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A study of the decommissioning procedure of an activated structure through an evaluation of the decommissioning cost for a research reactor

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ABSTRACT

As decommissioning of a research reactor and a nuclear installation requires a long period of time from the decommissioning preparation work to the site remediation, the management of the data generated during the entire period of decommissioning is one of the most important tasks. In particular, the data obtained from research reactor decontamination and decommissioning activities can be important resources securing the safety and economic feasibility for other research reactor decommissioning. The owner of the research reactor and nuclear power plant need to submit decommissioning plan to the regulatory body at the starting stage of the research reactor and nuclear installation decommissioning project. The cost plan for decommissioning and the method for assessing the amount of exposure to protect workers must be stated in the decommissioning plan.

This paper introduces the DES (Decommissioning Engineering System) that can be able to manage the data generated in the process of decommissioning of the TRIGA research reactor, to calculate an amount of waste, to evaluate decommissioning cost after deriving unit work productivity factor, and to predict the decommissioning process in advance. To verify the usability of this system and data integrity through connections among the unit systems, it describes the process to calculate the decommissioning cost using the data generated in dismantling an activated bio-shielding concrete in the TRIGA research reactor.

As a result of the experiment to calculate the decommissioning cost with the TRIGA research reactor structure, it was found that the calculations were done precisely without flaw as the purpose of the experiment. Therefore, the DES can not only be used for other research reactors decommissioning, but also it is expected to be applied to other research reactors in the future. As a decommissioning cost between an activated concrete and a non-activated concrete according to the method of the dismantling procedure was significantly different, a study regarding the dismantling procedure needs more research.

1. Introduction

In 1996, as the decommissioning of Korean research reactor 1 and 2 (KRR-1&2: TRIGA Mark type II & III) was decided, decontamination and the decommissioning project of KRR-2 started from 1997. In Nov. 2000, with the approval of the decommissioning plan, the decommissioning project could officially start. The subsidiary facilities within the KRR-2 such as the laboratories, lead hotcells, and concrete hotcells were dismantled. The subsidiary facilities and surrounding facilities of KRR-1 as well as reactor of the KRR-2 were dismantled. The decommissioning project of the Uranium Conversion Plant (UCP) located inside the Korea Atomic Energy Research Institute (KAERI) started and decommissioning was completed; In addition, decommissioning of 25 compartments out of a total of 27 compartments inside the UCP had completed.

For the systematic management of the data generated from the research reactor decommissioning site and efficient operation of the decommissioning project, DECOMMissioning Information System (DECOMMIS) was developed. Based on this system,

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DEcommissioning FAcility Characterization System (DEFACS) to calculate the amount of waste, DEcommissioning WOrk-unit productivity Calculation System (DEWOCS) to derive the work productivity factor, DEcommissioning MOdeling System (DEMOS) to assess the decommissioning cost, and DEcommissioning Procedure Establish System (DEPES) to analyze the decommissioning process in advance, were developed. Recently, based on the facility code and WBS (Work Breakdown Structure) code management prepared from the DECOMMIS system, DES was developed to assess the worker exposure, amount of waste, and decommissioning cost from the decommissioning facility characteristics, and to comprehensively manage the important factors required for the decommissioning plan and decommissioning process procedure establishment.

This paper describes the contents of the assessment of the decommissioning cost in the recently developed decommissioning engineering system with the activated bio-shielding concrete of KRR-2 as the target, to verify the precision of the data compatibility and data integrity among the unit systems and decommissioning cost calculation.

As a result of testing the performance of the decommissioning engineering system, it was found that the decommissioning cost for the activated bio-shielding concrete at the KRR-2 was calculated precisely. This proves that there is no problem of connectivity in the data structure among the unit systems and that there are no flaws in the data integrity. The decommissioning engineering system used a database and engineering technique accumulated through research reactor decommissioning so that it can be used for establishment and design of another research reactor decommissioning plan, and it is expected to be able to applied to as the basic data for establishing of an other research reactor decommissioning information project management system in the future.

2. Related works

To successfully complete the nuclear installations decommissioning project, the decommissioning experience information and technical data need to be used effectively. Globally, many computer systems to manage decommissioning technology information were developed and used, and these computer systems are mainly divided into three operation types.

