Comparative Study on Research Reactor Design Requirements between IAEA and Korea

Won Joon Chang*, Young Gill Yune, Myung Ho Song, Seung-Ho Cho

Korea Institute of Nuclear Safety, 62 Gwahak-Ro, Yuseong-Gu, Daejeon, Korea, 305-338 *Corresponding author: Rawing@kins.re.kr

1. Introduction

The IAEA safety standards encompass international consensus to strengthen the nuclear safety and to reflect the latest advancement of nuclear safety technologies. Also, they provide 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. Since Korea has exported research reactor technologies abroad these days and will continue to export them in the future, it is desirable to harmonize domestic safety requirements for research reactor with those of the IAEA. [1]

The KINS (Korea Institute of Nuclear Safety) has performed a review of the IAEA safety requirements for design of research reactors [3] comparing with those of Korea. The purpose of this comparative study is to harmonize the safety requirements for the design of research reactors 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 nuclear safety technologies into the safety requirements for the design of research reactors of Korea. Design requirements for structures, systems, and components of research reactors 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. Review Methods

The review was performed to identify the gaps in the safety requirements for the design of research reactors of Korea comparing with those of the IAEA. These review results will be utilized to develop a draft revision of domestic safety requirements to fill the gap.

The IAEA safety standards have three tiers: Safety Fundamentals, Safety Requirements, and Safety Guides (see Fig. 1). Safety Fundamentals present safety objectives and principles, 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 No. NS-R-4, "Safety of Research Reactors" [3] provides the requirements to be met in design of research reactors. 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. NS-R-4 is similar to that of technical standards, notices of NSSC (Nuclear Safety and Security Commission), and regulatory standards of Korea.

Since safety requirements for the design of nuclear power plants are applied to research reactors in Korea, the following domestic regulatory documents were used for the comparison with those for the design of research reactors of the IAEA:

- 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.

The safety requirements for design of nuclear power plants of Korea aforementioned above were reviewed comparing with those for design of research reactors of the IAEA in the following aspects:

- 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. Hierarchy of safety standards of IAEA and Korea

3. Results

The safety requirements for the design of research reactors of the IAEA consist of 32 items and 171 paragraphs in. All the requirements of the IAEA have been reviewed comparing with those of Korea. It is found out that the safety requirements of Korea show gaps in 58 requirements.

The safety requirements of the IAEA for which those of Korea show gaps were as follows:

- Application of probabilistic methods in classifying the safety importance of the SSCs
- Adoption of the automatic reactor shutdown system actuated by an earthquake
- Conduction of explosion hazard analysis
- Keeping of minimum necessary amounts of flammable and combustible materials, and providing of adequate facilities to keep reacting substances segregated
- Specification of maximum authorized unavailability limits for operation
- Consideration of design features to facilitate the commissioning process for research reactor
- Consideration of design to facilitate the ultimate decommissioning
- Consideration of design for radiation exposure of personnel and public during decommissioning to be as low as reasonably achievable
- Taking special precautions to know the configuration of the reactor in relation to the utilization and modification of research reactors
- Conduction of a safety analysis for experimental devices including an analysis of the damage to the experimental devices by postulated initiating events of research reactors
- Provision of measures to monitor the parameters for experiments in the reactor control room, where necessary
- Establishment of LCOs(operational limits and conditions) and limit conditions for safe operation of experimental devices
- Preparation of preliminary decommissioning plan for experimental devices
- Establishment of provisions to meet the needs arising in long shutdown periods of research reactors
- Consideration of the safety relating to experimental devices and their effects on the safety of research reactors in design of experimental devices
- Consideration of the requirements relating to the long term management of irradiated elements in the design of the fuel elements
- Provision of a second independent shutdown system
- Provision of the diverse means of ensuring fulfillment of the protection functions when the integrity of computer based system cannot be demonstrated with a high level of confidence
- Verification of the functioning of natural circulation cooling system in the application of the single failure criterion
- To provide physical protection against theft and sabotage

 Table 1. Safety requirements of the IAEA showing differences from that of Korea

Document	Relevant Requirements
NS-R-4 Design Part	6.12, 6.13, 6.14, 6.18, 6.21, 6.22, 6.24, 6.26, 6.27, 6.28, 6.35, 6.36, 6.37, 6.38, 6.40, 6.43, 6.44, 6.45, 6.47, 6.48, 6.49, 6.50, 6.51, 6.52, 6.53, 6.63, 6.65, 6.66, 6.67, 6.68, 6.70, 6.71, 6.76, 6.80, 6.81, 6.82, 6.85, 6.90, 6.99, 6.105, 6.107, 6.108, 6.109, 6.111, 6.125, 6.129, 6.131, 6.132, 6.134, 6.135, 6.140, 6.141, 6.145, 6.150, 6.152, 6.153, 6.158, 6.169

4. Conclusions

This study has identified the gaps in the safety requirements for design of research reactors of Korea comparing with those of the IAEA. The review results showed that the gaps have arisen mainly from the following aspects:

- The differences in the characteristics of design and operation between power reactor and research reactor
- Enhancement of the level of safety of nuclear reactor facility
- Consideration of advanced safety technologies.

The review results will be utilized to reflect the IAEA safety requirements for design of research reactors into those of Korea, which will contribute to enhancing the level of safety and improving the technical standards of research reactors of Korea.

REFERENCES

[1] Won Joon Chang, et al, "Comparative Study on NPP Design Requirements between IAEA and Korea", 2012 Autumn KNS, 2012.

[2] Won Joon Chang, et al, "Comparative Study on NPP Commissioning and Operation Requirements between IAEA and Korea", 2012 Fall KNS, 2012.

[3] "Safety of Research Reactors", Specific Safety Requirements, IAEA Safety Standards, No. NS-R-4, IAEA, 2005.

[4] "Regulation on Technical Standards for Nuclear Reactor Facilities, Etc.", Nuclear Safety and Security Commission, 2011.