# Regulatory gap analysis for i-SMR

Yoon Seok Jong

Korea Hydro and Nuclear Power company

Daejeon, Republic of Korea

Email: seokjong.yoon@khnp.co.kr

**Abstract**

Korea government and nuclear industry now have been developing the new SMR called innovative SMR(i-

SMR) by leading from the Korea government and KHNP(Korea Hydro and Nuclear Power company). KHNP

sets the top tier requirements to secure the high level of safety, economic efficiency and flexibility. The i-SMR

adopts the new plant design including integrated modular reactor, fully passive engineered safety features,

and boron-free system. Due to the characteristics of i-SMR design, it will be anticipated that there are difficulties

to apply the existing light water reactor regulatory requirements and guidance to achieve standard

design approval by Korea nuclear regulatory body.

In this paper, the results of the KHNP gap analysis assessment are summarized. First, the analysis involved

a detail review of nuclear safety laws(including technical standards) of the Korea regulatory body are performed.

Afterward, the KHNP derives the “16 gaps” inappropriate with the existing LWR-based regulations

and technical guidelines. These gaps are including system improvement and safety standards(aspect of safety

analysis, non-safety class electrical system, passive safety system etc.). The KHNP had published the gap analysis

report to prepare for pre-design review for standard design approval. The KHNP will continuously try to

establish new regulatory standards and guidelines suitable for i-SMR.

## INTRODUCTION

To achieve the carbon-neutralization and enhance the safety level of Large NPP(Nuclear Power Plant), SMR is considered as an advanced brand-new type of NPP. Recently, more than 70 types of SMRs are being under developed in worldwide. It is anticipated that SMR will be commercialized around 2030s’. In Korea, Korea government and nuclear industry now have been developing the new SMR called innovative SMR(i-SMR) by leading from the Korea government and KHNP(Korea Hydro and Nuclear Power company).

The KHNP sets the top tier requirements to secure the high level of safety, economic efficiency and flexibility. The i-SMR adopts the new plant design including integrated modular reactor, fully passive engineered safety features, and boron-free system etc. Due to the characteristics of i-SMR design, it will be anticipated that there are difficulties to apply the existing large light water reactor regulatory requirements and guidance to achieve standard design approval by Korea nuclear regulatory body. In particular, it is expected that the issues of boric acid-free operation with improved reactivity control and inherent safety, fully passive engineered safety features without using safety-graded electricity, multi-module integrated control room, reduction of EPZ(Emergency Planning Zone) that do not require evacuation of residents in the event of an accident will be the representative items of regulatory aspects.

In this paper, the results of the KHNP gap analysis assessment are summarized. First, the analysis involved a detail review of nuclear safety laws(including technical standards) of the Korea regulatory body are performed. Afterward, the KHNP derives the “16 gaps” inappropriate with the existing LWR-based regulations and technical guidelines. These gaps are including system improvement and safety standards(aspect of safety analysis, non-safety class electrical system, passive safety system etc.).

## Review compliance with current safety standards and identify gaps

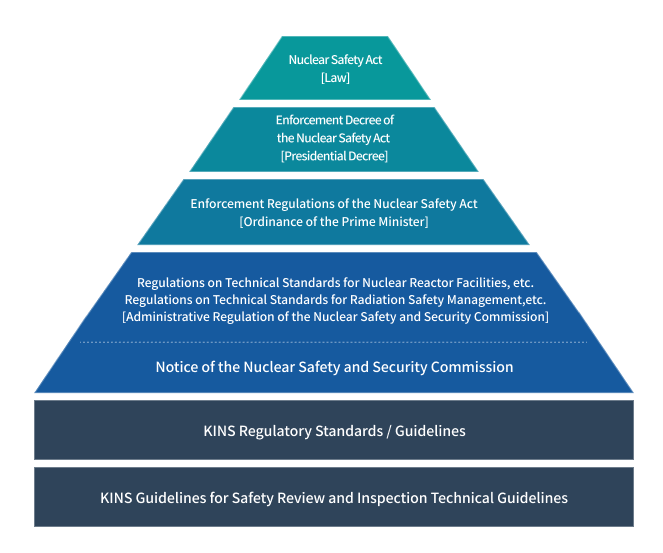
Licensing of nuclear reactor facilities in Korea is carried out in accordance with the nuclear safety act(Law), and the main contents described in the NSSC(Nuclear Safety and Security Commission) regulations “regulations on technical standards for nuclear reactor facilities”. But, most of the domestic regulatory standards are focused on large nuclear power plants, so it is highly likely that many innovative design characteristics in i-SMR are difficult to meet the currently regulatory standards. So, it is important that reviewing compliance with current safety standards and characteristics of i-SMR to identify the gaps.

