Development of issues and response measures on the inspection of suppliers for SMRs

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1. Introduction

The inspection system of suppliers, etc. for nuclear power plants was introduced in 2014 with the revision of Article 15-2(reporting of contracts on safety-related equipment) of the Nuclear Safety Act[1]. This system inspects designers, manufacturers, and qualification agencies who supply safety-rated structures, systems, and components to power, research, and educational reactor facilities. The inspection of suppliers, etc. is conducted to ensure that the work performed during the design, manufacturing, and qualification stages prior to installation of safety-related equipment in nuclear power plants has been properly performed in accordance with relevant regulatory requirements. The scope of this inspection is stipulated in Article 31-2 (inspections of suppliers, etc.) of the Enforcement Decree of the Nuclear Safety Act[2].

This paper identifies the issues and response measures expected when applying the current inspection system of suppliers, etc. to light-water SMR nuclear power plants, and proposes the revised inspection system for light-water SMR nuclear power plants based on these findings.

2. Inspection System of Suppliers, etc.

The amendment to the Nuclear Safety Act(Act No. 12666) has initiated the “inspection of suppliers, etc.,” which is a regulatory inspection toward designers, manufacturers, and qualification agencies. Contract reporting, pursuant to Article 15-2(reporting of contracts on safety-related equipment) of the Nuclear Safety Act, requires those who have submitted an application for a construction permit for a nuclear reactor facility or who install and operate a nuclear reactor to report within 30 days of making a contract for the design, manufacture, and qualification of safety-related equipment (including subcontracting transactions by contractors). Under this Act, the licensees must report the details of their contracts for safety-related equipment, including subcontracting agreements. A sample of the companies that have reported contracts will be selected for inspection of suppliers, etc., as shown in Figure 1. Inspection of suppliers, etc. are divided into planned inspections and responsive inspections, and the main contents of the inspection are as follows.

1) Whether the design, manufacturing, and qualification activities for safety-rated facilities (structures, systems, and components) meet the construction permit and operating license criteria required by the Nuclear Safety Act.
2) Whether the contract reporting for safety-related equipment is appropriate.
3) Whether a system for reporting nonconformance has been established and the related evaluation results are properly recorded and managed.

3. Issues on Inspection of Suppliers, etc. for Light-Water SMR Nuclear Power Plants

The impact and applicability of the current inspection regulations of suppliers, etc. on those for light-water SMR nuclear power plants, including supplementation or revision were analyzed and presented in Table 1.

Table 1. Results of applicability analysis for light-water SMR NPPs

Regulations for inspection of suppliers, etc.	Large NPPs	SMR NPPs	Remarks
NSA: Article 15-2 (reporting of contracts on SR equipment)	Applied as it is.	To be revised.	Due to differences in safety class methods, SR equipment needs to be redefined.
NSSC Notice: No.2017-32, Inspection regulations of suppliers, etc.	Applied as it is.	To be revised.	But, for SMR reactors, items are selected using the RISC method.
KINS IGs: ·General ·12-specific IGs	Applied as it is.	To be revised.	If the NSSC Notice No. 2017-32 is revised, the scope of the KINS IGs will also need to be revised.

NSA: Nuclear Safety Act. NSSC: Nuclear Safety and Security Commission, SR: Safety-Related, NPP: Nuclear Power Plant

3.1 Problems due to Differences in Safety Classification Methods

1) Safety-related equipment in Article 15-2(reporting of

contracts on safety-related equipment) of the Nuclear Safety Act refers to equipment classified into Safety Class (SC) 1, 2, and 3 as defined in the Nuclear Safety and Security Commission(NSSC) Notice No. 2024-3, "Regulation on the Safety Classification and the Applicable Codes for Nuclear Reactor Facilities" [3].

2) Light-water SMR equipment are classified into RISC-A1, B1, A2, and B2[6] based on risk significance, reflecting the results of probabilistic risk analysis (PRA) in addition to the traditional safety classification system SC-1, 2, and 3[3].

