The effectiveness evaluation of neutron absorbers for aging management

Kiyoung Kim, Donghee Lee, Beomgyu Kim, kyungho Noh
KHNP-CRI, 70 Yuseong-Daero 1312, Yuseong-gu, Daejeon, Republic of Korea, 305-343
Email: kiyoungkim@khnp.co.kr

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1. Introduction

The spent nuclear fuel generated during the operation of NPP(nuclear power plant) is stored in a wet storage pool in NPP. Currently, A high-density storage rack is used to increase the storage capacity of spent nuclear fuel, and neutron absorbers are used to control the criticality of spent nuclear fuel. In general, Neutron absorbers such as Boral, Maxus, BSS and Metamic are installed on the wall of the high-density storage rack. The purpose of this paper is to propose improvements in the management of neutron absorbers, which is one of the aging management items conducted by KHNP (Korea Hydro & Nuclear Power) to support the continued operation of nuclear power plants.

2. Domestic Status and Results

The effectiveness evaluation of aging management items is conducted every five years as part of both the periodic safety review and the continued operation of nuclear power plants[1]. In South Korea, the neutron absorbers installed in spent fuel pools vary in type and management methods due to differences in suppliers. This paper aims to enhance safety and management efficiency by standardizing the management methods and inspection items for neutron absorbers based on the effectiveness evaluation results of aging management items.

2.1 Domestic Status of Neutron Absorbers

In the case of domestic nuclear power plants, four types of neutron absorbers are used: BORAL, Maxus, BSS, and METAMIC. BORAL, METAMIC, and Maxus, which are aluminum alloy neutron absorbers, are installed in the neutron absorber pockets, and BSS, which is a stainless-steel alloy neutron absorber, is installed in the spent fuel pool as the high-density storage rack and is used to control criticality. The table below shows the neutron absorbers installed in domestic nuclear power plants.

Table I: Current status of domestic neutron absorbers

		BORAL	BSS	METAMIC	MAXUS
Type		Clad.	Non-Clad	Non-Clad	Clad’
% B_4C			-	32 wt%	
Mater-ial	Clad.	Al 1100 (Al-0.12 Cu)	-	-	Al 5052 (Al-2.5 Mg-0.25 Cr)
	core	Al 1100, B_4C	SS	Al 6061 (Al-0.6 Si-0.28 Cu-1.0 Mg-0.2 Cr), B4C	Al 1070 (Al>99.7), B_4C
Corrosion resistance		Good	Good	Good	Good (Better than BORAL)

In South Korea, neutron absorbers installed in spent fuel pools are periodically inspected. However, the fact that different inspection items and criteria are provided depending on the supplier of the neutron absorbers has led to a decrease in management efficiency. The inspection items typically conducted in the country include visual inspection, measurement of length, width, thickness, weight, and specific gravity[2]. If the results do not meet the acceptance criteria, a neutron attenuation test is performed[3]. However, due to the different inspection items and criteria adopted by some power plants, there is a need for improvement in this area. Additionally, measures are required for power plants with limited remaining samples for inspection.

2.2 Improvement of Neutron Absorber Management

This paper aims to standardize the management methods and inspection items for neutron absorbers to enhance safety and management efficiency. Specifically, the basic inspection items for neutron absorbers are limited to visual inspection, and the measurement of length, width, and thickness. If the thickness measurement is unsatisfactory, the weight and specific gravity will be measured, and a neutron attenuation test will be conducted. Additionally, if the neutron attenuation test results are unsatisfactory, further neutron attenuation

tests will be performed on adjacent coupons. If similar results are observed, the supplier will be contacted for follow-up actions.

To address the depletion of coupons due to the continued operation of nuclear power plants, coupons that have only undergone basic inspections will be allowed to be reused. Furthermore, the neutron attenuation test, which evaluates the neutron absorption performance of neutron absorbers, has been revised to be mandatorily conducted every 10 years across all nuclear power plants. These improvements will be incorporated into the standard procedures for neutron absorber inspection management[4].

3. Conclusions

The paper reviews the inspection items for all nuclear power plants based on the effectiveness evaluation of neutron absorbers, an aging management item. Based on this review, the inspection procedure for neutron absorbers performed at all domestic nuclear power plants has been standardized. Additionally, at some nuclear power plants, continued operation has raised concerns about the depletion of inspection coupons, leading to improvements that allow for their reuse. Furthermore, the neutron attenuation test, which checks the neutron absorption performance of the neutron absorbers, has been revised to be conducted every 10 years across all nuclear power plants. These findings have been incorporated into KHNP's standard procedures to systematically manage neutron absorbers, thereby enhancing safety and efficiency.

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