Direction of Technology Development for Nuclear Power Plants at the O&M Phase

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1. Introduction

Recently, Korea has attempted to advance overseas markets by securing competitive power in nuclear power technology. In order to develop and operate overall construction management systems with Korea's own brand equipped with sufficient applicability and competitive power in the market abroad and to ensure equal competitive power with other foreign advanced companies of nuclear power plants, Korea has launched a project called "Data Centric Integration/Automation Technology for NP Project Management System" since July 2011 [1].

This project is divided into two phases: the first phase from 2012 to 2016 realizes EPCS stage, and the second phase from 2017 to 2020 extends to O&M stage.

Appropriate technology development planning must be established if "Data Centric Integration/Automation Technology for NP Project Management System" conducted at the first phase would extend to O&M stage at the second phase. Therefore, this study aimed at drawing out the direction of technology development based on present analysis of process at the operational phase of nuclear power plants in Korea conducted as previous study.

This study analyzed current operation and maintenance systems first, analyzing the results of differences between the operation process of nuclear plants in Korea which was suggested at the previous study and the process of the Korea Hydro & Nuclear Power Co., Ltd. (hereafter referred to as "KHNP") and drawing out the direction of technology development for nuclear power plants at the operational phase from the viewpoint of life cycle.

2. Review of Precedent Literature

2.1 Analysis of operation and maintenance systems for nuclear power plants in Korea

Here, the systems currently constructed in KHNP at the operational phase were investigated and the result hereof was used as the data comparing to derive direction of technology development in the future. Table I shows the details of system currently operated in KHNP.

Table I: Comparison of operation and maintenance systems in nuclear power plants between the NPM and KHNP

SNPM(APP 907)items	Operation and maintenance system in KHNP
Information Technology /Management	-KHNP Nuclear Information System (KONIS) -Nuclear technology supporting system -Environmental Radiation Information Management -Disaster management system -Seismic safety of nuclear power plants -Status of power plant operation
Materials and Services	-Integrated reactor core management system
Work Management	-System Integrity Evaluation System -SPV Monitor
Operation of Plants	-Design change control system -Long Term Asset Management (LTAM) -Web risk monitoring system -Measurement and test equipment management system -Effective maintenance and rule system (e-MR) -electronic-Piping & Instrumentation Drawing(e-P&ID) -KHNP Nuclear Information System(KONIS)
Equipment Reliability	-SPV equipment reliability system -Quality assurance of general standards -DB management system of reliability on nuclear power plants
Support Service	-Engineer work support system(EWS)
Training	-e-Learning
Nuclear Fuel	-Integrated reactor core management system
Loss Prevention	-System Integrity Evaluation System -SPV Monitor
Performance Improvement	-K-HPES -Operational improvement (CAP)

2.2 Standard Equipment Management Model

In 1998, US Nuclear Energy Institute (NEI), Electric Utility Cost Group (EUCG), and Institute of Nuclear Power Operations (INPO) co-developed Standard Nuclear Performance Model (SNPM). This model provides 3D model consisting of process, performance index, and cost to analyze performance and cost of power plants, in which indices of process and performance were mainly developed by INPO and NEI while the area of cost was developed by EUCG.

Based on the results of connection between the procedures of SNPM and KHNP, processes of KHNP that were not presented but included in the 5th edition of SNPM were analyzed (Fig. 1). The processes of KHNP not presented were as follows : CM01 Evaluate Problem Design Change, CM02 Change Design Requirement, CM03 Change Physical Configuration at Configuration Management category, and WM01 Planning & Scheduling, WM02A Preventive Maintenance, WM02E Non-Capital Plant Improvement, WM02F Fix-it Now Team(Dedicated) at Work Management category, and ER01 Long Term Planning & Life Cycle Management and ER03 Continuous Equipment Reliability Improvement process at Equipment Reliability category. At Loss Prevention category, LP04 Corrective Action Program, and finally at Training category, TR01 Training-Develop/Conduct process.

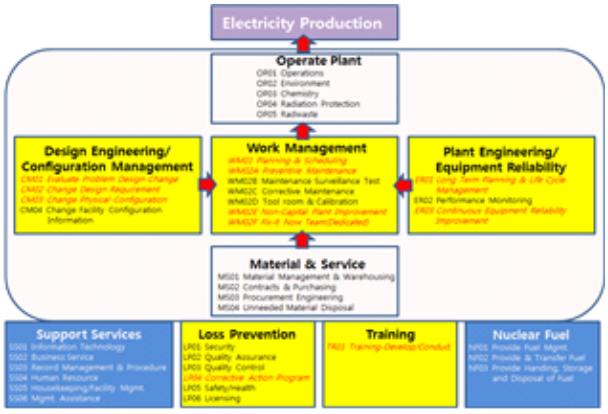

Fig. 1: NEI SNPM(Rev.5) vs KHNP's Process

Based on this analysis, a link diagram of the Standard Equipment Management Model is shown at Fig. 2. The highest level of the process link that has three-level link structures is a link between processes, while the link relationships were set at the conceptual diagram development phase. The second level link is a link between process modules, which aims at safe power generation as its ultimate goal. Here, 9 processes were marked with several modules separated for each process.