3) Table 2 outlines the safety classes, quality classes, quality groups, seismic classes, and quantities for APR-1400, AP-1000 and NuScale SMR DC nuclear power plants[7,8,9]. APR-1400 and AP-1000 both adopt the traditional safety classification methods, with equipment classified as safety-related equipment in SC-1, 2, and 3 categories being subject to reporting contracts under Article 15-2(reporting of contracts on safety-related equipment) of the Nuclear Safety Act.

4) However, in the case of NuScale SMR DC, classes A1 and A2 according to the Risk-Informed Safety Class (RISC) methods are safety-related and have the quality class of Q, while classes B1 and B2 are non-safety-related and have a quality class of AQ-S, AQ, or Non-Q[9]. Although class B1 is non-safety-related, but is a risk-significant category, so the decision-making must be strategically made as to whether it should be classified as safety-related equipment. In particular, the lowest class B2 is non-safety-related and not risk-significant, but it has approximately 50 seismic class I items, making it subject to reporting contracts under Article 15-2(reporting of contracts on safety-related equipment) of the Nuclear Safety Act.

5) Therefore, due to the differences in safety classification methods as mentioned above, it is expected that there will be a lot of confusion in applying Article 15-2(reporting of contracts on safety-related equipment) of the Nuclear Safety Act to the light-water SMR safety-related equipment and the inspection of suppliers, etc.

3.2 Problems in Selecting Items for Inspection of Suppliers, etc.

1) According to Article 3 (planned inspection), Paragraph 2 of the NSSC Notice No. 2017-32, "Regulation on Inspection of Suppliers, etc. for Safety-related Equipment of Nuclear Reactor Facilities"[4], the Commission selects contractors being subject to the planned inspections from among contractors reported pursuant to Article 15-2 (reporting of contracts on safety-related equipment) of the Nuclear Safety Act, taking into account the following factors; "1. Safety class, quantity, and complexity of structures, systems, and components (hereinafter referred to as 'items') to be designed, manufactured, or qualified."

2) The safety classes in 1) above are based on the NSSC Notice No. 2024-3[3]. Items with safety classes 1, 2, and 3 are subject to the planned inspections pursuant to Article 3(planned inspection) of the NSSC Notice No. 2017-32[4].

3) However, as mentioned in 3.1 above, the criteria for reporting of contracts on safety-related equipment for light-water SMRs are ambiguous due to differences in safety classification methods.

3.3 Problems with the Scope of KINS Inspection Guidelines

1) The Korea Institute of Nuclear Safety (KINS) has been conducting the inspection of suppliers, etc. since March 2015 in accordance with the Nuclear Safety Act. Pursuant to Article 3 (planned inspection of the NSSC Notice No. 2017-32[4], the scope of the inspection guidelines suppliers, etc. has traditionally been defined as one general matter and 12-specific guidelines[5].

2) The above inspection guidelines are determined based on the traditional safety classification methods so making their direct application to the light-water SMR reactors designed according to the RISC methods is problematic.

3) Therefore, the KINS inspection guidelines of suppliers, etc. need to be revised to reflect the safety classification methods and design characteristics of light-water SMR reactors.

4. Response Measures on Inspection of Suppliers, etc. for Light-Water SMR Nuclear Power Plants

Based on the applicability analysis results presented in Table 1, the following response measures are proposed for the inspection of suppliers, etc. of light-water SMR nuclear power plants.

4.1 Definition of Safety-Related Equipment

1) According to Article 15-2(reporting of contracts on safety-related equipment) of the Nuclear Safety Act, the safety-related equipment are classified as SC-1, SC-2, and SC-3 being subject to reporting contracts, according to the NSSC Notice No. 2024-3[3].

2) However, for light-water SMRs, the RISC methods are applied instead of those of the NSSC Notice No. 2024-3[3].

3) Therefore, the safety-related equipment must be

refined as those with quality class Q and/or seismic class I, as shown in Table 2, for example, the NuScale SMR DC[9]. These equipment are proposed to be subject to reporting contracts.

