

## Review of Canning Methods of Intact and Damaged Spent Fuel Rods

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### 1. Introduction

The Post Irradiation Examination Facility (PIEF) at the Korea Atomic Energy Research Institute (KAERI) has been received spent fuel rods from nuclear power plant sites since 1987, and it has been stored in PIEF pools and hot cells. The mechanical and chemical experiments of fuel rods has been performed and this generates lots of damaged fuel rods, and rod fragments. Accordingly, KAERI PIEF is required to determine an optimum solution to store or transport the fuel rods to nuclear plant site safely. In this paper, we review the possible solutions for the transportation or storage of intact and damaged fuel rods, and rod fragments.

### 2. Results and Reviews

In this section, the storage status of intact and damaged fuel rods, and rod fragments in KAERI is described. A few of commercial canning solutions for fuel rods and rod fragments developed by various companies are also described.

#### 2.1 Status of spent fuel rods in KAERI

The intact and defective fuel rods extracted from fuel assemblies are stored in fuel rod storage baskets (Fig. 1a). Some fuel rods have been changed in to various forms from the mechanical and chemical experiments. The fuel fragments or mounting specimens are stored in rod cut container (RCC) in the storage pool (Fig. 1b). For the safe storage and transportation of fuel rods, fragments and specimens, it is required to adopt the advanced and efficient canning solutions considering the conditions of spent fuels and KAERI PIEF facility.

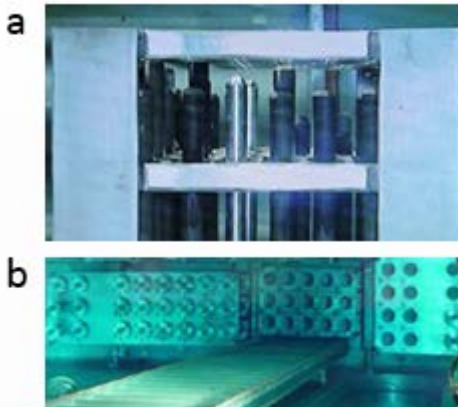


Fig. 1. Storage status of fuel rods, fuel segments and fuel specimens in storage pool at KAERI PIEF. a) Fuel rods in rod storage basket, b) Rod cut container in the storage pool.

#### 2.2 Quiver (Westinghouse)

The Westinghouse Quiver can provide the simple, safe solution for handling and storing intact and damaged spent fuel rods and fragments. Quiver is available for both boiling water reactor (BWR) and pressurized water reactor (PWR), with the capacity of 14 to 28 positions in BWR, and 30 to 60 positions in PWR, respectively [1]. Westinghouse Quiver also ensures the function of leak tight and gas tight.



Fig. 2. Westinghouse Quiver System for storing intact and damaged spent fuel rods for PWR spent fuel rods.

#### 2.3 Integrated Quiver (GNS)

The GNS Integrated Quiver System is a versatile container for the disposal of damaged fuel rods. This GNS Quiver is designed like “second cladding” to accommodate large varieties of fuel rods with defects. This Quiver consists of a forged stainless steel base body, as well as a forged lid, bolted and welded to the base body. These conditions can provide a leak-tight sealing [2].

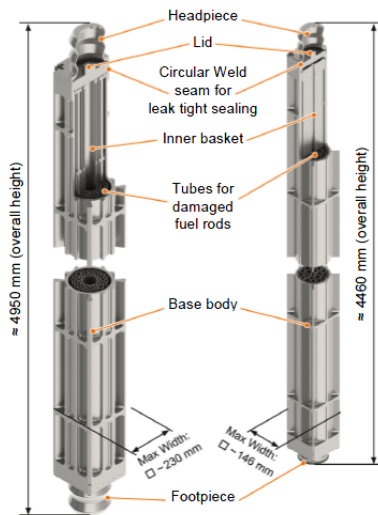


Fig. 2. GNS IQ Integrated Quiver for casks for PWR and BWR, respectively.

#### 2.4 Capsule and Capsule Canister (Framatome)

Framatome's capsule solutions provide a technology to safely enclose defective fuel rods for dry storage. Single rod encapsulation and capsule canister designs allow for flexibility and improved handling of spent fuel rods [3].



Fig. 3. Framatome (AREVA NP) opened and closed fuel rod capsules

### 3. Conclusions

Status of spent fuel rods in KAERI PIEF and various canning solutions for intact and damaged fuel rods have been introduced. To achieve the safe transportation and long-term storage of spent fuel rods in the storage pool or interim storage site, it is essential to determine the optimum canning solutions based on the conditions of fuel rods and fragments, facility adaptability as well as licensing issues. Based on the review of canning

solutions from various nuclear companies, KAERI will determine the optimum canning solution for intact and damaged fuel rods and rod fragments stored in KAERI PIEF.

### REFERENCES

- [1] Westinghouse Quiver Digital Handout, <http://www.westinghousenuclear.com/>
- [2] GNS IQ integrated Quiver System. <http://www.gns.de/language=en/29870/quiver-iq>
- [3] Matthew French, David Nixon, Roger Thetford, Mark Cowper, "Packaging of Damaged Spent Fuel", Amec Foster Wheeler, 204895-UA00, 2016.