The Improvement in Safety and Quality Classification of Parts Used in Nuclear Power Plant Applications

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1. Introduction

In Korea, the safety classification of structures, systems and components (SSCs) and its requirements of applicable codes and standards are specified in Nuclear Safety Acts.

Based on these regulatory requirements, pertinent safety class and quality assurance criteria are applied to activities affecting the safety-related functions of SSCs.

Today, however, with emphasis on procurement, replacement and evaluation of sub-component or piece-part, concerns have been accompanied with detailed and specific classification criteria for parts and the need for detailed classification criteria of components increased.

Because each plant owner or component supplier has different part classification practices in Korea nuclear industry, their criteria vary from plant to plant and supplier to supplier resulting in the problem such that an item has been determined as different classification between procurement and the replacement phase.

In addition, domestic regulations and standards have been limited to SSCs. So the categories, criteria and methodology for part-level classification have not been sufficiently established for licensee or supplier to determine a part classification procedure by themselves.

Therefore, this paper proposes improved classification methodology for parts, which can improve the current parts control and management system by integrating each classification criteria, establishing a detail methodology, and finally classifying parts into five categories.

2. Review of present safety classification requirements

ANSI/ANS-58.14 provides safety and pressure integrity classification criteria with recent practices and requirements applicable to licensed light water reactor designs. In addition, EPRI report NP-6895, a base standard of ANSI/ANS-58.14, describes safety classification methodology of systems, structures, components and parts used in nuclear power plant applications, and the EPRI report 1008256 also describes the components and parts classification in terms of the evaluation process for replacement items.

3. Part Classification

3.1. Part Safety Classification Criteria

Safety classification presented in the standards of section 2 divides all items into ‘safety-related’, ‘non-safety-related’ and ‘augmented quality’. First, safety-related item is determined by concerning its safety function and the effect of failure mechanisms to the parent component. Then, the augmented quality, as a subset of non-safety-related items, is driven by a special regulatory or design basis commitment within the scope of licensee quality assurance process.

Part safety classification depends on its parent component’s safety classification, design functions and functional mode. Parts in a safety-related component can be classified by considering two conditions. One is confirming whether the part is required in order for the component to carry out its safety-related functions. If the answer of this question is no, then the other is analyzing whether the part’s credible failure mechanism effects on the component’s safety-related functions. Although a part does not perform a safety function directly, it should be classified as safety-related when its failure can prevent safety functions of parent component.

That is, part in a safety-related component should be determined as a safety-related when it performs a safety function or its failure can affect safety functions of parent component. Otherwise, a part is determined as non-safety-related including augmented-quality.

3.2. Part Quality Classification Criteria

To allow appropriate quality assurance requirements for parts, it is required to review the safety classification criteria and associated quality classification criteria specified in the licensee quality assurance program.

Because the safety classification categories, ‘Q, A, N’ of ANSI/ANS-58.14, ‘SR, AQ, NSR’ of EPRI NP-6895, and ‘Q, A, S’ of the quality class of domestic licensee KHNP have consistency in the definition, following requirements that can be applied for these three groups has been considered.

3.2.1 Technical Requirements

Technical requirements are imposed on all the safety-related items used in nuclear power plants. According to those requirements, appropriate specifications are developed for each procurements, design, fabrication, installation, and inspection and testing. Technical requirements specified in the regulations for each safety-related component are as follows;

- SC-1, 2, and 3 Mechanic Items: KEPIC MN(ASME Section III applicable codes)
- SC-3 Electronic Items: KEPIC EN (IEEE 279, 308 and 603 applicable standards)
- SC-2, and 3 Structures: KEPIC SN, MN (ASME Section III, ASI-348 and ANSI/AISC N-690 applicable standards)

For parts, applicable codes and standards of technical requirements are same as those of the parent components.

3.2.2 Quality Assurance Requirements

Nuclear quality assurance means all those planned and systemic actions necessary to provide adequate confidence that safety-related, augmented quality, or non-safety-related items will perform satisfactorily in service.

So, it is required to determine pertinent quality assurance activities for each safety classification.

Safety-related items, except for commercial-grade item (CGI) to be dedicated, shall be designed and manufactured under the 18 clauses of nuclear quality assurance criteria in accordance with Nuclear Safety Acts. A manufacturer or a supplier of CGI is not subject to nuclear quality assurance criteria, however, the dedicating entity who supply a CGI successfully dedicated as a safety-related application shall perform and control the items under a nuclear quality program.

3.2.3 Reporting of Noncompliance Requirements

According to 10CFR21 "Reporting of Defects and Noncompliance", a supplier shall perform the evaluation and inform the purchasers or licensees when any defects or noncompliance are founded in their basic component. Also, 10CFR21 required a CGI to be dedicated before it could be used as a basic component. The term basic component was defined as an item designed and manufactured under a quality assurance program complying with nuclear quality assurance criteria. In Korea, identical reporting requirement is imposed on the licensee, supplier and dedicating entity providing basic components under the Nuclear Safety Commission Notice 2017-33.

