Establishment and Evaluation of Decommissioning Plant Inventory DB and Waste Quantity

Jae Yong Oh [a*], Sang-Rae Moon [a], Taesik Yun [a], Nak-Hoon Sung [b], Seung Hyuk Jung [b], Hee-Geun Kim [a]
[a]*Decommissioning Team, CRI, KHNP, 70, Yuseong-daero 1312beon-gil, Yuseong-gu, Daejeon, Korea*
[b]*Construction Team, KONES Corp., 65, Myeongdal-ro, Seocho-gu, Seoul, Korea*
[*]*Corresponding author: jaeyongoh@khnp.co.kr*

1. Introduction

Decommissioning is a representative stage in back-end cycle of Nuclear Power Plant (NPP). OECD/NEA defines decommissioning as all of the administrative and technical actions associated with early planning for cessation of operations through termination of all licenses and release of the site from nuclear regulatory control [1]. Korea Hydro and Nuclear Power (KHNP) made a decision for permanent shutdown of Kori-1 and has progressed the strategy determination and R&D for the decommissioning of Kori-1.

Decommissioning waste, Structure, System and Components (SSCs) is one of the most important elements. Decommissioning waste quantity is calculated based on Plant Inventory Database (PI DB) with activation and contamination data. Due to the largest portion of waste management and disposal in decommissioning, it is necessary to exactly evaluate waste quantity (applying the regulation, guideline and site-specific characterization) for economic feasibility. In this paper, construction of PI DB and evaluation of waste quantity for Optimized Pressurized Reactor (OPR-1000) are mainly described.

2. Methods and Results

In order to understand the recent conditions of NPPs that plan to be decommissioned, analysis on plant inventory and waste quantity of decommissioning NPP is essential. In this study, establishment of PI DB and evaluation of waste quantity for decommissioning are carried out as shown in Fig. 1.

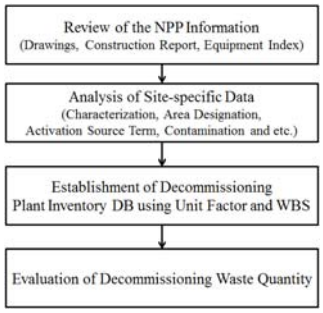

Fig. 1. Flow diagram of decommissioning waste evaluation.

2.1 Investigation of Plant Inventory Data

PI DB must be prepared to figure out SSCs (concrete and structural steel as structure, reactor coolant system and the others as system, and pipes, pumps, valves and tanks as equipment inventory) on NPPs under construction, in operation and decommissioned earlier. To investigate PI DB, the estimators should gather and obtain the detailed information of NPP. So, drawings such as General Arrangement (GA), Radiation Controlled Zoning (RZ) and Piping and Instrumentation Diagrams (P&IDs), construction experience reports, and equipment indices are gathered and reviewed.

2.2 Unit Factor Constitution

Unit factor is defined as the simplified units for estimation of decommissioning activities for a number of SSCs [2]. Accordingly, estimating the unit factor is the most specific work in the project. Table I exemplifies one of the unit factors for a decommissioning activity. The unit factor is composed of activity description, duration, required labor crew, and equipment & consumable for work unit. If estimators want to compute the costs of the total decommissioning project, labor rates, equipment & consumable costs, Work Difficulty Factor (WDF) for duration adjustment are supplemented with unit factor composition. In this case, unit factors are changed to Unit Cost Factor (UCF).

Fig. 2 illustrates the position of unit factor in Work Breakdown Structure (WBS) for decommissioning [3]. There are different types of WBS, but in this WBS type, the same unit factors can be assigned to various upper categories.

Table I: Example of unit factor

Removal of Contaminated Heat Exchanger < 3,000 lbs		
1. Activity Description and Duration		
ID	Description	Duration (min)
a	Remove insulation	60
b	Mount pipe cutters	60
c	Install contamination controls	20
d	Disconnect inlet and outlet lines	60
e	Cap openings	20
f	Rig for removal	30
g	Unbolt from mounts	30
h	Remove contamination controls	15
i	Remove, wrap in plastic; send to packing area	60
Total Activity Duration		355

2. Required Labor Crew		
Labor Crew	Number	Duration (hr)
Laborers	3	9.95
Craftsmen	2	9.95
Foreman	1	9.95
General Foreman	0.25	9.95
Fire Watch	0.05	9.95
Health Physics Technician	1	9.95

