Preliminary Evaluation of Building Dismantling Costs at Nuclear Power Plants for ALARA Evaluation

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1. Introduction

During the site remediation phase of nuclear power plant (NPP) decommissioning, residual radioactivity must be reduced to the Derived Concentration Guideline Level (DCGL) based on the intended reuse of the site or buildings. However, if the DCGL does not satisfy ALARA (As Low As Reasonably Achievable) criteria, residual radioactivity should be further reduced below DCGL levels, or the structures must be demolished. Since additional costs may arise in the process of reducing residual radioactivity of buildings below DCGL, it is necessary to establish an appropriate residual radioactivity level that balances costs and benefits through ALARA evaluation.

In the case of building reuse, costs are determined by the type of remediation activities required to remove contamination. In the case of dismantling, the cost of the subsequent process is added to the remediation costs. Therefore, this study performed a preliminary evaluation of building dismantling costs to support ALARA evaluation.

2. Materials & Methods

Dismantling cost evaluation is performed through several stages, with numerous considerations at each step. Currently, however, South Korea lacks a proceduralized method for NPP dismantling. This study assumed that the media subject to dismantling are in a state of very low contamination following the completion of remediation activities. To calculate the dismantling costs of buildings, the Standard Construction Estimate provided by the Ministry of Land, Infrastructure and Transport (MOLIT) was used.

2.1 Dismantling cost evaluation method

Table 1 shows the calculation methods for dismantling costs by category. The 2025 Standard Construction Estimate provides information on the labor and equipment required for dismantling work. Additionally, it specifies that safety facility installation costs, waste loading/transportation, and waste disposal costs must be accounted for separately. In this section, demolition costs were categorized into 1) Labor costs, 2) Equipment costs, 3) Safety facility installation costs, and 4) Waste disposal costs.

Table 1. Calculation methods for dismantling costs

Category	Cost Calculation Formula
Labor Cost	Worker hourly wage × Working hours
Equipment Cost	(Hourly equipment rate × Working hours) + (Machine maintenance rate × Labor cost) + (Material unit price × Volume)
Safety Facility Installation	(Labor cost + Equipment cost) × Industrial safety management fee rate
Waste Disposal Cost	Volume × Unit weight of concrete × Unit waste disposal cost

Building demolition includes concrete structure dismantling, crushing, and byproduct sorting. Embedded piping within the building is also subject to cost evaluation. Demolition methods for reinforced concrete structures are divided into manual labor and mechanical equipment. For NPPs, which involve large-scale facilities, only mechanical demolition was considered. The Standard Construction Estimate for mechanical demolition distinguishes between "obstacles not removed" and "obstacles removed". This study applied the "obstacles removed" condition, assuming all obstacles (rebar, pipes, etc.) are removed during the demolition process.

2.2 Volume of dismantling structures

Dismantling building was assumed to be single-room structures based on the room size used for deriving DCGLs at the Rancho Seco NPP. The structure was assumed to be concrete, with a floor area of 137 m^2, a height of 3.89 m, and a thickness of 0.228 m.

3. Results

Table 2 shows cost evaluation factors based on the Standard Construction Estimate. Worker wages were calculated by considering both the standard estimate and market labor rates. Labor requirements and work speed were based on the "obstacles removed" mechanical demolition condition. Equipment costs utilized the hourly equipment rates from the construction machinery maintenance schedule. Machine maintenance rates (for tools and light equipment) were calculated according to standard criteria. Material unit prices included oxygen and acetylene required for obstacle removal.

Table 2. Cost evaluation factors

Factor	Value
Worker Hourly Wage (KRW)	111,392.75
Labor Force	1 Laborer, 2 Special Laborers, 1 Welder
Work Speed (m^3/h)	5.625
Equipment Cost (KRW/h)	70,088
Machine Maintenance Rate	4% of Labor Cost
Material Unit Price (KRW/m^3)	1,678.2
Industrial Safety Fee Rate	3.11% of (Labor + Equipment Cost)
Waste Disposal Cost (KRW/ton)	68,563
Unit Weight of Reinforced Concrete (ton/m^3)	2.4

3.1 Labor Cost

Labor costs assumed 1 common laborer, 2 special laborers, and 1 welder. The hourly wage was set at 111,392.75 KRW based on the 2025 Construction Industry Wage Survey. Dividing the volume (109.27 m^3) by the work speed (5.625 m^3/h) resulted in 19.43 working hours, yielding a labor cost of 2,163,914 KRW.

3.2 Equipment Cost

Equipment costs were calculated based on one 1.0 m^3 excavator with a crusher and one 0.6 m^3 excavator. Total working time was 19.43 hours. Summing the hourly equipment rates, machine maintenance (4% of labor), and material costs for obstacle removal resulted in a total equipment cost of 1,631,464 KRW.

3.3 Safety Facility Installation

According to MOLIT and Ministry of Employment and Labor standards, an industrial safety management fee of 3.11% was applied since the sum of labor and equipment costs (3,795,378 KRW) is below 500 million KRW. This resulted in a cost of 118,036 KRW.

3.4 Waste Disposal Cost

Using the unit disposal cost for mixed construction waste (68,563 KRW/ton) and a unit weight of 2.4 ton/m^3 for the 109.27 m^3 volume, the disposal cost was calculated at 17,980,705 KRW.

Category	Value (KRW)
Labor Cost	2,163,914
Equipment Cost	1,631,464
Safety Facility Installation	118,036
Waste Disposal Cost	17,980,705
Total Cost	21,894,120

4. Conclusions

This study performed a preliminary evaluation of dismantling costs for buildings to support ALARA evaluation. Given the current absence of domestic NPP dismantling procedures, the evaluation utilized MOLIT's Standard Construction Estimates. The results indicate that waste disposal costs constitute the largest portion of the total demolition expense. These findings are expected to serve as foundational data for future ALARA evaluation in domestic NPP decommissioning.

REFERENCES

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