

## Development status of the Simulator for i- SMR

Kyungmin Kim \*, Chanho Sung, Jooyoul Lee

KHNP Central Research Institute, 70 1312-gill, Yuseung-daero, Yuseung-gu, Daejeon, Korea

\*Corresponding author: kyungmin@khnp.co.kr

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### 1. Introduction

Currently, KHNP is developing i-SMR(Innovative-SMR) with the aim of obtaining SDA(Standard design approval) in 2028. The ultimate goals of i-SMR is to enhance the safety, economy and flexibility compare to existing commercial nuclear power plants. One of the important operating concepts for the economic feasibility of I-SMR is the concept of operating multi-unit module with three operators. A simulator is essentially used to verify the suitability of multi-unit three-person operator.

The purpose of this paper is to describe the development plan for the I-SMR simulator development and the iMCR(Integrate Main Control Room) design concept of i-SMR..

### 2. Characteristics of i-SMR's Control Room

According to the i-SMR conceptual design and basic design report[1], i-SMR adopts the concept of operating multiple reactor modules in one iMCR, unlike existing large nuclear power plants. These small nuclear power plants require a different control room than before. Man-machine interface, human factors, work computer placement, and alarm management are very important considerations in the control room design of many reactor modules. In particular, we consider different man-machine interface from the existing ones, such as integrated control of multiple reactor modules, new information systems and new operating procedures.

In the i-SMR, a three-person operator operates four reactor modules in one integrated main control room. The multiple reactor module operation is expected to have a higher workload than the existing single reactor operation. To compensate for this, it is designed to reduce the dependence on the operator by minimizing the intervention of the operator when designing the ergonomic design of the i-SMR integrated main control room. Two Reactor Operators (RO) and one Control Room Supervisor (CRS) reside in the integrated main control room, and a dedicated operator console is provided to each operator. The operator can perform condition monitoring and control for i-SMR operation through the operator console. The integrated main control room schematic diagram of i-SMR is as follows.

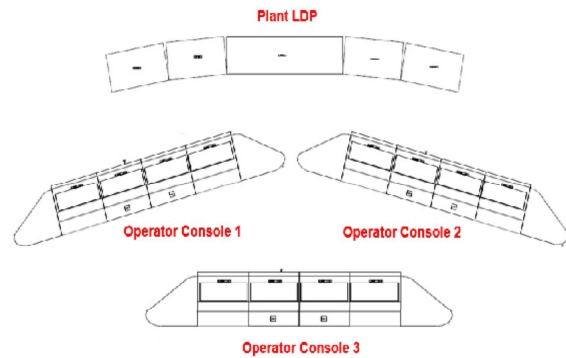


Figure. 1. I-SMR Simulator configuration concept

### 3. i-SMR Simulator

#### 3.1 Configuration of the Simulator

The i-SMR simulator is currently under construction at CRI with the goal of completion in May 2024. The simulator computing facility consists of four servers to operate four reactor modules and a client PCs for operator console, safety console, and instruction.

The LDP is located in front of the operator console, providing information so that all operators can quickly grasp the overall status of the i-SMR.

The simulator LDP configuration is as follows.

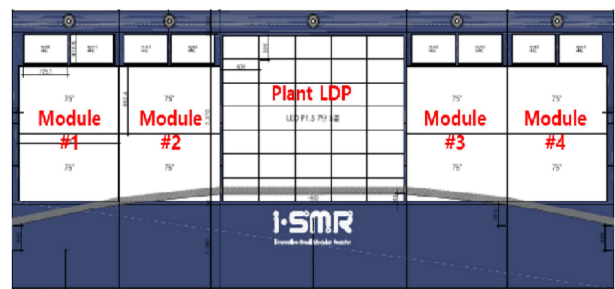


Figure. 2. I-SMR Simulator LDP configuration

#### 3.2 SPV of i-SMR using the Simulator

The main top-tier requirements(TTR)[2] in the HFE(Human Factors Engineering) field of i-SMR are (1) Monitoring and control of multiple units in one MCR and (2) Three-person operating in one MCR. And in order to acquire i-SMR SDA, the above design concepts must be verified through a simulator.

The SPV(staffing Plan Verification and Validation) will be carried out in two stages. In the first stage, the

development of simulator based on the basic design of I-SMR will be completed by 2025, and the suitability of the three-person operation will be verified through this facility. The first stage of SPV will be carried out as a scenario-based test. The scope of SPV will be verification of operation support based on scenarios(including normal, abnormal, and emergency operation) for verification of compliance with the three-person operation. In the second stage, HFE V&V will be performed in a full-scope simulator to which the standard design is applied. The scope of SPV will be based on the performance of the operation scenario(achievement of goals within a set time, verification of suitability for three-person operation, etc.) based on the MCR standard design.

#### **4. Conclusions**

The i-SMR has completed the basic design and the standard design is in progress. iMCR design verification and HFE verification/validation are essential for SDA. SPV will be performed using this simulator. However, this simulator is not at the level of the existing commercial nuclear power plant because the i-SMR design is in progress, and it will be updated as the design proceeds.

#### **REFERENCES**

- [1] Technology Development for Innovative Small Modular Reactor (I), 2024
- [2] i-SMR Top Tier Requirements Research Report, 2023