Comparison of Experimental Data with Results of Computations on a Boiling Water Reactor Under Blowdown Loads

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Battelle Institute, Frankfurt/Main, performs blowdown tests on RPV of PWR and BWR. The general purpose is to relate to interested persons comparative data for verification of computer codes. This paper gives results for the BWR model test vessel under blowdown loads initiated by a feed water line rupture.

With DAPSY, GRS has made a computer code suitable for calculations of pressure wave propagation on LWR primary coolant systems. The mathematical model is based on a homogeneous two-phase flow model with non-equilibrium thermodynamic state in one-dimensional flow channels, resolved by the method of characteristics. Three-dimensional fluid flow may be simulated by the network design accompanied by node features. In the actual case of a downcomer this can be a rectangular grid of flow channels. Symmetry is assigned to reduce the effort required. The first blowdown phase, up to 130 msec, has been investigated.

Concerning PWR's, there is much operating experience with DAPSY and the code also contains features for free surfaces and for vapor separation both of which are substantial for the modelling of BWR's. There are essential differences between PWR and BWR in operating with DAPSY. BWR demands strict accuracy in calculating the hydrostatic pressure profile and thermodynamic equilibrium for the initial values. Loss of accuracy mainly in regions of a two-phase medium leads to local vapor expansion and condensation shock respectively, and causes instable code behavior. Similar problems were discovered on the discontinuous profile of independent thermodynamic quantities.

For BWR it can be stated that the pressure-time blowdown profile is smoother than that of PWR. Therefore, reduced reactor inlet loads and also interaction effects between fluid and structure were be found. The mean pressure after the first peakdown falls off very slowly as a consequence of the stabilisation effect of the steam volume in the upper plenum and the continuous evaporation in the core region. Pressure waves are nearly absorbed in regions of high void fraction and on free surfaces. They can only be transfered from the downcomer into the under plenum and core via the bypass line.

Comparison of experimental data and computational results show close agreement for all important parameters. Relatively high pressure peaks appear in subcooled regions only. Regions of high void fraction show smooth curves with gradual degrees of pressure level. The experimental data do not reproduce the periodic character of the pressure because of superposition of noise, but there are more high frequencies caused by the real three-dimensional behavior as estimated by the two-dimensional computer model. Due to the mainly vertical elongation of the RPV these influences are insignificant. Inside the reactor core the results agree very well, the documentation of void fraction during blowdown excepted. Pressure differences and loads on the core cover have lower peaks on experiment.