

SEA TRANSPORT SYSTEM FOR LOW AND INTERMEDIATE LEVEL RADIOACTIVE WASTE IN KOREA

Sunghwan Chung

Nuclear Engineering and Technology Institute
Korea Hydro and Nuclear Power Co., Ltd.

Jongrak Choi

Nuclear Engineering and Technology Institute
Korea Hydro and Nuclear Power Co., Ltd.

Seungho Lee

Nuclear Engineering and Technology Institute
Korea Hydro and Nuclear Power Co., Ltd.

Yoondong Lee

Head Office
Korea Hydro and Nuclear Power Co., Ltd.

ABSTRACT

Korea Hydro and Nuclear Power Co., Ltd.(KHNP) is establishing a dedicated sea transport system to transport low and intermediate level radioactive waste(LILW) from nuclear power plants(NPPs) to disposal facility. The sea transport system consists of a purpose-built vessel, IP-2 packages, related equipment and on-site wharfs of NPPs. Transport for LILW will be securely carried out in accordance with IAEA's regulation for the safe transport and Korea Atomic Energy Act from the beginning of 2009. This paper introduces the sea transport system to transport LILW in Korea.

INTRODUCTION

In November 2005, KHNP, which has 20 commercially operating NPPs and is responsible for the radioactive waste management in Korea, has successfully designated Wolsong in the southeast of Korea as the site of LILW disposal facility as shown in Figure 1, which was one of the national problems. Since then, KHNP has been in the process of constructing the disposal facility smoothly. Operation of the disposal facility for LILW will commence in 2009 with a capacity of 100,000 drums in the first stage and 800,000 drums total.

Thereupon KHNP is establishing a dedicated sea transport system to transport LILW from NPPs to the disposal facility. The sea transport using the vessel is one of the most prospective transport modes for current situation in Korea because both all NPPs and the disposal facility are located alongside the coast. Most of LILW generated from NPPs including dry active waste, spent resin, spent filter and concentrated waste are packaged into DOT-17 type steel waste drums of 200-liter and 320-liter, and temporarily stored on NPP sites. The sea transport system consists of purpose-built vessel, IP-2 packages, related equipment including several special vehicles, folk lifts and drum loading equipment, and on-site wharfs of NPPs. The vessel with maximum loading capacity of 1,520 waste drums will be constructed to conform to the regulatory requirements for transport of LILW, and equipped with double hull and double bottom

structure. The IP-2 packages containing eight waste drums will be loaded into the vessel using an on-board crane at the on-site port of NPP, transported by sea to the port nearby the disposal site using the vessel, unloaded from the vessel using the on-board crane, and transported overland to disposal facility using the special vehicles. Transport for LILW will be securely carried out in accordance with IAEA's safe transport regulations and Korea Atomic Energy Act from the beginning of 2009.



Figure 1. Disposal facility site in Korea

TRANSPORT OPERATIONS

Transport of LILW from NPPs such as Kori, Yonggwang and Uljin to the disposal facility in Wolsong will be started early in the year of 2009. Transport modes of LILW as shown in Figure 2 are road transport from the storage facility to the NPP port, sea transport from the NPP port to the port of the disposal facility and road transport from the port to the disposal facility. Transport operations will be carried out in the following way :

- 1) LILW waste drums will be confirmed to comply with the regulatory requirement for disposal and packaged in the IP-2 packages, eight drums for each, using a drum loading equipment in the temporary storage facility of NPP.
- 2) IP-2 packages will be loaded onto the special vehicles, two packages for each vehicle and radiation dose rate around the vehicles is measured.
- 3) The special vehicles will transport overland IP-2 packages to the NPP port.
- 4) IP-2 packages will be unloaded from the special vehicles and loaded into the shielded holds of the purpose-built vessel using the gantry type on-board crane at the NPP port.
- 5) The vessel will transport by sea IP-2 packages to the port of disposal facility.
- 6) IP-2 packages will be unloaded from the shielded holds of the vessel loaded onto the special vehicles, two packages for each vehicle, using the on-board crane at the port of disposal facility.
- 7) The special vehicles will transport overland IP-2 packages to the disposal facility nearby Wolsong NPP.
- 8) IP-2 packages will be unloaded from the special vehicles in the disposal facility.
- 9) LILW waste drums will be unloaded from IP-packages and confirmed again for disposal by the regulatory requirements in the disposal facility.

