Configuration Management for Decommissioning Nuclear Power Plants

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1. Introduction

As the nuclear power plants (NPPs) under operation since 1970s have reached 40 years of age, the number of NPPs that step into the decommissioning phase is increasing. However, there are few decommissioning cases of commercial NPPs and no systematic procedures have been established for decommissioning. After accidents at TMI and Salem, it became required to apply NPP configuration management as a way to secure safety for operating NPPs. However, configuration management should be beneficial not only for operating NPPs but also decommissioning NPPs.

The IAEA recommended that configuration management be applied throughout the design, construction, operation, and decommissioning stages of NPPs [1]. The Canadian regulatory agency CNSC also requires decommissioning plant operators to apply configuration management. Since, if parts or records are lost unintentionally during the decommissioning, it is expected to deteriorate public acceptance and cause schedule delays for decommissioning, systematic configuration management is essential. In addition, it is important to develop a configuration management process for a decommissioning NPP in order to systematically manage the decommissioning process and to transparently manage the decommissioning wastes for improving the safety of decommissioning and increasing the public confidence. However, the concept of configuration management for the decommissioning of NPPs has not been defined clearly so far.

This paper presents the concept of configuration management for the decommissioning NPPs. The current concept of configuration management for the operating NPPs is explained, and the concept of decommissioning configuration management is proposed and compared with the configuration management of the operating NPPs in the following sections.

2. Configuration Management

Configuration management (CM) in the NPP is defined by ANSI/NIRMA [2] as "The systematic approach for identifying, documenting, and changing the characteristics of a facility's structures, systems and components and ensuring that conformance is maintained between the Design Requirements, Physical Configuration and Facility Configuration Information." This concept of CM can be briefly depicted as in Fig. 1.

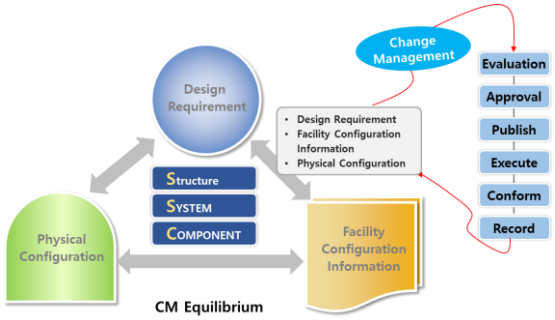

Fig. 1. Configuration Management Equilibrium Model

The main purpose of the configuration management is to maintain the equilibrium between design requirement, physical configuration, and facility configuration information in order to ensure safety for NPPs.

In the following, four elements in the CM equilibrium model are described.

2.1 Design requirement

Design requirement is "a technical requirement, derived from the design process and reflected in design information (documents and/or data) that defines the form, fit and function (including capabilities, capacities, physical sizes and dimensions, limits and setpoints, etc.) specified by the design authority for a structure, system or component of the facility. Each design requirement has a basis, documented or not [2]."

In other words, the design requirement describes what needs to be in the NPP. It might be laws, rules, regulations, acts, guides, and so on. Engineers should observe the design requirement when they design the NPPs.

2.2 Physical configuration

Physical Configuration is "the actual physical location, arrangement and material condition of structures, systems and components within a facility including electronic hardware and software performing a facility function [2]."

In other words, the physical configuration describes what is actually in the NPP. It is the NPP itself.

2.3 Facility configuration information

Facility Configuration Information (FCI) is also referred to as Facility Configuration Documentation (FCD). It is "recorded information that describes,

specifies, reports, certifies, or provides data or results regarding the design requirements or design basis, or pertains to other information attributes associated with the facility and its structures, systems and components. This information may be contained in original hard media (mylar, etc.), paper copies, electronic media and any other sources of information used to make sound technical decisions regarding authorization or licensing, design, construction, procurement, modification, operation, maintenance and decommissioning of the facility. It includes current information, pending information and records. The scope of Facility Configuration Information is defined and the level of control is determined using a graded approach [2]."

In other words, the FCI describes what we say is in the NPP. It might be drawings, operation manual, etc., which are used for operation and maintenance.

