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EFFECTS OF ROD WORTH AND DROP SPEED ON THE BWR OFF-CENTER ROD DROP ACCIDENT*

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In recent years several multi-dimensional coupled neutronic/thermal-hydraulic calculations of the BWR control rod drop accident (RDA) have been performed.[1-4] Typically, two dimensional (r,z) RDA calculations require that the dropped rod be a center rod, as a result of geometric limitations, while in three dimensional calculations the dropped rod is generally taken to be the center rod in order to allow a quarter core representation and limit computer running times.[4] However, for typical BWR core loadings the center rod is not necessarily the highest worth rod.[5] The purpose of the present study was to determine the effect of increasing the control rod worth and the rod drop speed on the off-center RDA. An increase in either of these parameters results in an increase in peak core power and fuel enthalpy, and the objective of this study is to determine the margin to the fuel damage threshold.

The RAMONA-3B[6] model used in these calculations is based on a generic 764-bundle 3293 MW_t BWR/4 beginning-of-life core. The core is assumed to be at hot-zero-power (HZP) conditions, with the core flow at 25% of nominal and zero subcooling.[4] The calculations were carried out in half-core geometry using a multi-channel thermal-hydraulics description employing a non-equilibrium two-phase flow model. The control rods were arranged in a checkerboard pattern with an approximately 50% control density. The off-center rod was located on the core axis in the second outermost ring of control rods.

transients are presented in Figures 1 and 2. The increased rod speed results in a faster reactivity insertion, a shorter period, and an earlier and stronger transient. The calculated peak core power and fuel enthalpy are ~ 25 GW and ~ 96 cal/g, respectively.

In summary, BWR off-center RDA calculations have been performed for selected control rod worths and drop speeds. While in all cases the peak fuel enthalpy was well below the 280 cal/g fuel criterion, a substantial sensitivity to control rod worth and rod drop speed was observed.

References

1. H.S. Cheng and D.J. Diamond, "Analyzing the Rod Drop Accident in a Boiling Water Reactor," Nucl. Tech. 56, 40 (1982).

2. D.J. Diamond, "BNL-TWIGL, A Program for Calculating Rapid LWR Core Transients," BNL-NUREG-21925, Brookhaven National Laboratory (1976).

3. D.M. Cokinos and J.F. Carew, "Dynamic Behavior of a Subcooled BWR Core During a Rod Drop Accident," Trans. Am. Nucl. Soc., 43, 705 (1982).

4. P. Neogy and J.F.Carew, "A Comparative Analysis of the CRDA Using BNL-TWIGL and RAMONA-3B," Trans. Am. Nuc. Soc., 45, 465 (1983).

5. D.M. Cokinos, P. Neogy, J.F. Carew, "Comparison of a Center and Off-Center BWR Control Rod Drop Accident," Trans. Am. Nuc. Soc., 47 405 (1984).

6. D.J. Diamond, H.S. Cheng, W. Wulff and M. Khatib-Rahbar, "A Description and Assessment of RAMONA-3B MOD.0 CYCLE 4: A Computer Code With ThreeDimensional Neutron Kinetics for BWR System Transients", BNL NUREG-51746 (1984).

