

Applying Digital Engineering Guide to Domestic Digital Nuclear Power Plant

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1. Introduction

In the Electronic Power Research Institute (EPRI), research on the Digital Engineering Guide (DEG) has been conducted since the early 2010s, and there have been many considerations for its application.

Korea's Nuclear Power Plants (NPPs) are the only one operated by Korea Hydro & Nuclear Power Co., Ltd. (KHNP). Operating means that you have the responsibility and authority to manage the entire process from construction to maintenance.

Therefore, it is necessary to clearly manage the entire life cycle of a power plant in KHNP, a NPP operator. This requires the agreement of the designer, the manufacturer, and the various agencies involved.

In this paper, I would like to mention the existing processes, capabilities and collaboration for domestic application.

2. Digital Engineering Guide

2.1 DEG Overview

DEG is a description of a wide range of procedures and responsibilities for design and manufacture for the safe and efficient maintenance of nuclear systems.

Existing engineering procedures focusing on fluids and mechanical systems are not suitable for digital and software-based applications to new or existing systems, suggesting an effective method of applying digital technology.

2.3 DEG summary

DEG has the following contents. [1]

- 1) Suggesting activities and strict ratings for digital engineering product production
- 2) Introduction of DEG, access standards by grade, digital Instrumentation and control (I&C) strategy and programming interface
- 3) Design and requirements technology including technical requirements, design synthesis, plant integration, verification and verification (V&V), risk analysis, testing, installation and operation
- 4) Implement system engineering procedures by repeating at each stage of the engineering procedure
- 5) Providing guidance on the tasks of system engineering, additional technologies, and sub-procedures (guidelines) such as “procurement, ergonomics, data communication, cyber security, power plant integrated design, test, configuration management, digital aging management, etc.”

- 6) Provide a worksheet for engineering practitioners to implement application and accountability activities
- 7) EPRI synthesizes workshops and industry benchmarks, and suggests an organizational optimization method using digital technology in nuclear systems

2.3.1 The process of design change

DEG described the process required for digital design change and the roles for each parts.

The following figure shows the entire process of design change, and the work part is divided in detail from the initial scope designation to operation and maintenance (O&M).

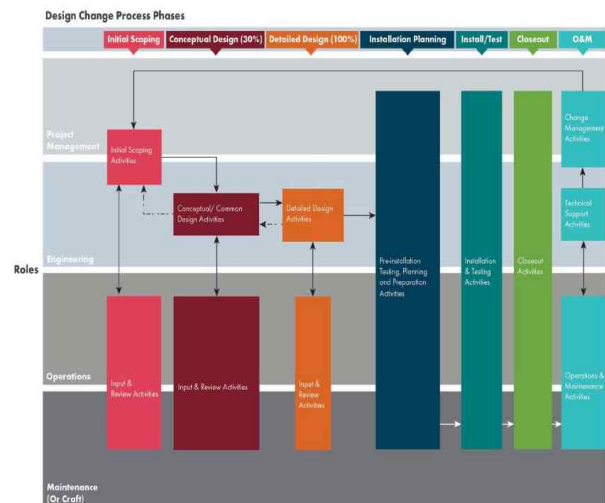


Fig. 1. Design Change Process Swimlane Diagram

2.3.2 Performing System Engineering

The following figure details the tasks required in systems engineering.

Each item is an activity that must be performed by all, and is not only performed by the operator, but is performed through cooperation of all (production, designer, etc.).

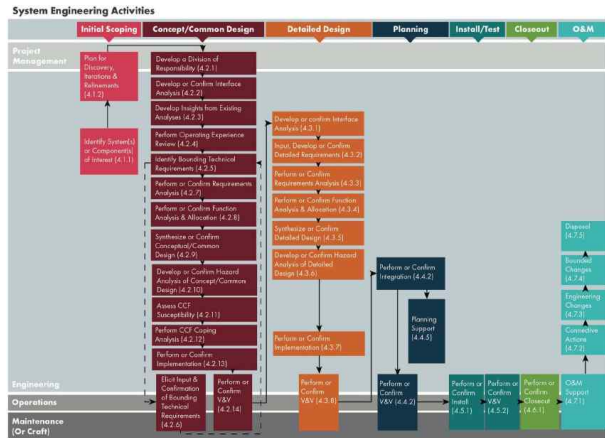


Fig. 2. System Engineering Process Activities

2.3.2 System Engineer

The role of the system engineer in the initial scoping (Identify System (s) or Component (s) of Interest) phase of Figure 2 is very important.

As shown in the figure below, the system engineering process consists of four activities that are applied to successive iterations up to the conceptual design, system design, and subsystem/component design level.

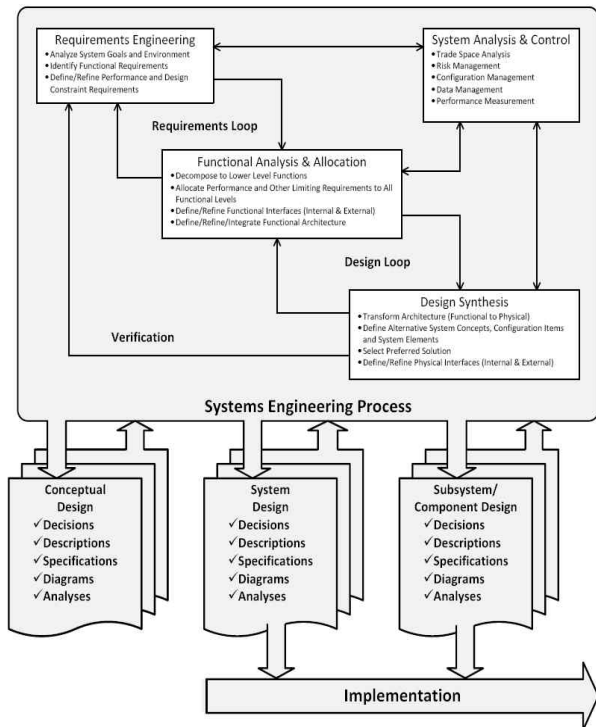


Fig. 3. The Systems Engineering Process

The system engineer performs analysis and improvement through each step until the design can be implemented with system description, analysis, specifications and drawings.

In the initial process (not just the initial one), not only the system engineer, but also all engineers (design/manufacturing technicians) must work in collaboration.

3. Application of DEG

3.1 Domestic Status

The strict separation between O&M and design/manufacturing makes maintenance very difficult, and the responsibilities are divided as follows.

- 1) (Partner) Responsibility for Design / Production
- 2) (KHNP) Responsibility for O&M

Separation of duties and responsibilities has the following problems.

- 1) Difficult to transfer know-how at the design phase
- 2) Difficult to reflect the design of O&M's point of view

3.2 DEG needs

For O&M in digital NPPs, DEG needs to be applied for overall management from design to disposal, and has the following effects.

- 1) Suggestions for solving important problems in digital technology applied to nuclear systems
- 2) Maintenance of existing and new systems and effective application of digital technology
- 3) Improve the efficiency of engineering processes and engineering personnel

3.4 How to apply DEG

- 1) Overall management of digital engineering by fostering system engineers
- 2) Development of life cycle management procedures for digital systems and optimal management process for digital systems through integration of existing engineering procedures

4. Conclusions

It is important to develop system engineers who can manage the entire process from the design phase to the O&M phase, and to increase their capabilities, and it is necessary to cooperate with various organizations such as the design, manufacturing, and operating companies.

REFERENCES

[1] EPRI TR-3002011816, Digital Engineering Guide: Decision Making Using Systems Engineering, 2018