2.4 Change management

INPO provided a configuration management process flow chart to maintain CM Equilibrium [3]. The three elements in the CM equilibrium model should conform to each other so that the NPP could be operated safely. When replacing aged equipment, changing regulatory requirements, or changing drawings, all three components must be checked and kept consistent so that nuclear power plants can be operated safely.

3. Configuration Management for Decommissioning

The most important value in NPP is 'safety'. It is also the goal of configuration management. In the same sense, the final goal of decommissioning is to 'safely' dismantle the NPPs which will not be used anymore and to 'safely' restore the site. In other words, NPPs to be decommissioned are safely removed and then the site could be safely reused. Therefore, dismantling work must be done with focus on the safety.

The configuration management of the operating NPP maintains the consistency between the three elements of the configuration management so that the function of the NPP can be safely maintained. On the other hand, the configuration management of the decommissioning NPP aims to complete the dismantling work while maintaining the safety of workers and residents around the NPP.

The key elements of configuration management for decommissioning NPP are ① All requirements for securing dismantling safety, ② All information and data related to decommissioning, ③ Structures, Systems, and Components (SSCs), decommissioning waste, and physical properties of the remaining buildings and site. ④ All procedures to maintain consistency through systematic change management between the three elements throughout the entire process from preliminary/final decommissioning plan through establishment → demolition/decontamination → site restoration → operation license termination → site reuse. The CM for decommissioning can be depicted as in Fig. 2.

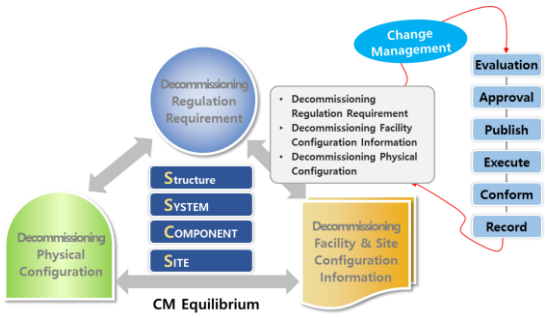

Fig. 2. Decommissioning Configuration Management Equilibrium Model

3.1 Decommissioning regulation requirement

Decommissioning regulation requirements are all requirements to secure dismantling safety, which are domestic/foreign laws and technical standards, DSAR, final decommissioning plan and applicable overseas technical standards.

The requirements for decommissioning regulations are derived from domestic and foreign laws, sub-laws, administrative rules, regulatory standards and guidelines applicable to the dismantling of nuclear power plants, domestic industrial technical standards and international standards, including the nuclear and non-nuclear sectors, and the requirements for dismantling safety cases and licensing commitment based on the decommissioning plans. The requirements are also derived from international safety standards and industrial standards and the conditions agreed upon by the decommissioning business operators. The requirements should be analyzed and managed for easy use during decommissioning.

Based on these regulatory requirements, decommissioning tasks should be planned, performed, and evaluated, and all decommissioning tasks should be confirmed to be carried out in accordance with regulatory requirements.

3.2 Decommissioning physical configuration

Decommissioning physical configuration is the physical characteristics of structures, systems, and components, decommissioning wastes, sites, and remaining buildings. The decommissioning of NPPs requires the management of the physical changes in the process of gradual disposal of existing facilities and buildings and the conversion to waste.

The change management of physical features manages both the physical and the radiological changes. Physical change is the visual changes, which are to be made until the plant's buildings/facilities are dismantled and there is no more material left to be disposed of. The physical change should be managed until the disposed

material is converted into waste and safely transferred to the waste management agency. Radiological change is the changes in the radioactivity and radioactive contamination. The radiological change should be managed until the site is restored with the radioactivity below the limit prescribed by the law.

The target of physical configuration management is the plant site, the plant building, and all facilities, including all wastes generated during decommissioning. It is proposed to manage the physical configuration management targets in the hierarchy of buildings, floors, rooms, facilities, and wastes as shown in Table I.