The safety regulation infrastructure systems in Korea are shown as Fig.1 [1]. Analysis and comparison with safety standards are conducted based on “Plant Design Description Report of i-SMR” [2] and basic design development of i-SMR. The laws and regulations reviewed to analyze the gap with safety standards are as follows.

* Nuclear Safety Act [Law] [3]
* Enforcement Decree of the Nuclear Safety Act [Presidential Decree] [4]
* Enforcement Regulations of the Nuclear Safety Act [Ordinance of the Prime Minister] [5]
* Regulations on Technical Standards for Nuclear Reactor Facilities, etc. [6]
* Regulations on Technical Standards for Radiation Safety Management, etc. [7]

[Administrative Regulation of the Nuclear Safety and Security Commission]

* Notice of the Nuclear Safety and Security Commission [8]
* Nuclear Facilities Protection and Radioactive Disaster Prevention Act [Law] [9]
* Enforcement Decree of the Nuclear Facilities Protection and Radioactive Disaster Prevention Act [Presidential Decree] [10]
* Enforcement Regulations of the Nuclear Facilities Protection and Radioactive Disaster Prevention Act [Ordinance of the Prime Minister] [11]



*FIG. 1. Safety regulation infrastructure system in Korea [1]*

Following the analysis and comparison with safety standards, thirty-six gaps are derived. The gaps are mainly about the number of operators in MCR(Main Control Room), defining the EPZ(Emergency Planning Zone) in site boundary, multiple modules in a single reactor building, unnecessary detecting variable measurement instrument due to the characteristics of i-SMR(For detail leak detection), unnecessary for flammable gas control measures due to the design of excluding severe accidents, power supply system gap due to safety system without safety-class DC power, design characteristics excluding diversity protection system, reactivity control system considering the design concept of boron free, residual heat removal system by adopting fully passive engineered safety features regarding PAFS(Passive Auxiliary Feedwater System), PCCS(Passive Containment Cooling System) and PECCS(Passive Emergency Core Cooling System), source of ultimate heat sink, plan of radiation dose evaluation, ILRT(Integrated Leakage Rate Test) for leak-tight steel containment vessel etc.

## Gap analysis by safety standards in Korea

In this chapter, the results of the gap analysis assessment are summarized. These results are the optimum value in current status of developing i-SMR. So, it could be modified during the specific design period in i-SMR.

### 3.1 Nuclear Safety Act and Nuclear Facilities Protection and Radioactive Disaster Prevention Act [Law]

#### 3.1.1 Nuclear Safety Act (Safety standards regarding operation)

Significant reduction in operators is one of the design goals of i-SMR. The i-SMR is in the process of designing four nuclear reactor modules that can be operated by three operators in an integrated MCR. Following the Nuclear Safety Act article 26 (Safety Measures for Operation, etc.) as shown in Table 1, it is required that each nuclear reactor module requires at least one person of SRO(Senior Reactor Operator) license and one person of RO(Reactor Operator) license. If the four nuclear reactor modules are divided into individual reactors, it will be required more than eight license people for operating one i-SMR power plant.

