Five Years after Initial Repair, Socket Weld Overlay at Cook Nuclear Plant Still Holding Strong

EPRI-supported socket weld repair method is proven to save money, reduce downtime, and maintain structural integrity over time.

Weld overlay was applied to a socket weld in the reactor coolant system at AEP's DC Cook nuclear plant.

In 2008, American Electric Power (AEP) applied a weld overlay technique to repair a cracked, leaking socket weld in the reactor coolant system of its D.C. Cook plant. This first-of-a-kind repair was performed in accordance with EPRI-supported American Society of Mechanical Engineers (ASME) Code Case N-666, enabling AEP to:

- Conduct an in-situ repair of the leaking socket weld with an overlay to restore pipe joint strength to the equivalency of the original socket weld configuration
- Avoid an extended plant outage that would have required execution of high-risk activities, including removing the reactor vessel head, offloading and refueling the reactor, draining the reactor vessel, and performing other disruptive activities
- Save several million dollars in maintenance and downtime costs

In 2013, analysis of the initial overlay per N-666 demonstrated that the crack arrested five years earlier had not propagated into the weld, providing further evidence of the long-term reliability of this EPRI-developed innovation.

"Our research demonstrated that the crack tip should remain blunted and would not grow into the engineered overlay, and this research provided the technical basis allowing this repair technique to be used in the field," said Greg Frederick, program manager of EPRI's Welding and Repair Technology Center (WRTC). "The 2013 analysis from AEP validated that original technical basis and will be used to support implementation of this repair technique by other utilities."

Solution to a Common Problem

Socket welds at nuclear power plants are vulnerable to high-cycle vibration fatigue and subsequent cracking. 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. This method is costly and requires significant downtime. To address this issue and enable safe, cost-effective plant operation, WRTC began an extensive research and testing program in 2000 in collaboration with a number of nuclear plant operators.

EPRI's testing and analyses ultimately demonstrated that a socket welded joint repaired by a weld overlay offered equal or superior fatigue strength to that of a standard socket weld repair. This research resulted in ASME Code Case N-666 Weld Overlay of Class 1, 2, and 3 Socket Welded Connections, Section XI, Division 1.

"The big advantage of this Code Case is that it allows nuclear plants to repair the leaking system online and can be applied while under a reduced pressure and a temperature range emphasized in the Code Case," Frederick said. "In a standard repair, it could take days to get the system down to room temperature before you can actually open it up for repair."

"The weld overlay ultimately saved the plant several million dollars in extended shutdown costs as well as high-risk activities involving draining the reactor coolant system."

~ Matt White, *AEP*

How A Socket Weld Overlay Works

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.

Refinements to N-666 are being explored to extend overlay repair to valve, pump, and other piping connections, and to allow implementation at a higher temperature and pressure range.

Socket Weld Overlay: An Effective Repair Option

Following a refueling outage, operators performing a plant heat-up at the D.C. Cook plant discovered a leak in an ASME Class 1 socket weld located in an un-isolable section of the reactor coolant system. Operating the plant to a condition to allow cutting out the defective socket weld at D.C. Cook would have required an extended outage and significant additional cost. AEP obtained permission from the U.S. Nuclear Regulatory Commission to use an alternative weld overlay in accordance with ASME Code Case N-666.

By applying the weld overlay method, AEP repaired the leaking and cracked socket weld successfully without draining the reactor vessel or performing other activities needed in a traditional repair.

"The weld overlay ultimately saved the plant several million dollars in extended shutdown costs as well as high-risk activities involving draining the reactor coolant system," explained Matt White, welding engineer at the D.C. Cook Nuclear plant.

The weld overlay remained installed until spring of 2013 when the cantilever configuration was replaced as a part of other maintenance. Laboratory evaluation of the overlaid socket weld showed that the overlay repair performed in accordance with ASME Section XI Code Case N-666 was sufficient to prevent propagation of the 2008 crack into the repair weld through approximately three fuel cycles.

Application in Spain

The success of the socket weld overlay repair at AEP has done a great deal to convince the industry that the socket weld overlay is a viable repair method.

Recently, the WRTC recently received confirmation that a second socket weld overlay was installed at a nuclear plant in Spain. Following a pipe valve leak and difficulty in completely isolating the valve, a socket welded vent line to valve was repaired with a structural weld overlay according to ASME Code Case N-666.

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