Nuclear data for Non-refueling core design

Tetsuo Matsumura, Yasushi Nauchi and Nobuyuki Ueda
CRIEPI: 2-11-1, Iwado Kita, Komae-shi, Tokyo 201-8511 JAPAN, matsu-t@criepi.denken.or.jp

Shigeaki Okajima
JAEA, Tokai-mura, Naka-gun, Ibaraki-ken, 319-1195, JAPAN, okajima@fca001.tokai.jaeri.go.jp

Toshikazu Takeda
Osaka University, Yamada-oka, 2-1, Suita Osaka 565-0871, JAPAN, takeda@nucl.eng.osaka-u.ac.jp

The 4S, Super Safe, Small and Simple~~,~~ reactor is a kind of fast reactor core in which burn-up reactivity loss is compensated by decrement of neutron leakage probability with movement of reflector. For extending core life of 4S up to 30 years generating 30MW thermal power, a core of 2.5m height has been ~~is~~ designed and studied in which 20%/24%-Pu-enriched Pu-U-Zr metallic fuel pins are loaded.

For design of innovative control system and safety characteristic of the 4S core of long life, we have to verify and improve neutronics calculation methods. However, there are few experimental data measured focusing on reflector reactivity, small (zero or negative) Na void reactivity, etc. For the verification of the design methods, A series of critical experiments is conducted at the fast critical facility, FCA of JAEA-Tokai. A core of metallic fuels of Pu and Pu+U surrounded by massive reflector of stainless steal has been mocked up and measurement of several kinds of reactivity and reaction rate distribution has been conducted. The measured data have been analyzed by conventional deterministic diffusion / transport codes and continuous energy Monte Carlo codes. By the comparison of calculated one to the data, prediction accuracies of neutronics codes have been clarified.

Using the experimental data, the bias factor, the ratio of measured neutronics characteristics to the calculated ones, is obtained. The uncertainty of this bias factor is also calculated. To quantitatively estimate the uncertainty reduction through critical experiments, an uncertainty reduction ratio (UR) is introduced, using the cross section error. By using UR, better experimental core can be mocked up and required accuracy for experiments have been identified to reduce the uncertainty of the bias factor, i.e., to improve the accuracy of design calculation of the target 4S core.

For achievement of long core life of 30 years without refueling, prediction of burn-up reactivity depletion is important. With sensitivity analysis of the cross sections, important cross sections are clarified for burn-up calculation.

The present study is the results of "Development of Advanced Controlling System for Non-Refueling Reactor Core" in fiscal year 2003 and 2004 entrusted by Ministry of Education, Culture, Sports, Science and Technology (MEXT) to Central Research Institute of Electric Power Industry (CRIEPI).