# Kori-1 reactor pressure vessel cutting and storage method

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## 1. Introduction

The major components such as reactor pressure vessel (RPV) and its internals have high-level radiation. Thus it restricts access by human workers, and makes an accident or outage during the dismantling process more difficult to deal with. Since unexpected situations causes increase of wastes and an unexpected accidents during decommissioning, the preliminary verification of the dismantling processes and equipment by the tangible remote dismantling simulator is very important. In this paper, we propose the cutting and storage methods depending on the radiation level of the storage drum for decommissioning by using graphic simulation.

## 2. Methods

2.1 RPV radioactivity inventory

It is important for decommissioning of RPV to know radioactive inventory. The radioactive inventory determines the classification of the radioactive waste and the thickness of the shield. Therefore, to know the radioactivity of Kori unit 1 after 40 years of operation was calculated by MCNP program. Specific activities of radionuclides from Kori unit 1 are shown in Table I.[1]

Table I : *Activities of radionuclides from Kori unit 1*

| *Nuclides* | *Half-life* | *40years (Bq/g)* |
|---|---|---|
| *H-3* | *12.6y* | *8.12890E-04* |
| *Co-60* | *5.263y* | *3.81470E+03* |
| *Ni-63* | *92y* | *1.25282E+05* |
| *C-14* | *5730y* | *3.69519E-02* |
| *Ni-59* | *8.0E+04y* | *1.04858E+03* |
| *Nb-94* | *2.0E+04y* | *3.65412E-02* |
| *Tc-99* | *2.12E+05y* | *1.09076E+00* |
| *Fe-55* | *2.6y* | *1.80042E+07* |

Specific activities decrease by undergoing radioactive decay. Thus, specific activities for each nuclide are calculated with by using its half-life

2.2 Disposal method of RPV

RPV is pretreated by cutting and storage. Then, the metal waste from RPV is transported to recycling or disposal facilities (Fig.1). The metal waste can be recycled to be used in the nuclear industry or can be disposed of. The radioactive waste disposal facility of KORAD (Korea Radioactive Waste Agency) can accommodate 150,000 drums (200 L/drum) of radioactive waste. To transport radioactive waste to the facilities, it is required to comply with the provisions by Nuclear Safety and Security Commission. The provisions are as follows: the radiation dose rate on the surface shall not be higher than 2 mSv per hour. Thus, the thickness of the shield was calculated to meet the provision.

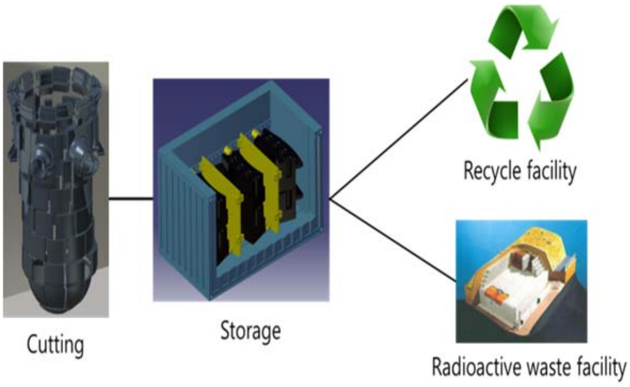


Fig 1. Disposal method of RPV

2.3. Estimation of RPV cutting and storage

It was estimated the various scenarios according to both the level of radiation and the cutting size. The scenarios was simulated by using graphical simulation which is operating Delmia. Its digital manufacturing applications drive manufacturing innovation and efficiency by planning, simulating, and modeling production processes. Thus, Delmia use modeling and simulation of RPV.

