Transaction of the Korean Nuclear Society Spring Meeting

Development Study on Review Guidance for Cybersecurity Plan and Implementation Results of SMR in ROK

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Introduction

- Nuclear energy has emerged as a **crucial power source** globally, accounting **32.9% of the total electricity generation** in the Republic of Korea (ROK), as of 2023.
- However, there is a growing need to enhance nuclear safety post the Fukushima disaster and to consider improvements in nuclear energy utilization, such as accommodating the increasing coexistence of renewable energy sources. **Therefore, attention has turned to Small Modular Reactor (SMR) technology.**
- To ensure the safe utilization of nuclear energy, cybersecurity regulation including review of operator's cybersecurity plan against to nuclear facilities is essential. However, differences in design features between SMR and existing nuclear power plants(NPPs) require to assess the applicability of existing review guidance to SMR.
- This study analyzes **the feasibility of applying existing review guidance for cybersecurity plan(CSP) and implementing results of SMR** and proposes amendments to the guidance based on the analysis results.

Methods and Results

- In this section, we analyze the distinctive features of SMR compared to conventional NPPs and assess the feasibility of applying existing review guidance to these features. Based on the result, we derive necessary improvements on review criteria for SMR.

2.1. SMR Technology and Differences from Conventional Nuclear Power Plants

- SMR is characterized by integrating key components like steam generator and pressure vessels into a single container, typically with an output of less than 300MWe. The main features of SMR are enhanced safety features, improved economic flexibility, and the adoption of innovative technologies.

a. Enhanced Safety Features

a. Introduction of passive safety functions
b. Minimizing the intervention of operator during accidents
c. Reducing the necessity for evacuation of nearby residents
d. Zero severe accident

b. Improved Economic Flexibility

a. Modular Form
b. Design to utilize existing power grids
c. Simplified system design
d. Significantly reduced staffing requirements
e. Enabling transported inland

c. Adoption of Innovative Technologies

a. Incorporating innovative technologies; autonomous operation and remote diagnostics
b. Utilizing multiple modules
c. Using power source for various purposes; integration with renewable energy

2.2. Existing Regulatory Review for Nuclear Facilities in ROK

- In ROK, the Nuclear Safety and Security Commission (NSSC), the government agency responsible for nuclear safety and security, evaluates and approves the CSP of nuclear facilities to provide high assurance of cyber security on the site. Especially, regulatory activity of review for CSP is delegated to and carried out the Korea Institute of Nuclear Nonproliferation and Control (KINAC).
- KINAC evaluates the CSP of each facility according to APPRE, which is a law related on the nuclear security in ROK and regulatory guidance, referencing the KINAC regulatory standard and internal regulatory manual and procedure of review.

2.3. Analysis the Review Guidance for Applying to SMR

- To assess the applicability of existing review guidance to SMR, we applied the characteristics of SMR analyzed in Section 2.1 to existing regulatory manual for review.

Table I: Analysis results of assessing the applicability of existing review guidance

No.	SMR feature	Considerations
1	Application of Passive Safety Functions	**Reduction or elimination of protected area**
		Difference in identifying critical digital asset (CDA) and establishing defense-in-depth protective strategy of SMR
		Difference in considerations for DBT
2	Reduction of Intervention of Operators and No Need for Evacuation of Residents in Accidents	**Need Supplementary approach required for on-site Incident Response Security Team**
		Difference in scope of site's emergency planning
3	Design for Zero Severe Accidents	**Difference in considerations for DBT**
4	Modularization and Simplified Design	**Reduction of the number of on-site operators**
		Being vulnerable in supply chain and design phases
		Difference in identifying CDA and establishing defense-in-depth protective strategy of SMR
		Existing regulation is excessive relative to the size of SMR.
5	Shortening Construction Period	**Reformulation of regulatory review period**
6	Inland Transportation Feasibility	**Extend regulatory scope of adopted cyber security such as access control**
7	Introduction of Innovative Technologies	**Supplementing regulatory requirements of new technologies**
		Including areas remotely controlled within the scope of cybersecurity program
8	Compatible with renewable Energy	**Considering regulatory requirements for cyber security in renewable energy utilization**

2.4. Development of Enhanced Review Guidance

- Based on the considerations derived from Section 2.3, we derived the improvement strategy of review guidance, linking the considerations in Table 1 to the categories of requirements in the KINAC regulatory manual for review.

Table II: Improvements of the review guidance

Relevant Requirement in [7]	Proposed Improvements (Relevant Consideration's Row #s in Table1)	Guidance Improvement Method*
Cyber Security Team	Revision of roles and responsibilities of cyber security team and incident response team due to reduction in on-site operating personnel (2, 4)	**R**
Identification of CDAs	Examining closely the identified CS and CDA lists during review due to differences in design features (1, 4)	**AC**
	Reviewing criteria for deciding addition or changes to existing criteria for identifying CS to consider changed protected scope (1, 7)	**E, R**
Defense-in-Depth Protective Strategy	Examining closely defense-in-depth protective strategy during review due to differences in design features (1, 4)	**AC**
Security Controls	Examining closely the scope of security measures considering to inland transportability and new technologies (6, 7)	**AC**
	Examining closely whether security measures for enhancing cyber security in supply chains and design phases (4)	**AC**
Continuous Monitoring and Assessment	Examining closely the analysis of vulnerability for DBT of site due to differences in design features (1, 3, 7)	**AC**
Incident Response and Contingency Planning	Revision of acceptance criteria to include alternative solutions for on-site incident response security team (2)	**R**
	Examining closely scope of emergency planning of site such as contact and reporting process during review due to unnecessary evacuation in accidents (2)	**AC**
Etc.	Re-establishment of review period due to shortened construction period (5)	**R**
	Find a way to relax the regulations to SMR due to the simplified design (4)	**R, AC**
	Considering cyber security guidance for renewable energy utilization and deciding the scope of review (8)	**E**

*** Guidance Improvement Method: Establishment (E) / Revision (R) / Additional Consideration during review (AC)**

Conclusions

- Recognizing the differences in SMR designs compared to conventional reactors, an analysis was conducted to assess the applicability of existing review criteria and identify potential gaps in the review process for SMR. Based on these findings, proposed improvements to the current regulatory guidance for review in SMR were formulated.
- Proposed improvements will serve as a foundation for establishing revised review standard in advance, facilitating the implementation of evaluating the CSP of SMR in the future.