

## The Case Study on the Handling of Non-Fuel Materials in the SFP of PWR

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### 1. Introduction

In accordance with the 2nd High-Level Radioactive Waste Management Master Plan announced in December 2021, the general design services for on-site dry storage facilities and systems were launched, while the FDP (Final Decommissioning plan) of Kori #1 is in the licensing process. Once the decommissioning approval is completed, it is necessary to take out SNF (spent nuclear fuel) and other non-fuel materials from the SFP. The policy was decided to temporarily store SNF in on-site dry storage facility, but the treatment/disposal policy of non-fuel materials in the SFP is undecided. Even if non-fuel materials are processed and stored temporarily or packaged for disposal, a handling process is required, so this paper intends to derive a handling plan using the specifications of these non-fuel materials. [1]

### 2. Methods and Results

This section briefly describes the storage status of non-fuel materials in the SFP of domestic PWR (Pressurized Water Reactor), and classifies non-fuel material handling types to derive handling measures using rough specifications information by selecting one unit each of OPR (Optimized Power Reactor) and WH-type nuclear power plants.

#### 2.1 Status of non-fuel material storage in SFP

Non-fuel materials from domestic PWR occupy 732 racks of the total SFP rack (as of the first quarter of 2023). Out of these, control rods and in-core instruments (ICI) account for 64%. However, in the case of WH-type nuclear power plants, the control rod and some burnable poison rods are stored being inserted into SNF. Tables 1, 2, and 3 show the storage status of non-fuel materials of one WH-type nuclear power plant and one OPR nuclear power plant, respectively.

Table 1. Storage status of non-fuel materials in WH-type nuclear power plants (Rack storage)

Type	Q'y	Remark (Dimension)
1. Fuel Skeleton	6	Occurs upon reassembly of nuclear fuel (20x20x400cm <sup>3</sup> )
2. ICI Basket	2	Storage of in-core instrument (400 cm)
3. Dummy Fuel	3(1)	(1) stored outside the rack (20x20x400cm <sup>3</sup> )

4. Damaged Fuel Rod Basket	3	Damage Fuel Rod (400 cm) and Storage of damaged Fuel fragments
5. Debris Basket	3	Store debris occurred from the core (20x20x400cm <sup>3</sup> )
6. Neutron Source Ass'y (NSA) Basket	3	Store damaged Neutron Source (20x20x400cm <sup>3</sup> )
7. Rx Structural Parts Basket	2	Occur when repairing Rx Upper Structures (20x20x400cm <sup>3</sup> )
8. Surveillance specimen Basket	1	Store specimen (20x20x400cm <sup>3</sup> )
Total	23	

Table 2. Storage status of non-fuel materials in WH-type nuclear power plants (in SF)

Type	Q'y	Remark (Dimension)
1. Thimble Plug	92	Fuel Thimble Plug (15x15x30cm <sup>3</sup> )
2. Burnable Poison Rod	129	Burnable Poison Rod Ass'y (400cm)
3. Control Rod	69	Control Rod Ass'y (400cm)
Total	290	

Table 3. Storage status of non-fuel materials from OPR nuclear power plants (Rack storage)

Type	Q'y	Remark (Dimension)
1. Control Rod Basket	33	Storage of spent control rod (20x20x400cm <sup>3</sup> )
2. ICI Basket	15	Storage of spent ICI (400cm)
3. Dummy Fuel	1	Nuclear fuel configuration (20x20x400cm <sup>3</sup> )
4. Damaged Fuel Rod Basket	1	Damaged spent fuel rod (20x20x400cm <sup>3</sup> )
5. Waste Basket	1	Storage of consumables after repaired fuel (20x20x400cm <sup>3</sup> )
6. Ultrasonic Cleaning Equipment filter	2	Underwater ultrasonic cleaning (15(D) x 80(H)cm <sup>3</sup> )
7. Ultrasonic Cleaning Equipment Pump	2	Underwater ultrasonic cleaning (15(D) x 150(H)cm <sup>3</sup> )
Total	55	

The types of non-fuel materials stored in the SFP of WH-type and OPR-type plants are similar, but in the case of WH-type, some inserts, such as control rods, thimble plugs, and burnable poison rods, are stored while inserted into SNF.

