

## Comparative Study on NPP Design Requirements between IAEA and Korea

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### 1. Introduction

The IAEA safety standards encompass international consensus to strengthen the nuclear safety and to reflect the latest advancement of safety regulation related technologies. Also, they provide a reliable means to ensure the effective fulfillment of obligations under the various international safety conventions. Many countries have adopted the IAEA safety standards as their national standards in nuclear regulations. And Korea has exported nuclear power plant technologies abroad these days.

The KINS (Korea Institute of Nuclear Safety) has performed a review of the IAEA safety requirements for the design of NPPs (Nuclear Power Plants) [1] comparing with those of Korea. The purposes of this comparative study are to harmonize the design safety requirements for the NPPs of Korea with those of the IAEA as a member state of the IAEA, and to encompass global efforts to enhance the nuclear safety and to reflect the latest advancement of safety regulation related technologies into the design safety requirements for the NPPs of Korea. Design requirements for structures, systems, and components of NPPs as well as for procedures and organizational processes important to safety, which are required to be met for assuring safe operation, for preventing events that could compromise safety, or for mitigating the consequences of such events, have been reviewed in this study.

### 2. Methods

The comparative review was performed to identify the gap of the safety requirements for the design of NPPs between the IAEA and Korea. Based on the review results, draft revision of domestic safety requirements were developed to fill the gap.

#### 2.1 Review Method between IAEA and domestic Safety Requirements for Design of NPPs

The IAEA's safety standards have three categories: Safety Fundamentals, Safety Requirements, and Safety Guides (see Fig. 1). Safety Fundamentals present safety objectives and principles of safety, and provide the basis for the safety requirements. Safety Requirements provide the requirements that must be met to ensure the safety. Safety Guides contain recommendations and guidance on how to comply with the safety requirements.

The IAEA safety standards series No. SSR-2/1, "Safety of Nuclear Power Plants: Design" [1] provide the requirements to be met in design of NPPs. It belongs to the category of Specific Safety Requirements in the hierarchy of the IAEA safety standards (see Fig. 1). The level of detail of the requirements of the IAEA No. SSR-2/1 is similar to that of technical standards, notices of NSSC (Nuclear Safety and Security Commission), and regulatory standards of Korea (see Fig. 1).

In this study, the design safety requirements of the IAEA were reviewed comparing with those of Korea aforementioned above in the aspects of the following:

- Completeness of regulatory topics addressed by safety requirements;
- Level of safety achieved by safety requirements; and
- Scope and depth of regulatory positions provided by safety requirements.



Fig. 1. Safety standards hierarchy of IAEA and Korea

The domestic regulatory documents used for the comparison are as follows:

- Regulations on technical standards for nuclear reactor facilities, etc;
- Regulations on technical standards for radiation safety control, etc;
- Notices of nuclear safety and security commission; and
- Regulatory standards for LWR nuclear power plants

### 3. Results

There are 82 items and 268 paragraphs in the safety requirements of the design of NPPs of the IAEA. All the requirements of the IAEA for the design of NPPs have been reviewed comparing with those of Korea and it was found that there exist gaps in 58 safety requirement items.

The gaps of safety requirements of design for NPPs between the IAEA and Korea found in this study were classified into 3 groups: requirements for strengthening safety, improving regulatory requirements, and improving completeness of regulatory documents. The safety requirements of the IAEA that show differences with those of Korea are explained in the below.

### *3.1 Strengthening of safety*

The safety requirements of the IAEA that shows differences in the level of safety through the gap analysis are as follows:

- Enhancing the plant's capabilities to withstand design extension conditions without unacceptable radiological consequences, and eliminating practically design extension conditions that could lead to significant radioactive releases;
- Ensuring that radiation doses to workers at the plant and to members of the public remain as low as reasonably achievable in and following accident conditions;
- Providing protection and security measures against unauthorized access to important facilities for safety, accidental disruption, and electronic invasion, including establishment of cyber security measures;
- Strengthening defence in depth by assuring that defence in depth has been implemented in the design of the plant, that no particular features or postulated initiating event (PIE) makes a disproportionately large or significantly uncertain contribution to the overall risks, and that the levels of defence in depth are independent to the extent practicable;
- Considering certain events, that might be consequences of other events such as a flood following an earthquake, to be part of the original PIE;
- Incorporating features to facilitate the future decommissioning and dismantling of a nuclear power plant at the design stage.
- Taking due account of relevant experience that has been gained in the design, construction, and operation of other nuclear power plants and of the results of relevant research program; and
- Providing measures to control any buildup of solid substances that might be released inside the containment, which could affect the operation of systems important to safety.

### *3.2 Improvement of regulatory requirements*

The following requirements were derived to improve regulatory requirements of Korea:

- Including limits on the permissible leakage of fission products from the fuel in anticipated operational occurrences into the fuel design limits;
- Encompassing the non-safety class system important to safety in the scope of computer based equipment for which quality and reliability shall be assured;

- Taking due account of the potential for specific hazards making simultaneous impacts on several units on multiple unit plant sites;
- Establishing ageing management program for monitoring, testing, sampling, and inspection to assess ageing of the plant in service; and
- Permitting share of systems between multiple units of a nuclear power plant only if this contributes to enhancing safety.

### *3.3 Improvement of completeness of technical standards of Korea*

Some safety requirements of the IAEA were identified to improve the completeness of the current technical standards of Korea by stipulating the regulatory practices of Korea and by reflecting the safety requirements of the IAEA. Such safety requirements identified in this study are as follows:

- Taking account of design extension conditions in design of nuclear power plants;
- Assessing design safety using probabilistic methods;
- Applying the concept of defence in depth in design and maintaining all levels of defence in depth to be available;
- Imposing the responsibility to satisfy all safety requirements for design of NPPs and to establish safety culture on an applicant for a license to construct and/or operate them;
- Preventing adverse effects of the interaction between systems; and
- Etc.

Also, in order to improve the completeness of the technical standards of Korea, the following safety requirement items were identified, which should be added in "Regulations on Technical Standards for Nuclear Reactor Facilities, Etc." [2]: postulated initiating events, support system and auxiliary system for the reactor, steam and power conversion systems, NPPs for heat utilization and desalination, use of proven technologies in design, and etc.

## **4. Conclusions**

This study was useful to identify the gap between the safety requirements for design of NPPs of the IAEA and Korea. The review results will be utilized to reflect the IAEA's safety requirements into those of Korea, which will contribute to enhancing the level of nuclear safety and improving the technical standards of Korea.

## **REFERENCES**

- [1] "Safety of Nuclear Power Plants: Design", Specific Safety Requirements, IAEA Safety Standards, No. SSR-2/1, IAEA, 2012.
- [2] "Regulation on Technical Standards for Nuclear Reactor Facilities, Etc.", Nuclear Safety and Security Commission, 2011.