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APPLICATION OF VERSION 3.1 OF EPRI BWR RADIOLYSIS MODEL

Jim Henshaw (National Nuclear Laboratory), United Kingdom (jim.henshaw@nnl.co.uk)
Dave Morgan (Finetech), United States (dmorgan@finetech.com)
Joe Giannelli (Finetech), United States (jgiannelli@finetech.com)
Susan Garcia (EPRI), United States (sgarcia@epri.com)
Dave Ha (dha@epri.com)

ABSTRACT

Version 3.1 of the EPRI BWR vessel internals application (BWRVIA) code for calculating oxidant and electrochemical corrosion potential (ECP) around a BWR primary circuit has recently been released and this paper outlines the changes that have been carried out to the model and how the model compares with plant observations. There were two primary motivations for the development of BWRVIA V3.1 for plants injecting hydrogen into the feedwater to mitigate intergranular stress corrosion cracking (IGSCC) of reactor piping and internals; the fact that many BWRs now add Pt to the primary system to catalyze hydrogen:oxidant recombination at surfaces so the model needs to provide an accurate description of molar ratio (ratio of hydrogen to oxidant) around the primary circuit, and secondly to improve predictions of ECP in the lower plenum region for plants operating under moderate hydrogen water chemistry (HWC-M). Version 3.1 upgraded the model's benchmark for neutron and gamma dose rates and provided for model calculations with core axial power shapes that were bottom, middle and top peaked, characteristic of some core designs at beginning, middle, and end of cycle conditions. Improved reaction rate expressions also were incorporated along with refinements based on sensitivity testing and comparison to plant data under noble metal hydrogen water chemistry regimes.

In the presence of Pt deposits on surfaces, molar ratios greater than 2 at a particular location in the primary circuit imply reducing conditions, low ECP and therefore protection from stress corrosion cracking. Plants that apply noble metal will therefore be protected from SCC in these locations. In recent years several HWC-M plants have obtained ECP data from local power range monitors sampling water from the bottom head of the vessel. These ECP measurements have shown that not all BWRs respond similarly to hydrogen addition with some plants requiring very high feed water hydrogen levels to achieve ECP values less than –230mV (required for mitigation) in the bottom head, while others require much less. It is important to understand this observation and predict the behaviour.

This paper therefore compares model predictions of molar ratio with plant data for plants using noble metals and also predictions of lower vessel ECP with HWC-M plant measurements. The paper explains what controls the plant to plant variation in bottom plenum ECP. The paper also shows comparisons of the model with chemistry measurements from other locations in the plant, such as recirculation oxidant, steam oxidant and from data from an Advanced Boiling Water Reactor (ABWR), the top of the downcomer. These comparisons indicate the model gives a reasonable representation of the radiolysis chemistry and ECP in a BWR, despite all the uncertainties associated with this chemistry.