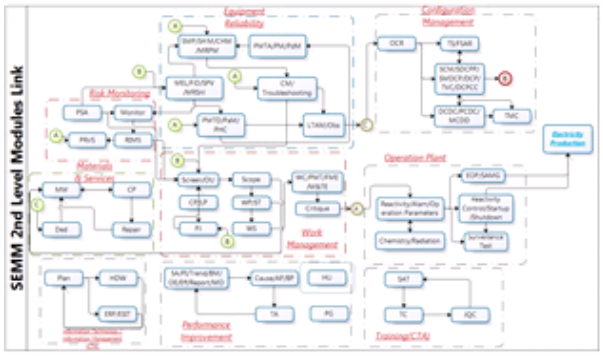

Fig. 2: SEMM 2nd Level Modules Link

Process gap analysis was conducted to aim at improving performance and safety by strengthening the link between processes while maintaining superior equipment operation performances through the gap analysis between processes, which were under operation at KHNP in the past, and the equipment management standard model of KHNP, which was formed by benchmarking the advanced overseas equipment management such as NEI and INPO [2].

The gap analysis was conducted throughout 18 detailed processes at Equipment Reliability category, 14 detailed processes at Work Management category, 13 detailed processes at Configuration Management category, 14 detailed processes at Performance Improvement category, 4 detailed processes at Material management category, 3 detailed processes at Training category, 4 detailed processes at Risk Monitoring category, and 4 detailed processes at Information & Technology category.

This gap analysis were used to draw out areas where improvement of information systems is needed for the current nuclear power plant at the operational phase, those where links between systems are required, and those where new processes are required.

3. Results and Conclusions

The study procedure for drawing out the direction for technology development through the gap analysis is as follows:

Step 1: Description of the link between gap analysis results and the direction for technology development

Step 2: Compare and summarize drawn out directions for technology development with the current systems of KHNP.

Step 3: Categorize summarized direction for technology development into new development, complementary development, and linked development.

Step 4: Advice and survey by experts, using the results of Step 3.

Step 5: Advisory survey results are reflected to determine the items of technology development.

The direction and conception of technology development drawn out by the procedure above are shown at Table II.

Table II: Direction for technology development of nuclear power plants at the operational phase

Category	Item for technology development
Equipment Reliability	-Link between design change configuration change and e-MR -Performance monitoring planning management system on critical systems -Unavailability rating system (Improving e-MR) -Maintenance improvement management system -Preventive maintenance grounds management and prevention maintenance work effect analysis system -Failure and maintenance trend analysis system for each equipment and equipment type -Discontinued product management DB (linked with overseas discontinued product information management system and material procurement system) -Enterprise SPV(Single Point Vulnerability) equipment multiplexing total management system -Enterprise integrated Equipment Integrity Evaluation System -Prevention maintenance standards operation system -Power plant integrity evaluation system -Integrated preventive maintenance management system -Long-term equipment management system (linked with current LTAM system)
Work Management	-Input personnel management system for each equipment importance -Test after maintenance, re-test, evaluation management system
Configuration Management	-Restoration management system from temporary changes -Design Based Drawing (DBD) management system
Performance Improvement	-Power plant total performance index management system -Enterprise data total analysis system for evaluating validation and analyzing causes -Corrective action tracking management system for work distribution and tracking management
	-Enterprise benchmarking management system for performance improvement -Performance improvement project planning establishment system -Technical exchange group operation effectiveness measuring and diagnosing system
Procurement and Management	-Material life cycle integrated management system (material request, purchase, warehousing, inspection, management, disposal, reuse)
Information Technology	-Lack of systematizing linkage structure of data between systems, data duplicate calls have occurred many times, and so on -Rebuilding is needed, which consists of existing systems and new systems suggested in this study
Others	-Work Breakdown Structure (WBS) and Object Breakdown Structure (OBS) at the operational phase -Nuclear power plant life cycle integrated knowledge management system -Information management process for nuclear power plants at the operational phase in consideration of PLIMS operation

Acknowledgements

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REFERENCES

[1] KHNP, Plan Development for Managing the Life-Cycle Information, 2013
[2] KHNP, Development of Standard Equipment Management Model, 2012