Active EPRI research in three key areas – stress corrosion cracking, denting at the top of the tubesheet, and tubing degradation predictions – will enhance understanding of nuclear grade Alloy 800 steam generator tubing.

The performance of steam generator tubing is critical to the safe operation of pressurized water reactor plants. The tubing comprises a significant percentage of the primary pressure boundary, and also is responsible for transferring heat to the secondary side. Many of the corrosion issues observed with mill-annealed Alloy 600 were mitigated with the transition to more advanced steam generator tubing heat treatments and tubing alloy (such as Alloy 690 and Alloy 800).

Nuclear plants began using Alloy 800 for steam generator tubing in the 1970s after primary water stress corrosion cracking was observed in Alloy 600. Since then, nuclear grade Alloy 800 has been used in more than 50 nuclear power plants worldwide and has not exhibited this type of degradation. This performance can be attributed to the chromium and nickel in the alloy, as well as to the presence of titanium, which prevents sensitization of the microstructure. Some degradation, however, has been observed in recent years, and EPRI is conducting research to characterize and mitigate the applicable degradation modes.

For instance, stress corrosion cracking (SCC) has been observed on the secondary side within deep tubesheet crevices, in crevices at the top of the tubesheet, in dents at the top of the tubesheet, and at tube supports. An EPRI testing program is working to define the precise conditions that result in this cracking, including the effects of lead and potential inhibitors. A separate program on eddy current technique equivalency may lead to more effective non-destructive evaluation of mechanical wear from loose parts and foreign objects.

Dents at the top of the tubesheet result from the buildup of corrosion products. This process can induce stresses in the tube and lead to SCC. A recent EPRI report (1024991) finds that susceptibility is likely to be affected by the plant design, operational history, and the type of Alloy 800 (cold worked to increase strength or shot peened to impart beneficial compressive stresses). Work continues in this area to model the stresses in dented tubes, investigate potential links to chemistry upsets, and identify mitigation methods.

The Alloy 800 tube degradation experience captured in EPRI report 1024992 (June 2012) is being used to guide future research efforts and to develop accurate probabilistic models. These models could then be employed to predict future Alloy 800 steam generator tubing performance, yielding predictions of tubes requiring repair as the steam generators accrue service time.

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Stress corrosion cracking produced in an Alloy 800 specimen using an accelerated laboratory test environment containing lead.