4.2 Selection of Inspection Items for Suppliers, etc.

1) For existing large-scale nuclear power plants, inspection items for suppliers, etc. are selected from among the equipment contracted for in accordance with Article 15-2(reporting of contracts on safety-related equipment) of the Nuclear Safety Act, taking into account the equipment safety classes SC-1, 2, and 3, as defined in Article 3 (planned inspection) of the NSSC Notice No. 2017-32[4].
2) For light-water SMRs, inspection items for suppliers etc. are proposed to be selected from the safety-related equipment proposed in Section 4.1.3) above, i.e., equipment with quality class Q and/or seismic class I.
3) To this end, this paper propose to further revise the application of the RISK approach to Article 3 (planned inspection) of the NSSC Notice No. 2017-32[4] as follows.

	Existing context	Proposed context for revision
NSSC Notice No.2017-32, Article 3	1. The safety class, quantity, and complexity of the structures, systems, and components (‘inspection items’).	1. The safety class, quantity, and complexity of the structures, systems, and components (‘inspection items’). However, for light-water SMR nuclear power plants, the Risk-Informed Safety Class methods are applied to select items contracted as SR equipment, i.e., equipment with quality class Q and/or seismic class I.

4) Based on the revision of Article 3 (planned inspection) of the NSSC Notice No. 2017-32[4] as above, this paper proposes the revised inspection system for suppliers, etc. as shown in Figure 1.

4.3 Revision of the KINS Inspection Guidelines

1) Based on the revision of Article 3 (planned inspection) of the NSSC No. No. 2017-32[4] in Section 4.2.3) above, this paper proposes revising the KINS Inspection Guidelines applicable to inspection of suppliers, etc. for light-water SMR nuclear power plants, as shown in Figure 2.

5. Conclusions

This paper identified the issues and response measures expected when applying the current inspection system of suppliers, etc. to light-water SMR nuclear power plants, and proposed the revised inspection system for light-water SMR nuclear power plants based on these findings.

From an inspection system perspective, the Risk-Infored Safety Class methods should be adopted, taking into account the characteristics of light-water SMRs, as shown in Figure 1.

From a technical aspect, this paper emphasizes modular reactor factory manufacturing and transport inspections, taking into account the characteristics of light-water SMRs compared to the current inspection system. It also newly adds performance tests for safety-related passive valves, performance and qualification tests for FORK equipment, and performance tests for non-safety-class (e.g., RTNSS) equipment, as shown in Figure 2.

REFERENCES

[1] 「Nuclear Safety Act」(Act No. 19826, 2023.10.31)
[2] 「Enforcement Decree of the Nuclear Safety Act」 (Presidential Decree No. 35230, 2025.1.24.)
[3] 「Nuclear Safety and Security Commission Notice」 No. 2024-3, “Regulation on the Safety Classification and the Applicable Codes for Nuclear Reactor Facilities,” 2024.3.14.
[4] 「Nuclear Safety and Security Commission Notice」 No. 2017-32, “Regulation on Inspection of Suppliers, etc. for Safety-related Equipment of Nuclear Reactor Facilities,” 2017.12.26.
[5] 「KINS/GI-N023」 “Inspection Guidelines for Suppliers, etc. for Nuclear Reactor Facilities,” Revision 1, 2025.08.15.
[6] 10 CFR 50.69, “Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors,” Nov. 22, 2004.
[7] APR1400 Design Control Document Tier 2, Section 3.2 Classification of Structures, Components, and Systems, Revision 3, August 2018.
[8] AP1000 Design Control Document Tier 2, Section 3.2 Classification of Structures, Components, and Systems, Revision 19, June 2011.
[9] NuScale Standard Plant Design Certification Application Tier 2, Section 3.2 Classification of Structures, Components, and Systems, July 2020.