Table I: Scope of Decommissioning Physical Configuration

Physical Element		Description
Site		Land and remaining buildings where the plant is located in
Plant	Building	Plant building
	Floor/Level	Floor in the building
	Room	Room or area in the floor
	Component	Components installed in the plant
	Large component in the primary system	Reactor
		Steam Generator
		Reactor coolant pump
		Pressurizer
Waste		Waste during decommissioning

3.3 Decommissioning Facility Configuration Information

The decommissioning Facility Configuration Information is all the information and data related to decommissioning, as well as the requirements documents and physical and radiological characteristics information throughout the decommissioning process.

For physical and radiological change management, it is much more efficient to create a 3D integration model associated with the data collected in various ways and to carry out the configuration management for decommissioning NPPs with the 3D integration model. The physical and radiological changes can be more intuitively understood using the 3D integration model, and the data associated with the flow of change over time can be managed more efficiently. Fig. 3 shows how the 3D integration model is formulated and utilized.

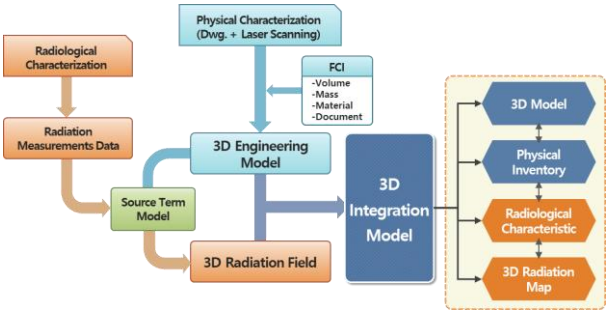

Fig. 3. Utilization of 3D Integration Model

3.4 Change management

Change management can be considered in several ways in accordance to the works performed during the decommissioning. The change management can be conceptually depicted as in Fig. 4.

1) Radiological work management: Change management is carried out through the management of work schedules based on the work permit in the radiation control area and the management of work contents based on the entire decommissioning work log.
2) Waste management: Information on wastes generated during decommissioning is managed, and facility information (physical characteristics) and radioactive level (radiochemical characteristics) are managed together.
3) Material balance management: The total inventory of all facilities managed in the dismantling plant is safely tracked and managed without omission during the decommissioning process so that the total inventory of the facilities and converted waste during decommissioning is maintained within the acceptable margin of error. The total amount of waste and the amount by radiation level finally taken out of the site are kept consistent with the inventory before removal.

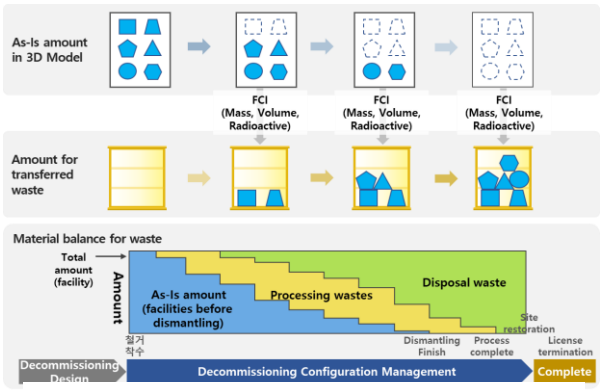

Fig. 4. Material Balance Management

4) Requirement Change Management: The requests for change and the procedure for change are controlled and managed.

4. Conclusions

The configuration management of decommissioning NPPs is to manage the process to dismantle old nuclear power plants and acquire the license termination so that safe decommissioning of the NPP is carried out until the final site restoration.

Comparison of the configuration management for operating NPPs with that for decommissioning NPPs is summarized in Table II.

It is expected that a safe and efficient decommissioning of NPPs can be carried out with use of the decommissioning configuration management.

Table II. Comparison between CM Concepts

Item	For Operating NPP	For Decommissioning NPP
Goal	The operation safety	Securing safety and transparency
Application	Operation permit to permanent suspension	Preparation of decommissioning to site restoration
Key elements	1) Design requirement 2) Physical Configuration 3) FCI	1) Decommissioning regulation requirement 2) Decommissioning physical and radiochemical configuration 3) Decommissioning FCI
Change Management	INPO AP-929	Decommissioning Work Management and material balance management

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