Feasibility Study On Application Of WIMS-AECL To Wolsong-1 Refueling Simulation

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ABSTRACT

At present, in Wolsong nuclear power plant, all of the reactor physics calculations are based on the cell code POWDERPUFS-V (PPV). PPV code use semi-empirical approximation rather than direct solving of transport equation with robust methodology. Switch from PPV to more robust transport solver is world-wide trend in addition to GAI issued from Canadian regulatory body (CNSC).

In this paper, feasibility study on the replacement of cell code POWDERPUFS-V (PPV) with WIMS-AECL was performed for Wolsong-1 NPP. The impact of the cell code replacement on physics design parameters and refueling simulation was assessed.

First, fuel isotopic composition affecting core reactivity is compared between PPV and WIMS-AECL. Generally it was shown that WIMS-AECL predicts higher uranium fissile concentration while less plutonium concentration as fuel burnup increases compared with prediction of PPV. Infinite multiplication factor of WIMS-AECL is slightly less predicted than that of PPV. Also core reactivity change from operating condition change such as moderator temperature, coolant temperature, fuel temperature and coolant density were compared for both fresh fuel and equilibrium fuel. Specially the analysis of void reactivity which is current hot issue for positive reactivity insertion in LOCA was also performed. As a result of this study, all of WIMS-AECL results were similar to PPV based calculation in the fresh fuel. However, there is a tendency that the deviation between the two codes increases as the fuel burn-up increases. This is because PPV code was made from the laboratory condition with fresh fuel and low fuel temperature.

Second, refueling simulation with WIMS-AECL based RFSP was tried to compare with current PPV based RFSP simulation for about 20 months (5775FPD ~ 6324FPD). To cover wide range of operating parameter condition such as purity of moderator and coolant and boron concentration, tremendous amount of computation time is needed with WIMS-AECL. To overcome long computation time of WIMS-AECL, Simplified Cell Methodology(SCM) was tried for Wolsong-1. It was shown that excess reactivity predicted by WIMS-AECL is around 7mk less than PPV results but trend was almost similar. Channel power distribution in addition to peak channel/bundle power and axial tilt was analysed also. In terms of channel power, maximum and average peak channel power difference are 193Kw , 37.5Kw respectively. And location of peak channel power is same for each burnup steps. From this study WIMS-AECL can be used in refueling simulation because average difference of channel power is less than 1%. But main obstacle to the use of WIMS-AECL is long computation time. For each refueling simulation, 1400 sec is needed for SCM based RFSP simulation while 40 sec is needed for current PPV based RFSP simulation.

From this study, application of WIMS-AECL to Wolsong-1 NPP is feasible except for the long computation time. The impact on safety analysis including void reactivity is also necessary before application in Wolsong-1 NPP.