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<u>Outline of the thesis</u>

Neutronic Study on Fuel Recladding for CANDLE Burning with Melt and Refining Procedures

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The application of melt and refining procedures is found able to solve the metal fuel and its cladding integrity at high burnup condition of CANDLE reactors. The idea of applying the melt and refining procedures to the CANDLE burnup before it reaches the cladding limitation would seem a possible solution for the metal fuel cladding integrity problem at high burnup. However, if melt and refining procedures are applied during operation, the reactor might lose all the nuclides distribution in the fuel pins and CANDLE burning become impossible to achieve. The purpose of this study was to investigate the possibility of applying melt and refining procedures in CANDLE operations, to solve the cladding limitation problem due to radiation displacement damaged at high burnup condition, to estimate the effects of burnup performance improvement on removal of fission products and also to investigate the effects of cooling time during melt and refining procedure.

In this study, a large LBE core at 3000MWth at 65% of fuel volume ratio (FVR) with metal fuel and ODS cladding was set as a reference core case. The initial core loading are assembled using 50 load-and-discharge units (LDUs) that are arranged axially in the core. In the calculation, the CANDLE core are divided into 50 zones in axial and 20 zones in radial region. The burnup operation are calculated at 3167 days in 1 fuel movement cycle (FMC). The frequency of applying melt and refining (MR) procedures to the CANDLE core are quantified from the radiation damaged to the fuel cladding during the operation. All of the fuel pins that received ≥ 200dpa shall underwent MR procedures in the appropriate time. In the MR procedures, the fuel element are cut into several melt and refining region (MRR) and refabricated/recladded to reuse in the CANDLE core. Three different melt and refining region (9MRR, 5MRR and 3MRR) are simulated to obtain the appropriate region for the CANDLE burning. The volatile and reactive fission products are released in the MR procedures. The cooling time interval between melt and refining cycle (MRC) are also been investigated. The cooling time of 1, 2, 4 and 8 years are simulated at each MRC to investigate its effects to the CANDLE burning. The SRAC and COREBN code are used to calculate the MR procedures with nuclear data libraries of JENDL3.3.

It became clear that with the application of MR procedures, it is feasible to achieve CANDLE burning if the appropriate number of regions is chosen based on practical core design. The fission products released by the MR procedures has given significant impact to the burnup performance of the CANDLE core. It is found that the effective multiplication factor has increased up to 4% and its burnup increased at ~22%. The FVR can be reduced at ~48% with the fission products removal without reducing its burnup performances. This mean, it is also able to improve the engineering design by reducing the fuel volume fraction to the practical value. The effects of cooling time to the excess reactivity varies with the cooling period. At ≤4 years of cooling interval, it has gave little effects to the change of effective multiplication factor. The significant cooling effects can be observed if the cooling interval ≥8 years. It is found that the effective multiplication factor has reduced significantly due to the accumulation of AM241 in the longer cooling time. It was shown that the cladding limitation can be solved by MR procedures and it can also improve the burnup performance of the reactor.