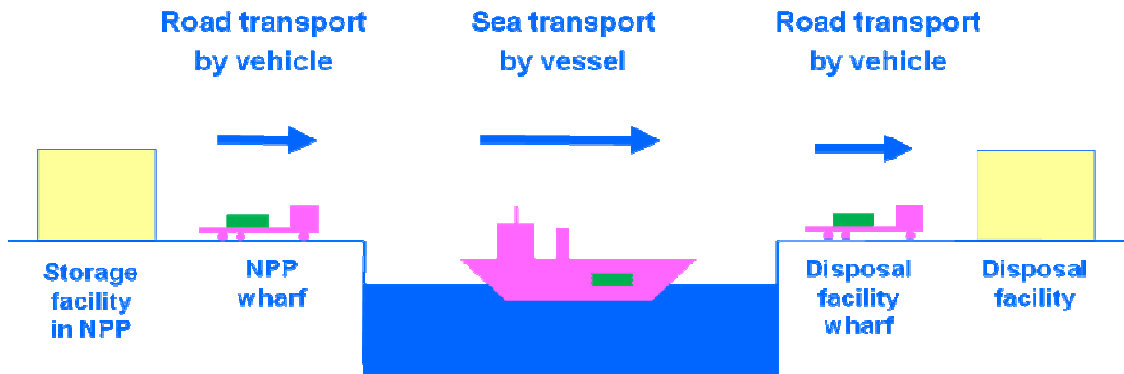


Figure 2. Transport modes of LILW

TRANSPORT REGULATIONS

Regulation to govern all transport of radioactive materials including LILW in Korea is Korea Atomic Energy Act, which is in compliance with IAEA Safety Standards Series No.TS-R-1 and is regulated by Korean regulatory authority, MOST(Ministry of Science and Technology). Moreover regulation related to sea transport of LILW is Korea MOMAF (Ministry of Maritime Affairs and Fisheries) Notice, which is in accordance with IMO's International Maritime Dangerous Goods Code(IMDG Code) and Code for the Safe Carriage of Irradiated Nuclear Fuels, Plutonium and High Level Radioactive Waste in Flasks on Board Ships(INF Code).

SEA TRANSPORT SYSTEM

KHNP is establishing a dedicated sea transport system for efficient transport of LILW as shown in Figure 3. The sea transport system consists of one purpose-built vessel, IP-2 packages, related equipment including special vehicles, folk lifts and drum loading equipment, and NPP wharfs.

