A Study on Integrated Regulatory System through Review of US Experience

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1. Introduction

Safety and security have been considered importantly since the early days of the nuclear industry for the protection of the public health and environment. Ensuring the safety and the security has been the first priority and pursued in every aspect of designs, constructions, and operations of nuclear facilities by all stakeholders. In that, the regulatory authority has been playing a central role by setting the licensing criteria and regulatory requirements, inspecting the licensee performances and conducting the regulatory responses. It is important to note that the fundamental philosophy in commercial use of nuclear energy has not been changed, but the implementation goals and strategies have been changed according to regulatory situations and industrial needs. Therefore, the current regulatory framework and programs have been evolved by reflecting several decades of technological developments and operational experiences.

The Reactor Oversight Process (ROP) is the U.S. NRC's program to inspect, measure, and assess the safety and security performance of operating commercial nuclear power plants, and to respond to any decline in their performance and has been implemented since April 4, 2000 [1]. ROP adopts the risk-informed and performance-based approach to reduce the excessive regulatory burdens both of licensees and regulation staffs and has been revised to resolve the political and industrial issues. Several countries have been introduced the ROP framework and benchmarked it with their regulatory programs [2]. It can be found that NRC's regulatory programs are systematically linked with ROP framework; i.e., NRC's mission and vision are pursued in implementation goals /objectives/strategies as can be seen in Fig. 1 [3] and ROP has been the main tool to achieve them.

In this study, the nuclear regulation in U.S. has been briefly reviewed and the motivations of changes in regulatory programs have been identified. In particularly, the links between the major issues or events and the revisions of regulatory program have been addressed in view of reflections in ROP framework. Based on those insights, the suggestions on improving and adopting ROP framework in Korean regulatory program has been made.

Fig. 1. U.S.NRC's Strategic Structure [3]

2. Review of U.S. Nuclear Regulation Experience

2.1 U.S.NRC's Regulatory Philosophy

Safety and Security have been considered most importantly from the very beginning of the commercial nuclear energy utilization and the emphasis on them never have been compromised; however, the focusing area has been changed depending on technological maturity, economic purposes and political issues. Especially, the accidents on nuclear power plants have significantly impacted on the regulatory policies and practices reflecting public concerns and industrial consensus [4~6].

In the early stages (i.e., 1950~1960s), the safety priority was given on design features. The main safety functions and the concepts (e.g., maximum credible accident, defense in depth) had been established. Because there were not enough information and data for regulatory decision making, the regulatory agency (i.e., Atomic Energy Committee, AEC) took the leading role for Research and Development of nuclear safety system design and experiments. During 1960-1070s, the nuclear power industry had been growing and the nuclear power plant construction orders were increased rapidly. However, the industry had experienced difficulties due to inadequate workmanship, faulty materials and other construction problems. Therefore, regulations on the construction activities had been emphasized and quality assurance programs had been established. The accident at Three Miles Island in 1979 had a significant impact on nuclear society and a lot of lessons learned were investigated regarding usefulness of probabilistic safety assessment, importance of human

