Configuration Management Model for Designing Construction Nuclear Power Plant considering Knowledge Management

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***Keywords :** Configuration Management, Knowledge Management, Nuclear system design, NPP, Small Modular Reactor*

1. Introduction

Configuration Management(CM) is the process of identifying and documenting the characteristics of a facility's structures, systems and components of a facility, and of ensuring that changes to these characteristics are properly developed, assessed, approved, issued, implemented, verified, recorded and incorporated into the facility documentation [1]. In the domestic nuclear power industry, since configuration management for operating nuclear power plants began for some systems of Hanbit Unit 3·4 in 2006, efforts have been made to apply configuration management to constructed nuclear power plants [2]. However, CM applications in the nuclear industry is still in its conceptual stage due to the ambiguity of CM definitions, insufficiency of CM procedures and so on [3,4]

In the case of the newly developed reactor types such as small modular reactors(SMRs), it requires CM from the design stage. If pre-operational CM data reflected from the design stage is effectively utilized, it is expected to be useful in terms of technical data management and knowledge management as well as appropriate licensing response to regulatory flows. This work presents a CM system model that considers permit response and knowledge management from the design stage perspective.

2. Development of CM Model for Design of Construction NPPs

2.1 Process to development of CM application

Jeon et al. follows the following process to develop a CM methodology for efficient and systematic management in the event of configuration changes of launch vehicle development test facilities [5]:

1) Review the characteristics and status of the facility being developed and consider cases where configuration changes occur.
2) Analyze domestic and overseas CM cases and status.
3) Derive CM activities and procedures to be applied through analysis of international standards for CM.

Considering the above process, CM activities for operating nuclear power plants can be confirmed through domestic and international CM application cases and analysis of international standards. However, it is difficult to find examples of nuclear power plants under construction. Therefore, a CM system applicable to the development process of a new plant must be newly developed by considering the characteristics and status of the new plant design process.

2.2 Characteristics of Design Process of First-of-a-Kind Construction NPPs

CM in the nuclear industry is applied considering the construction and operation process, and the general construction and operation process is shown in Fig. 1. [6].

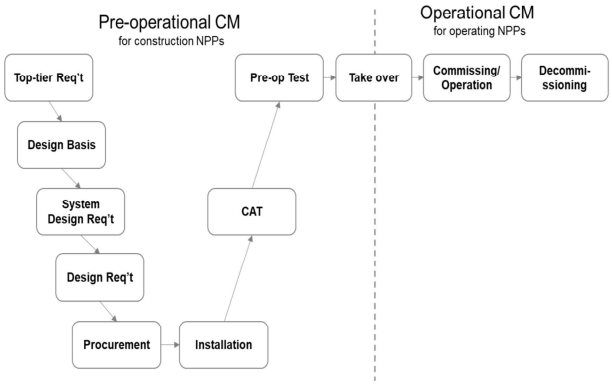

Fig. 1. Technical Process of Construction and Operation in the Nuclear Industry

The main technical process reflected in Operational CM applied to operating NPPs is mainly from the purchasing stage. Operational CM reflects trial and error information in the construction and equipment supply process after the design results. This information can provide a basis for the feasibility of applying the changed equipment when changing the equipment during the operational phase. The technical process reflected by the pre-operational CM applied to construction NPPs refers to the stage after the Top-tier requirement and before the operation of the NPP. The purpose of pre-operational CM is to maintain the consistency of design requirements, power plant configuration information, and physical configuration based on data as shown in Fig.2 [7]. If only the consistency of design requirements and design results is

considered, however, it is difficult to secure evidence for the feasibility of applying the design to be changed when a design change is necessary. In order to secure the technical basis for a design that is to be changed, a system is necessary to preserve and use information about the impact of events and trials and errors that occurred during the design work process.

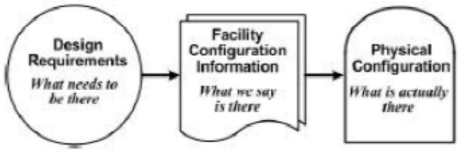

Fig. 2. CM Process Description for Construction Plant [7]

The design process goes through conceptual design, basic design, and detailed design. In each process, the final design is determined while facing various problems such as system-specific problems, inter-system connection problems, material supply and demand problems, manufacturability problems, and changes in user requirements. If information on internal and external difficulties, coping cases, trials and errors, and design decision processes derived from this design process are appropriately linked to Pre-operational CM, this can become a database that can provide technical basis for design results. It can also serve as an educational tool to provide lessons learned to novice designers for nuclear reactor development and insight in the development of new reactor types to designers.

Therefore, a CM model is presented that can simultaneously satisfy the role of response to licensing from a pre-operational CM perspective and as an educational knowledge management system for nuclear system designers.

2.3 Modelling of CM for Design of Construction NPPs considering Knowledge Management

In order to develop the pre-operational CM system that includes the functions of the educational system mentioned in chapter 2.2, the model that takes knowledge management into consideration is proposed as shown in Fig. 3.

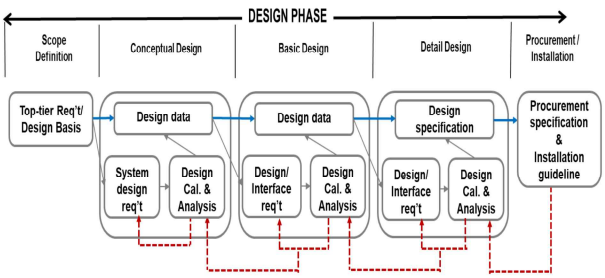

Fig. 3. Model for Pre-operational CM System considering Knowledge Management

The blue line is input information showing consistency between derived data, and the red line represents data generated during the design process. Data generated during the design process refers to information that is design documents or not in the form of design documents, such as data related to pending issues derived from events and decisions made at discussions. The red line-related information is not an essential element for permit response work that requires configuration management consistency. However, it is expected to be very meaningful information in terms of education and knowledge transfer for designers since it provides information on the design basis

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3. Conclusions

CM for the construction NPP is required and the concept of CM process is provided. However, the generally provided guidance is still ambiguity, and it is insufficient to cover the meaning of the application of CM to the construction NPPs. In this paper, a configuration management model considering knowledge management was presented. If a CM system is developed based on the proposed model, it is expected that it will be possible to secure the basis for the feasibility of applying change design, which means applying configuration management to construction NPPs. The CM system developed based on the proposed model is expected to respond appropriately to licensing and can be used as a means of education for system designers.

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