CORE CONCEPT FOR LONG OPERATING CYCLE SIMPLIFIED BWR (LSBWR)

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Introduction

A long operating cycle simplified BWR (LSBWR) is currently being developed by Toshiba Corporation and Tokyo Institute of Technology. It is a new nuclear reactor concept for the new era of world nuclear requirements.

LSBWR adopts a new BWR core concept optimized for long cycle operation and an improved simplified BWR configuration with simplified modular structure. Purpose of this paper is to show the new BWR core design and its performance.

Core Concepts

One way to achieve the super long operating cycle (over the 15 years) is adoption of high conversion core, which is attainable with a hard neutron spectrum. Some designs use combination of tight lattice core and plutonium MOX fuel to attain hard spectrum. Instead of hardening neutron spectrum, we adopted the combination of enriched uranium oxide fuels and non-tight lattice bundle, because this configuration facilitates natural circulation for core cooling.

A combination of isotope-enriched gadolinium design and 0.7-times large bundle with peripheral-positioned gadolinium rod are adopted as a core design concepts for the LSBWR.

Isotope-Enriched Gadolinium

It is an important core design issue to suppress the large excess reactivity for a long operating cycle. Although gadolinium has been used as a burnable poison in BWR core design, it is difficult to apply gadolinium to core design for LSBWR as it is because of large concentration. Large concentration of gadolinium has adverse effect on physical properties of fuel rod and reactivity. It is effective design measure to utilize isotope-enriched gadolinium, because concentration can be sharply decreased compared with natural gadolinium.

A 0.7-times Large Bundle with peripheral-positioned gadolinium rod

It is an important subject to depress the initial large reactivity of uranium based fuel. Additionally, it is an important subject to control large excess reactivity caused by unexpected error due to long term operation. A 0.7-times large bundle with peripheral-positioned gadolinium rod are the answer for these subjects. The 0.7-times large bundle has the 0.7 times larger channel width compared with conventional BWR. The peripheral-positioned gadolinium rod is the design concept for the peripheral positioning of gadolinium. The thermal neutron flux is large at a peripheral position, therefore reactivity of a gadolinium rod is very large. This feature is fit for the depression of initial excess reactivity for a long operating. Moreover, it is favorable feature of 0.7-times large bundle that control rod worth is larger than conventional BWR. The reason is that the control rod worth increases when the bundle cross-sectional area decreases.