#### 3.1.2 Nuclear Facilities Protection and Radioactive Disaster Prevention Act (Defining EPZ)

Following the Nuclear Facilities Protection and Radioactive Disaster Prevention Act article 20, it is defined that the precautionary action zone and urgent protective action planning zone are within a maximum radius of 30 km. In i-SMR, the design concept of EPZ would be set within the site boundary. So, it can be the gap comparing to the safety standard.

TABLE 1. Nuclear Safety and Nuclear Facilities Protection and Radioactive Disaster Prevention Act[3], [9]

|  |  |  |
| --- | --- | --- |
| Law | Article number | Contents |
| Nuclear Safety Act | 26 (3) | The operator of the nuclear power rector shall let, not less than one license holder of the supervisor of the nuclear reactor operation and also not less than one license holder of the operator of nuclear reactor under the provisions of Article 84, be present at the controls at all times during the operation of each nuclear reactor |
| Nuclear Facilities Protection and Radioactive Disaster Prevention Act | 20-2 (1) | The commission shall publish areas that will provide a base for the designation of radiation emergency plan zones by type of nuclear energy facilities (“base areas”). In case nuclear energy facilities fall under power generation nuclear reactors or related facilities, they shall comply with the following standards:   1. Precautionary action zones : Zones within a radius of 3~5 km from the area where a power generation nuclear reactor or the related facilities are installed 2. Urgent protective action planning zone : Zones within a radius of 20~30 km from the area where a power generation nuclear reactor or the related facilities are installed |

### 3.2 Regulations on Technical Standards for Nuclear Reactor Facilities

In this chapter, the results of the gap analysis assessment are categorized and summarized.

#### 3.2.1 Regulations on Technical Standards for Nuclear Reactor Facilities (Limitations on Location)

Following the Regulations on Technical Standards for Nuclear Reactor Facilities article 5 (as shown in Table 2), it is required that nuclear reactor facilities could be located away from the populated areas. The i-SMR will design to enhanced safety system, multipurpose utilization including hydrogen production, process heat, district heat and desalination. So, the i-SMR is being designed to be located near demand areas including the populated areas. It can be the gap comparing to the regulations.

TABLE 2. Regulations on Technical Standards for Nuclear Reactor Facilities [6]

|  |  |  |
| --- | --- | --- |
| Law | Article number | Contents |
| Regulations on Technical Standards for Nuclear Reactor Facilities | 5 (1) | Reactor facilities shall be located away from very densely populated areas |
| 5 (2) | Reactor facilities shall be installed at a place where the total radiation  dose to public in the event of an accidental release of radioactive materials does not exceed the acceptable value determined and publicly notified by the Nuclear Safety and Security Commission. |

#### 3.2.2 Regulations on Technical Standards for Nuclear Reactor Facilities (Construction of Multiple Units)

In the Regulations on Technical Standards for Nuclear Reactor Facilities article 10 (as shown in Table 3), when two or more nuclear reactor facilities are installed on the same site, it is required that each nuclear reactor facility should be installed in a place where it does not affect each other, and the boundary of the restricted area shall be considered for each nuclear facility. Following the i-SMR design concept, four reactor modules are adjacent to each other. When the definition of a nuclear reactor facility is interpreted as a single nuclear reactor module, it can be the gap comparing to the regulations.

TABLE 3. Regulations on Technical Standards for Nuclear Reactor Facilities [6]

|  |  |  |
| --- | --- | --- |
| Law | Article number | Contents |
| Regulations on Technical Standards for Nuclear Reactor Facilities | 10 (1) | If more than one reactor units and their related facilities are constructed on a site, the multiple reactor facilities shall be installed on such a site where site-related factors of any one unit do not affect the safety of the other units. |

#### 3.2.3 Regulations on Technical Standards for Nuclear Reactor Facilities (Sharing of Structures, Systems, and Components)

Following the Regulations on Technical Standards for Nuclear Reactor Facilities article 16 (as shown in Table 4), sharing of safe-related structures, systems and components is prohibited. Following the i-SMR design concept, four reactor modules are operated by three operators in integrated MCR. Accordingly, the gaps in safety standards are expected in i-SMR which are being designed to share equipment. But following the article 16 (2), it could be discussed that a plan to share equipment can be reviewed through two provisos.