3. Equipment & Consumables
Consumable/Materials
Blotting paper for 50 square feet
Plastic sheets/bags for 50 square feet
Gas torch consumables for 1 EA

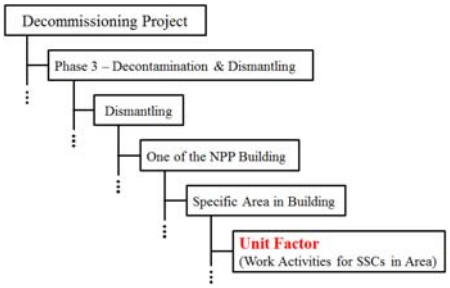

Fig. 2. Position of unit factor in decommissioning WBS.

2.3 Establishment of Plant Inventory Database

SSCs should be surveyed by various types of data and methods for establishment of PI DB. In this section, methodologies of PI DBs for a sort of SSCs will be explained in the abstract.

Quantities for Large Components are calculated by using site data for dimensions. Additionally, activation analysis is required to consider the quantity for Reactor Pressure Vessel and Internals. Concrete waste quantity is derived from construction report, and also, results of activation analysis should be utilized for waste quantities of bioshield. Pipes, valves and other equipment, for example, pump, heat exchanger, tank and etc., are worked out from equipment index and contamination of system and area. It is necessary for evaluation of soil waste quantity to characterize the decommissioned the incumbent NPP site. However, site characterization data for decommissioning cannot be secured yet. Thus, conservative computation was conducted for the case of the soil waste in this study.

2.4 Application of DeCAT

DeCAT (Decommissioning Cost Analysis Tool) developed by KHNP, KEPCO E&C and RSCS is cost computational tool for NPP decommissioning. Also, waste quantity can be calculated from PI DB, waste types, and etc., by DeCAT. Fig. 3 depicts the summary of input and output by DeCAT. Table II shows categories of decommissioning waste from PI DB in this research.

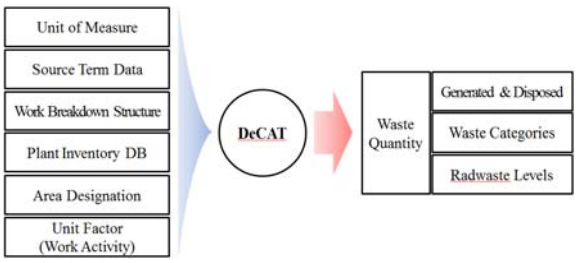

Fig. 3. Outline of DeCAT for decommissioning waste quantity.

Table II: Composition of waste quantity from PI DB

Plant Inventory	Waste Category
Concrete Rubble(Debris)	Concrete
Concrete Scabbling	
Reactor Pressure Vessel & Internals	Metal
Large Component	
Pipe, Valve	
Pump, Heat Exchanger, Tank	
Resin and Filter	
Soil	Soil
Insulation	Others
Hazard Material (HAZMAT)	
Dry Active Waste (DAW)	

2.5 Evaluation of Decommissioning Waste Quantity

In this study, decommissioning waste quantity for OPR-1000 was calculated by the methods and procedures as suggested above. As a result, waste quantity is categorized by materials like Table II and Table III. Although radioactive waste level should be included to make a division of waste quantity, in this table, classification by radioactive waste level was not considered.

Table III: Decommissioning Waste Quantity for OPR-1000

Category	Generated Quantity (g)
Concrete	3.155×10^{11}
Metal	1.169×10^{11}
Soil	1.612×10^{10}
Others	3.980×10^{9}

3. Conclusions

Decommissioning waste quantities evaluated are going to be applied to calculation of the project cost. In fact, Ministry of Trade, Industry and Energy (MOTIE) in Korea expected the decommissioning waste quantity in a range of 14,500~18,850 drums, and predicted appropriate liability for decommissioning fund by using waste quantity. The result of this study is also computed by the range of 14,500~18,850 drums. Since there is no site-specific data for the NPP site, this evaluation is the preliminary analysis. It is noted that a quite big discrepancies might be presented between actual quantity and evaluated quantity.

REFERENCES

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[3] TLG Services, Inc., “Decommissioning Cost Estimate for the Zion Nuclear Power Station Unit 1 and 2”, No. C04-1326-002, 1999.