Transactions of the Korean Nuclear Society Autumn Meeting
Changwon, Korea, October 20-21, 2022

Current Status of the SMART100 Standard Design Approval

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1. Introduction

KHNP and KAERI have been pursuing the standard design approval (SDA) for the System-integrated Modular Advanced ReacTor 100 (SMART100) since January 2019. The previous SMART model acquired the SDA from the Korean regulatory institute in 2012, however, the safety systems have been changed from partially to fully passive one, accordingly, the new SDA has been promoted. The SMART100 has been designed to meet the regulatory requirements [1, 2] as well as standard design requirements effective in June 2019, and KHNP, KAERI and K.A.CARE, as co-applicants, applied for SMART100 SDA at the end of 2019. The SDA is carried out in three steps: pre-application review, safety review by the Korea Institute of Nuclear Safety (KINS), and safety evaluation by the Nuclear Safety and Security Commission (NSSC).

In this paper, overall review status and issues of SMART100 SDA are described.

2. Design Features of the SMART100 for SDA

2.1 Major Design Description

The passive safety injection system (PSIS), passive containment pressure and radioactivity suppression system (CPRSS), automatic depressurization system (ADS), and passive residual heat removal system (PRSHS) are introduced in the SMART100 instead of the previous partially passive safety systems [3]. The safety-grade emergency diesel generator (EDG) and active containment spray system (CSS) have been removed accordingly. Table I summarizes the major design characteristics of the SMART100, and Fig. 1 shows the passive safety systems.

Table I: SMART100 Design Characteristics

Items	Description
Safety injection system	4 Passive Core Makeup Tank & Safety Injection Tank sets
Containment spray system	Containment Pressure and Radioactivity Suppression System
Depressurization system	1 Stage 2 Trains (2 Lines for each) ADS
Passive residual heat removal system	4 trains (72 hrs) 2 valve trains for each
Shutdown Cooling System	2 Active Function (Non-Safety)
Emergency Power Source	DC Batteries (4 Trains), Non-Safety DGs

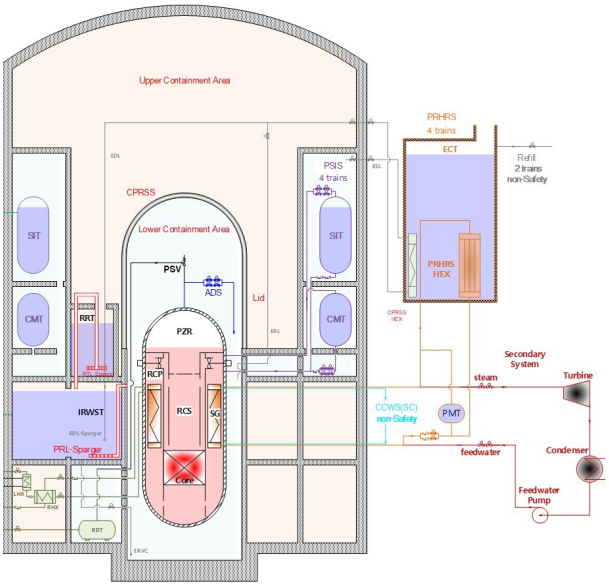

Fig.1. Passive safety systems of SMART100

2.2 Complementary Design

The complementary design was performed to meet the recent requirements according to the code cut-off date. It is largely divided into nuclear steam supply system (NSSS), auxiliary system, nuclear fuel, and main component design. For NSSS design, thermal-hydraulic behavior data evaluation in the design basis accidents of the reactor coolant system/PSIS, development of standard design specifications for fluid equipment, development of a comprehensive vibration assessment program (CVAP) methodology for a reduced NSSS model and flow/structural analysis, development of in-core instrument insertion/withdrawal analysis model, development of in-core instrument design concept and performance requirements, and source term evaluation after the loss of coolant accident were performed.

