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Finding Comprehensive Disposal Plan for Clearance Concrete Waste from Decommissioning of NPP

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1. Introduction

As of 2022, Korea`s nuclear power plant decommissioning schedule is unclear, and it is time to develop a strategy for managing possible wastes in the event of decommissioning. Many industries, universities, and research institutes have proposed various decontamination and decommissioning methodologies, and have evaluated the economic and radiological impacts of each methodology.

In Korea, the low- and intermediate- level radioactive waste generated during the decommissioning of nuclear power plants was estimated to be 14,500 drums (200 L size) per unit, and a repository for radioactive waste already was constructed.

Waste that is expected to be generated the most amount when decommissioning a nuclear power plant is clearance waste. In order to meet the goal of the amount of low- and intermediate- level radioactive waste disposal, as much decontamination and cutting work will be needed. In this situation, clearance waste amount will be increase, and this increase is inevitable.

Accordingly, this study intends to suggest scenarios other than landfill in response to the situation in which concrete, which account for the major amount of waste generated during the decommissioning of nuclear power plants, will be incorporated into Korea's industrial and construction waste.

2. Backgrounds

When classifying nuclear power plant decommissioning wastes by material, it has been proven in several preliminary evaluations and decommissioning cases that scrap and concrete account for almost all of them. A management plan for non-ferrous metals that can be recycled can be considered, but since the amount is not at a remarkable level, it will be omitted from this proposal.

Table I: Scrap and concrete ratio in the decommissioning cases and evaluations

	Total waste(ton)	Scrap & Concrete ratio
Maine Yankee	180,451	72.33%
Oskarshamn-3	344,062	94.12%
NUREG-1640 PWR	216,462	99.67%
NUREG-1640 BWR	389,836	99.80%

Finding at the recycling practices of metal and concrete in the Korea`s industrial and construction waste management system, both types of waste are predominantly recycled, and landfill disposal option is extremely rare.

Considering these Korean industrial and construction waste practices, it is quite difficult to clearance waste disposal in general landfills.

3. Methodology

Checking the overseas clearance waste recycling cases, it was confirmed that the unrestricted reuse of concrete and scrap iron, site restoration, and reuse within the nuclear industry were mainly performed [1].

In this study, the annual generation of concrete waste at the clearance level will be confirmed and the radiological effect will be briefly evaluated through RESRAD-ONSITE.

4. Scenario Proposal

4.1 Assessment for the clearance concrete

Various estimations are possible for the amount of concrete that is the subject of clearance, but the calculation was performed using the metal waste amount estimation formula proposed in NUREG-1640 [2]. Assuming that the concrete for dismantling is prepared for 5 years, dismantled for 10 years, and then the concrete for self-disposal is disposed of when the dismantling is complete, the annual amount of concrete for disposal is derived as shown in Fig. 1.

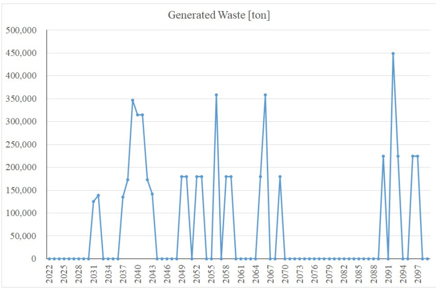

Fig. 1. Prediction of annual generation of clearance concrete waste (when disposing of the entire amount of waste after decommissioning is complete)

Based on this, a maximum of 449,081 ton in 2092 would be emitted in a single year. Assume that this will be incorporated into the construction waste recycling system (data from 2019). In this case, the dilution factor can be calculated as 0.0296.

When this is applied to RESRAD-ONSITE and calculated [3], it can be evaluated as 0.286 μSv/y for the scenario "People who use recycled concrete with 0.1 Bq/g of ^{60}Co for banking and live on the site" with the highest radiation exposure.

4.2 Concrete Recycling Options Suggestion

As can be seen in the case of decommissioning nuclear power facilities abroad, the first thing to consider is the construction of a shielding material and the construction of a structure that surrounds the SNF storage container. Many studies already have evaluated this positively from the viewpoint of radiological impact evaluation, but the evaluation from the viewpoint of managing the amount of clearance concrete waste is insufficient.

The option to use as a backfill to fill the underground space that may occur after the decommissioning of a nuclear power plant will also be applicable. It is expected that at least 307 m^3 per unit can be accommodated using a depth of 4 m using the 48 m diameter of the containment building.

Another limited reuse methodology is to use clearance concrete waste as a backfill when the silo for low and medium level radioactive waste currently operated by KORAD is finally terminated. This will also require a detailed evaluation.

Finally, the residual clearance concrete waste will be incorporated into the construction waste recycling system, and as previously evaluated, it is difficult to show a large radiation dose. Regarding this option, it is judged that the option used for road construction, which is different from the scenario proposed in this study, is appropriate from the viewpoint of resident acceptability, and it will also be beneficial in reducing resident exposure. The previously suggested options can be organized as shown in Fig. 2.

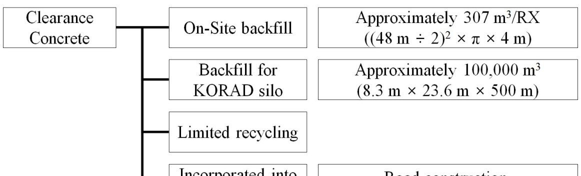

Fig. 2. Reuse options of clearance concrete waste reflecting conditional reuse.

As a result, it is beneficial to encourage reuse of clearance concrete waste in nuclear facilities as much as possible, and to incorporate the remaining amount into Korea's construction waste recycling system. In particular, as the amount of reuse in nuclear facilities increases, there will be an effect of diluting the concentration of nuclides when incorporating the construction waste recycling system.

5. Conclusions

In this study, considering the various disposal options of concrete waste, which take up the largest volume, it is safe enough to approve unconditional reuse as construction waste, but it is possible to limit the reuse option and backfill required at the nuclear facility site. It was intended to show that it would be beneficial to incorporate the remaining amount into construction waste after using it as a furnace.

When evaluating the radiological effects, the dilution factor has a lower value as the amount of quantity used for limited self-disposal increases, which means that the general public can receive a lower radiation dose for the unrestricted reuse option.

Quantification of options that cannot be quantified, recycling options for metal waste, and quantity estimation will be evaluated later.

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