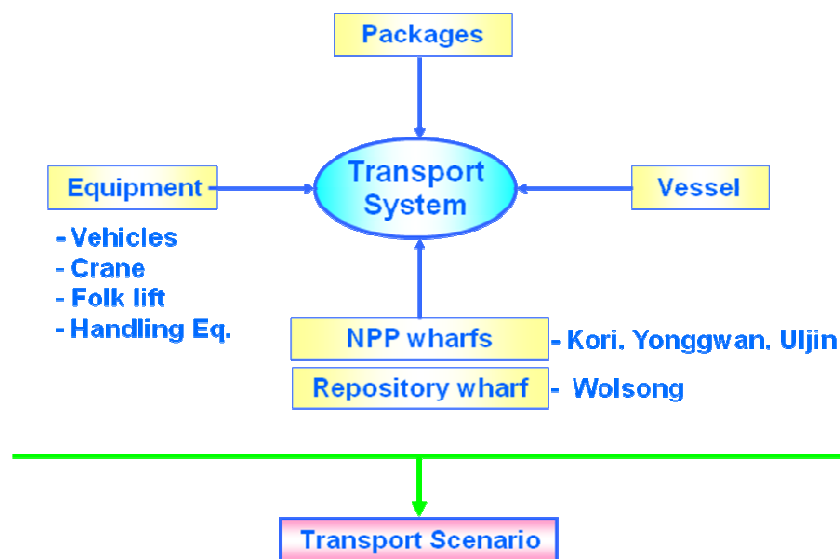


Figure 3. Sea transport system

Transport vessel

One purpose-built vessel as shown in Figure 4 is being constructed to conform to the regulatory requirements, which are in compliance with the requirement of the class INF 2 vessel of IMO's INF Code and Korea MOMAF Notice. The vessel will be classed by Korean register. Safety margins are provided and the risk of the vessel involved in an accident is considered to be minimized by the duplication of equipment. The vessel is equipped with double hull and double bottom structure to ensure the integrity of LILW packages in the event of collision and stranding. Four holds of the vessel are fully shielded against radiation by steel plates and concrete. Dimension of the vessel is 78.6m(length) x 15.8m(width) x 7.3m(depth) and draft is about 4m. The vessel has a gross tonnage of 2,600 tons and a dead weight tonnage of 1,365 tons. And maximum cargo capacity of the vessel is 1,520 waste drums.

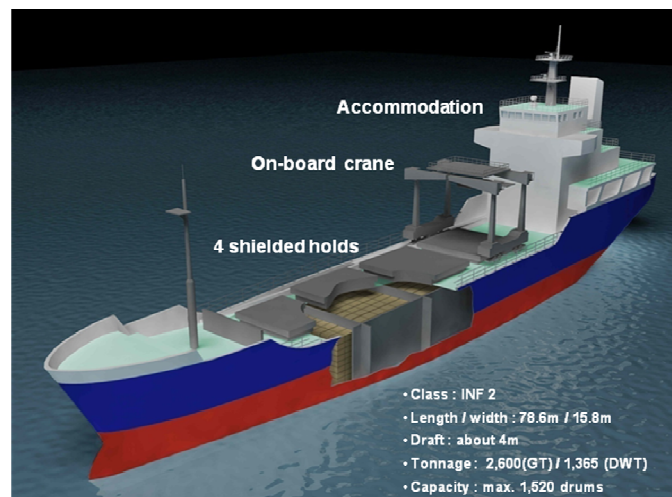


Figure 4. Purpose-built vessel

IP-2 packages

Considering safety and efficiency of LILW handling, two kinds of packages, which are designed to comply with the requirements of IAEA and Korean regulations for IP-2 packages, will be used to transport eight LILW waste drums of 200-liter and 320-liter with the same external dimensions of 1.6m(W) x 3.4m(L) x 1.2m(H). The weight of each package is about 6 tons including 8 waste drums due to the capacity of the gantry type on-board crane of the transport vessel and about 2.8 tons for package itself. The package as shown in Figure 5 consists of a body, a lid, lid bolts and waste drums to be loaded. The lid is securely fastened to the package body by lid bolts and 8 waste drums are secured by internal drum supports.

Performance of the packages under normal conditions of transport in accordance with the transport regulations was demonstrated by a combination of analyses using the verified computer codes and safety tests carried out on prototype test models



Figure 5. IP-2 package

Related equipment

Special vehicles will be used to transport overland IP-2 packages in NPP sites (from the temporary storage facility to the NPP port) and in the disposal facility site (from the port to the disposal facility). Two IP-2 packages will be loaded on the vehicle and transported at a time. The packages are fixed onto the vehicle frame using the locking mechanism.

Exclusive drum loading equipment as shown in Figure 6 will be used to load efficiently LILW drums into IP-2 package in the waste storage facility in NPPs. The equipment will be controlled automatically and remotely.

