

## Nuclear Safety and the Role of Quality Assurance

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### 1. Introduction

At the early stage of industrialization, quality of a product is determined and achieved by the skill and know-how of a craftsman who made his product. With the development of industry, however, products were diversified and became increasingly complicated. And, the necessity of quality verification by an independent expert, i.e. inspector, became imperative as a means of quality control and quality assurance. Quality should not be a hostage of a consequent tremendous disaster by an accident or malfunction of a product, but should be achieved by pre-planned and systematic control and management actions to assure safe operations. Quality assurance in the nuclear industry is most important because the failure of a safe operation of nuclear power plants or nuclear facilities would cause tremendous disaster to public safety.[1]

### 2. Safety Class and Quality Class

Structures, systems and components are classified as Safety Class 1, 2, 3 and Non-Nuclear-Safety (NNS) Class in accordance with their importance to nuclear safety and their possible radioactive release. Equipment is assigned to a specific class by recognizing that, within a system, parts may be of a differing safety importance. A single system may thus have components in more than one class. Safety Class 1 applies to components of the reactor coolant pressure boundary.[2-3]

The equipment and materials are classified as Quality Group A, B, C and D in accordance with their necessity of quality assurance, based on the importance to the safe operation of their components or systems. Quality classifications are different by the reactor type, design concept and regulatory policy.[4]

Those structures, systems, and components that should remain functional if a Safe Shutdown Earthquake (SSE) occurs are designated as Seismic Category I. Most of the Safety Class 1, 2 and 3 items are in general coincident with Seismic Category I items.[5]

The KEPIC Code recognizes the different levels of importance associated with the function of each item as related to the safe operation of a nuclear power plant. The Code Classes 1, 2, 3, CS and MC allow a choice of rules that provide an assurance of a structural integrity and quality commensurate with the relative importance assigned to the individual items of the nuclear power plant.[6]

Relations of each classification are summarized in Table 1 below.

Table 1. Relations of Each Classification

Safety Class (ANSI/ANS-51.1)	Quality Group (RG 1.26)	Seismic Category (RG 1.29)	Code Class (KEPIC, or ASME)
1	A	I	1
2	B	I	2, MC
3	C	I	3, CS
NNS	D	NA	-

### 3. Regulatory Inspection and Quality Assurance

All of the nuclear installations in Korea are subject to a regulatory control from the design stage to the final dismantling. For the permission of construction and operation of a nuclear installation, the applicant shall submit a QA program for the Government's approval. During the construction and/or the operation, regulatory inspections by the Government's representative (KINS) follow.

On the construction phase, the licensee shall be subject to the pre-operational inspection to prove that the construction and functional tests of the reactor facilities meet the safety requirements specified in the relevant technical standards.

On the operational phase, the licensee shall be subject to the regulatory periodical inspection, which is usually conducted on an annual basis. This inspection should confirm that the performance of the reactor facility ensures operation within the allowed service conditions in view of the pressure, radiation and other environments.

The QA inspection shall be performed as a part of the regulatory inspection, but separately. It shall be carried out periodically, every one to three years, to check the quality assurance activities of the licensee which should be performed in accordance with the QA program submitted.

### 4. Nuclear Industry and Quality Assurance

The quality assurance program requirements for an applicant of a nuclear installation in Korea are specified in Article 7 of the Enforcement Regulation of the Atomic Energy Act (AEA), which consists of 18 criteria. It is the basis of the nuclear quality assurance requirements for nuclear reactors and related facilities.

All structures, systems and components of nuclear installations shall be designed, fabricated, installed, erected, inspected and tested in accordance with the established QA program. For pressure retaining items, the KEPIC Code rule shall apply and the QA requirements are specified in the QAP.[6]

In the case of the HANARO research reactor at KAERI, Quality Class Q is designated for all of Safety Class 1, 2 and 3 items. The HANARO QA Program in effect now is established to satisfy QA requirements of 18 criteria specified in the Atomic Energy laws. Recently, the Government adapted ANS15.8 as a QA program requirement for the construction and operation of research reactors, and the HANARO QA Program will be revised accordingly.[7] ANS15.8 consists of 19 criteria elements for the design, construction and modification phase, and 15 criteria elements for the operational phase.

## 5. Quality Culture and Nuclear Safety

The initial concept of a quality control for controlling the quality of products is now evolving toward a Management System achieving safety, through a quality assurance thus assuring the quality of the products and the Quality Management managing quality by a systematic approach. The term 'Management System' and 'safety' hereinafter is adopted instead of 'Quality Assurance' and 'quality', respectively. The Management System concept has been developed and adapted by nuclear industries and research institutes in advanced nations and now it is endorsed by IAEA in several safety guides.[8-10]

Regulatory quality assurance requirements are mainly focused on the achievement of an ultimate public safety regardless of the cost effectiveness. However, Management System approach aims to achieve a required safety under the most efficient economic considerations, resource management and work process operations.

Now, nuclear safety could be best achieved through an integrated Management System that ensures that the health, environmental, security, quality and economic requirements are considered together with the nuclear safety requirements.

Management System approach is also developed by realizing that most of nuclear accidents occurred not by the malfunction of hardware or equipment, but by human error. The Management System is a set of inter-related or interacting elements (system) that establishes policies and objectives and which enables those objectives to be achieved in an efficient and effective way.[9, 10]

The Management System enables the achievement of aims to foster and support a strong safety culture through the development and reinforcement of good safety attitudes, values and behavior in individuals,

teams and an organization so as to allow them to carry out their tasks safely.

## 6. Conclusion

Nuclear safety may be better achieved by the implementation of a comprehensive Management System focusing on the performance of all organizational divisions of the health, environment, security, safeguards, emergency planning, quality and administrations by achieving and improving safety through the planning, control and supervision of safety related activities in normal, transient and emergency situations.

It is believed that the integrated Management System is the most active way of achieving a nuclear safety which overcomes a passive way of following regulatory quality assurance requirements by nuclear industries.

## REFERENCES

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