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The AHP Approach for Selecting a Decommissioning Scenario

a Sung-Kyun Kim,a Hee-Sung Park,a Kune-Woo Lee,a Jong-Hun Jung,a Jin-Ho Park
a Korea Atomic Energy Research Institute, Dukjin-Dong, Yuseong-Gu, Daejeon, South Korea, sungkyun@kaeri.re.kr

1. Introduction

The evaluation of decommissioning scenarios is critical to the successful development and execution of a decommissioning project. This paper presents the logical method that is the analytic hierarchy process for selecting a decommissioning scenario. The AHP provides a structure on decision-making processes where there are a limited numbers of choices but each as a number of attributes. In this study, the AHP model to evaluate decommissioning scenarios reflecting quantitative and qualitative considerations is presented. This AHP model is implemented for the two candidate scenarios of the thermal column in KRR-1 to find the better scenario. The weightings of each criteria and sub-criteria and the quantitative figures about both scenarios were obtained.

2. Methods and Results

In this section the AHP model for selecting a decommissioning scenarios and the implementation results are described. The AHP model includes goal, criteria, sub-criteria, and alternatives.

2.1 AHP procedure

The dismantling scenarios have to be estimated with both quantitative and qualitative results with a logical and systematical process. In this case the analytic hierarchy process (AHP) method [1-5] is commonly used in different fields. The AHP is an intuitively easy method for formulating and analyzing decisions. It was developed by Saaty in 1970's to solve a specific class of the problem that involves prioritization of potential alternative solutions. This is achieved by evaluation of a set of criteria elements and sub-criteria elements through a series of pairwise comparisons. Numerous applications of the AHP have been made since its development and it has been applied to many types of decision problems [6,7]. The procedure of the AHP has 4 steps as following.

1. Hierarchy of Decision Problem
2. Pairwise Comparison of Decision Elements
3. Estimation of Relative Weights
4. Aggregation of Relative Weights

Figure 1 shows the AHP model of decommissioning scenario and it consists of 3 levels (goal, criteria, and alternative). For first level, we setup the final goal in this project that is the selection of the best reasonable scenario in consideration of national technology status and social environment. The second level is the criteria for estimating decommissioning scenario. The following criteria were included in the AHP hierarchy: cost, safety, technical ripple effect, and social recipiency. They were chosen through a preferential rank from decommissioning experts after selecting candidate criteria.

Cost involves the personnel expenses, tool expenses, and waste treatment expenses. Safety is related to the degree of difficulty. It includes worker's exposure, worker's safety, and work difficulty. Technical characteristics include the originalities of the dismantling technologies and contributions to other industries. Social recipiency includes public relations for the public and understandings for the public.

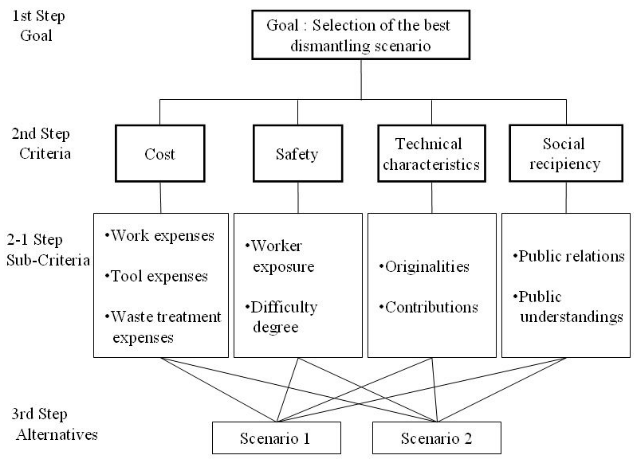

Figure 1. The AHP model

In this study, in order to get the prioritization of each criteria and sub-criteria, we mailed questionnaires to a group. The members consisted of 10 managers who were serving in the decommissioning department and who had experience exceeding 10 years. They all had their doctor degrees in the different fields like chemical engineering, nuclear engineering, physical engineering and mechanical engineering. In order to compare the relative preference with respect to the main criteria and the sub-criteria the questions assigned the highest rank to score 5 and the lowest rank to score 1. The prioritizations were calculated by using the geometric mean method to minimize the weakness that the evaluation was controlled with a few lowest value and/or highest value.

2.2 Candidate scenarios of thermal column

Table 1. Synthesized priorities and ranks for the goal

Hierarchy 1 (Weighting)	Hierarchy 2 (Weighting)	Scenario 1 (Plasma)	Scenario 2 (Nibbler)
Decommissioning Cost 0.1796	personnel expenses (0.0544)	0.0544	0.0389
	tool expenses (0.0304)	0.0187	0.0304
	waste treatment expenses (0.0782)	0.0782	0.0658
	sub-total	0.1513	0.1350
Safety 0.4162	worker's exposure (0.2509)	0.2509	0.0618
	work difficulty (0.1327)	0.0660	0.0536
	sub-total	0.3169	0.1153
Technical characteristics 0.1599	originalities (0.0460)	0.0231	0.0195
	contributions (0.1113)	0.0583	0.0454
	sub-total	0.0814	0.0650
Social recipiency 0.1829	Public relations (0.0670)	0.0337	0.0305
	Public understandings (0.0998)	0.0432	0.0517
	sub-total	0.0768	0.0822
Total		0.6264	0.3976
Rank		1	2

- Plasma arc cutting scenario

Firstly, the worker surveys the entire thermal column by using a detector. According to the real detecting results, the radioactivity level of the inside of thermal column is quite low so the graphite blocks staking in the thermal column can be removed manually. In order to remove the thermal column, lead shield plates and the plasma arc cutting equipment are installed in the opposite side of the thermal column. The thermal column and the thermalizing column are both removed by the installed equipment and the pieces of waste are collected into a waste container and then the container moves out of the reactor pool and the wastes are managed in the waste treatment process.

- Nibbler cutting scenario

Firstly the procedures of survey and removing graphite blocks in nibbler cutting method are as same as the procedures doing in the plasma arc cutting scenario. Then in order to make sure of enough space where nibbler equipment is inserted into the thermal column, the top of thermal column and thermalizing column is cut by the plasma arc cutting equipment. Then the nibbler equipment and a cradle for worker are installed on the top of the reactor pool and then the thermal column and the thermalizing column are dismantled by the nibbler equipment. Then the cutting wastes move out of the reactor pool and they are sealed off into a waste container.

2.3 Implementation and Ranking

The synthesized priorities and ranks with respect to the goal resulted in Table 1. In hierarchy 1 we found the highest weighting of the criterion is the safety and it accounts for 52% of the total. The second highest weighting of the criterion is the decommissioning cost and social recipiency and ripple effect have almost the same weighting. In order to verify the weighting of criteria, we calculated the C.R.(consistency ratio) of all the main criteria. They were all bounded by the limit(C.R.<0.2). Ultimately the value of plasma cutting scenario is 0.6264 and nibbler cutting scenario is 0.3976 so we can conclude the plasma cutting scenario is better in both alternatives.

3. Conclusion

In this paper a decision-making method for selecting the best decommissioning scenario through the AHP was presented. So the scenarios are able to be evaluated logically and quantitatively. And this approach was implemented to choose the best scenario about thermal column in KRR-1. This study has a great meaning that it can present the reliable scenario while this work had only been done through the subjective evaluation. We believe it will be a useful thing as a system engineering tool for other nuclear facility decommissioning.

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