Table 2. Safety classification for major nuclear power plants (examples)

NPPs	Safety Class (ANS 51.1)	Quality Class (QA Program)	Quality Group (RG 1.26)	Seismic Class (RG 1.29)	Quantity (ea)
APR-1400 DC	SC-1	Q	A	I	32
	SC-2	Q	B	I	76
	SC-3	Q	C	I	79
		Q	G	I	50
		Q	NA	I	49
	NNS	Non-Q	D/E/NA	II	26
		Non-Q	D/E/F/NA	III	237
AP-1000	SC-1	Q	-	I	248
	SC-2	Q	-	I	449
	SC-3	Q	-	I	349
	NNS	Non-Q	-	I	44
		Non-Q	-	II/III	22
NuScale SMR DC	RISC-A1	Q	A	I	4
		Q	NA	I	12
	RISC-B1	AQ-S	NA	I	3
	RISC-A2	Q	A/B/C	I	4
		Q	NA	I	6
	RISC-B2	AQ-S	B/C	I	50
		AQ	B/C	II	30
		Non-Q	D/NA	III	139

1. Abbreviations
   NPP: Nuclear Power Plant, SC: Safety Class, Non-Nuclear Safety: NA: Not Applicable, RISC: Risk-Informed Safety Class, AQ: Augmented Quality
2. RISC Classification
   · A1 - SSC that are determined to be both safety-related and risk-significant
   · B1 - SSC that are determined to be both nonsafety-related and risk-significant
   · A2 - SSC that are determined to be both safety-related and not risk-significant
   · B2 - SSC that are determined to be both nonsafety-related and not risk-significant
3. Quality Classification
   · Q indicates that quality assurance requirements of 10 CFR 50 Appendix B are applicable in accordance with the quality assurance program.
   · AQ indicates that pertinent augmented quality assurance requirements for non-safety-related SSCs are applied to ensure that the function is accomplished when needed based on that functionality's regulatory requirements.
   · AQ-S indicates that the pertinent requirements of 10 CFR 50 Appendix B are applicable to non-safety-related SSC classified as Seismic Category I or Seismic Category II in accordance with the quality assurance program.
   · Non-Q indicates no specific QA program or augmented quality requirements are applicable.