In performing the decommissioning project, decommissioning planning is one of the most important processes, and according to the appropriateness of the plan, it was reported that there was a big difference of the decommissioning cost. The general order of the decommissioning planning is a decommissioning strategy establishment based on the target decommissioning facility data, deciding on the appropriate decommissioning method, selection of the equipment, a safety evaluation and action plan establishment, and assessment of the decommissioning cost based on these. Therefore, an assessment of the decommissioning cost means that overall scenario of the target facility decommissioning is completed, and you can say that there is no method to simply assess the cost only. You can find the case of a computer system including such process in PRICE (Parametric Cost Estimating System) developed by UKAEA in U.K (UKAEA's Decommissioning, 2001). CORA (Component Registration and Analysis)-CALCOM (Calculation and Cost Management) developed by NIS in Germany is a program system designed for use in planning decommissioning projects, calculating costs, manpower requirements and radiation exposure levels as well as component registration/analysis and integrated waste disposal planning for nuclear facilities (CORA-CALCOM, 2011). Safety evaluation technology to decide on a decommissioning method to assess the safety in advance in the decommissioning planning stage according to the decommissioning scenario is being developed. In order to optimize the workload, exposure dose, waste mass and cost by selecting appropriate dismantling plan at the planning stage of the decommissioning, Development of Decommissioning Engineering Support System had developed by adopting new information technologies such as 3-dimensional computer aided design (3D-CAD) systems and virtual reality (VR) systems (Iguchi et al., 2004). British UKAEA developed the CARMEN (Care and Maintenance Activity Optimization Database) system with the purpose of a continuous surveillance of the facility and management of the status during the nuclear power facility decommissioning period (A review by HM Nuclear Installations Inspectorate, 2002).

Almost all countries operating a nuclear facility such as a NPP specify in law to maintain the records of the facility characteristics, operation characteristics, abnormal status characteristics, and a plan to process waste until the decommissioning is completed. In addition, recording and preserving these facility status data can be said to be essential in the decommissioning planning stage. As the decommissioning progresses, a huge amount of decommissioning data such as the decommissioning worker manpower requirement, workers exposure, decommissioning waste, and their radiological characteristics are generated. They are very different for each country, but there are cases in which several data generated from the decommissioning process must be reported to the regulatory body of that country, and the decommissioning process data are also required for the decommissioning process efficiency and safety evaluation after completion of the decommissioning. In addition, a safety and cost assessment in decommissioning planning can be said to be most precise when based on data obtained from already performed decommissioning experience. Therefore, if a following decommissioning project for a nuclear facility is expected, it is very favorable to utilize the decommissioning experience data as much as possible. Many causes of enhancement and changes occur, such as the development of decommissioning equipment to respond to the radioactivity level change of the facility not expected during the decommissioning plan establishment, changes of the decommissioning procedure and method as the project is performed over a long period of time, and change of the supply of construction manpower according to the project scale. To overcome such an environment, EWN in Germany stores and manages the data generated in the process of Greifswald NPP decommissioning in the DeMons system, and uses this system to perform various assessments required for a decommissioning strategy establishment and planning.

To rationally perform nuclear facility decommissioning, Japan established a Decommissioning Engineering System (DENESYS) for Nuclear Facilities, collected various project management data such as workforce, exposure and secondary waste generation from the decommissioning, and modified the calculation formula used for evaluation of the project management data.

DENESYS is composed of Project Management Data Evaluation Code (Usui et al., 2012) for Dismantling Activities used for detail review of the nuclear facility decommissioning plan and cost assessment, a simple cost assessment system used for a review and cost assessment of many decommissioning plans in the long term, the remaining radioactivity inventory assessment system used for radioactive waste level classification and assessment of the amount, and an exposure amount assessment system used for a safety evaluation by the assessment of the exposure amount on the workers and nearby residents during the decommissioning work. The PRODIA code uses the project management data calculation formula used in the COSMARD code (Yanagihara., 1993), which assess the project management data on nuclear reactor facility decommissioning developed by the previous Japan Nuclear Power Research Institute.