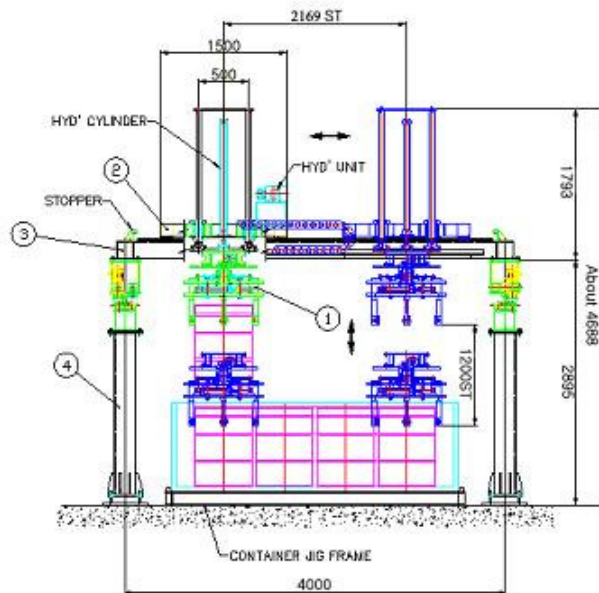


Figure 6. Drum loading equipment

NPP wharfs

All on-site wharfs of NPPs will be repaired to secure the operation of the vessel and the loading and unloading of IP-2 packages in the wharfs. The Uljin and Wolsong NPP wharfs have been under construction since 2006 and the construction for Yonggwang and Kori NPP wharfs will commence in 2008. Wolsong NPP port will be used in common as the port of the disposal facility because the disposal facility is adjacent to Wolsong NPP. Figure 7 shows the overview of Wolsong NPP port under construction.

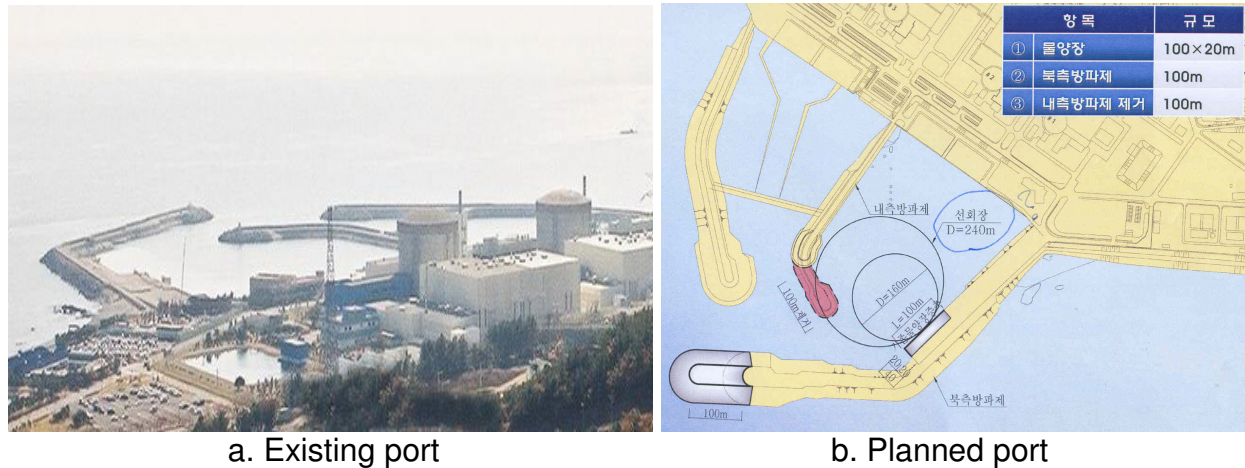


Figure 7. Wolsong NPP Port

CONCLUSIONS

KHNP is establishing a dedicated sea transport system to transport LILW by sea and overland from the on-site waste storage facility of NPPs to the disposal facility in Wolsong. The sea transport system consists of one purpose-built vessel, 300 sets of IP-2 packages, related equipment including several special vehicles, several fork lifts and drum loading equipment, and NPP wharfs. Transport for LILW will be securely carried out in accordance with IAEA, IMO and Korean transport regulations from the beginning of 2009. The vessel will be making about 9 trips a year between NPPs and the disposal facility.

REFERENCES

- [1] Korea MOST, Korea Atomic Energy Act, 2001
- [2] Korea MOST Notice No.2001-23, Regulations for Packages and Transport of Radioactive Material, 2001
- [3] IAEA, Safety Standards Series No.TS-R-1, Regulations for the Safe Transport of Radioactive Material, 2005
- [4] Korea MOMAF Notice No.2006-55, Safety Criteria for Transport Vessel of Radioactive Material, 2006
- [5] IMO and IAEA, International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High Level Radioactive Wastes on Board Ships under the International Convention for the Safety of Life at Sea of 1 November 1974, 1999