

Development of a Radiation Safety Culture Index (RSCI) and Its Assessment Framework

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1. Introduction

Nuclear facilities inevitably involve radiation exposure. Therefore one approach to evaluating worker safety is to use a “Safety Index” that incorporates various factors, including facility operation, safety systems, safety standards, and safety culture of an organization [2].

This study introduces ‘Radiation safety culture’, one of the factors constituting the “Safety Index”, and proposes an approach for quantifying the level of radiation safety culture as an index.

2. Methods

Ensuring worker safety from radiation requires considering not only compliance with relevant laws and regulations but also safety awareness and attitude, relevant knowledge, and actual behaviors in the workplace. Existing safety culture assessments have mainly relied on individual indicators such as training, regulatory compliance, or on surveys designed to evaluate safety awareness and attitude [1].

However, these approaches have limitations in comprehensively evaluating individual awareness, actual safety behavior, and radiation exposure outcomes in an integrated manner. Therefore, this study proposes the Radiation Safety Culture Index (RSCI), which consists of four elements, each quantified using a method appropriate to its characteristics. The RSCI could be intended to provide an integrated measure of the level of radiation safety culture within an organization or facility [4].

2.1 Safety Attitude (S_A)

Safety Attitude refers to an individual's perception of safety and the extent to which they regard safety as important.

In this study, Safety Attitude is quantified and evaluated using a Likert-scale survey to assess the extent to which workers recognize potential hazards in

the workplace and regard safety as an essential component of task performance. This factor encompasses not only the sense of responsibility to comply with safety requirements but also the attitude of accepting safety as a means of protecting oneself and one's colleagues. The main survey questions address self- and peer-assessment of safety awareness, sensitivity to potential hazards, and the priority given to safety in the workplace.

Since 2024, KOMAC has conducted surveys on radiation safety and has continuously improved them by refining the questions and expanding the scope of participants [3,4].

2.2 Safety Knowledge (S_K)

Safety knowledge indicates how accurately an individual understands, when a situation occurs at a nuclear facility. It means that workers recognize of some situations (for example, knowing whether it is an abnormal situation such as an accident), and the corresponding response related regulations.

At first, recognizing a situation requires basic knowledge of radiation safety, work procedures, and the correct use of personal protective equipment.

The solutions to overcome depends on the situation, and such behavioral guidelines are based on regulations. Therefore, the ability to know the regulations and precautions applicable in the working environment and to make appropriate judgments is also an important factor.

Through testing, the workers' understanding of the situation and regulations can be quantified (converted into numerical scores) relatively easily. In Korea, radiation workers must complete training and pass a test before they register as radiation workers. By this existing test system, it is possible to check as a score, how well individuals understand basic radiation safety knowledge and the facility's safety management regulations [4].

2.3 Safety Practice (S_P)

3. Results

This study divides radiation safety culture into four core elements for evaluation: safety attitude, safety knowledge, safety practice, and exposure dose.

Table1. RSCI Components

	Element	Measurement Method	Data Type
S_A	Attitude	Likert survey	0~100 score
S_K	Knowledge	Test result	0~100 score
S_P	Practice	Compliance rate	0~100 %
S_D	Dose	Comprehensive Dose result	0~100 score

Safety attitude evaluates an individual's perception of and responsibility for safety. Safety knowledge evaluates the level of understanding of nuclear-related hazards and relevant regulations and procedures. Safety practice uses objective data generated during actual work processes, and exposure result comprehensively considers individual dose results and distributions as well as the occurrence of abnormal doses.

This study standardizes each element to a 0–100 scale to represent its individual safety level, and integrating these scores according to Equation (1) yields the RSCI.

$$RSCI = \frac{S_A + S_K + S_P + S_D}{4} \quad \text{----- (1)}$$

Table2. Example of RSCI calculation

	Element	Results	RSCI
S_A	Attitude	70 score	75 score
S_K	Knowledge	60 score	
S_P	Practice	80% (~80 score)	
S_D	Dose	90 score	

Given the following results for each element, the final RSCI value becomes 75 score. Then this result indicates the level of safety culture among all KOMAC workers.

Using the above results as an example, the lowest scoring area, “knowledge”, can be improved through repetitive education. If the RSCI is re-measured later, the final core would be higher than 75.

4. Conclusions

This study defines radiation safety culture using for elements-safety attitude, safety knowledge, safety practice, and radiation exposure- and proposes the Radiation Safety Culture Index (RSCI) as a method for quantifying each element, rather than relying on a single indicator such as survey or training record.

Safety Practice refers to the extent to which workers consistently follow safety regulations and procedures during actual work. This factor serves as an important indicator of whether an individual's safety awareness and knowledge are translated into actual safety behavior.

An approach in which administrators remain on site and continuously monitor whether workers properly follow safety protocols is impractical and may also introduce subjectivity and observer bias.

Therefore, KOMAC utilizes existing safety systems and procedures to automatically collect data generated during work and quantify actual safety behavior. This method calculates a compliance rate for each predefined behavioral step. For example, it assesses whether a worker submitted a work plan in advance, whether the worker obtained the required personal/secondary dosimeters as verified through the access control system, and whether the worker recorded the required radiation measurements [2].

2.4 Radiation Exposure (Dose) (S_D)

Radiation Exposure (Dose) refers to the actual level of radiation exposure received by workers while performing radiation-related work. The exposure dose measured using a thermoluminescent dosimeter (TLD) allows an objective evaluation of the actual level of radiation safety management. However, because individual dose levels can be influenced by various external factors, such as working hours and the intensity of the radiation source, using dose alone as an indicator of radiation safety has limitations.

Therefore, this study comprehensively evaluates radiation exposure using the following four indicators:

- Average individual dose
: Evaluates the overall level of radiation exposure.
- Maximum individual dose
: Identifies whether any worker received a relatively high radiation dose.
- Proportion of high-dose workers
: Represents the proportion of workers whose doses exceeded the predefined reference level.
- Number of abnormal dose occurrences
: Identifies cases in which the recorded dose exceeded the expected range.

S_D consists of these four indicators, each converted to a score on a 0– 100 scale, which are aggregated into a single overall value.

RSCI makes it possible to confirm the level of radiation safety culture within an organization or facility. Moreover, it also identifies which element is comparatively weak.

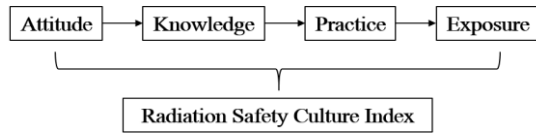


Fig1. Basic concept diagram of RSCI

KOMAC plans to conduct further research on how to construct each of the four elements (S_A , S_K , S_P , S_D) in units of 100 scales.

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