Return Momentum Effect on Reactor Coolant Water Level Distribution during Mid-Loop Conditions

Jae Kwang Seo
Korea Atomic Energy Research Institute
150 Dukjin-dong, Yusong-gu, Taejon 305-353, Korea

Jae Young Yang
Korea Power Engineering Company
150 Dukjin-dong, Yusong-gu, Taejon 305-353, Korea

Goon Cherl Park
Department of Nuclear Engineering
Seoul National University
San 56-1. Shillim-dong, Kwanak-gu, Seoul 151-742, Korea

Abstract

An accurate prediction of the Reactor Coolant System (RCS) water level is of importance in the determination of the allowable operating range to ensure safety during mid-loop operations. However, complex hydraulic phenomena induced by the Shutdown Cooling System (SCS) return momentum causes different water levels from those in the loop where the water level indicators are located. This was apparently observed at the pre-core cold hydro test of the Yonggwang Nuclear Unit 3 (YGN 3) in Korea. In this study, in order to analytically understand the effect of the SCS return momentum on the RCS water level distribution, a model using a one-dimensional momentum and energy conservation for cylindrical channel, hydraulic jump in operating cold leg, water level build-up at the Reactor Vessel (RV) inlet nozzle, Bernoulli constant in downcomer region, and total water volume conservation has been developed. The model predicts the RCS water levels at various RCS locations during the mid-loop conditions and the calculation results were compared with the test data. The analysis shows that the hydraulic jump in the operating cold legs, in conjunction with the pressure drop throughout the RCS, is the main cause creating the water level differences at various RCS locations. The prediction results provide good explanations for the test data and show the significant effect of the SCS return momentum on the RCS water levels.