TABLE 4. Regulations on Technical Standards for Nuclear Reactor Facilities [6]

|  |  |  |
| --- | --- | --- |
| Law | Article number | Contents |
| Regulations on Technical Standards for Nuclear Reactor Facilities | 16 (1) | Structures, systems, and components important to safety shall not be shared among more than two nuclear facilities. |
| 16 (2) | Notwithstanding the foregoing Paragraph (1), structures, systems, and components important to safety may be shared in cases where such facilities meet all the following requirements:   1. For each nuclear facilities, all the safety requirements for the relevant shared facilities are satisfied; and 2. In the accident conditions of one of the units sharing the structures, systems, and components, an orderly shutdown, cooldown, and residual heat removal of the other units shall be achievable. |

#### 3.2.4 Regulations on Technical Standards for Nuclear Reactor Facilities (Instrumentation and Control System)

Instrumentation and control system of i-SMR is composed of protection system, monitoring system, control system and measurement system. The measurement system is designed to measure various physical variables of the process system, such as the primary coolant system and fluid system, and to convert the measured physical variable values into electrical signals and provide them. But, considering the i-SMR design concept such as helical coil steam generator, integrated reactor and boron-free, some measurement variables cannot be measured or are expected to be unnecessary. As a representative example, since no soluble boron is used in normal operations, anticipated operational occurrences, design basis accident, and severe accident conditions, there is no need to install a boric acid concentration measuring device. Also, since the inside of the containment vessel is maintained in a vacuum state, it can be considered that there is no hydrogen accumulation, so measuring hydrogen concentration is judged to be unnecessary. But following the article 20 (1) as shown in Table 5, it is required that twelve physical variables are need to be measured. So, it can be the gap comparing to the regulations.

TABLE 5. Regulations on Technical Standards for Nuclear Reactor Facilities [6]

|  |  |  |
| --- | --- | --- |
| Law | Article number | Contents |
| Regulations on Technical Standards for Nuclear Reactor Facilities | 20 (1) | In order to obtain adequate information required for the reliable and safe operation of the plant, instrumentation shall be provided to monitor related variables, including the following, and systems over their anticipated ranges of normal operations, anticipated operational occurrences, and accident conditions. Provided, that it should be difficult to measure some variable directly, the apparatus that measure them indirectly may be used as a substitute:   1. Neutron flux density of a reactor core; 2. Location of the control rod and density of liquid control materials, if used. 3. Information on the primary coolant set forth in each of the following: 4. Concentration of radioactive materials and impurities; 5. Pressure, temperature, and flow rate at the entrance/exit of a reactor pressure vessel. 6. Water level of a reactor pressure vessel (including a pressurizer, if any)and of steam generators; 7. Pressure, temperature, and flow rate of the secondary coolant at the exit of steam generators, and concentration of radioactive materials in the secondary coolant; 8. Pressure, hydrogen concentration, and radioactive material concentration inside a containment vessel; 9. Concentration of radioactive materials in ventilated air at the exit of a ventilation duct or its vicinity; 10. Concentration of radioactive materials in draining water at the drainage outlet or its vicinity; 11. Radiation dose rate in the controlled area; 12. Direction and velocity of the wind, atmospheric stability, precipitation, and temperature at the site where the plant is located; 13. Concentration of radioactive materials and radiation dose rate in the air on the boundary of the exclusion area of the plant; 14. Acceleration due to earthquakes in structures that are important to the ground and safety. |

#### 3.2.5 Regulations on Technical Standards for Nuclear Reactor Facilities (Electric Power System)

The i-SMR plans to apply a fully passive safety design in which all safety systems can perform safety functions without power supply system. Therefore, all power systems, including the switchyard system, main power system, auxiliary power system, DC distribution and measurement and control power system, are designed to a non-safety class, and there is no need to install an alternative AC power source. But following the article 24 (1) as shown in Table 6, it can be the gap comparing to the regulations.