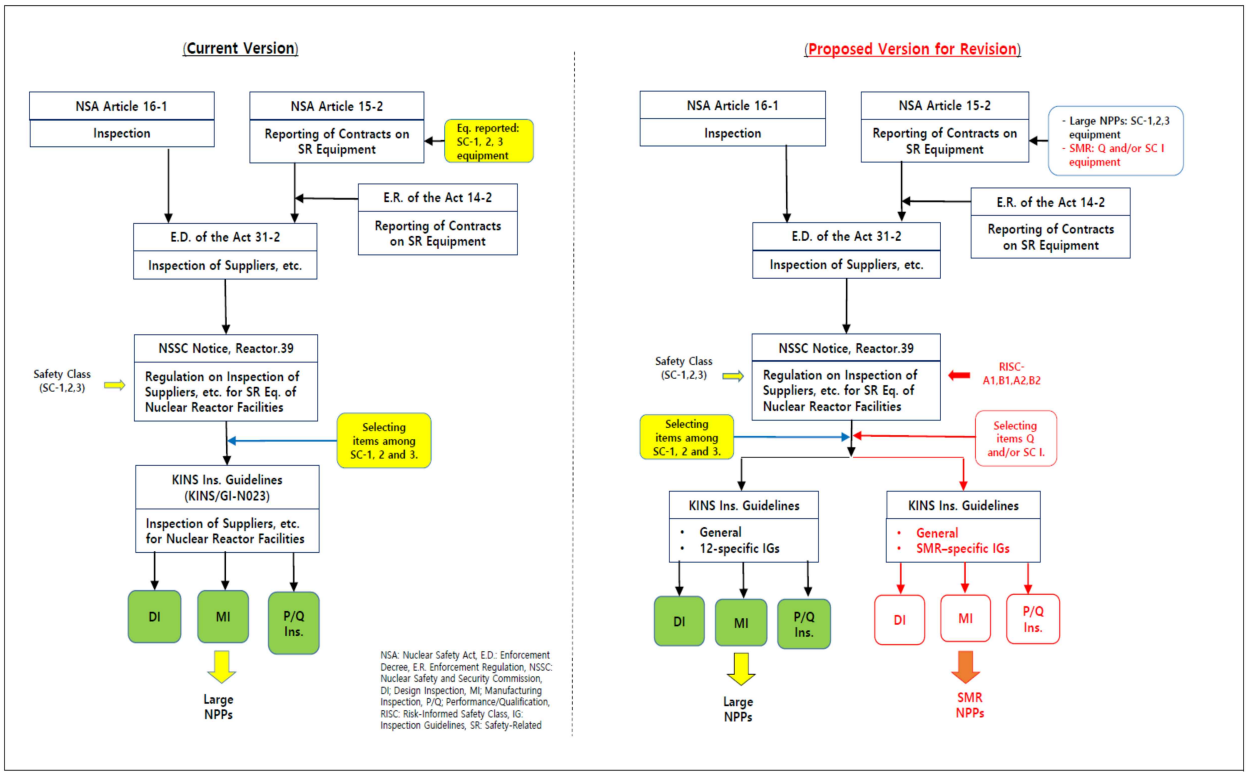

Figure 1. Block diagram on the proposed revision to inspection of suppliers, etc. for light-water SMRs

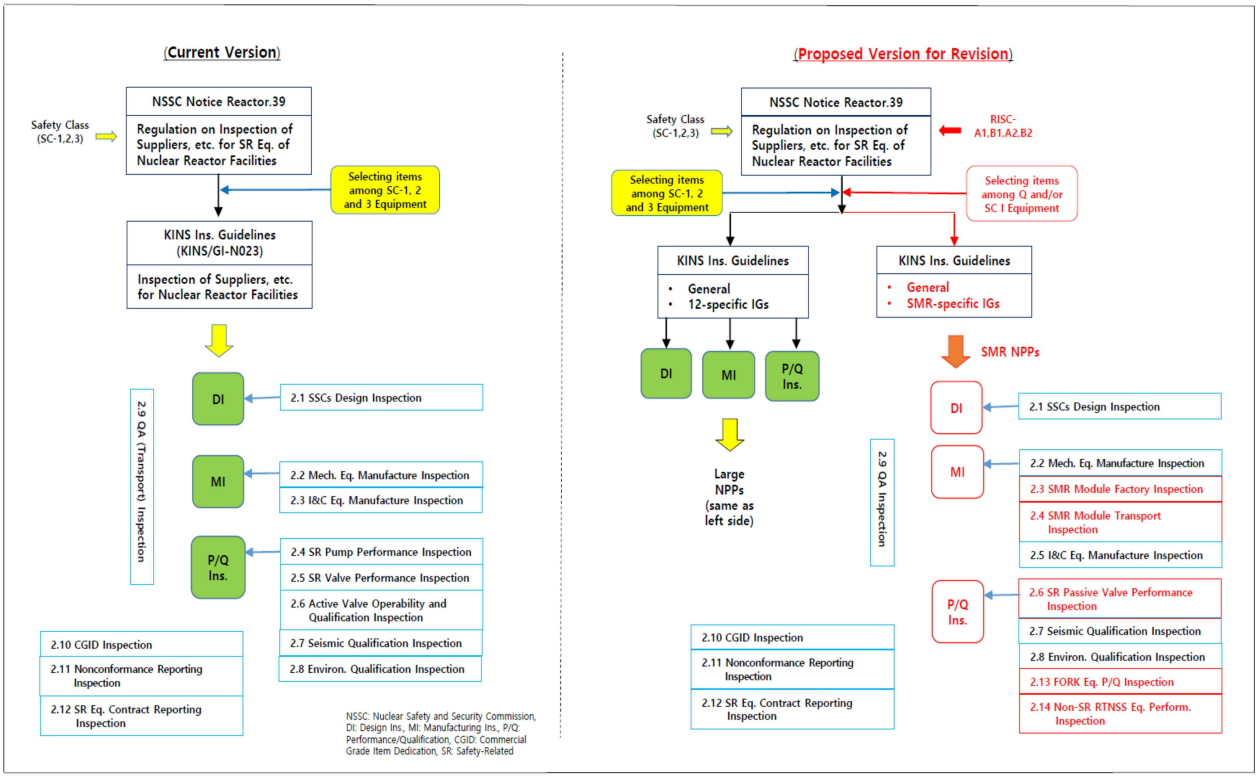

Figure 2. Block diagram on the proposed revision of the KINS inspection guidelines