Assessment of Licensing Feasibility for Gen-IV Reactors 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", targeting to get the construction permit of SFR/VHTR demonstration reactors (recently changed to prototype reactor for SFR) by 2023 or before. Demonstration reactors are necessary in order to demonstrate the performance and safety through its operation before the construction of commercial power plant. The schedule proposed by KAERI designer is shown in the following figure.

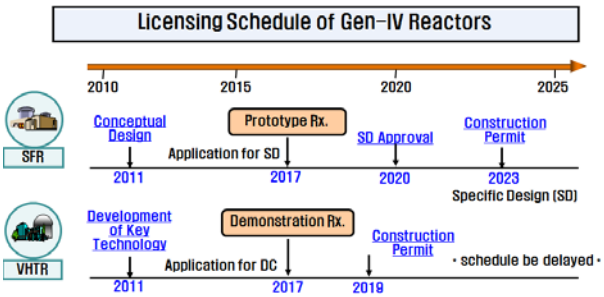

Fig. 1. Licensing Schedule of Gen-IV Reactors Proposed by KAERI

A project to develop the future 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. Even though the schedule is still flexible, since the objective of KINS research is to make the timely licensing review of demonstration reactor, it is right time to assess the feasibility of the licensing strategy proposed by KAERI. Section 2 introduces the concept of 4 design processes and we will evaluate the proposed strategy in section 3. Section 4 concludes proposing future efforts needed.

2. Four Design Phases

SECY-90-377 [1] compares the so-called one-step licensing process (COL, combined license) and the two step licensing process. We need to clearly understand the difference of each design phase to establish the design level and scope for the prototype reactors. The following sections will summarize the concept.

2.1 Conceptual Design Phase

The conceptual phase involves the development of basic design criteria, preliminary calculation, and functional requirements for structures, systems, and components. System-level design products at this stage include flow diagrams, general plant arrangements, principal single-line diagrams, and lists of major equipments.

2.2 Preliminary Design Phase

In the preliminary design phase, there is increased definition of the engineering analyses and design products. In this phase, the design groups from different disciplines typically compete for available space to locate components and to route piping, cable tray, and conduit systems. In parallel with the preliminary phase, the utility prepares and dockets a preliminary safety analysis report (PSAR) to support issuance of a construction permit.

2.3 Detailed Design Phase

In the detailed design phase, the utility's design agent and vendors continue to prepare drawings and specifications to construct the plant, procure material, and fabricate equipment. The engineering products include piping isometrics, and associated stress analyses, raceway layouts and cable routing, structural drawings, and instrument loop diagrams. The utility continues to develop the final safety analysis report (FSAR) in parallel with the site construction activities and vendor fabrication activities.

2.4 Final Design Phase

The final design reconciliations occur when the design agent assesses the vendor information and as-built information with respect to the engineering analyses.

3. Feasibility of Current Licensing Strategy

According to Fig.1, the SFR designer targets to submit the specific designs for licensing review at 2017, get the specific design approval by 2020, and then get the construction permit by 2020, 3 years later. The feasibility of this schedule is assessed in the following.

3.1 Design Scope and Level for Specific Design

Timely licensing review of prototype reactor necessitates establishing the design scope and level for specific design before the official process starts.

Unfortunately, there was no systematic approach to define the level and scope of prototype reactor. Supposing that the specific design approval should be at the same level with standard design approval, a previous study for SMART (System integrated Modular Advanced ReacTor) [2] showed that basically Level 3 is enough for the design certification under two-step licensing process, but the safety important systems are required to be designed to Level 2.

Level 2 and 3 are defined in SECY-90-247 [3]. Level 3 design will provide identical functional and performance characteristics of all systems, structures, and components, except for site-specific characteristics. Level 2 design should provide physically similar, and identical functional and performance characteristics of all structures, systems, and components affecting safety, except for site specific characteristics.

Thus the design level and scope for specific design approval should be at least at level 3, a conceptual design phase except for some safety important systems which need to be designed to Level 2. Our previous study [4] could be referred to define the level and scope in a concise and comprehensible format.

3.2 Assessment of Feasibility

The proposed schedule of Fig.1 is very tight and ambitious one, judged from experiences of the current LWR licensing review. If we do not approach in a systematic way, the target might not be achieved since the licensing of SFR is first-of-a-kind in Korea. Social consensus is also needed about what should be the safety goal of Gen-IV reactors. Licensing review of specific design will raise many safety issues which are hard to be revolved in the planned 3 year period which is available for PSAR preparation. The best way is to start interaction between the designer and regulatory body as soon as possible. Thus, pre-application activities should start as soon as possible under the auspice of government. The designer should provide the design documents of lower completeness even before the year 2017 to identify the safety issues. To do this, the first step the designer should do is to make the roadmap more detailed and feasible. Providing the top-tier requirement and design bases might be the next step to do.

4. Conclusion

The proposed licensing schedule of SFR prototype reactor was assessed. Licensing review of SFR prototype reactor should be a big challenge for regulatory body. More systematic and concerted approach and efforts are in need to make the target come to be realized. The first step is to establish the design scope and level to make more detailed and feasible schedule. Strong interaction between the designer and the regulatory body from the very early stage is in need.

REFERENCES

[1] SECY-90-377, Requirements for Design Certification under 10 CFR Part 52, U.S. NRC, 1990
[2] Namduk SUH, Design Scope and Level for Standard Design Certification of SMART under a Two Step Licensing Framework, Paper 11257, Proceedings of ICAPP 2011, 2011
[3] SECY-90-241, Level of Detail Required for Design Certification under Part 52, U.S. NRC, 1990
[4] Namduk SUH, Changwook HUH, Proactive Role of Regulation for SMART Design Certification, Tran. of KNS Spring Meeting, 2010.