TABLE 6. Regulations on Technical Standards for Nuclear Reactor Facilities [6]

|  |  |  |
| --- | --- | --- |
| Law | Article number | Contents |
| Regulations on Technical Standards for Nuclear Reactor Facilities | 24 (1) | Onsite and offsite electric power systems necessary for the performance of the functions of the structures, systems, and components important to safety shall be provided to nuclear reactor facility to meet the following requirements:   1. In the event of a loss of either onsite or offsite electric power systems, the remaining available system shall have sufficient capacity and capability to prevent the specified acceptable fuel design limits and the design conditions of reactor coolant pressure boundary from being exceeded in anticipated operational occurrences and to maintain the safety; and 2. The systems shall have sufficient capacity and capability to maintain reactor core cooling, containment structural integrity, and other essential functions in the design basis accidents. |

#### 3.2.6 Regulations on Technical Standards for Nuclear Reactor Facilities (Diverse Protection System)

The rules are in place to reflect the requirements to reduce possibility of ATWS(Anticipated Transient Without Scram) in the technical standards. In the article 27 as shown in Table 7, it is specified to have a diversity protection system in preparation for the possibility of ATWS occurring.

The i-SMR is designed to reduce the risk of software common cause failures leading to reactor shutdown failures and the risk of ATWS events by integrating diversity within the nuclear reactor protection system, and applies heterogeneous platforms to design diversity in the nuclear reactor protection system. By this, the i-SMR is planning a design with characteristics such as independence and multiplicity of channels. But following the article 27, it can be the gap comparing to the regulations.

TABLE 7. Regulations on Technical Standards for Nuclear Reactor Facilities [6]

|  |  |  |
| --- | --- | --- |
| Law | Article number | Contents |
| Regulations on Technical Standards for Nuclear Reactor Facilities | 27 (1) | An additional independent protection system (hereinafter referred to as “diverse protection system”) which has the functions of reactor shutdown, actuation of emergency auxiliary feedwater system, and turbine trip shall be installed to prepare for anticipated transients without scram. |
| 27 (2) | The diverse protection system shall be separated from the protection system, ranging from the part of producing output signal of the equipment to monitor the operating condition to the driving mechanism of final actuator. |

#### 3.2.7 Regulations on Technical Standards for Nuclear Reactor Facilities (Reactivity Control System)

The i-SMR has adopted boric acid-free operation as one of its design features, and is currently designing to actively utilize burnable poison material instead of using soluble boric acid and to minimize the frequency of control rod use. Following the article 28 as shown in Table 8, it requires that two independent reactivity control systems with different design principles and a reactivity suppression function when operational power output changed. So, it can be the gap comparing to the regulations.

TABLE 8. Regulations on Technical Standards for Nuclear Reactor Facilities [6]

|  |  |  |
| --- | --- | --- |
| Law | Article number | Contents |
| Regulations on Technical Standards for Nuclear Reactor Facilities | 28 (1) | Reactivity control systems (meaning systems to control reactivity using control rods and using liquid absorber material by its injection or changes in its concentration) shall be installed to meet each of the following requirements:   1. Reactivity control systems shall be capable of reliably controlling anticipated reactivity changes under normal operations and anticipated operational occurrences, and capable of maintaining operating states without exceeding specified acceptable fuel design limits. 2. Two independent reactivity control systems of different design principles shall be provided and one of the systems shall use control rods. 3. One of the systems as provided in the foregoing subparagraph 2 shall be capable of rendering the reactor subcritical from normal operation and maintaining the core subcritical under cold condition. |
| 28 (3) | The second reactivity control system using liquid absorber material or etc. shall be capable of reliably controlling the rate of reactivity changes due to planned normal power changes to assure that specified acceptable fuel design limits are not exceeded. |

