Two types of disposal concepts for CANDU spent nuclear fuels using storage baskets

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1. Introduction

In Korea, the long-term R&D program for spent nuclear fuels for safe management as high level radioactive waste was started in 1997. There has been active research on the development of the Korean HLW disposal system and several disposal concepts in deep geological formations for spent nuclear fuels have been developed through the R&D program according to the nuclear policy environment in Korea. These disposal concepts were from general concept in the early stage, and next KRS (Korean Reference disposal System), KRS-HB (KRS-High Burn-up), KRS+ to the high efficiency disposal concept. In version of KRS+, we had two types of disposal concepts for CANDU spent nuclear fuels, one of two types (PWR-Pressurized Water Reactor, CANDU-Canada Deuterium Uranium) of spent nuclear fuels in Korea. In this paper, these disposal concepts for CANDU spent nuclear fuels using storage basket of 60 bundles are presented.

2. Disposal concepts for spent nuclear fuels in Korea

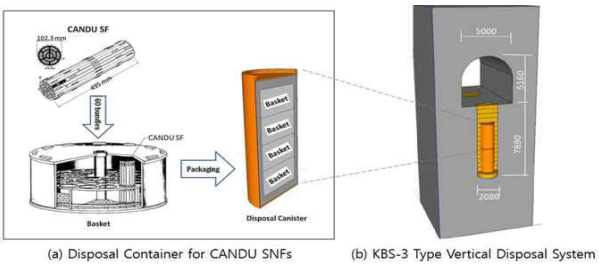
A deep geological disposal system for spent nuclear fuel called KRS was developed to confirm the possibility of disposal of spent nuclear fuel in the Korean peninsula [1]. This concept referred to the KBS-3 type concept applied in Sweden and Finland, which is a deep geological disposal method entailing directly disposal of spent nuclear fuel in stable rock at a depth range of 400 to 700 m, and is currently evaluated as the safe method internationally. Since then, as the burnup of the spent nuclear fuel has been increased in Korea, a deep geological disposal system called KRS-HB, which reflected the characteristics of high burnup spent nuclear fuel generated in domestic nuclear power plants, was derived. Then, considering the dimensions of the spent nuclear fuels and the cooling period at the disposal time point, an improved disposal concept (called KRS^{+}) in view of the disposal area was subsequently developed [2,4].

Recently, it was essential to conduct various studies to optimize the area required for the disposal of spent nuclear fuel in cases where the nationally available land is extremely limited, such as in Korea. As a part of efforts to enhance the disposal safety and efficiency, a high efficiency deep geological disposal concept was developed.

3. Disposal concepts for CANDU spent nuclear fuels

For the CANDU type spent nuclear fuels, two disposal concepts considering the disposal container concept with interim storage baskets (60 bundles/baskets) were developed during the long-term R&D program for spent nuclear fuels for safe management.

In a vertical type disposal concept of high burnup CANDU spent nuclear fuels, 4 baskets of 60 bundles (total 240 bundles) were loaded in a disposal container [3]. The container material was a double layered. They are a cast iron inner vessel for structural support at the disposal depth environment and a copper outer shell for corrosion resistance. Also thickness of the copper outer shell for corrosion resistance was10 mm by cold spray coating or 3-D printing technology [4]. Two disposal container with spent nuclear fuels would be emplaced in a deposition hole drilled at the floor of the disposal tunnel excavated in stable rock at a depth of 500 m. This disposal concept and the result of thermal stability analysis [5] were shown in Figure 1 and 2.



(a) Disposal Container for CANDU SNFs (b) KBS-3 Type Vertical Disposal System

Figure 1. Vertical type disposal concept

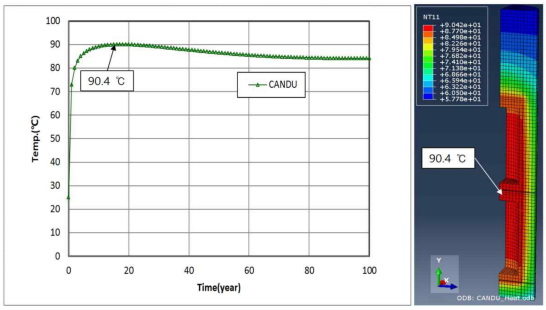


Figure 2. Result of thermal stability for vertical type disposal concept

Another disposal concept for CANDU spent nuclear fuels was a horizontal type disposal. In this horizontal type disposal concept, 1 basket of 60 bundles was loaded in a disposal container. The container material was the same as the vertical type concept for the same purposes. A disposal container was surrounded by compacted bentonite box, which was called supercontainer concept. This supercontainer assembly was emplaced horizontally in a disposal tunnel in stable rock at a depth of 500 m. This disposal concept and the result of thermal stability analysis were shown in Figure 3 and 4.

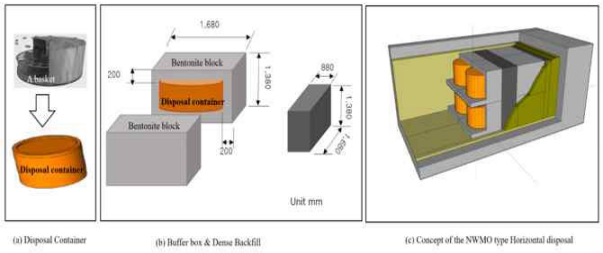


Figure 3. Horizontal type disposal concept

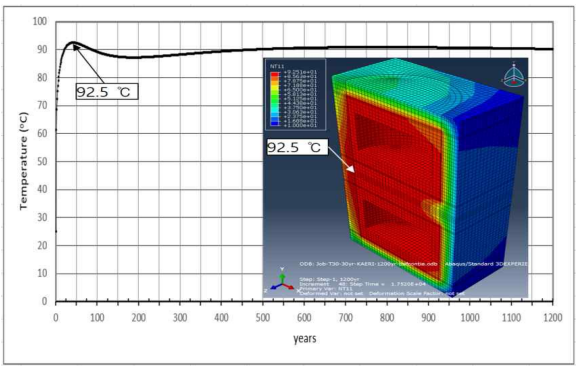


Figure 4. Result of thermal stability for horizontal type disposal concept

3. Conclusions

In Korea, R&D for HLW management technology development was initiated in 1997. As the progress of the technology development work, the disposal concepts were advanced from a general concept to the KRS+ concept and the High efficiency disposal concept. In the KRS+ concept, there were two disposal concepts for CANDU SNF called vertical type and horizontal type. In this paper, these two CANDU disposal concepts were presented briefly.

They will be compared with further analyses and the reference concept for demonstration will be decided by results of several analyses.

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