Verification and validation of numerical models for seismic fluid-structure-interaction analysis of advanced nuclear reactors

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Earthquake shaking of fluid-filled advanced reactors induces interactions between the vessel, the contained fluid, and the internal components. Fluid-structure-interaction (FSI) analysis of verified and validated numerical models will be required for the seismic design and qualification of the advanced reactors. The numerical models need to accommodate realistic geometries and boundary conditions used for the reactor vessel and its internal components and three-directional ground shaking.

This presentation describes verification and validation for numerical models of a 1/10th-scale base-supported cylindrical tank used for earthquake simulator tests. The tests were performed at the University at Buffalo using a 6 degrees-of-freedom earthquake simulator. The dimensions of this 1/10th-scale test tank were loosely based on those used for advanced reactor vessels. The numerical models are analyzed using the Arbitrary-Lagrangian and Eulerian (ALE) solver in LS-DYNA, which is capable of calculating nonlinear fluid-structure responses. To verify the models, numerical results of fluid-structure responses are compared with those calculated using analytical solutions for one-directional seismic motion of a small amplitude. To validate the models, the numerical results are compared with those generated by the earthquake simulator tests. Three-component translational and two-component rocking seismic motions of strong intensity are considered in the analysis for the validation.