

Design of a decommissioning procedure requirement management of a nuclear facility based on requirement engineering

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1. Introduction

The dismantling of a nuclear facility should satisfy various kinds of conditions required by the Nuclear Safety Act to take the safety of the workers and the public into consideration during the full-life cycle of the decommissioning. To systematically manage various kinds of requirements during the full-life cycle of the decommissioning, a requirement management system should be established using requirement engineering based on system engineering.

The decommissioning procedure requires management for a research reactor and a nuclear facility classified through a dismantling strategy, design and planning, decontamination and decommissioning activities, and dismantling management. After collecting a variety of documents such as the ordinance, regulatory requirements, technical requirements, and criteria, the requirements between groups are connected.

Based on this, an environment allowing the relationship between the upper-most law to lower-most regulation guide and the technical requirements for dismantling activities to be traced was implemented.

2. Methods and Results

2.1 Requirements Engineering

Requirements engineering has an important role in accomplishing a project as it manages systematically national development projects such as the military industry, aerospace, and ITER (International Thermonuclear Experimental Reactor). The technology has been used to implement a deep geological disposal of high-level (HLW) and transuranic (TRU) radioactive waste from the Japanese nuclear program [1].

The purpose of the requirement management shows how traceability from the stakeholder requirements through the system requirements to the design can be used to measure the progress, manage change, and assess risks. Traceability is about understanding how high-level requirements, i.e., objectives, goals, aims, aspirations, expectations, and needs, are transformed into low-level requirements.

2.2 Classification of decommissioning requirement management and analysis of connection between groups

Management of the decommissioning procedure requirements for a research reactor and a nuclear facility can be classified using a dismantling strategy, design and planning, decontamination and decommissioning activities, and dismantling management. The decommissioning strategy phase is divided into regulatory requirements and can affect the decommissioning design and planning, D&D (Decontamination & Decommissioning) activities, and decommissioning project management. The decommissioning design and plan phase can be classified using facility characterization, cost evaluation, amount of radioactive waste assessment, and licensing. The D&D (Decontamination & Decommissioning) activity phase can be divided into radiation control, radioactive waste process, and site remediation. The decommissioning project management phase can be classified into organization, staff, equipment, radiation protection, and radioactive waste management.

2.2.1 Collection of requirement materials

The ordinance related to the dismantling of a nuclear facility refers to the Nuclear Safety Act, Enforcement Decree of Nuclear Safety Act, Enforcement Regulation of Nuclear Safety Act, NSSC Notification, Regulation Criteria, and Regulation Guide provided by the Office of Legislation.

The technical requirements and criteria needed in the decontamination and decommissioning activities use experience obtained through a dismantling of a research reactor, and a decommissioning handbook published by the DOE (Department of Energy).

2.2.2 Connectivity analysis between requirements

The connection structure between the technical requirements required in the decontamination and decommissioning activities, and the legislation regarding the dismantling of a nuclear facility were implemented.

2.3 Implementation of DB structure and computing environment

The data structure of the decommissioning procedure requirement management can be defined as various kinds of data, data properties, and connections between data, and has a connectivity with the documentation of a decommissioning project. The structure can be presented through an ERA (Entity, Relationship, and Attribute). Entity represents the item type to be used, Relationship indicates the relation between item types, and Attribute indicates the properties of an item type.

2.3.1 Computing environment

The computing environment of the decommissioning requirement management can be classified using a master tree that represents a work flow in a hierarchy, a query that filters data stored in a database under specific conditions, and a view that can be shown in the data properties through a query. The computing environment of the decommissioning requirement management is shown in Fig. 1.

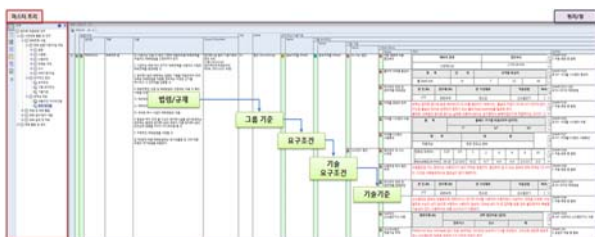


Fig. 1 Workbench UI of the decommissioning procedure requirement management system

2.3.2 Case study: Traceability test

Traceability was used to test an Arc Saw regarding the first dismantling method for cutting the structure of a reactor vessel contaminated by radiation. The results show that the system can trace the information in an order such as Nuclear Safety Act→Enforcement Decree of Nuclear Safety Act→Cutting→Metal Structure→Arc Saw→Function Criteria of the Arc Saw.

The dismantling experts and supervisor can refer to the requirement conditions and technical criteria in connection with various kinds of equipment, as well as which regulatory requirements should be satisfied when dismantling a metal structure during the decommissioning strategy and planning phase.

3. Conclusions

Legislation that should be complied with at the decommissioning strategy phase of the decommissioning procedure requirements management during the full-life cycle of the decommissioning was defined. To satisfy the defined legislation at the

decommissioning strategy phase, technical requirements and criteria related to the design and planning, the decontamination and decommissioning activities, and the dismantling management were defined. After collecting materials such as the ordinance, regulatory requirements, technical requirements, and criteria related to the decommissioning procedure requirements management, the connectivity of the requirements between four groups was established. Because a database can be managed through a variety of regulatory requirements related to the decommissioning of a nuclear facility from the Nuclear Safety Act to Regulation Guide, the system can utilize the decommissioning plan required by the NSSC when dismantling the research reactor and nuclear power plant.

The system can improve the reliability and the accuracy of the assessment by referring to the regulations required in the related legislation on the evaluation of cost and worker dose.

REFERENCES

- [1] Hiroyoshi Ueda, Satoru Suzuki, Katsuhiko Ishiguro, Matt White and Roger Wilmot, "NUMO-RMS: A PRACTICAL REQUIREMENTS MANAGEMENT SYSTEM FOR THE LONG-TERM MANAGEMENT OF THE DEEP GEOLOGICAL DISPOSAL PROJECT", Proc. of the 12th International Conference on Environmental Remediation and Radioactive Waste Management ICEM2009, October 11-15, 2014, Liverpool, UK