Analysis of Core Physics Experiments of High Moderation Full MOX LWR

Toru YAMAMOTO
Reactor Core and Fuel Reliability Group, Safety Standard Division
Japan Nuclear Energy Safety Organization (JNES)
Fujita Kanko Toranomon Bldg. 7F, 3-17-1, Toranomon, Minato-ku, Tokyo 105-0001
E-mail: yamamoto-toru@jnes.go.jp

1. Introduction

Full MOX LWR cores are favorable since they enable a large amount of plutonium to be loaded in a small number of reactors. Higher moderation LWR cores are also favorable to enhance the consumption of plutonium and reduce the residual plutonium in burned MOX fuel. Nuclear Power Engineering Corporation (NUPEC) studied such high moderation full MOX cores as a part of advanced LWR core concept studies from 1994 to 2003 supported by the Ministry of Economy, Trade and Industry. In order to obtain the major physics characteristics of this advanced MOX cores, high moderation full MOX LWR cores, NUPEC carried out the core physics experimental programs called MISTRAL and BASALA in collaboration with CEA in the EOLE critical facility of the Cadarache Center from 1996 to 2002. NUPEC also obtained a part of experimental data of the EPICURE program that CEA had conducted for 30 % Pu recycling in French PWRs under the collaboration with French industrial partners. Those experimental data was transferred to Japan Nuclear Energy Safety Organization (JNES) by March 2005 for further effective utilization.

The analysis of the experimental data was performed by NUPEC from 1996 to 2003 with SRAC, a deterministic code system for pin cell and core calculations, and MVP, a continuous energy Monte Carlo calculation code, based on a common nuclear data library, JENDL-3.2. A part of analysis was also done with JENDL-3.3, ENDF/B-VI and JEF-2.2.

2. Outline of Experimental Programs

The UO2 and MOX fuel rods other than 11 wt% MOX fuel rods used in the experiments have the same geometry of the standard PWR 17x17 assembly with Zry-4 claddings of an outer diameter of 9.5 mm except for the fuel effective length, about 800 mm; the 11 wt% MOX fuel rods have a little smaller diameter that had been used for High Conversion LWR studies before. Those rods are sealed by aluminum over-claddings for adjusting the core moderation ratio and protecting the rods in handling. The MOX pellets except for the 11% MOX fuel are composed of typical reactor grade plutonium with a fissile plutonium content of 60 to 70% and ^{240}Pu content larger than 20% in a depleted UO2 matrix. The total plutonium contents of the MOX pellets are 3.0, 4.3, 7.0 and 8.7wt%. These experimental programs consist of eleven reference critical cores and several derivative cores based on each reference core.

This paper describes an outline of those MOX core physics experiments and summarizes the analysis results that have been published in a large number of papers and others.