

A methodology of Decommissioning Cost Estimation for Nuclear Research Reactor

KwanSeong Jeong, DongGye Lee, ChongHun Jung, KuneWoo Lee,
Korea Atomic Energy Research Institute, 150, Dukjin-dong, Yuseong-gu, Daejeon
ksjeong1@kaeri.re.kr

1. Introduction

Decommissioning cost estimation should be made according to the phases of the decommissioning activities and the installed components of the nuclear facilities.

In this paper, the basic framework for decommissioning cost estimation is completed so that it could be used as a technique for decommissioning cost estimation by specifying the cost items and the group components as well as unit cost factors on which the work time is calculated. Also, the approach for the decommissioning cost estimation of the major activities and tasks are considered and reviewed. Afterwards, these methods will be utilized as the basic technologies during establishing the decommissioning planning of nuclear research reactor.

2. The Decommissioning Cost Estimations of Nuclear Research Reactor

2.1 A Framework of the Decommissioning Cost Estimations

The main framework of decommissioning cost estimation consists of 6 cost groups, 38 tasks, 46 subtasks and resources including the cost items of all the activities from the decommissioning plans to a final waste disposal.

○ Cost Group 1 - "Preparation and Project Management" Cost Group covers all the activities carried out during the preparation and management of the actual decommissioning.

○ Cost Group 2 - "Facilities Shutdown" Cost Group covers all the activities relating to the shutdown operations of the facility

○ Cost Group 3 - "Decontamination and Dismantling Operations" Cost Group covers all the activities relating to the decontamination and dismantling operations

○ Cost Group 4 - "Waste Processing and Management" Cost Group covers all the activities related to the treatment, processing, packaging and temporary storage of the decommissioning wastes

○ Cost Group 5 - "Site Restoration" Cost Group covers all the activities related to the residual radiological characterizations and site restorations

○ Cost Group 6 - "Other Activities" Cost Group covers all other activities costs that cannot be classified into the foregoing groups

The structure is a hierarchy of the decommissioning activities by breaking down a cost group into its tasks,

then breaking down the tasks into subtasks, and the subtasks into resources shown in Figure 1[1][2].

At the lowest in the above hierarchy are the 'resources' and it is at this level that the costs are attributed.

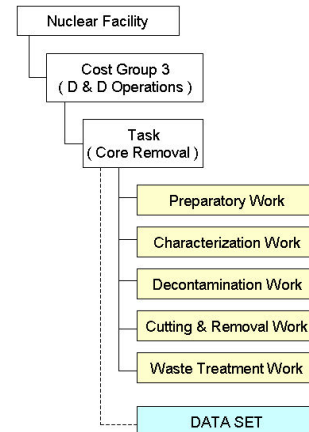


Figure 1. The Structure of Cost Estimations

The 'resources' mainly comprise of the categories of the labor costs, equipments and material costs.

At the top, the cost groups will be divided into 2 types in view of their completion costs. One type is the preparation and general support activities such as cost group 1 and cost group 6.

Another is the physical D & D activities such as cost group 2, cost group 3, cost group 4 and cost group 5.

There is a further consideration for the cost groups of the physical activities to analyze and summarize the cost items of subtask. A further consideration is a deeper classification of the sub-tasks, by applying an additional work time to each sub-task, considering the D & D techniques and applying data set's to the tasks of the activities. A deeper classification for the cost estimations of sub-tasks are divided by 5 distinct work groups, preparatory works, characterization works, decontamination works, cutting & removal works and waste treatment works.

2.2 A Method of the decommissioning cost estimations

The decommissioning cost estimations of nuclear research reactors include a survey their installations and the contaminants of the decommissioned facilities and the decommissioning activities and procedures to complete it. Also, the labor costs are calculated by the unit work time of the decommissioning objects. In addition, equipment and material costs are summed and then the unit work cost is summed. For a cost estimation of the decommissioning activities, the configuration

method of the cost items and the unit cost factors are the most important.

To classify the cost items for an estimation of nuclear research reactors, the overall data such as the structure of the facility, construction design, instruments and pipes and operation history must be reviewed. On the basis of these reviewed data, decommissioning activities must be configured hierarchically in view of the decommissioning technologies and the cost items of the facility must also be divided and grouped.

The approach is a unit cost factor (UCF) methodology. The UCF method simplifies the calculations for estimating the activity costs. The unit cost factor method provides a demonstrable basis for establishing reliable cost estimates [3].

The details of the activities provided in the unit cost factors for the activity time, labor costs and equipment and consumable costs provide an assurance that the cost elements have not been omitted.

These detailed unit cost factors, coupled with the site-specific inventory of the piping, components and structures, provide a high degree of confidence in the reliability of the cost estimates.

For all the systems except for the main systems and components, the calculation method is based on the unit decommissioning cost method. Also, each typical decommissioning phase is related to a measurable unit, that is, the work effective time required to accomplish the tasks or subtasks of a activity, the number of operating staff necessary to realize the decommissioning job in a defined effective time, tools used to realize the decommissioning repressed as a function of the effective worked time and the used consumable items expressed as a function of the effective work time [4].

2.3 The Unit Cost Factors for the Decommissioning Cost Estimations of Nuclear Research Reactor

The method of calculating the work time is to use unit factors classified into shapes, sizes and dimensions according to the specifications and properties of the decommissioning objects [1]. So, the labor costs result from unit costs multiplied by the calculated work times.

- Material properties in conjunction with dimensions
- Size properties such as a weight, volume, and diameter which are needed for the amount of waste generation
- Shape properties such as linear, spherical, cylindrical, and rectangular
- Surface properties such as structure, wall, and ceiling

Shape Work	Preparatory	Characterization	Decontamination	Cutting/Removal
Linear	15	10	4	51
Sphere	30	22	8	106
Cylindrical	64	45	17	224
Rectangular	59	43	16	210

Table 1. The decommissioning work times of the metal objects (Unit:Mh/m)

The reason why the cost factors of objects can be classified is that the composition of the nuclear research facilities are various and have several shapes and

properties different from those of the nuclear power plants because of usages and objectives of the facilities.

Table 1 and table 2 shows that the decommissioning working times of the metal and concrete objects.

Work	Preparatory	Characterization	Decontamination	Cutting/Removal
Time	6	5	2	23

Table 2. The decommissioning work times of the concrete objects (Unit:Mh/m³)

Also, the work difficulty factors are classified as radioactive/non-radioactive, and the complexity of the components and objects. The decommissioning work difficulty factors of the metal and concrete objects are shown in Table 3 and 4.

Factor	Shape of Objects			
	Linear	Sphere	Cylindrical	Rectangular
Complexity	1.55	1.5	1.4	1.4
ALARA/Radiation	2.0			

Table 3. The decommissioning work difficulty factors of the metal objects

Factor	Weighting
ALARA/Radiation	2.0

Table 4. The decommissioning work difficulty factors of the concrete objects

3. Conclusion

In this paper, the basic framework for decommissioning cost estimation is completed so that it could be used as a technique for decommissioning costs estimation by specifying the cost items and the group components as well as unit cost factors on which the work time is calculated. Also, the approach for decommissioning cost estimation of major activities and tasks are considered and reviewed. But it is insufficient to consider more significantly the factors of work difficulty, the sensitivity of cost factors and uncertainties of cost calculation processes. Afterwards, it is expected to establish a methodology for the decommissioning cost estimations of nuclear research reactor.

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