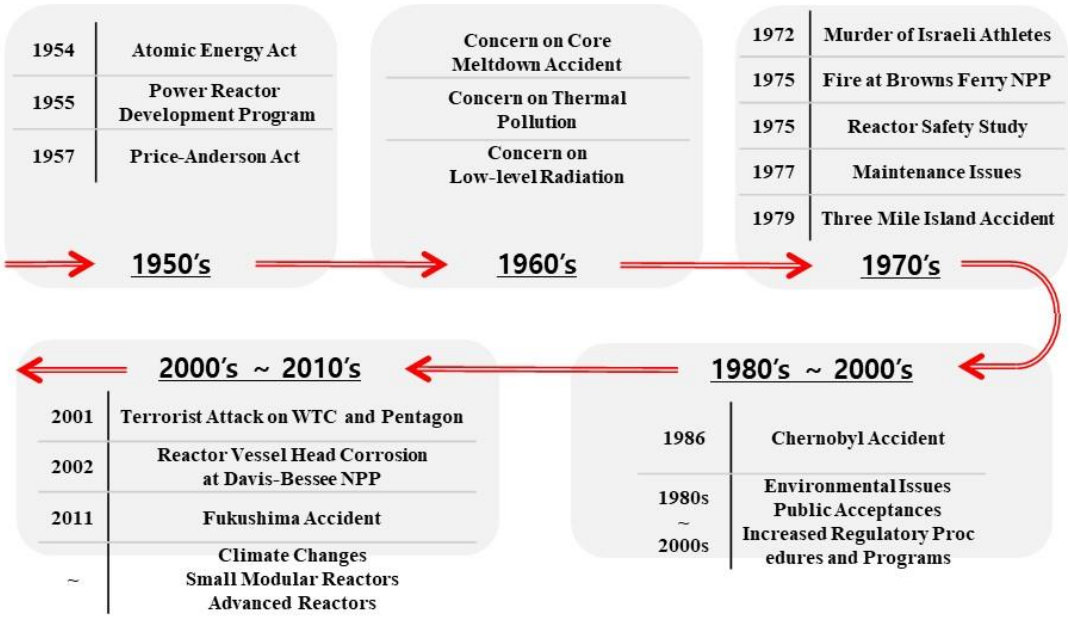

Fig. 2. Historical Events and Impacts on Nuclear Regulation

factors, adequate procedure and emergency plans, etc. Most importantly the operational aspect of nuclear safety has been emphasized since then. After that, the international efforts have been pursued for peaceful use of atomic energy and protection of public health and environment throughout the world. Throughout the nuclear history, the probabilistic approach for safety measurement has been emphasized and its application has been extended. Risk-informed performance-based regulations have been showing its value in effectively monitoring and controlling the licensee performance and efficiently managing the efforts and the resources of regulation staffs and licensees.

Especially for security, the international treaty, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) has been prepared to prevent the spread of nuclear weapons and weapon technologies and signed in 1969. With increasing concerns of terrorist attacks and strengthening the nuclear security, the physical protection has been emphasized to protect against theft, lose or unauthorized diversion of nuclear materials and against sabotage of nuclear facilities by individuals or groups. IAEA prepared the INFCIRC/225, Recommendations for the Physical Protection of Nuclear Material in 1972 and INFCIRC/274, the Convention on the Physical Protection of Nuclear Material has been established in 1979. After September 11, 2001, the security requirements for nuclear facilities have been enhanced and the security-related information has been no longer publicly available.

2.2 Reactor Oversight Process

The Reactor Oversight Process (ROP) is the U.S. NRC's program to inspect, measure, and assess the safety and security performance of operating commercial nuclear power plants, and to respond to any decline in their performance and has been implemented since April 4, 2000 [1]. There are three key strategic performance areas: Reactor Safety, Radiation Safety, and Safeguards. Each strategic performance area has cornerstones, which are affected by cross-cutting areas. As can be seen in **Fig. 3**, NRC develops findings from inspections, and licensees collect performance indicator data. NRC evaluates inspection findings for safety significance using a significance determination process (SDP) and compares performance indicators (PIs) against prescribed risk-informed thresholds. Then, the agency assesses the resulting information and determines an appropriate response using the guidelines in an action matrix. This oversight program provides a more predictable and objective approach to enforcement that is commensurate with the plant performance declination and violations.

As a consequence of the terrorist attacks on September 11, 2001, ROP was modified so that individuals could not obtain and use sensitive, security-related information about a nuclear facility's design, operation and protective capabilities for malevolent purposes [7,8]. In order to protect the security-related information from public disclosure, NRC developed and implemented a security assessment process separate from the safety cornerstones within the ROP framework on May, 2005. However, the staff recognized that the application of separate assessment processes had the potential to programmatically constrain its regulatory response and not holistically evaluate licensee performance. Therefore, the security cornerstone was reintegrated into one ROP action matrix that would include inputs from all seven ROP cornerstones on July 1, 2012 to more accurately reflect a holistic representation of licensee performance. Currently, the

security performances of the plants are available on the web, but the detailed information about the inspection findings are not publicly available.

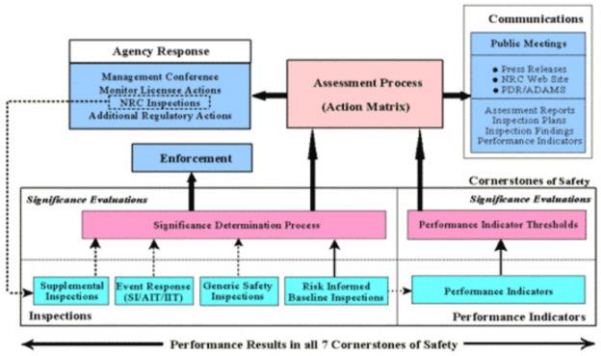

Fig. 3. Overview of Reactor Oversight Process [1]

2.3 U.S. Nuclear Regulation Experience

In US regulation, the goal, i.e., protection of public health and environment, has been pursued in all aspects of NRC's strategic structures and advanced concepts and means for efficient regulations have been reflected in ROP framework. The main features are summarized as follows:

○ Clarification of Mission and Vision

Nuclear regulation requires the authority to inspect the licensee, check if the licensee adheres to the laws and the regulation requirements and if not, order the responsive actions. Therefore, it should be a legislative and administrative management process and should establish the criteria and requirements for regulation supported by a technical basis. Those regulation requirements would be achieved only when those are based on the concrete philosophy on adequacy (adequate protection) with agreements of all stakeholders. It should be clarified that (1) ensuring the safety is primarily the licensee's responsibility, and (2) ensuring the safety for licensee should be satisfying regulatory requirements not assuring public safety unlimitedly. Therefore, the regulatory authority's mission and vision should be set for (1) establishing the regulatory requirements that guarantees the public protection from radiative hazard, and (2) conducting the oversight of licensee to maintain the assurance.