Therefore, commercial-grade procurement refers to an item that is purchased without the provisions of 10CFR21 but is intended to be dedicated after receipt for use in applications functionally safety-related.

According to above requirements, safety-related parts can be classified into three categories, ASME Section III (KEPIC MN/SNB) class parts, basic components designed and manufactured under nuclear quality assurance criteria, and commercial grade items designated for use in safety-related application.

3.3. Part Classification Categories and Methodology

As stated in section 3.1., parts are classified into safety-related (SR), augmented quality (AQ), and non-safety-related (NSR). Based on this safety classification determination, quality assurance criteria should be considered together to conduct appropriate level of control activities. Because current domestic licensee's nuclear quality assurance classification 'Q, A, and S' is consistent with SR, AQ, and NSR class in definition, final classification categories are as follows:

- Q1; Safety-Related ASME
- Q2; Safety-Related not ASME
- Q3; Safety-Related Commercial Grade
- A; Augmented Quality
- S; Non-Safety-Related

This classification methodology is outlined in the flowchart in Fig. 1.

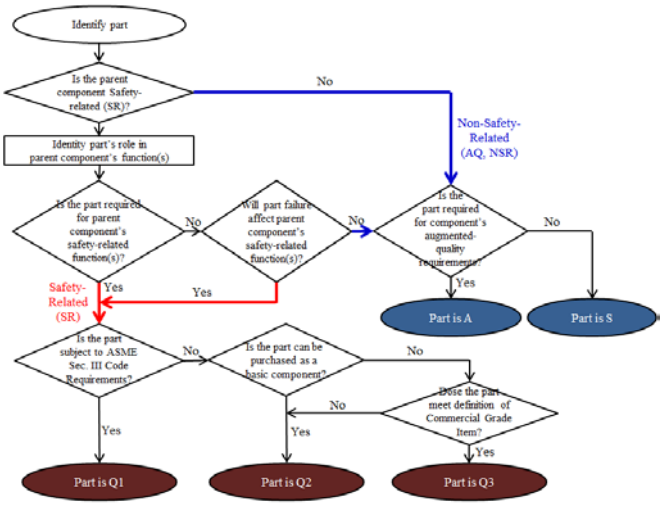

Fig. 1. A process for improved part classification

First step is to identify the part and develop technical specification by reviewing applicable codes, drawings, industry standards and vendor operation and maintenance manuals. Then, the safety classification of parts is determined as SR, AQ, or NSR. In cases of SR, it is required to confirm the requirements that can be applied to parts according to above section 3.2, and then, the final part classification is determined as Q1, Q2, or Q3. Remaining items that do not perform or assist in the accomplishment of safety function and whose failure would not prevent the accomplishment of a safety function is determined as NSR.

For the parts in AQ parent component, after confirming component's regulatory requirements or special requirements imposed by the utility, parts which perform or impact to their component's functions are classified as AQ to assure that the identified requirements are met.

Table I: Part Classification and Applicable Requirements

Safety classification	Certificate requirement	Commercial Grade Item Requirement	Quality Assurance requirement	Reporting of Noncompliance requirement	Part Classification
SR	ASME Sec.III	Not acceptable	Nuclear Quality Assurance Program	Applicable to Utility/Supplier	Q1
	-	Not acceptable	Nuclear Quality Assurance Program	Applicable to Utility/Supplier	Q2
	-	Commercial Grade Item Dedication	-	Applicable to Dedicating Entity	Q3
AQ	-	Acceptable	Regulatory /Special Utility requirement	-	A
NSR	-	Acceptable	-	-	S

4. Conclusions

Once the classification of the part is decided as one of five categories, applicable requirements can be optionally assigned to three types; technical requirement, quality assurance requirement, and reporting requirement. Because the safety classification methodology of ANSI/ANS-58.14 and EPRI NP-6895, 1008256 conforms to the licensee's quality assurance criteria and their classification system, it has been confirmed that those methodologies of safety classification can be applied part-level. The final safety and quality categories for the parts are summarized in Table II.

Table II: Improved part safety and quality classification

Systems, structures, and components		Parts		
Safety Class	Quality Class	Safety Classification	Quality Classification	
			Current	Improved
Safety-Related (SC-1, 2, 3)	Q	SR	Q	Q1, Q2, Q3
			A	S
			S	
Non Safety Related (NNS)	A	AQ	A	A
			S	S
	S	NSR	S	S

Therefore, based on the consistency between standards and licensee's criteria, the expected effectiveness of the proposed part classification methodology is as follows;

- Not only does it comply with the requirements of Nuclear Safety Act such as design· manufacture· installation· testing requirements for safety-related items, but the quality assurance requirements can be applied at the part-level, and the suitability of the quality assurance activities is guaranteed.
- Because the existing Q, A, S quality class items are subdivides into five categories, as Q1, Q2, Q3, A, and S, the overall procurement process can be improved. It will be practical and efficient to utilize the classification into actual process such as purchasing planning, evaluation of available supplier, or planning or procurement method.

REFERENCES

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