A Study on intensive QA Inspection using information from Risk-Informed Classification of SSCs

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1. Introduction

It is important to ensure both safety and reliability in Nuclear Power Plants (NPPs). NPPs in Korea are applying the KEPIC QAP [1] following the US Quality Assurance (QA) Requirements "ASME NQA-1 [2]" based on deterministic concepts. According to the Risk-Informed analysis, which is a probabilistic concept, some equipment considered important by deterministic methods were analyzed as insignificant, and some equipment considered insignificant were analyzed as important [3].

This paper intends to suggest a method for intensive QA Inspection of Structures, Systems, and Components (SSCs), which are important to actual NPPs safety, by using the Risk-Informed.

2. NPP Operator's QA requirements

2.1 KEPIC QAP

KEPIC QA requirements consist of 18 chapters. And Quality Assurance Manual (QAM) for construction and operation is established to systematically implement them. Also, Procedures and guidelines are prepared and implemented in the NPPs [1].

In accordance with the KEPIC QAP Chapter 10 "Inspection" requirements, NPPs shall establish and implement an inspection plan to ensure that an item or business meets the stipulated requirements [1].

2.2 QA Inspection [4]

QA Inspection is an activity that confirms whether an item or maintenance conforms to specified requirements through examinations, observations, or measurements. It is performed by the QA inspector who is not directly responsible for the relevant work. In the operating NPPs, QA inspector performs QA Inspections for maintenance and outsourcing repair of SSCs corresponding to Safety-Related Class (Q) and Augmented Class (A) [1, 4].

SC and NNS Class of Safety Class correspond to Q and A Class of QA Class, respectively [5].

Table 1. Basic requirement of each safety class

Safety Class	Seismic Category	Electrical Class	QA Class
SC	Category I	Class 1E	Q
NNS	Category Ⅱ or Ⅲ	Non-class 1E	A or S

The following tasks related to the maintenance of NPPs are subject to maintenance QA Inspection.

- O/H, Performance Test
- Maintenance Work
- In-Service Examination
- Design Change
- Outsourcing Repair, etc.

For the QA Inspection, QA inspector sets inspection point. The Witness Point (WP) and Hold Point (HP) for the maintenance are inspection points.

- WP can proceed to the next step even if the QA inspector is not present.
- HP is an important QA Inspection step. Maintenance work cannot proceed to the next stage without passing the HP inspection.
- In the case of setting HP, Q and A Class SSCs, Single Point Vulnerability (SPV), and special processes (welding, non-destructive testing, etc.) are selected by a QA inspector in consideration of the operating and maintenance experience, importance of work and inspection schedule.
- However, since it is an arbitrary decision of the QA inspector's selection of the inspection point, there is no standard criterion for selection.

When an inspection point (HP, WP) is selected, the QA inspector conducts a QA Inspection during maintenance work and determines whether it is satisfactory or unsatisfactory.

If there is any dissatisfaction during the QA Inspection, the QA inspector issues a Corrective Action Request (CAR) or Non-Conforming item Report (NCR) to take corrective action.

Modification, repair, or replacement of items performed after the final inspection shall be appropriately re-inspected or re-tested to confirm the acceptability.

Records of QA Inspections shall be properly maintained.

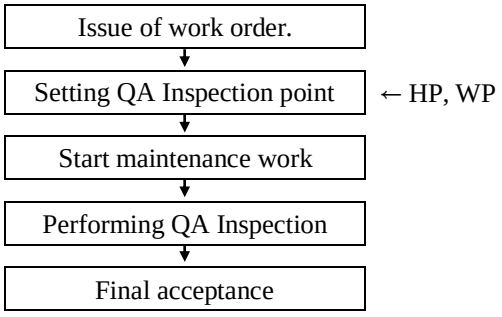

Fig. 1. QA Inspection workflow chart.

3. Risk-Informed Classification of SSCs

3.1 SSCs grade classification according to 10 CFR 50.69

Risk-Informed Classification of SSCs is a method presented as the second option (Option 2) among the options presented by the 10 CFR Part 50 revision method using risk information [3]. It started with the Graded Quality Assurance (GQA) program, which was approved in November 1997 by the South Texas Project (STP) result in the United States [6].

NRC endorsed 10 CFR 50.69 [3]. It aimed at regulating reclassified safety-critical SSCs using risk information, and the Risk-Informed Safety Classification is shown in Figure 2 [7].

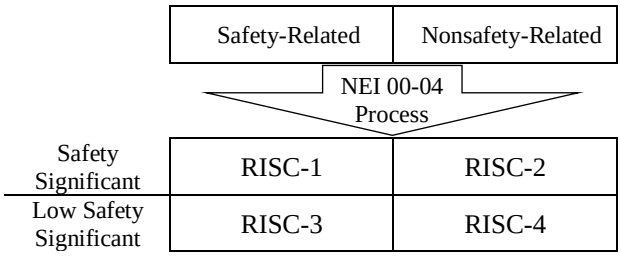

Fig. 2. Risk-Informed Safety Classification. [7]

3.2 Guide of NEI 00-04 SSC categorization

In 2003, NEI revised the "10 CFR 50.69 SSC Categorization Guideline" to reflect the regulatory position of the NRC and announced Revision D [7].

This guideline goes through a total of eight processes as follows.

- Assembly of plant-specific inputs
- System engineering assessment
- Component safety significance assessment
- Defense-in-depth assessment
- Preliminary engineering categorization of functions
- Risk sensitivity study
- IDP review and approval
- SSC categorization

3.3 Needs for Risk-Informed classification of SSCs in QA Inspection

Consistent selection of QA Inspection points for Q and A Class by deterministic methods is inefficient as it inspects even devices that are not important to NPPs safety. In addition, there is a possibility that the HP of maintenance work important for safety may be omitted due to the selection of the inspection point according to the arbitrary interpretation of the QA inspector [4].

The purpose of classifying risk information using PSA results is to ease the burden of special treatment (i.e., Setting HP and QA Inspection) on SC Class that are not significant to NPP safety. In addition, important NNS Class SSCs should strengthen QA Inspection.

By concentrating QA Inspection on areas with high-risk, it will be possible to optimize the quantity of QA Inspections and safety improvement of NPPs.

4. Conclusions

The nuclear industry continues to make efforts to integrate QA requirements into the PRA model. However, the classification of grades according to the Risk-Informed SSCs of the domestic NPPs is still in the discussion stage. The application of the SSCs grade classification method requires reasonable engineering judgment and a common agreement between NPP operator and regulator. Furthermore, this application should not deviate from the NEI 00-04 basic methodology as follows [7]:

- Use relevant risk assessment information.
- In the absence of risk information, deterministic or qualitative information should be used.
- The classification process should use a mixture of quantitative PRA information and qualitative information.
- The principle of how to use risk information in "RG. 1.174" must be followed.
- Safety-related SSC is RISC-1 if it is not classified as RISC-3.
- Safety Importance SSCs should document their characteristics.

Beyond the limitations of the existing deterministic SSCs classification methodology, the QA Inspection for safety-significant SSCs (RISC-1) analyzed in risk information will be strengthened to perform maintenance work efficiently compared to human resources and cost.

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