## 3. Results

Before dismantling of RPV, it is assumed to require 10 years for fuel cooling, stabilizing the reactor, and preparing equipment. The only γ-ray emitter from RPV is Co-60, which is the main factor of operator exposure to radiation. Therefore, the radioactivity of Co-60 was taken into account. According to Table 1, the specific radioactivity and half-life of Co-60 is 3.81E+03 Bq/g and 5.26 yr, respectively. The specific radioactivity of Co-60 after 10 years was estimated to be 1.02E+03 Bq/g. The activities of metal waste is affected by its weight, so radiation dose was calculated by applying various weight of metal waste from 0 to 500 kg with an increment of 50 kg. The calculation was based upon a premise that the shielding material was concrete (shown Table Ⅱ).

Table Ⅱ : Radiation dose was calculated by applying various weight of metal

| Kg | Shield thickness(mm) | mSv/hr |
|---|---|---|
| 0 | 0 | 0 |
| 50 | 8.2 | 1.98 |
| 100 | 10.1 | 1.97 |
| 150 | 11.4 | 1.9 |
| 200 | 12.2 | 1.97 |
| 250 | 12.9 | 1.98 |
| 300 | 13.5 | 1.98 |
| 350 | 14 | 1.99 |
| 400 | 16 | 1.95 |
| 450 | 1.64 | 1.98 |
| 500 | 1.68 | 1.98 |

The optimal conditions were obtained from Delmia program, and the results are shown in Table Ⅲ.

Table Ⅲ : Optimal conditions

| | |
|---|---|
| Shield thickness | 12.9mm |
| Radiation dose rate | 1.98mSv/h |
| Metal waste weight | 225kg |
| Metal waste angle | 6.5 degree |
| Metal waste height | 595mm |
| Inner diameter | 330mm |

The volume of RPV after cutting is estimated to be equivalent to 890 drums by using the graphical simulation of Delmia. The virtual images shows cut and stored metal waste in a drum (shown in Fig.2 and 3).

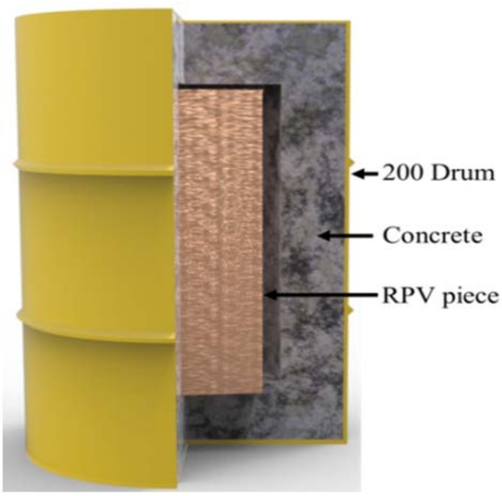

Fig. 2. Stored metal waste in a drum

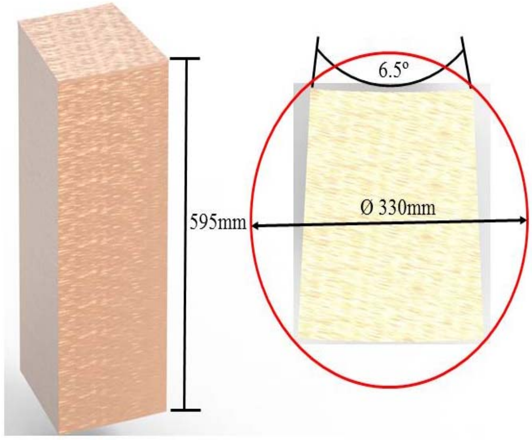

Fig. 3. Cut of RPV

## 4. Conclusions

This study is about storage method after cutting for RPV at KORI-1 by using Delmia.
Assuming that the nuclear power plant have been operated for 40 years, the thickness of shielding was calculated by using the radiation dose of RPV. The thickness of shielding was used to simulate cutting and storing RPV to obtain the optical conditions
Consequently, the total volume of RPV is equivalent to 890 drums.
This study may be applied to a metal waste about disposal in the future.

## REFERENCES

[1]Seong-hwa Shin, Neutron activation analysis of reactor pressure vessel, Kyung Hee University.