

Design of a requirements system for decommissioning of a nuclear power plant based on systems engineering

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1. Introduction

The nuclear industry has required an advanced system that can manage decommissioning information ever since the Korean government decide to decommission the Gori No.1 nuclear power plant. The D&D division at KAERI has been developing a system that can secure the reliability and sustainability of the decommissioning project based on the engineering system of the KRR-2 (Korean Research Reactor-2). To establish a decommissioning information system, a WBS that needs to be managed for the decommissioning of an NPP has been extracted, and requirements management research composed of system engineering technology has progressed.

This paper propose a new type of system based on systems engineering technology. It introduces a WBS system that plays an important role in organizing the decommissioning project. Finally, it describes a frame that needs to implement the standardization of a decommissioning procedure.

2. Methods and Results

2.1 Decommissioning System Engineering

As a strategy to establish a new system, we have been adding a previous project management method into a system engineering technology. Project management for full life cycle decommissioning should be organized into cost management, schedule management, radioactive waste management, radiation control management, quality assessment management, and risk management. Systems engineering is an engineering discipline whose responsibility is creating an interdisciplinary process to ensure that the stakeholder's needs are satisfied at a high quality, with a cost efficient and schedule compliant manner throughout the system's entire life cycle. It focuses on defining the stakeholder needs and required functionality early in the development cycle, documenting requirements with a design synthesis and system validation while considering the complete problem.

This technology has been widely used in the area of aerospace [1], ITER [2], and NPP construction [3]. System engineering will be applied to NPP decommissioning through a procedure of top down vs bottom up, efficiency vs effectiveness, verification vs validation, MOP (Measure of Performance) vs MOE (Measure of Effectiveness). To satisfy a component model of the system with the original stakeholder's requirements, system engineering has to transform stakeholder's requirements at a higher level into the component model at a lower level. The relationship between a decommissioning system engineering and a decommissioning project management is shown in Fig. 1.

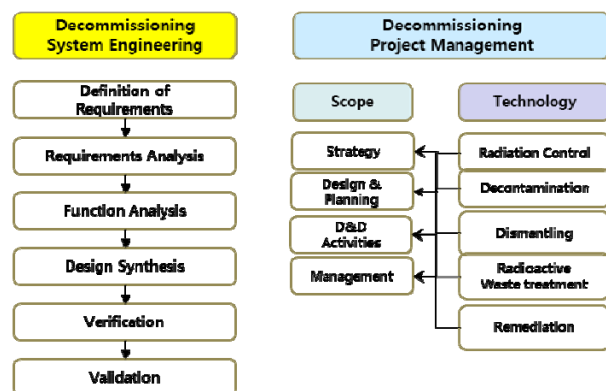


Fig. 1 Procedure of the decommissioning system engineering and items of decommissioning project management

A design process of the decommissioning system engineering composed of a requirement analysis, functional analysis/allocation, and synthesis for system analysis and optimization. The step makes it through the iterative process as a requirement loop, design loop, and verification loop. The process of the system engineering begins with defining high level requirements in the requirement analysis. Functional analysis and allocation decompose to lower-level functions and allocate other limit requirements to all functional levels. We can make a final output like an SOW (Statement of Work) through the procedure (Fig. 2).

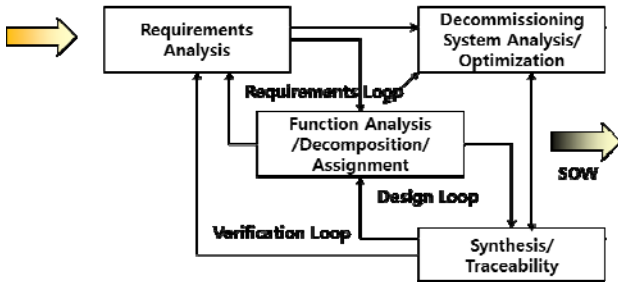


Fig. 2. Design process of the decommissioning system engineering

2.2 Decommissioning procedure requirements

According to the general project management process, requirements of the stakeholders are defined in the initial stage, and the WBS should be made after a detailed technical report that defines the acceptance criteria and scope/goal of the decommissioning project. Sweden has been using a WBS to evaluate the preliminary nuclear power plant decommissioning cost [4], and Germany has been managing a nuclear power plant decommissioning project management system using DeManS (Decommissioning Management System). Many nations with an organized NPP in the EU (European Union) have used an ISDC [5] to estimate the decommissioning cost. We are now developing WBS concepts compounding the data provided by OECD/NEA, ISDC data, and information used by KRR-2.

A schema of the requirement management, which can be a force in the standardization of the decommissioning process of the NPP based on the WBS, was created. In requirement management, research reactor dismantling data, ISDC data used in the NPP decommissioning cost evaluation, and OECD/NEA data were used. A requirement management for a decommissioning procedure includes a decommissioning strategy and planning, a facility characterization, decontamination and decommissioning activities, radioactive waste management, radiation protection, and remediation. Items needed to manage the decommissioning procedure for requirement management are shown in Fig. 3.

The individual dose rate and cumulative dose should comply with the ALARA concept when decommissioning an NPP. This paper describes a system in which the requirements (regulatory, principle, and criteria) related to worker safety can trace the effect of worker safety during decontaminating and dismantling activities from preparation to the remediation phase.

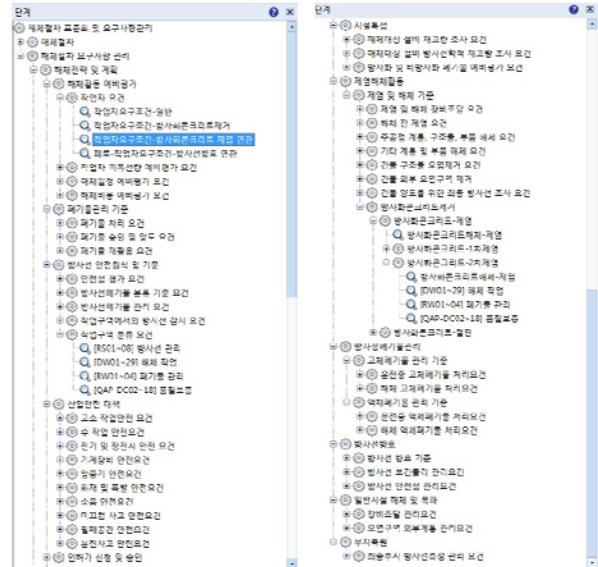


Fig. 3. Items need to be used in the decommissioning requirements management

The worker requirements prepared in this paper include a HAZOP (HAZard of OPERability) accident encountered during the dismantling activities, decontamination and decommissioning activities, and radiation protection. In this way, requirement management can guarantee a rational assessment of the decommissioning cost and schedule as well as worker safety, and recognize whether the requirements defined in the decommissioning strategy will be satisfied or not when decontaminating and dismantling an NPP facility and structure.

3. Conclusions

Even though a decommissioning engineering system was developed through the KRR-2, we are now developing an advanced decommissioning information system because it is not easy to apply this system to a commercial nuclear power plant. An NPP decommissioning is a project requiring a high degree of safety and economic feasibility. Therefore, we have to use a systematic project management at the initial phase of the decommissioning. An advanced system can manage the decommissioning information from preparation to remediation by applying a previous system to the systems engineering technology that has been widely used in large-scale government projects. The first phase of the system has progressed the requirements needed for a decommissioning project for a full life cycle. The defined requirements will be used in various types of documents during the decommissioning preparation phase.

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