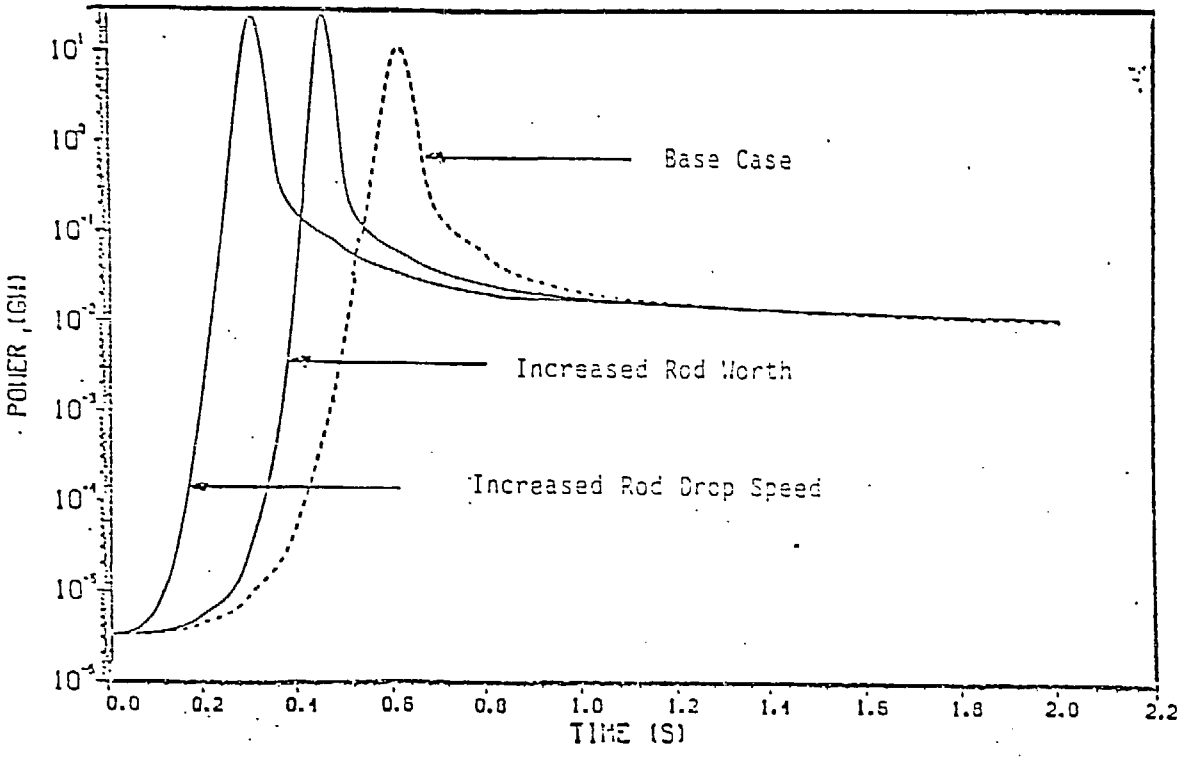

Figure 1. Core Power Transients for the BWR Off-Center RDA

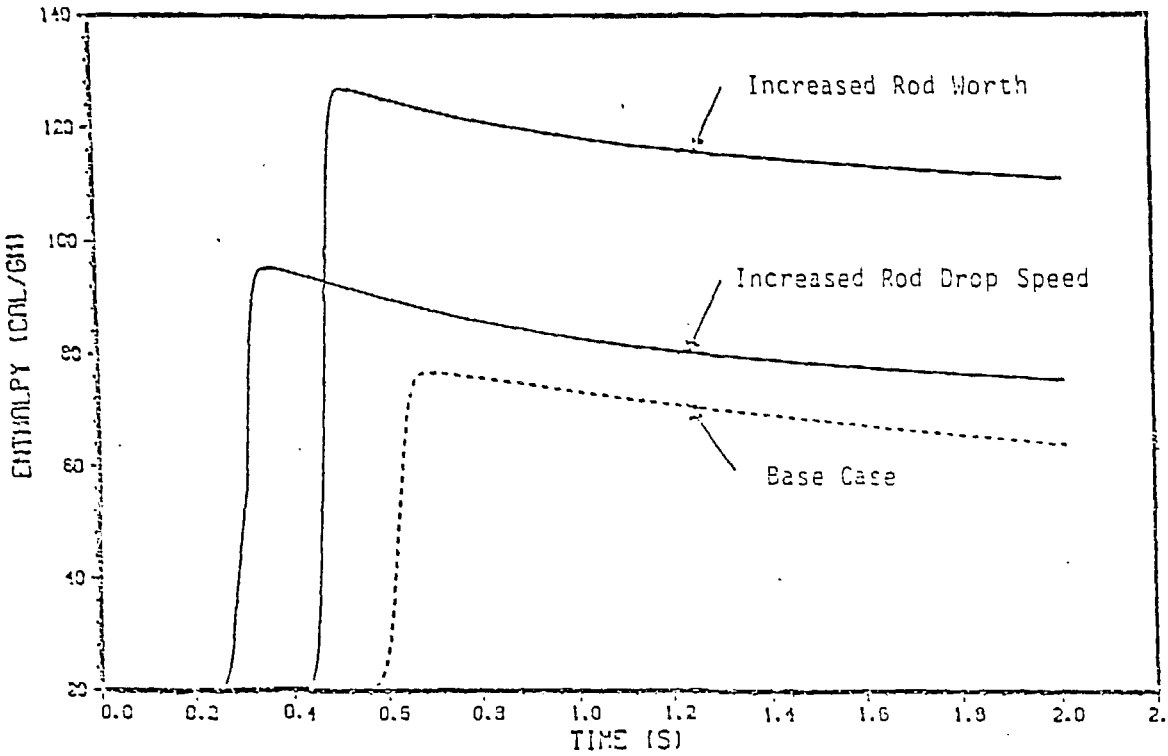

Figure 2. Peak Fuel Enthalpy Transients for the BWR Off-Center RDA