DEVELOPMENT OF THE PCRV STEAM GENERATOR CAVITY CLOSURE FOR THE GCFR*

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SUMMARY

One phase of the program to develop a Prestressed Concrete Reactor Vessel (PCRV) for the 300 MW(e) Gas-Cooled Fast Reactor consists of a series of model tests conducted to provide verification of the steam generator and central core cavity closure designs. The General Atomic Company has the overall design responsibility, and the Oak Ridge National Laboratory under sponsorship of the U.S. Energy Research and Development Administration is responsible for the design, analysis, and testing of the closure models. The program is divided into a series of 1 : 15-scale and 1 : 4-scale models. The smaller models will be used to determine the ultimate pressure capacity of the closure plugs and to obtain a limited amount of strain and deflection data for preliminary design verification; the larger models are intended to provide confirmation of the load response of a model closely representing the geometry and design features of the prototype plug and hold-down system. In this paper, the results of the pressure test of the 1 : 15-scale steam generator cavity closure plug model will be described and compared with calculated results.

High-tolerance machining was used to fabricate a model having rigorous linear scaling of the prototype, and the metallic components were subjected to heat treatments selected to produce reasonably homologous model-to-prototype stress versus strain curves. The microconcrete for the model was selected from a matrix of trial mixes to accurately represent the mechanical properties of the prototype concrete. The greatest discrepancies between the model and prototype plug are with respect to the hold-down and seal, which were modified in the model to withstand the high pressures required to determine the ultimate capacity of the plug.

The nonlinear finite element code ADINA was used to calculate the pressure response of the model. The concrete materials representation in the code consists of a non-linear stress-strain law, and cracking and crushing models that are implemented via modifications of the materials properties at the integration points.

The plug which was designed for a maximum cavity pressure of 10.1 MPa (1462 psi) withstood a pressure of 75.8 MPa (11,000 psi) without showing any visible signs of distress. The test was terminated at that point to prevent damage to the test apparatus. The analytical model proved to be relatively accurate in predicting the onset of nonlinear response and in tracking the initial nonlinearity; however, the agreement between calculated and experimental values tended to deteriorate for the higher pressures.

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