#### 3.2.8 Regulations on Technical Standards for Nuclear Reactor Facilities (Residual Heat Removal System, Emergency Core Cooling System, Ultimate Heat Sink)

Following the Regulations on Technical Standards for Nuclear Reactor Facilities article 29, 30 and 31 (as shown in Table 9), residual heat removal system is required to have safety functions such as redundancy, leak detection, and isolation functions to maintain safety even under the assumption of single power and single failure. The i-SMR adopts fully passive safety features such as PAFS, PCCS and PECCS without electricity to operate. Therefore, the i-SMR residual heat removal system performs the required functions without relying on offsite or onsite power system. So, it can be the gap comparing to the regulations.

TABLE 9. Regulations on Technical Standards for Nuclear Reactor Facilities [6]

|  |  |  |
| --- | --- | --- |
| Law | Article number | Contents |
| Regulations on Technical Standards for Nuclear Reactor Facilities | 29 (2) | The system for residual heat removal shall have the design features of redundancy, leak detection, and suitable isolation capabilities to maintain the safety under the assumption of loss of offsite or onsite power-single failure. |
| 30 (1) | A system for emergency core cooling with sufficient capability necessary to maintain the safety shall be installed to meet each of the following requirements following loss of residual heat removal capability or loss of reactor coolant accidents, and such system shall meet the requirements determined and publicly notified by the Nuclear Safety and Security Commission:   1. Cladding temperature shall not exceed an acceptable design value; 2. Oxidization and hydrogen generation in cladding shall be limited to an allowable level; 3. Deformation of fuel and internal structures shall not reduce the effective core cooling; and 4. Core cooling shall be ensured for a time necessary for the removal of decay heat. |
| 30 (2) | The system for emergency core cooling shall have the design feature of redundancy, leak detection, isolation, and containment capabilities to maintain the safety functions with sufficient reliability under the assumption of loss of offsite or onsite power-single failure. |
|  | 31 (2) | The system shall have the design feature of redundancy, suitable interconnection and isolation capabilities, and etc. to maintain the safety under the assumption of loss of offsite or onsite power-single failure. |

### 3.3 Notice of the Nuclear Safety and Security Commission

#### 3.3.1 Technical standards for the location of nuclear reactor facilities

To evaluate the site suitability of existing large NPP, the Notice of the Nuclear Safety and Security Commission sets conservative emission standards based on deterministic approaches such as 10.CFR.100.11 and TID-14844. The evaluation results using this conservative methods are expected to result in abnormal results that misinterpret the i-SMR design and performance characteristics, so gaps are expected.

#### 3.3.2 Regulations on detailed standards for accident management scope and accident management ability evaluation

The i-SMR is being designed by applying safety characteristics and passive safety systems that are different from existing large NPP. For example, as an integrated nuclear reactor, large piping for connection between equipment was removed to exclude large-break loss of coolant accident, and a passive safety system was designed and natural circulation cooling system was applied, fail-safe equipment was adopted, and the steel containment vessel and underground reactor building was applied.

Essential or additional considerations required by the Notice of the Nuclear Safety and Security Commission may be unnecessary or inapplicable in i-SMR.

#### 3.3.3 Standards for leak testing of nuclear reactor containment buildings

The i-SMR uses a steel containment vessel whose size is significantly reduced compared to the huge concrete containment buildings of existing large NPP. Following the Notice of the Nuclear Safety and Security Commission, as a standard for tightness testing for nuclear reactor containment buildings, integrated leak rate tests and local leak rate tests are required to be conducted within a certain period before initial nuclear fuel loading and operation period. Therefore in i-SMR, it is expected that tightness testing to check the existing containment building should be replaced with steel containment vessel internal pressure testing, so gap is expected.

