N162. Winning The Battle Against IGSCC

Intergranular stress corrosion cracking (IGSCC) in Boiling Water Reactor (BWR) steel piping has been recognized as a problem since 1974. This has prompted much research into ways to stop or completely avoid the problem. Results of this research have yielded new methods to effectively control the problem in both new and operating reactors.

IGSCC is brought on by three main factors. Specific remedial measures have been developed for each of these:

- Stress - Among the remedies developed to address this issue are the use of induction heating stress improvement (IHSI), mechanical stress improvement (MSIP), and weld overlay repairs (WOL).
- Susceptible material - Material remedies include use of new IGSCC-resistant materials such as Type 316 NG stainless steel, application of a corrosion-resistant barrier to the inside of the pipe in the weld heat affected zone (corrosion-resistant cladding), and weld overlay repairs which apply a corrosion-resistant structural reinforcement to the outside of the pipe.
- Aggressive environment - The environmental remedies include the incorporation of a very high purity, low conductivity water chemistry, and the implementation of an alternative water chemistry which is benign to austenitic stainless steels - Hydrogen Water Chemistry (HWC).

These techniques have been used on both new and operating BWRs. They have reduced the rate of new cracking as well as slowed down existing cracks. IHSI has been used on piping welds and nozzles for some time. Recently, MSIP has been shown to be economical when only a few welds need to be treated. New BWRs have all of these options available to them. Operating plants, however, have a more restricted choice of procedures. One measure that has proven effective in battling IGSCC in existing plants is the weld overlay repair. These repairs have been accepted in treating flawed joints for ten years.

The weld overlay process is relatively simple. New weld metal is applied over the IGSCC affected area, around the entire circumference of the pipe and over a length sufficient to allow load transfer around the cracked area. These repairs provide three main benefits:

- They provide sufficient reinforcement for the damaged area to satisfy ASME Code Section XI flaw evaluation margins.
- They provide a highly resistant barrier to IGSCC propagation into the weld overlay material.
- They develop a favorable weld residual stress distribution in the underlying weldment, such that further IGSCC propagation is reduced or eliminated.

Welds repaired with this process were tested to failure at Battelle Columbus Laboratories. In every case, the experimental failure loads equaled or exceeded the predicted failure loads of the applicable ASME Code Section XI rules. An ASME Code Case has been developed to establish the acceptability of these repairs. It was recently approved and when incorporated into the ASME Code, it will provide a generic basis for the acceptance of weld overlay repairs, without the need for special approvals on a case-by-case basis.

Taken from "Winning the Battle Against IGSCC," P.C. Ricardella, A.J. Gianuzzi, and W.J. Childs, Nuclear Engineering International, pp. 36-37, June 1992.