In the auxiliary system design, jet impingement and blast wave load evaluation were performed when high-energy piping is broken. In the nuclear fuel design, structural soundness evaluation of nuclear fuel assembly, fuel assembly characteristic test, fuel rod design evaluation, and cladding corrosion resistance performance test were performed. In the main component design, design of a reduced model facility for CVAP, confirming for completeness of control rod drive device design, evaluation of standard design licensing data of steam generator heat pipe and soundness, main component design and soundness, etc. were performed.

3. Status of the Request for Additional Information

3.1 Licensing Documents and Schedule

In the licensing documents, the main subjects of review are the standard design safety analysis report, standard design specifications, and preliminary accident management plan. KINS reviewed whether the licensing documents contain sufficient information to conduct a review, and the review results were officially provided to the applicant on February 28, 2020. As a result of the document conformity review, 263 supplementary information was provided, and the applicant submitted all responses on March 30, 2020. Table II shows the target schedule for SMART100 SDA.

Table II: Target Schedule for the SMART100 SDA

Tasks	Target Date
Report Conformity Results to NSSC	Jul. 2021
1st RAI	Sep. 2021
Final Meeting on Key Issues	Oct. 2022
Final Safety Evaluation Report	Dec. 2022
Safety Expert Council	Dec. 2022
Issues SMART100 SDA	Jun. 2023

3.2 RAI Status

So far, there are around 2,200 requests for additional information (RAI) regarding the SMART100 SDA from KINS, and KHNP responded to around 2,000 RAIs. Fig.2 shows the number of RAIs and their responses for SSAR chapters, SDS, and PAMP. From the figure, there are lots of RAIs in Chapter 3: structures/components/equipment, and system, Chapter 4: reactor, Chapter 6: engineered safety features, and preliminary accident management program (PAMP).

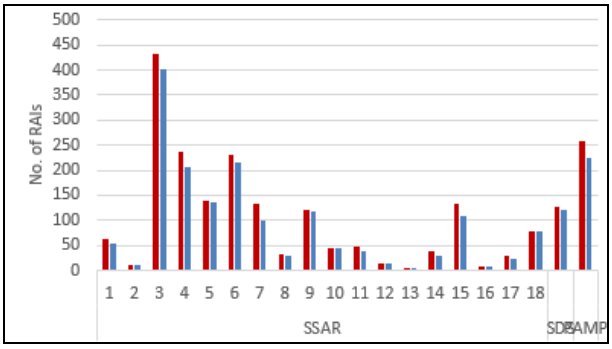

Fig.2. RAIs issued per chapter, SDS, and PAMP

3.3 Key Review Items

SMART100 is a small modular reactor (SMR) with fully passive safety systems. Accordingly, the first of a kind (FOAK) design is the main focus of the safety review. To resolve this issue, technical meetings have been frequently held and regular monthly meetings between regulators and applicants are held. The technical meetings were conducted more than 30 times in various fields such as instrumentation and control (I&C), in-service inspection (ISI), severe accident, regulatory treatment on the non-safety system (RTNSS), safe shutdown, ancillary containment spray system (ACSS), heating, ventilation and air conditioning (HVAP), probabilistic safety analysis (PSA), CPRSS, integrated leak rate test (ILRT), and electric system.

The final issues are CPRSS, whether RG 1.236 is applied to control rod departure accident analysis, compliance with the regulatory requirements of the ILRT method, whether the regulatory position of the safe shutdown is satisfied, and RTNSS.

4. Conclusions

KHNP, KAERI, and K.A.CARE are pursuing SMART100 SDA since 2019. SMART100 is an SMR with fully passive safety systems, thus, the FOAK design is the key review item. Table II shows the target schedule for the SMART100 SDA. The final SER will be issued in December 2022, and the Safety Expert Council to review the SER will be held in December 2022. The resolution plans for final issues have been provided to the KINS, and they are under addressed as scheduled. Licensing documents as reviewed and marked up in response to KINS's RAI will be incorporated into the next revision of the documents.

REFERENCES

[1] NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)," U.S. Nuclear Regulatory Commission, various dates and revisions.

[2] Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," U.S. Nuclear Regulatory Commission, 2007.

[3] S-000-PT403-001, Rev.1, General System Description of SMART, KAERI, 2017.