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Review of Non-Radiological Risk Assessment Methodology in Nuclear Facilities Decommissioning

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1. Introduction

In NPP decommissioning activities, non-radiological risks are the main risks compared to radiological risks, as the inventory of nuclide material in the site gradually decreases as decontamination and demolition work progresses. The IAEA has noted that non-radiological risks can have a greater impact on workers during decommissioning than radiological risks. This indicates that decommissioning a nuclear power plant with radioactive material removed is similar to decommissioning general architecture.

The IAEA recommends that a safety assessment should be performed when decommissioning a nuclear power plant. A safety assessment is a process that identifies the hazards that may occur during decommissioning operations and establishes safety measures to ensure that the proposed decommissioning activities are safe. Korea Nuclear Safety Act's guidelines for safety assessment in the decommissioning plan specify that safety assessment must also consider hazards, i.e. non-radiological risks. Although Korean Nuclear Safety Act states that safety assessment must be included in the decommissioning plan, no systematic guidelines or methodologies have been established. Therefore, it is necessary to analyze non-radiological risk assessment methodology studies conducted at Korea and abroad to establish a safety assessment methodology for future nuclear power plant decommissioning.

This study analyzed the non-radiological risk assessment methodology and cases of nuclear facilities and general architecture decommissioned at Korea and abroad to establish a non-radiological risk assessment methodology.

2. Nuclear Facilities Non-radiological Risk Assessment Methodology

2.1 Atomic Energy of Canada Ltd

Atomic Energy of Canada Ltd (AECL) presents a risk management program to minimize risks during decommissioning of nuclear facilities, including a risk assessment.

The risk assessment is performed in three steps: 1) risk identification, 2) risk analysis, and 3) risk evaluation. The risk identification step identifies all hazards that may affect the decommissioning activities. Next, the risk analysis step analyzes the frequency and impact of the hazards identified. The level of risk analysis should be performed according to the type of risk, purpose of analysis, etc. In the risk evaluation stage, risk response measures and strategies are determined based on the results of risk analysis.

2.2 Sellafield Ltd

Sellafield Ltd has proposed a risk management framework to control the risks associated with decommissioning nuclear facilities at the Sellafield nuclear site, including risk assessment.

Figure 1 shows the risk matrix, a severity derivation method proposed by Sellafield Ltd. opportunity means a positive impact and threat means a negative impact. In the risk assessment, hazards that may cause risks during decommissioning operations are identified, and then a severity level is derived based on the probability of occurrence and impact of the hazard. Then, a risk treatment strategy is developed according to the severity level.

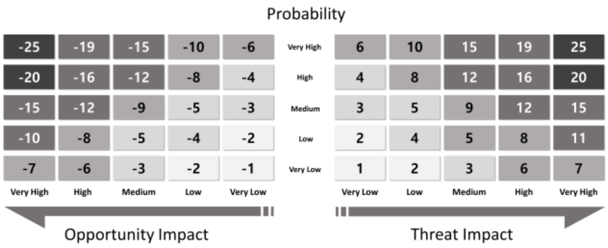

Fig. 1. Risk matrix to determine severity

2.3 Korea Atomic Energy Research Institute

Korea Atomic Energy Research Institute (KAERI) has developed a risk assessment methodology for the decommissioning of KRR-2. KAERI utilized a risk matrix to derive severity levels for the identified hazards. The risk assessment was then conducted by determining the priority level of safety measures based on the severity.

Table 1 shows the priority level of safety measures according to severity. The hazard was considered to be a combination of radiological and non-radiological hazards. The radiological hazards were dose-dependent, and the non-radiological hazards were categorized into five levels of probability and four levels of impact, and the severity was derived as the product of each level.

Table 1: Risk priority of the hazards

Risk Type	Level	Priority
Radiological	>10 mSv	1
Non-Radiological	16-25	2
Radiological	1 – 10 mSv	3
Non-Radiological	13-15	4
Radiological	0.1 – 1 mSv	5
Non-Radiological	6-10	6
Radiological	< 0.1 mSv	7
Non-Radiological	1-5	8

In general, radiological risks are determined by the level of risk based on the dose. On the other hand, non-radiological risks are determined the level of risk by the probability of occurrence and impact of the risk. This is because non-radiological risks lack a quantitative measure of risk, such as dose, and unlike radiological risks, the risk is not always present.

3. General Architecture Risk Assessment Methodology

3.1 Shropshire Council

Shropshire Council in the UK has provided guidelines for risk assessment that can be utilized in decommissioning projects. In this guidance, the risk assessment first identifies potential hazards that may occur during decommissioning. Each hazard is then categorized into five levels based on the probability of occurrence and the impact of the risk. A risk matrix is then performed to derive a severity level by multiplying the values of each level. Based on the severity level, the risk assessment is performed by categorizing the risk into very low risk, low risk, moderate risk, and high risk to determine the level of safety measures.

3.2 Shangoni Management Services Ltd

Shangoni Management Services Ltd conducted a risk assessment for the decommissioning of the Cullinan diamond refinery. The organization first identified the activities expected to be performed during decommissioning and the hazards that could have occurred. They determined the probability of impact and magnitude of impact for each hazard, then multiplied them together in a risk matrix to derive a severity level and developed safety measures accordingly.

Figure 2 shows how the probability of impact is determined. The magnitude of impact is also determined by obtaining the average rating values of 1) duration of impact, 2) extent, 3) volume/quantity/intensity, and 4) toxicity/destruction effect for the source and 1) reversibility and 2) sensitivity of environmental component for the receptor.

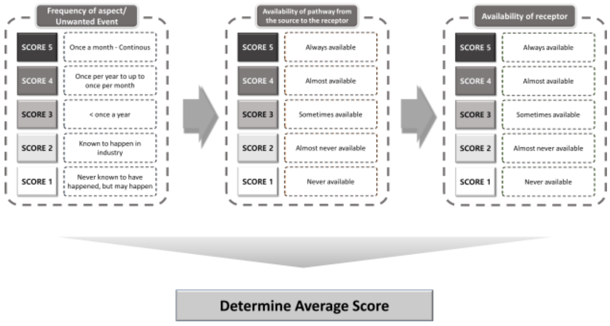

Fig. 2. Determination of probability of impact

General architecture also performed a risk matrix by selecting hazards in the risk assessment and grading the probability of occurrence and impact. The results of the risk matrix were used to derive the severity level and determine the corresponding safety measures. However, the methodology for grading the probability of occurrence and impact was slightly different depending on each organization.

4. Conclusions

In this study, the risk assessment methodologies and cases of Korea and abroad nuclear facilities and general architecture were investigated to analyze the non-radiological risk assessment methodology during decommissioning.

The risk assessments presented by nuclear facilities and general architectures all have in common the identification of hazards, followed by the analysis of the risk level based on the impact of the hazard and the probability of its occurrence, and the establishment of corresponding safety measures. However, there were differences in the methodologies used to determine the impact and probability of occurrence. The results of this study can be used as a basis for developing a non-radiological risk assessment methodology for future safety assessments.

ACKNOWLEDGEMENTS

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