Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 24-25, 2013

A Study on the Functional Elements of Configuration Management throughout the Life Cycle of Nuclear Power Plant

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1. Introduction

Configuration Management (CM) is a technical and management process for maintaining consistency and traceability of any performance, functional and physical attributes of SSCs (Structures, Systems, or Components) with its requirements, design, and operational information [1, 2]. SSCs are the elements which make up a "facility." A structure is an element that provides support or enclosure. A system is a collection of components assembled to perform a specific facility function(s). A component is an active or passive item of equipment such as a pump, valve, relay, or an element of a large array such as pipe segments, elbows or reducers [3].

For applying CM to nuclear industry, it is necessary to investigate and define the functional elements comprising CM. The elements can be used in planning and executing CM

2. Classification and Definition of CM Elements

In this section five top-tier functional elements are classified and defined for the purpose of applying CM to nuclear industry. The CM process consists of five interrelated elements which, when collectively applied, maintain consistency and traceability between SSCs and their configuration information based on design bases. The functional elements of CM are: 1) Configuration Management Planning and Management, 2) Configuration Identification, 3) Configuration Change Management, 4) Configuration Status Accounting and 5) Configuration Verification and Audit.

Meanwhile, US DOE (Department of Energy) defined the CM elements as Design Requirements, Work Control, Change Control, Document Control, and Assessments [4].

2.1 CM Planning and Management

CM planning shapes the application of solid, practical procedures that result in safety margin and operation margin, which also enables cost reduction and enhanced quality. But CM planning may be constrained by a compressed time schedule for program execution [5].

In practice, utilities planning to build new nuclear generation are faced with a wide variety of challenges, from initial stage to contract negotiations to licensing issues. At the onset, CM should be initiated since preliminary planning will prevent or at least lessen the consequences of configuration dis-connects as the plant is being designed, built and operated [6].

There are detailed elements to be considered in the process of CM planning and management such as the context and environment of the object of CM process to be applied, how to implement CM throughout the applicable phases of the life cycle to provide consistency and traceability of SSCs in an organization, and so on.

2.2 Configuration Identification

Configuration identification is the basis from which the configuration is defined and verified;

SSCs and their configuration information are labeled; changes are managed; and traceability is maintained throughout the life cycle.

Configuration information serves as the basis for design, development, construction, operation and maintenance/support of NPP (Nuclear Power Plant). The configuration identification information is the subset of NPP information that consists of Design Definition Information (DDI) and Operational Information (OI). DDI is the product of system and design engineering, providing the technical basis for design, development as specifications, requirements documents, and design information. OI is derived, in part, from the design definition information. OI consists of procedures and technical information needed by operators and support personnel to operate, maintain and dispose of the NPP including operating procedures, security procedures, spare pare lists, and disposal methods.

Information about physical configuration is typically provided as description of SSCs. SSCs that receive special CM attention because of their requirements, functionality, or relationships are referred to as configuration items, whose scope should be determined by stakeholders.

A baseline is established by agreeing to the definition of attributes of an object at a point in time, and identifies a known configuration to which changes are addressed as shown in Fig. 1.

For new plants, the opportunity exists to require and create a more complete set of information that will meet the needs of these stakeholders and provide the necessary information for engineering and maintenance over the life of the plant.

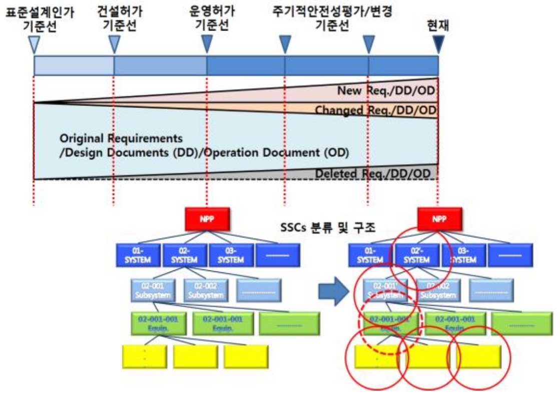

Fig. 1 Example of Baselines Based on Licensing

Interfaces between systems are managed by mutually agreeing to defined common object attributes, making them part of the object configuration and baselines for each system, and applying a process to maintain interface integrity.

2.3 Configuration Change Management

The configuration change management element includes managing both changes to and variance from the approved configuration information for NPP, using a systematic, measurable change process. A systematic change process effectively screens, controls and categories requests for the changes and captures all needed information about the change. The elements of this process are as in the following.

1) Justifying the need for a change
2) A unique change identifier
3) Classification of a requested change
4) Clear request for change document from technical, cost and scheduling perspectives.
5) Evaluating all configuration information, all potential impacts, including technical, operational, support, schedule and cost
6) Implementation of an approved change in accordance with documented direction approved by the appropriate level of authority.

DBD (Data Bases Document) can be used for the convenience of tracking the change within the design requirements. But DBD does not have to be published. In other words, it is recommended that the information for tracking the change is extracted by using a CM system, which includes configuration database based on structural hierarchy of NPP, according to a specific objective changed. Sometime user-defined input would be helpful to the completeness of DBI (Data Bases Information).

2.4 Configuration Status Accounting (CSA)

This element provide provides and accurate, timely information base concerning an object and its configuration information throughout the life cycle. SSCs and configuration information are captured as CM tasks are performed. The report from the information captured is assessable to support program/project activities as needed. Metrics derived from the CSA information are used to evaluate and improve CM effectiveness.

2.5 Configuration Verification and Audit

This element establishes that 1) the approved the definition information is complete, accurate and current to produce the product, and applicable operation and maintenance instructions, training, and spare and repair parts, 2) the physical, functional, and interface requirements, defined in the approved definition information, are achieved, and 3) and adequate process is in place to maintain consistency and traceability between SSCs and its configuration information throughout life cycle. And the detailed elements are as follows.

1) Verifying the compliance with the physical, functional, and interface requirements.
2) Ensuring the consistency and traceability between SSCs, their configuration information, and related support assets.
3) Assuring the configuration verifications and establishing baseline at key points in the life cycle.

3. Conclusions

Appropriate application of CM elements enables a user to plan and implement a CM program for SSCs of NPP. Although each element is separated, its implementation should not be performed in isolation because the CM elements should be balanced, consistent, and tracked. The degree of CM elements' application varies over the life cycle of NPP. The degree of rigor and techniques used in implementing CM is commensurate with type of NPP and its application environment as defined by the CM program requirements.

For the consideration, it is necessary to make a CM STANDARD, and HANDBOOK or GUIDELINE for enabling more effective planning and implementing CM in nuclear industry.

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