○ Clarification of Reactor Oversight Goals and Implementation Objectives

In order to achieve the regulatory goal, the oversight should be conducted to check if the regulatory requirements and licensing criteria on the nuclear facility would be satisfied and the safety performance level of licensee would be maintained as approved. The relationship should be clarified in the first place that dissatisfaction of regulatory/licensing requirements would result in safety declination and end up with accident or hazard. Therefore, the safety declination should be identified as early as possible and the level of safety declination should be continuously assessed based on inspection results qualitatively and quantitatively.

○ Clarification of Implementation Strategies

To enhance the efficiency and effectiveness of regulation efforts, the oversight and regulatory resources should be focused on the area of weakness with large contribution to safety firstly and, if any suspicious or insufficiency exists, supplementary inspections should be conducted. Therefore, the integrated and comprehensive licensee performance assessment would be essential so that the weak area could be identified definitely.

If there is no public and stakeholder's understanding and agreement, the regulatory oversight goals could not be achieved. Therefore, the inspection results and decision on regulatory action and response should be objective and consistent and the mutual communication among the stakeholders including public should be promoted.

The followings are the main features reflected in US regulatory framework to improve the regulation efficiency and the licensee safety performance and reflected in NRC ROP framework; 1) focusing the regulatory efforts on the weak point of the licensee and nuclear facilities, 2) conducting supplementary inspection for suspicious matters, 3) assigning and utilizing the regulatory resources primarily on the inspection findings with significances, 4) establishing the integrated and comprehensive safety and security oversight framework, 5) maintaining regulatory objectivity and consistency for obtaining public credibility, 6) establishing communication channel with public and stakeholders.

○ Performance Indicator System

Performance Indicator (PI) would provide the objective and quantitative information on licensee performance. The inspection by regulatory staffs should focus primarily on the areas which cannot be measured by PIs. PI monitoring data should be incorporated in assessing the overall plant performance and determining regulatory responses, i.e., oversight process.

○ Inspection System and Procedures

The inspection area and attributes should be determined in the perspective of risk and performance. The inspection findings should be assessed and the significance with respect to plant's overall performance should be evaluated. In order for that, the fundamental revision of inspection system would be required and related legislative basis and regulatory requirements should be revised or newly prepared. In addition, the training for regulatory staffs and licensee operators/field workers should be performed and conflicts in misunderstanding should be carefully resolved with sufficient time margin.

3. Discussion for Korean Nuclear Regulation System Improvement

3.1 Korean Nuclear Regulation System

Regulatory authority of Korean government is Nuclear Safety and Security Commission (NSSC). It established in 2011 having missions of protecting people and the environment and to contribute to the peace of mankind [9]. NSSC leads roles of rulemaking/enforcement on nuclear facilities and activities to ensure safety and developing/implementing nuclear regulatory policies. NSSC is delegating technical review and inspections on nuclear safety and nuclear security to KINS and KINAC, respectively. As a safety regulatory expert organization, Korea Institute of Nuclear Safety (KINS) established in 1990 and has been carrying out functions regarding nuclear safety review and inspection and developing technical standards and guidelines [10]. On the other hand, Korea Institute of Nuclear Nonproliferation and Control (KINAC) established in 2006 and, as a regulatory expert organization, has been executing safeguards, physical/cyber protection and export/import control regarding nuclear facilities and materials [11].

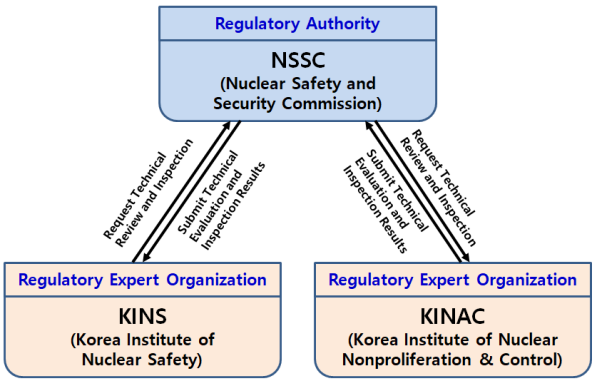

Fig. 4. Korean Nuclear Regulatory Framework [12]

3.2 Insights for Regulatory Improvements

Research and Development of Regulatory improvements have been supported by Nuclear Safety Law in Korea and the concepts and measures in US NRC's ROP has been studied extensively. Through the comparisons of reviews of US nuclear regulation history and regulatory structures including ROP framework to Korean nuclear regulation system, the high-level concepts and directive keywords to be considered in future policy making and regulatory improvements have been identified. In **Fig. 5 and Fig. 6**, the domestic licensee oversight framework and security oversight framework have been suggested.

