An Analysis on Applicability of Temporary Onsite Storage Facilities of Spent Fuel From PWRs in Korea

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1. Introduction

In South Korea, the spent nuclear fuel produced in light-water reactors is currently managed by the storage pools inside each NPP. As of the end of 2016, the cumulative amounts of spent nuclear fuel generated from the Korean nuclear plants were 16,289 and 408,797 bundles for light-water and heavy-water reactors, respectively. The Kori nuclear plant, which is scheduled to be dismantled, will trigger the shortage of the storage pools. Accordingly, interim storage facilities, which are commonly categorized into wet and dry types, are in need to resolve the issue of saturation.

Dry storage has an edge over wet storage in terms of the volume and operation of storage. Moreover, owing to its stronger economic and safety aspects, this type is currently dominant around the world. In Korea, there is a need for storage methods to address high burn-up as well as regular spent nuclear fuel generated in nuclear power plants. In particular, customization is of importance in Korea considering its limited lands. This paper examines the current status of interim storage technology for PWR spent fuel, and seeks to develop an optimal solution for Korea taking such limitations into account.

2. Main title

2.1 The Usage of Interim Storage Facilities in Korea

The used amount of the interim storage facilities versus their full capacities in NPPs in Korea at the end of 2016 are described in Table 1.

Table 1. Domestic Spent Fuel Pools saturation

Division	Capacity	Stock	Saturation
Hanbit	9,017	5,693	63.1%
Kori	6,494	5,612	86.4%
Hanul	7,066	4,855	68.7%
SinHanul	1,046	129	12.3%
WolSung	499,632	408,797	81.8%

The Hanbit and Kori plants will run out of their available capacity in 2024, Hanul in 2037 and Shin Hanul in 2038, with the overall use of 68.9% for light-water reactors only. Wolsung plant, which uses heavy water, operates a dry storage facility outside its premise, which displays a relatively high usage of 81.8% due to the large amount of spent fuel as commonly seen in PHWR.

2.2 Interim Storage Technology

The term 'interim storage' refers to a technique that collects and stores spent which is considered to be an intermediate phase between reusing and permanent disposal.

2.2.1 Wet Storage. Storage pools are the place where the spent nuclear fuel is collectively stored in cooling water of at least 20 ft, which is to provide sufficient protection to all workers from radiation. The bundles are moved through the bottom of the pool, so protection is needed for the staff who work nearby.

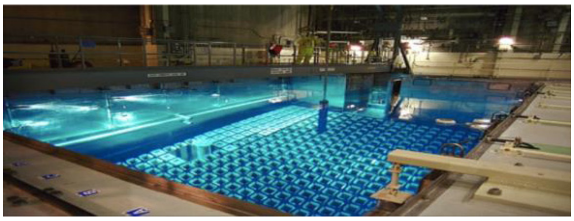

Fig. 1. Pools.

2.2.2 Dry Storage. Gas or air is used as a coolant instead of water in dry storage. Radiation shielding is provided by concrete or metal instead of water. There are three different types of dry cask storage techniques that are used in a commercial scale, i. e., metal cask,concrete silo, horizontal concrete modular storage.

2.2.2.1 Metal Cask. This method can be described rather simply the spent nuclear fuel is collected in a metal cask which is stored on a concrete pad. Some recent efforts in this area include development of multipurpose metal casks that can be used for storage/transport, or transport/storage/disposal.

Fig. 2. Metal Cask.

2.2.2.2 Concrete Silo. Concrete silo is basically similar to the metal cask technique This method is less expensive than the one using a metal cask, but has several shortcomings, including lower resistance to heat and shocks and poorer cooling performance.

Fig. 3. Concrete Silo.

2.2.2.3 Horizontal Concrete Modular Storage. This technique stores the shielded canister loaded with spent nuclear fuel on the concrete storage module in a horizontal fashion, which is established in the storage site. This method has rather complicated processing, but is known to be superior in terms of safety and economically efficient. It also has a variety of applications for other types of fuel.

2.3 Examples in the Overseas

The dry storage systems of spent nuclear fuel generally employs metal-concrete or concrete storage containers, and can be categorized into indoor and outdoor facilities depending on the storage location. .

Table 2 contains the overview of indoor and outdoor storage facilities.

Table 2. Indoors and Outdoors storage type

Type	Pros and Cons
Indoors	Good in terms of security and public acceptance, but relatively expensive to build.
Outdoors	Less expensive to build and economically feasible, but less favorable in terms of security and public acceptance as the facility is exposed.

Outdoor storage, which stores the spent nuclear fuel without water using a metal or concrete cask, or a concrete module, on top of a concrete mat, is commonly used in larger areas. For example, most of storage facilities in the United States use dry-type storages.

Indoor storage is more popular in Europe and Japan, where countries have limited lands and are densely populated. These facilities are excellent in terms of security and safety as they take into account external threats such as aircraft collision into an outside building. They tend to be better perceived by the local residents as well. In Germany, most of storages use a metal cask in the building. In addition, Japan has pursued indoor storage facilities to accommodate its spatial restraints, and built Mutsu interim storage facility, Asia's first indoor storage facility.

Fig. 4. Indoors Storage Type.

3. Conclusion

Korea can learn a lesson from Japan, which has longer history in NPP and became the first country in Asia to make an interim storage facility. The Korean government remains unchanged in its policy not to abandon nuclear energy despite the public opposition, and is getting warnings about the saturation of storage pools by the year of 2024. Interim storage facilities are being discussed as an alternative option that the government can choose to buy some time. Japan's Mutsu case can be a benchmark for Korea especially considering the limited space in both countries, from which Korea can refer to when selecting the type and site of interim storage facilities.

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