Conceptual Design for Kori Unit 1 Reactor Vessel and Internal Segmentation Process

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1. Introduction

The Kori unit 1 is a historic nuclear power plant (NPP) in Korean nuclear history. The experiences, including construction, criticality, continued operation permit, etc., enable the significant advancement in nuclear industry and R&D. As the permanent shut down of the Kori unit 1, the importance of decommissioning technology is increasing. The decommissioning strategy of the Kori unit 1 is a prompt decommissioning. The decommissioning activity will be implemented around 2025, after transient period and removal of spent fuels. One of the most important process in decommissioning activity is the segmentation and dismantling of activated large component. The reactor vessel (RV) and internals (RVI) are relatively highly activated among various systems. Since the direct disposal of RV and RVI is not available, the development of efficient RV and RVI segmentation and waste management plan are essential.

The conceptual design for the Kori unit1 RV and RVI segmentation process will be discussed in this paper. The accurate activation analysis is prerequisite for the successful development of the segmentation process. Also, the project duration and availability of remoted and underwater segmentation technology are considered to minimize radiation exposure during decommissioning.

2. Conceptual Design of RV/RVI Segmentation

The RV and RVI segmentation process consists of activation analysis, cutting plan development and experiment, and package plan development. It is important to understand the activation level of RV and RVI for the development of cutting plan, waste classification, and package plan. Using the cutting and packaging plan data, the mockup test follows. Through the mockup test, the verification of segmentation process and packaging plan will perform.

2.1 Activation analysis

The activation analysis of representative elements in PWR reactor vessel wall is shown in Table 1 [1]. It is generally accepted that the operation history, including nuclear designs and fuel distribution plans, should be considered for the accurate calculation of the neutron flux and activation. The previous result indicated that RVI near the core are classified as intermediate level waste (ILW). Upper and lower parts of RVI and RV are classified as low level waste (LLW) or very low level waste (VLLW) [2].

Table 1. Activation of reactor vessel wall [1]

Nuclide	PWR	
	Half Life (y)	Specific Activity (Bq/g)
Fe-55	2.70	2.18E+09
Co-60	5.27	1.18E+09
Ni-63	100.00	2.11E+08
Mn-54	0.85	3.07E+07
Zn-65	0.67	4.07E+06
Ni-59	8.00E+04	1.59E+06
T-3	12.30	4.81E+05
C-14	5730.00	2.70E+05
Cs-134	2.06	8.88E+04
Eu-154	8.6	3.37E+04
Ba-133	10.4	2.74E+04
Eu-155	4.8	1.33E+04
Cl-36	3.00E+05	5.92E+03
Sr-90	29.00	5.55E+03
Cs-137	30.1	5.55E+03
Mo-93	3500.00	2.85E+03
Nb-94	2.00E+04	2.33E+03
Kr-85	10.50	2.15E+03
Hf-178m	30.0	1.37E+03
Ho-166m	0.0	1.04E+03
Tb-158	150.0	7.70E+02
Ag-108m	130.00	7.40E+02
Ar-39	269.00	7.03E+02
Tc-99	2.10E+05	5.55E+02
Sm-151	93.0	1.41E+02
Pu-239	2.4E+04	9.99E+01
Ca-41	1.03E+06	5.18E+01
Mn-53	3.70E+06	1.70E+01
Pm-145	17.7	1.15E+01
U-233	1.6E+05	5.92E+00
Se-79	6.50E+04	3.70E+00
Kr-81	2.10E+05	5.92E-01
Zr-93	9.50E+05	3.70E-01

2.2 RV segmentation process

The RV is a massive and large component with diameter of 3.8 m, height of 9.7 m, and weight of 187 ton, without head. The RV and RVI are shown in Fig. 2. Since the space near the RV is not sufficient, the thermal cutting method is favored, which does not require heavy component to overcome the mechanical reaction force. In addition, the thermal cutting technology allows the short process period and minimal radiation exposure. The oxy-propane torch and auxiliary ventilation system are suggested in this study to prevent the generation of secondary wastes during segmentation process.

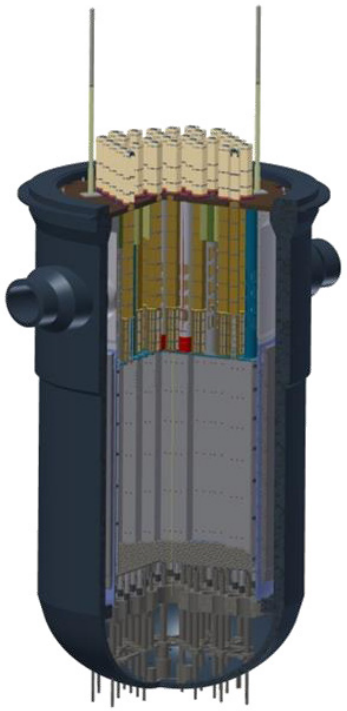

Fig. 1. Image of RV and RVI of Kori unit 1.

2.3 RVI Segmentation process

The RVI is a heavy and complex component, consists of various subsidiary items. Since they are assembled with attachments and have various shapes, it is important that the development of efficient disassembling equipment and various cutting method. In addition, the underwater cutting process is highly recommended to manage the radiation exposure efficiently. The example of RVI underwater cutting RVI is shown in Fig. 2 [3]. It is generally accepted that the segments of core part should be managed carefully due the high activation level. In this study, the intermediate storage plan of them is also considered for the development of waste management plan.

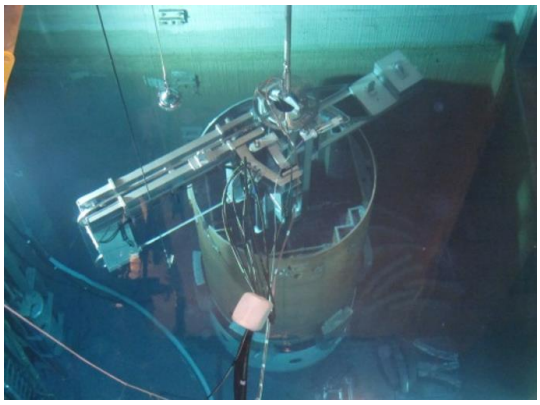

Fig. 2. Example of underwater cutting of RVI [3].

3. Conclusions

The conceptual design for the Kori unit 1 RV and RVI segmentation process is suggested. The segmentation process, waste classification, waste management plan, and packaging plan are systematically studied using activation analysis data. The thermal cutting method is mainly applied to RV segmentation to minimize the process period and radiation exposure to workers. In the case of RVI segmentation, disassembling technology and various underwater cutting processes are studied. In addition, remote segmentation technology and process are strongly favored for the efficient radiation protection.

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