○ Definitive Nuclear Regulation Oversight Goals
- Clear Definition of Regulatory Oversight Goals
- Efficient & Effective Regulatory Oversight Process
- Consistent Operation for achieving Goals
- Licensee Performance Assessment for identifying Performance Declination Objectively and Timely with Limited Regulatory Resources and Efforts

○ Consistent Regulatory Policy Formalization and Continuous Implementation
- Legislation of Overarching Regulatory Goals
- Setting the Regulatory Authority's Mission based on the Goals
- Systematical Managing and Monitoring for Ensuring Pursuance in all Policy Decision-Making and Regulatory Program Implementation

○ Transition to Inspection System Leading the Licensee's Safety Responsibilities Enhancement
- Regulatory Responses/Actions for implementing Graded Regulation commensurate with licensee performance on a specific nuclear facility to promote the public understanding and stakeholders' participation
- Resolve the specific Issues related to Licensee Type (US: private company in which the ensuring safety would permit the commercial operation, Korea: public corporation in which the decision-making would be directed by government policy)

○ Develop the Relationship between Regulatory Authority/Agency and Public/Stakeholders
- Objectivity, Consistency, and Timeliness of Regulatory Inspection Results and Decision Making
- Two-Way Communication to receive Feedbacks on Regulatory Activities from the Public and Stakeholders

○ Regulatory Response following the Overall Plant Performance Assessment on Safety and Security via Regulatory Inspection
- Comprehensive Evaluation of the results of Regulatory Oversight in the Safety and Security areas for the performance of nuclear facilities on the premise of establishing a regulatory action process

5. Conclusions

The U.S. nuclear regulation has been briefly reviewed focused on reflections of major issues/events on regulatory program and suggestions on improving and adopting ROP framework in Korean regulatory program has been made. Nuclear regulations in Korea have been maintaining the high efficiency and objectiveness and the regulatory framework has been revised and improved with short-term and long-term plans. However, as can be seen in the historical review of U.S., there would be changes in economic and politic

situations or negative events resulting in new demands for regulatory improvements. This study could be used as a high-level basis for identifying the improvement points and developing effective and efficient oversight program.

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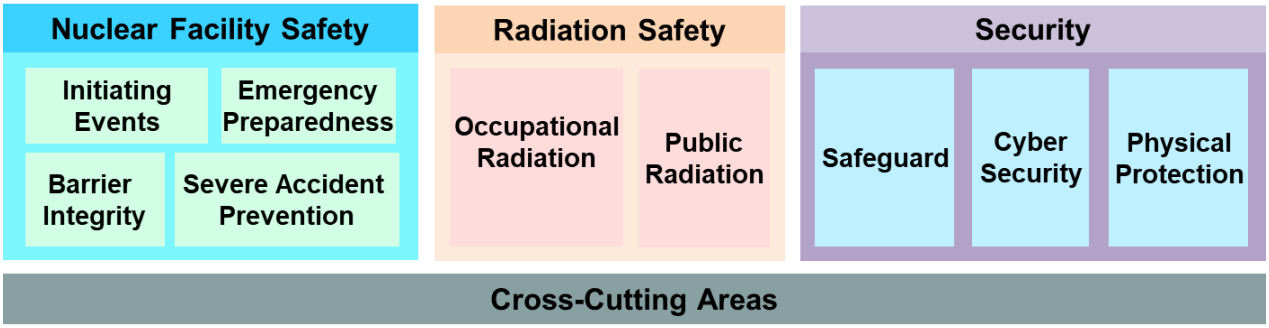

Fig. 5. Suggested Domestic Licensee Oversight Program Structure

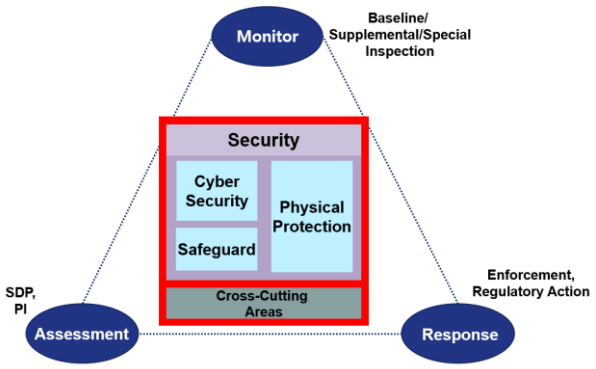

Fig. 6. Suggested Domestic Nuclear Facility Security Oversight Framework