Experiences on the Expansion of Spent Fuel Storage Capacity at PWR and CANDU plants in Korea

Hyeong-Joon Yun, Byung-Sik Lee, Sang-Bok Kim*
Korea Power Engineering Company, Inc.,
360-9 Mabuk-ri, Guseong-eup, Yongin-si, Gyeonggi-do 449-713, KOREA
* Korea Hydro & Nuclear Power Co. Ltd. (KHNP), 167 Samseong-dong, Gangnam-gu, Seoul 135-791, KOREA
ading@kopec.co.kr

1. Introduction

At present, Korea has twenty nuclear power plants (16 PWRs and 4 CANDUs) under operation. The cumulative amount of spent fuel discharged from PWR plants by 2006 is 3,973 ton on the Uranium basis and CANDU plants is about 4,697 ton. The current storage capacities at reactors are insufficient to store the spent fuels generated until the year 2016. According to the decisions made by Korean Atomic Energy Commission, which is the nation's highest decision maker on nuclear policy, the spent fuel shall be stored within nuclear power plants until 2016 by the expansion of its on-site storage capacity. KHNP(Korea Hydro & Nuclear Power Co., Ltd.), who owns andoperates all nuclear power plants in Korea, is performing the expansion project of spent fuel storage capacity in a reactor site by application ofhigh density storage rack, concrete silo-type and consolidated dry storage facility, and transshipment to neighboring reactor. Among these options, high density storage rack(HDSR), which increases the storage capacityby using various neutron absorbers such as Boral or Borated Stainless Steel, is adopted as a measure to easily expand the storage capacity of spent fuel in PWR plant, and, the dry storage facility is being constructed at the CANDU plant.

2. The Status of PWR plants

KHNP/KOPEC has started re-racking projects to replace the existing racks with HDSR from mid-1990's. Currently, re-racking project of Ulchin units 3&4 are in progress, Yonggwang units 3&4 re-racking projects was completed in 2006 and Kori unit 4 and Yonggwang unit 1 have been completed very recently. After the re-racking projects, transshipments of spent fuel from the pools with existing racks to the pools with HDSR within the same site is on going. The HDSRs have been installed at Kori units 3&4 and the 928 spent fuel assemblies have been transshipped from 1990 to 2004 at the Kori site.

2.1 Re-racking Project

In case of Kori unit 3 and 4, the first projectsto install HDSR in the empty space were carried out by SIMENS and HOLTEC in 1994 and 1996, respectively. The second project to replace existing standard racks by the HDSR except already installed HDSR has been completed in 2005. Total capacity of Kori site is enough to store the spent fuel generated from all 4 units until 2016. Full re-racking projects at Ulchin units 1&2 have been completed in 1995 and the second re-racking projects at Ulchin units 3&4 are on going. The HDSR installed at Ulchin units 5&6 was supplied by UST&D. The total storage capacity of Ulchin site will be saturated by 2017. At Yonggwang units 1 and 2 the HDSR was supplied by SIMENS and HOLTEC, respectively,in the empty space in 1996. Recently, the existing standard racks except already installed HDSR at Yonggwang unit 1 was replaced with the new HDSR supplied by DOOJUNG-HOLTEC, and the HDSR supplied by ENSA was installed at Yonggwang units 3&4 last year. Yonggwang units 5&6 was equipped with theHDSR supplied by DOOJUNG-HOLTEC. The total storage capacity of Yonggwang site will be saturated by 2016. Table 1 shows the overall status of re-racking at the nuclear power plants as of 2007.

2.2 Transshipment

After completion of replacing the existing standard racks with HDSR at PWR plants, transshipments of spent fuels between neighboring reactors in the same site from the storage pools with existing standard racks to the storage pools with HDSR has been carried out. The total 928 spent fuel assemblies have been transshipped from Kori units 1&2 to Kori units 3&4 by 2004 as shown in the Table 2.

Table 1. Re-racking status

Plant	Re-racking	Neutron Absorber (Supplier)	Pool Capacity		Installation (Year)	Expected Saturation Data(Year)
			Region 1	Region 2		
Kori 3	Yes	BSS(SIEMENS)	251	2,009	2002	2016
Kori 4	Yes	BORAL(HOLTEC)	456	1,800	2006	
Ulchin 1	Yes	BORAL(HOLTEC)	264	850	1995	2017
Ulchin 2	Yes	BORAL(UST&D)	261	801	2005	
Ulchin 3	Yes	BORAL(HOLTEC)	266	1,232	2008	
Ulchin 4	Yes	BORAL(HOLTEC)	266	1,232	2008	
YGN 1	Yes	BORAL(HOLTEC)	456	1800	2006	2016
YGN 2	Yes	BORAL(HOLTEC)	406	746	1997	
YGN 3	Yes	BSS(ENSA)	300	1,002	2006	
YGN 4	Yes	BSS(ENSA)	300	1,002	2006	

Table 2. Transshipment Status

Transshipment	Year	No. of Spent Fuels	Transfer Cask
Kori#1→Kori#3	1990-2004	424	KSC-4
Kori#1→Kori#4	1994-2004	188	KSC-4, KN-12
Kori#2→Kori#4	2000	12	KN-12
Kori#2→Kori#3	2001-2004	244	KSC-4, KN-12
Kori#4→Kori#3	2004	60	KN-12
Total		928	

3. The Status of CANDU plants

For the spent fuel management of Wolsong, a series of expansion of storage capacity have been pursued since 1990. It started with construction of concrete silos followed by three times extension and implementationof a very highly compact storage system is being undertaken. Wolsong site has four(4) CANDU units and each unit discharges 5,163 spent fuelbundles annually. The dry storage facility of concrete-silo type at Wolsong site was first constructed in 1990 and additional concrete-silos were recently installed to have 300 silos in total. New type of the dry storage system named as MACSTOR/KN-400is scheduled to be put into operation from middle of 2009, and it is expected to be able to store the spent fuel bundles generated from Wolsong's four(4) units until 2016. The spent fuel dry storage system for Wolsong site consists of spent fuel handling system, service building extension and dry storage site with concrete silos and MACSTOR/KN-400 modules.

3.1 Spent Fuel Handling System

The spent fuel dry storage system for Wolsong site is designed to store the intact fuel bundles with minimum six years of cooling time. The spent fuel handling system is composed of spent fuel storage basket (fuel basket) holding 60 bundles, in-bay tooling and equipment, a Shielded Work Station (SWS) including drying system, a transfer flask and a transporter.

3.2 Dry Storage Site

Concrete silos have been installed in Wolsong site and construction of MACSTOR/KN-400 modules are scheduled to be completed by middle of 2009.

4. Conclusion

In accordance with the decisions by AEC, the spent fuel shall be stored on-site until 2016 through the expansion of on-site storage capacity. For the PWR spent fuel, re-racking and transshipment arejudged to be the good option among various alternatives to easily increase the spent fuel storage capacity. In case of CANDU spent fuel, adoption of dry storage system such as concrete silos or consolidated storage module is estimated to be preferable solution for capacity expansion.

To cope with the current shortage of storage capacity for spent fuel in Korea,re-racking with high density storage rack, transshipment between adjacent units, and installation of dry storage system have been carried out and on going now. By execution of such a capacity expansion method, it is expected that the spent fuel generated from all nuclear power plants can be stored on-site by 2016.