#### 2.2 Classification criteria for handling non-Fuel materials

As shown above, there are various non-fuel materials in the SFP, but similar types exist for each reactor type. These non-fuel materials are classified into types that are stored directly or stored in a basket. In this study, for the handling of the materials, it was classified into

four types as follows based on whether the neutron irradiation environment was exposed and whether cutting was necessary.

- ① Radiated material that needs to be cut
- ② non-cutting radioactive material
- ③ Surface contaminants requiring cutting
- ④ surface contaminants that do not require cutting
- ⑤ Other materials

Table 4. shows the types of non-fuel materials classified by the above criteria.

Table 4. Types of non-fuel materials according to self-standards

분류	대상물	비고
① Radiated Waste (Cutting)	Fuel Skeleton	Large
	ICI	
	NSA	
	Basket (for storage of NSA and damaged fuel rod)	
	Burnable Poison Ass'y	
	Control Rod Ass'y	
② Radiated Waste (non-cut)	Rx Structural Parts	Small
	Surveillance Specimen	
	Thimble Plug	
③ surface contamination waste (cutting)	Basket (Storage for Debris, Rx Structural Parts, Surveillance Specimen, Control Rod, ICI, Waste)	Large
	Dummy Fuel	
④ Surface contamination waste (non-cut)	ultrasonic cleaning equipment filter	Small
	ultrasonic cleaning equipment pump	
⑤ Others	Damaged fuel rod	
	Debris	
	Waste	

### 2.3 Handling of Non-Fuel Materials by Type

The waste package unit size is defined as 1.5(L) x 1.5(W) x 1.5(H) or 1.5(D) x 1.5(H) in the acceptance criteria for waste cave disposal facilities, so cutting is necessary for larger materials.

#### 2.3.1 Radioactive materials requiring cutting

Due to the large size and amount of radiation, it is difficult to handle, and it is necessary to handle it after pre-cutting in the power plant. In the case of OPR plant, control rod dismantling procedures and equipment are provided, so this kind of material can be handled by referring to the control rod dismantling equipment and procedures.

#### 2.3.2 Radioactive material that does not require cutting

For small radiated wastes, drum treatment is possible and can be handled using tools such as tongs.

#### 2.3.3 Surface contaminants requiring cutting

In the case of large materials that can be decontaminated, a self-disposal plan is established through decontamination, or if decontamination is not possible, the handling equipment of large radioactive materials is used.

#### 2.3.4 Surface contaminants that do not require cutting

It is believed that it will be easy to handle if existing equipment is used as an item generated during the ultrasonic cleaning process.

#### 2.3.5 Other materials

The materials stored in the basket need to be handled before basket treatment, and in the case of damaged fuel rods, treatment/disposal is required after the spent fuel management policy and classification criteria for damage are determined.

## 3. Conclusions and Future Work

In order to temporarily store or transport to an analysis facility for disposal after taking out non-fuel materials in the SFP, a handling plan must be preceded. Accordingly, each unit of OPR plant and the WH plant was selected, and the handling plan of non-fuel materials was reviewed based on the storage status and rough specifications of non-fuel materials in the SFP. In the case of temporary storage after drum treatment through cutting, it is judged that it can be handled through the use and application of existing equipment. However, when considering the handling of non-fuel materials for the purpose of disposal, the method of transport to the facility and sampling should be considered. In order to set the direction for the treatment of non-fuel materials in the future, a follow-up plan will be established in consideration of the above reviewed handling measures.

## REFERENCES

- [1] Kyungho Roh\*, Younghwan Hwang, Beomgyu Kim, Sukwon Jung, Mihyun Lee, A Preliminary Study on Non-Fuel Radioactive Waste Stored in Spent Fuel Pool of PWR, Vol.21, No.1 p. 251, 2023.