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Critical Power Ratio (CPR) calculation methods for BWR licensing support

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One of the main requirements to the reactor safety is the assurance that the appropriate margins of fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. CPR (critical power ratio) defined as the ratio of the critical power to the bundle power at the reactor condition of interest is widely used as a figure of merit for expressing BWR thermal margin. Traditionally, CPR is predicted by applying empirical CPR-correlations developed by fuel vendors from the actual fuel design experimental data. The recent trend in new fuel bundle development is the enhanced application of subchannel codes to fuel designing. The paper discusses the applicability of CTF (COBRA-TF) subchannel code for CPR prediction in comparison to the classical CPR correlations. The CPR is estimated by subchannel analysis from the critical condition that is defined when the subchannel code CTF predicts critical heat flux at any location of the FAs during iterative simulations with a power ramp. The obtained CTF results are then compared to the CPR estimations obtained from 3-D core simulations using the fuel design specific CPR correlation. Finally, the uncertainties in CPR estimation by CTF are analyzed by applying classical Wilks formula and available uncertainties distributions for the most important parameters that affects CPR, i.e. power, coolant flow rate and system pressure.

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