Task Analysis of Decommissioning Activities in Nuclear Power Plants

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1. Introduction

At present, the decommissioning of Unit 1 of Kori Nuclear Power Plant in Korea is being prepared for a safe and economical decommissioning. As the decommissioning operation progresses, it is judged that accidents due to human errors will occur frequently. Therefore, to reduce the cause of human error, the Human Reliability Analysis (HRA) for the decommissioning activity of Unit 1 of Kori is required.

Reactor Pressure Vessel Internal is dangerous because of the highest radioactivity level among the decommissioning activities of Unit 1 of Kori, and because the dismantling operation of RPVI is performed in the water, depending on remote equipment and visual system, which occur a lot of human error possibility. Therefore, Task Analysis that should be important in the qualitative analysis of HRA is performed for RPVI decommissioning activities of Unit 1 of Kori.

2. Task Analysis

Task Analysis is an initial stage for evaluating human error, and it is a task to analyze the task objective, method, content and procedure and to identify task characteristics, vulnerabilities and propriety [1].

Among various TA, Hierarchical Task Analysis is a systematic and detailed task analysis method, which is a suitable method to identify detailed task compositions and conditions and to express complex task steps in a hierarchical structure [2]. Therefore, the HTA can identify information about physical characteristics, HMI, and possible accidents, etc. so it used this to perform TA for decommissioning activities. The format for task analysis of decommissioning activities was established using tabular format of HTA [3].

The purpose of this Task Analysis is to identify the characteristics, procedures and information of RPVI dismantling operation, and to identify possible human errors and performance shaping factors of decommissioning activities.

3. Task Analysis Application

As mentioned above, the target of task analysis is RPVI that the most complicated and have the highest radioactivity level in Kori 1. The following figure shows the internal components for the RPV of Unit 1 of Kori.

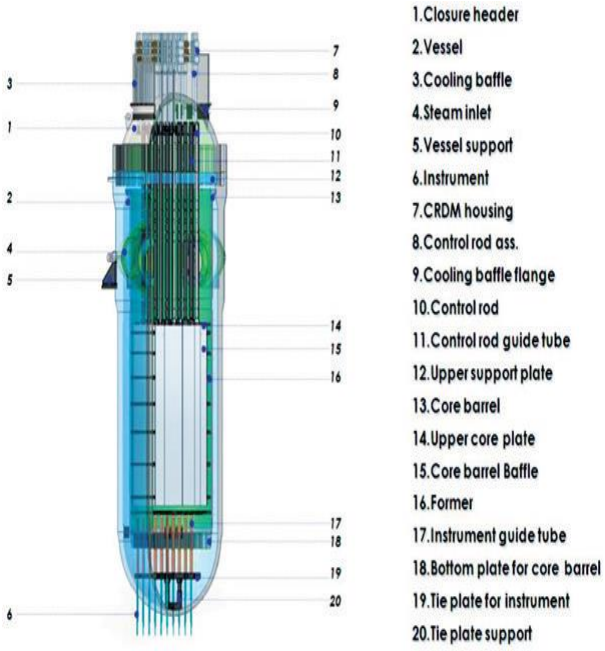

Fig. 1. Internal components for the RPV of Unit 1 of Kori [4].

RPVI dismantling operation was selected from Control Rod Guide Tube Upper Area Cutting Packaging to Lower Internal Structure Assembly Cutting and Packaging, and as shown in the following table 1, the sub tasks of RPVI dismantling operation are classified into 10 activities.

Table 1. Sub Tasks for the RPVI Dismantling Activity

No	Sub Task
1	Control Rod Guide Tube Upper Area Cutting and Packaging
2	Control Rod Guide Tube Lower Area Cutting and Packaging
3	Upper Plate Cutting and Packaging
4	Baffle Fixed Bolt Head Cutting
5	Baffle Cutting and Packaging
6	Former Separation
7	Barrel Upper Area Cutting and Packaging
8	Thermal Shield Cutting and Packaging
9	Barrel Lower Area Cutting and Packaging
10	Lower Internal Structure Assembly Cutting and Packaging

4. Task Analysis Results

Task Analysis was performed on 10 sub-tasks of RPVI dismantling operation shown in table 1 according to the HTA format, Task analysis results for RPVI dismantling operation are as follows.

- In general, in the decommissioning of nuclear power plants, the cutting of parts in the RPVI is the most complicated and difficult task during the dismantling process. Therefore, the influence on the internal factors of the workers was evaluated in order to have a relatively high value in terms of operator internal response.
- In general, RPVI dismantling operation is the most complicated and difficult task in the decommissioning process of nuclear power plant. Therefore, it was evaluated that the influence of 'operator internal response' on the internal factors of the operator was significant. However, in case of general decommissioning operation, the work procedure is not complicated when compared with the operation of NPP, and it is necessary to understand and acquire information such as equipment and workplace preparation. Therefore, the impact on internal factors of decommissioning operator will not be relatively large.
- Decommissioning operation is required high accuracy and reliability. Therefore, when the dismantling operation is performed, the influence on the internal and external factors of the operator is significantly large, so that sufficient training and education is required. However, the operation principle and method of these cutting equipment and device (cutting equipment, auxiliary equipment, display, remote control device, etc.) are not complicated and it is easy to operate them. Therefore, the operator is not required to have significant experience in using them.
- In advance, the dismantling operation should be planned in consideration of the work characteristics (the cutting target, equipment and facilities, and clothing according to work environment, etc.), a detailed work plan should be established in advance. Therefore, the work plan should be established for many times, so the psychological and physical effects that the supervisor and the operation can receive are considerable.
- Dismantling operation is not only dangerous, but it is carried out for a long time. Therefore, the operator carries out operation during day time/night time. In this case, various difficulties (such as break time, discomfort of clothes, and physiological factor) are generated. Since these difficulties have a significant impact on the internal/external factors of the operator, cooperation and communication is required between the supervisor and the operator in this working environment.
- The physical environment (radiological, under water environment) of the workplace is the major risk factors for the operators, and the influence of these environments on the internal and external factors of the operators was considerable.
- Decommissioning operation of nuclear power plant is not often performed work. Therefore, operators may have insufficient education, training and experience. Therefore, it is necessary to feedback the results of the decommissioning operation and to be reflected in the necessary work procedure and to be managed it as experience data.

5. Conclusion

Task analysis, which is the initial step of HRA for human error reduction, was performed. TA format was established using HTA which is one of task analysis methods. Also, complex and dangerous RPVI dismantling operation among the decommissioning activities of Unit 1 of Kori were classified into 10 activities. The results of task analysis were derived by applying these to TA format.

The results of the TA, the detailed planning, the difficulties during the work, the experience of the decommissioning, the physical environment (radiological environment, underwater operation) influenced the internal and external factors of the operator. Therefore, if these factors are identified and used, it will help to reduce the human error and to identify the cause.

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