## 4. Classification of topics by gap analysis and verification methods

The KHNP derives the “16 gaps” inappropriate with the existing LWR-based regulations and technical guidelines. These gaps are including system improvement and safety standards(aspect of safety analysis, non-safety class electrical system, passive safety system etc.). Regarding the contents described in chapter 3, the details of the gap by safety standard were classified based on similar topics. As a result, it is classified into two system improvement and fourteen safety standard gap classification, and the safety standard gap classification is further divided into five common designs and nine system designs as shown in Table 10.

TABLE 7. Improvement of current safety standards system and classification by gap

|  |  |  |  |
| --- | --- | --- | --- |
| Group | | Classification by gap | Safety standards |
| System improvement  (2) |  | 1.Multiple utilization | -Nuclear Safety Act [Law] |
| 2.Exemption or specification of application an alternative regulations | -Nuclear Safety Act [Law]  -Regulations on Technical Standards for Nuclear Reactor Facilities, etc. |
| Safety standard gap classification  (14) | Common designs  (5) | 1.Safety class | -Notice of the Nuclear Safety and Security Commission |
| 2.Multiple failure accidents | -Notice of the Nuclear Safety and Security Commission |
| 3. Construction of Multiple Units | -Regulations on Technical Standards for Nuclear Reactor Facilities, etc. |
| 4.Emergency Planning Zone | -Radioactive Disaster Prevention Act [Law]  -Regulations on Technical Standards for Nuclear Reactor Facilities, etc.  -Notice of the Nuclear Safety and Security Commission |
| 5.Alternative radioactive source | -Notice of the Nuclear Safety and Security Commission |
| System designs  (9) | 6.Independent reactivity control system | -Regulations on Technical Standards for Nuclear Reactor Facilities, etc. |
| 7.Leakage reactor coolant pressure boundary | -Regulations on Technical Standards for Nuclear Reactor Facilities, etc. |
| 8.Measurement control | -Regulations on Technical Standards for Nuclear Reactor Facilities, etc. |
| 9.Power supply system | -Regulations on Technical Standards for Nuclear Reactor Facilities, etc. |
| 10.Multi-module integrated MCR and operators | -Nuclear Safety Act [Law]  -Regulations on Technical Standards for Nuclear Reactor Facilities, etc. |
| 11.Diverse protection system | -Regulations on Technical Standards for Nuclear Reactor Facilities, etc.  -Notice of the Nuclear Safety and Security Commission |
| 12.Steel containment vessel | -Regulations on Technical Standards for Nuclear Reactor Facilities, etc.  -Notice of the Nuclear Safety and Security Commission |
| 13.Surveillance specimen | -Notice of the Nuclear Safety and Security Commission |
| 14.Passive safety system | -Regulations on Technical Standards for Nuclear Reactor Facilities, etc. |

Among these topics, KHNP plans to request prior review and approval from Korea regulatory body by submitting specific topical reports and technical reports for anticipated technical issues that are likely to pose licensing risks prior to applying for standard design approval. Also, KHNP are planning a strategy to receive vendor design review from Canada nuclear regulatory body to expected technical issues during the standard design approval.

## 5. Conclusion

The KHNP has led the i-SMR project, it is currently receiving strong support as a government-led national project. Many government organizations have been established and they will closely coordinate with KHNP to accelerate the technology development and commercialization of i-SMR.

For achieving successful standard design approval by Korea nuclear regulatory body, gap analysis assessment is required to be performed due to the difference characteristics of i-SMR and large NPP. In this paper, the results of the KHNP gap analysis assessment are summarized and introduced. First, a detail review of Korea nuclear safety laws are performed. Second, the KHNP derives the “16 gaps” inappropriate with the existing LWR based regulations, technical guidelines. The KHNP had published the gap analysis report[12] to prepare pre-design review for standard design approval. The KHNP will continuously try to establish new regulatory standards and guidelines suitable for i-SMR.

ACKNOWLEDGEMENTS

This work was supported by the Innovative Small Modular Reactor Development Agency grant funded by the Korea Government (Ministry of Trade Industry and Energy) (RS-2024-00404240)

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