Role of Regulatory Research for Gen-IV Reactor Development in Korea

Namduk SUH*, Moohoon BAE, Changwook HUH, Andong SHIN
Korea Institute of Nuclear Safety, 62 Gwahak-ro, Yuseong-gu, Daejon, 305-338, Republic of Korea
**Corresponding author: k220snd@kins.re.kr*

1. Introduction

In 2008, the Korea Atomic Energy Commission approved "Long-term R&D Plan for Future Reactor Systems", according to which an application for the design approval of an SFR/VHTR demonstration reactors were planned by 2017. Demonstration reactors are necessary in order to demonstrate the performance and safety through its operation before the construction of commercial power plant. A project to develop the Gen-IV reactors by KAERI have launched in 2010 to implement the long-term R&D. Also KINS started R&D project in parallel to prepare the licensing of the demonstration reactors in three phases. The Phase 1 period of KINS research lasted from 2010 to 2011 and the Phase 2 period which will last from 2012 to 2014 has just started. This paper summarizes the research results of Phase 1 and proposes the research strategy of Phase 2 to support the licensing of Gen-IV demonstration reactors.

2. Phase 1 Regulatory Research

During the Phase 1 period, research was focused on 3 areas.

1) Establishment of licensing procedures for demonstration/multi-purpose reactor
2) Development of design requirements
3) Identification and resolution of licensing issues

The main outputs of the research for each area are summarized in the following. Areas which need further efforts to complete the research are also pointed out.

2.1 Establishment of licensing procedures for demonstration/multi-purpose reactor

The current atomic energy law of Korea stipulates procedures and requirements only for commercial reactors. So there was no room for the designer of the demonstration reactors to apply the licensing review. A draft version of atomic energy law was developed to enable the licensing application of demonstration reactors. It opens the legal possibility for application, but we still need to develop the detailed documents and requisites for application. Also we need a consensus between different parties for the proposed procedures.

2.2 Development of design requirements

Draft version of general and specific design requirements for SFR and VHTR are developed. Applicability of the current LWR general requirements was evaluated [1] and it was concluded that 6 requirements be newly developed, 13 current requirements be modified, 2 requirements are not applicable, and 18 requirements can be applied as it is. The draft versions are developed taking into account the specific features of SFR/VHTR. Design requirements of other countries like U.S., Japan, France and European Communities are reviewed and the items to be reflected to domestic requirements are identified for further development. The same research was performed for specific design requirements [2].

2.3 Identification and resolution of licensing issues

Differences of major design features between KALIMER being developed by KAERI and PWR have been analyzed. Safety issues to be taken account in the design were identified and their resolution directions were reviewed. System safety evaluation technologies like reactor core design, event classification/acceptance criteria, accident analysis, structural materials in high temperature condition, severe accident analysis, and thermal-hydraulic phenomena / verification tests were surveyed and reviewed. The confirmatory computer code for LBB analysis in high temperature condition was developed.

3. Strategy of Phase 2 Research

Phase 1 research being completed by 2011, Phase 2 has started this year. The title of new research project is "Regulatory Framework Research for Licensing of Future Reactors". The official RFP (request for proposal) requires KINS 1) to establish licensing framework for SFR, 2) to develop regulatory audit technology for system safety of SFR, 3) to develop regulatory audit code system for SFR and 4) to develop licensing technology for VHTR. These are the fundamental regulatory technologies we need for the licensing review of demonstration reactor. This is shown in the left box of Fig.1 below.

These regulatory technologies will be developed based on the research results of Phase 1. Besides developing these basic technologies, government wishes

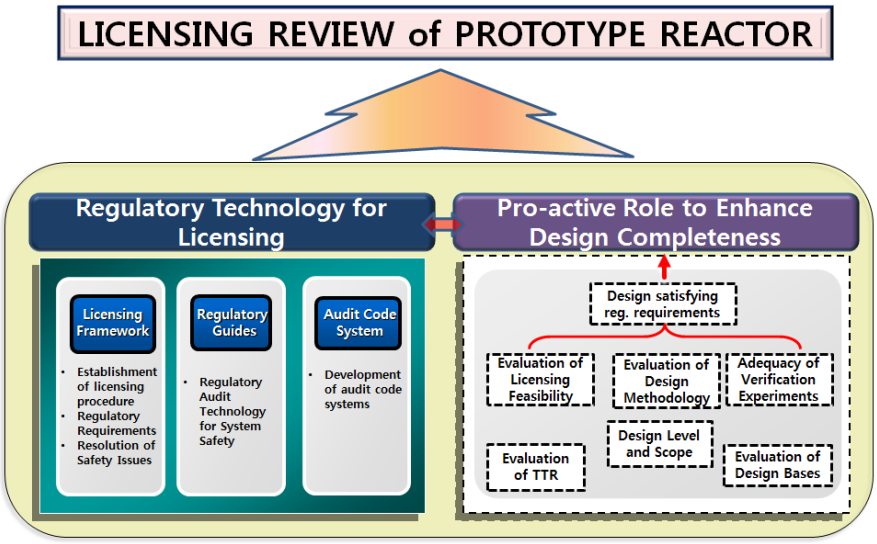

Fig. 1. Strategy of Phase 2 Regulatory Research

KINS to play a pro-active role of enhancing the design completeness of SFR/VHTR. This will be explained in the following sections.

3.1 Role of Regulatory Research

Development of new reactor needs large financial investment and there are high risks regarding the licensing feasibility. An efficient way of avoiding this risk is to have sufficient interactions between the designer and the regulatory body from early phase of design. By providing regulatory positions in advance before official licensing review starts, for example, about the expected safety issues or the regulatory requirements to be fulfilled, the designer can feedback these positions to their design in early phase. This is generally called a pre-application review and is a widely accepted way of improving design efficiency. We showed some pre-application activities needed in the right box of Fig.1.

3.2 Ranking of Research Importance

Among the pre-application efforts shown in Fig.1, we can rank the research importance like the following.

1) Defining the design level and scope for design certification is the first step we need to do. The only references available for design scope and level are the U.S. NRC documents [3,4]. This defines the design scope and level to apply design certification of commercial light water reactor. There are no documents worldwide defining the design scope and level for SFR/VHTR demonstration reactors. So this is going to be a big challenge for us all.
2) Top-tier requirements and design bases need to be evaluated to be feedbacked at right time to design. For this to be performed, the design should be mature to a certain level.
3) The third importance is to evaluate the licensing feasibility, adequacy of verification experimental plans and specific design methodologies.

When these pre-application efforts could be performed at right time, the design completeness for licensing review of demonstration reactors would be enhanced efficiently. But the difficulty is to assure the govenrment support and also to ensure experts to perform the research. The current resources are far beyond what are actually necessary.

4. Conclusions

Phase 2 regulatory research project to develop regulatory framework for Gen-IV reactor licensing has started in KINS. Pro-active role of KINS to enhance the completeness of the Gen-IV reactor design could contribute to the successful licensing and construction of the Gen-IV demonstration reactors. When necessary supports for financial resources and regulatory experts could be ensured, this ambitious project would attribute greatly to the safety and successful construction of Gen-IV demonstration reactors in Korea.

REFERENCES

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[4] SECY-90-377, Requirements for Design Certification under 10 CFR Part 52, U.S. NRC, 1990