Extended Validation of 3-D CFD Model for Liquid Poison Injection of CANDU Reactors

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Abstract

An extension of the validation of an existing CFD model for liquid poison injection phenomena of CANDU Shutdown System No.2 is made so that the model developed in the previous researches can be applied to the case where calandria tube banks are present in the CANDU moderator tank. While the previous validation[1] of the pertinent CFD model were limited to those experiments where no calandria tube banks are present as the existing 3-D CFD model for liquid poison injection assumes by postulating the wall effect on the poison growth negligible, current work shows that this assumption is really the case even for those experiments where calandria tubes are present in the CANDU moderator tank.

In this study, a set of model equations developed previously for analyzing the transient poison concentration induced by this high pressure poison injection jet initiated by the reactor trip has been summarized. The poison injection rate through the jet holes drilled on the nozzle pipes is obtained by a 1-D transient hydrodynamic code called, ALITRIG, and the injection rate is used to provide the inlet boundary condition to a 3-D model of the moderator tank based on a CFD code, CFX4.3[2], to simulate the formation of the poison jet curtain inside the moderator tank. As for validation, a new validation work is carried out for the liquid poison injection experiments for 850MWe CANDUs with and without the calandria tube banks present[3]. Along with the previous validation of the current model against the poison injection experiment performed at BARC[4] and the poison jet growth experiments[5] for a generic CANDU-6, the current work would extend the applicability of the current CFD models developed at KAERI for liquid poison injection for SDS 2 design analysis for the past a few years to the case where pressure tube banks exist in the moderator tank. The analyses results well agree with the experimental data for the case with and without the calandria tube bank present[5]. Therefore, the 3-D CFD model developed at KAERI is judged to be appropriate for verifying the effectiveness of SDS 2 liquid poison injection for intended functional design requirement of the system.