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Subject: Recommendation for PWR Owners with Alloy 600 Bottom Mounted Reactor Vessel Instrument Nozzles

During the current refueling outage at South Texas Unit 1, the utility discovered boric acid deposits around two instrument nozzles at the bottom of the reactor vessel. The deposits were analyzed for chemical composition and the analyses indicated the presence of boron, lithium, and cesium. South Texas Project Nuclear Operating Company (STPNOC) has informed the NRC that the source of the leakage may be the reactor coolant system. Analysis of cesium isotope ratios also indicated that the deposits were approximately 4 years old. Previous visual inspections, as recent as November 2002, of the bottom vessel head did not identify either deposit. No evidence of wastage of the low alloy steel adjacent to the leaking nozzles was found based on the lack of discoloration of the boric acid deposits and the small amount of boric acid accumulation. STPNOC is still investigating the cause of the leakage; however, through wall axial indications in the base metal of the penetration tubes have been identified for both nozzles.

The bottom mounted nozzles had been expected to be less susceptible to Primary Water Stress Corrosion Cracking (PWSCC) than other, hotter locations with Alloy 600 due to the lower temperature of the bottom head region of PWRs (essentially the cold leg temperature). If the leakage at STP-1 is determined to be caused by PWSCC, it could raise issue with the industry susceptibility model for the Alloy 600 upper head penetrations that uses temperature as the primary variable. This model has been effective to date for ranking upper head penetration susceptibility, but it may not be appropriate for the bottom mounted nozzles due to material and installation-related differences. Until the root cause investigation at STP is complete, the use of the current CRDM penetration susceptibility ranking model should be continued.

Based on the above discussion, it is recommended that during the current or next refueling outage, a bare metal visual examination of any Alloy 600 nozzles penetrating the bottom head of the reactor vessel be performed. This recommendation is deemed to be a necessary and appropriate industry response to the recent finding at STPNOC. These inspections will provide additional information that will be very beneficial in assessing the extent of the issue for the US fleet. Plants whose design significantly impedes access to perform the recommended examinations should initiate expedited actions, up to and including physical modifications, to allow implementation of the recommendation at the earliest possible scheduled outage opportunity.

The recommended inspection attributes are similar to the top head bare metal visual examinations. The entire circumference of the interface of each nozzle with the vessel should be evaluated for the presence of any deposits that might indicate leakage from the annulus between the nozzle and the head. Some RPV bottom heads may exhibit signs of leakage from refueling cavity seals or other sources that should be inspected and evaluated. Such evidence should be dispositioned in accordance with appropriate GL 88-05 plant guidance to aid future visual inspections of the bottom of the RPV.
Considering the reported age of the STP-1 deposits and the possibility that they only recently emerged from the tube annuli, incipient leaks from through wall flaws may not visually manifest themselves immediately on the external surface of the RPV. Consequently, non-visual NDE may ultimately be a prudent and necessary component in a comprehensive inspection plan to fully evaluate the condition of the BMI population of an RPV, particularly following visual detection of a leak.

More information on the South Texas bottom mounted instrument nozzles is available on the NRC website concerning this issue (http://www.nrc.gov/reactors/operating/ops-experience/bottom-head-penetration-leakage.html).
Regards,

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