Drawbacks

The standard method for repairing socket weld failures is to isolate the leak and cut out and replace the leaking joint, or replace the entire small-bore pipe section. In D.C. Cook's case, isolating the pipe section and cutting out the defective socket weld would have required an extended outage and significant additional cost.

A Practical Alternative: Overlay Repair

To avoid the costly drawbacks of the traditional approach to socket weld repair, D.C. Cook sought and obtained U.S. Nuclear Regulatory Commission permission to use an alternative repair method. The alternative was to apply a weld overlay in accordance with ASME Code Case N-666, Weld Overlay of Class 1, 2, and 3 Socket Welded Connections, Section XI, Division 1.

The overlay repair method is a three-step process that does not require removing the fatigue crack or replacing the entire pipe section. First, the active leak is controlled by peening weld metal over the fatigue crack. Second, a weld bead is installed over the peened area to seal the leak. Third, the structural overlay weld metal (generally a weld metal that matches the base metal composition) is installed once the leak is successfully sealed.

EPRI Research Supports Code Case

Code Case N-666 is supported by the results of an extensive test program conducted by EPRI's Welding & Repair Technology Center. The testing and analysis show that socket welds repaired with the overlay method have equivalent or better fatigue strength than a standard socket weld.

Results and Benefits

EPRI test results and finite element analysis showed that overlay weld repair is an effective method for repairing cracked socket welds subjected to high-cycle fatigue. The EPRI work also demonstrated that overlay-repaired socket welds perform at least as well as—and often superior to—standard socket welds.

By applying the weld overlay method, D.C. Cook successfully repaired the leaking and cracked socket weld without draining the reactor vessel or performing other activities that would not increase quality and safety compared to the overlay repair as specified in Code Case N-666. As a result, D.C. Cook saved at least $1 million in maintenance and downtime costs.

Further Work

D.C. Cook applied the methodology of Code Case N-666 through a relief request approved by the Nuclear Regulatory Commission. Code Case N-666 is now listed in Rev. 16 of Regulatory Guide 1.147 without conditions. Rev 16 is expected to be to be approved in 2010. As a result, future applications would not require regulatory approval through a relief request.

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com)

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