Application of Graded Approach to Periodic Safety Review of Predisposal Radioactive Waste Management Facilities

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1. Introduction

Since the periodic safety review (PSR) of the radioactive waste management facilities (RWMFs) was legislated on June 23, 2021 as shown in Table 1, facility operators must evaluate the comprehensive safety for 12 safety factors. This evaluation must be conducted every 10 years from the date of commencement of operation.

Table 1. Nuclear Safety Act related to RWMFs

Statute	Article	Content	Remarks
Nuclear Safety ACT	65-2	Periodic Safety Reviews	Newly Inserted on Dec. 22, 2020
Enforcement Decree of the Nuclear Safety ACT	104-2 104-3 104-4 104-5	Timing for PSR Details of PSR Methods and Criteria for PSR Periods for Examining PSR Reports	Newly Inserted on June 22, 2021
Enforcement Rule of the Nuclear Safety ACT	93-2	Detailed Items of PSR	Newly Inserted on June 23, 2021

The 12 safety factors in PSR for RWMFs are recommended in Article 104-3 of the Enforcement Decree of the Nuclear Safety Act in Korea. Table 2 compares the safety factors in PSR for NPPs and RWMFs. In the case of RWMFs, the potential radiological hazards to the public are low. The safety analysis report (SAR) for RWMFs has a much smaller scope and fewer details than that of NPPs. Therefore, it is difficult to apply the existing PSR methodology of NPPs.

It would be advisable for the regulatory body to consider a graded approach, taking into account the simpler configuration of predisposal RWMFs. This approach will depend on the hazards, complexity of facilities and activities, and characteristics of the waste, and the requirements will be applied as necessary and appropriate [1].

This paper describes a concept of the graded approach and its application for the periodic safety review of the predisposal RWMFs in accordance with IAEA Safety Standards Series (No. SSG-22 [2] and GSR part 5 [1]).

Table 2. Comparison of the safety factors in NPPs and RWMFs

No.	NPPs	RWMFs
1	Design	
2	Actual condition of SSCs important to safety	
3	Deterministic SA	SA (Safety analysis)
4	Probabilistic SA	
5	Hazard analysis	
6	Equipment qualification	
7	Ageing	
8	Safety performance	Safety performance, use of experience from other facilities and research findings
9	Use of experience from other facilities and research findings	
10	Procedures of operation and maintenance	
11	Organization, the management system and safety culture	
12	Human factors	Emergency planning
13	Emergency planning	Radiological impact on the environment
14	Radiological impact on the environment	Decommissioning

2. Application of a graded approach method for the PSR of the RWMFs

2.1 Concept of the graded approach without compromising safety

The graded approach in general is a structured method by which the stringency of application of requirements is varied based on the specific circumstances and the regulatory and management systems in place [2]. The application of the graded approach will determine the appropriate effort to be expended and the appropriate manner of complying with a requirement, in accordance with the attributes of the facility. A graded approach is applicable in all stages of the lifetime of an RWMF.

The application of grading begins with categorization of the facility in accordance with its potential hazard (Step 1). In this step, a facility can initially be categorized into a range from facilities with the highest potential hazards to those with the lowest potential hazards. This categorization serves to provide an initial grading of the facility. The next step (Step 2) involves analyzing and grading activities and/or SSCs (Structures, Systems, and Components) important to safety for more detailed

grading based on the particular characteristics of the facility [2]. The application of grading should be commensurate with the importance to safety of the activities and SSCs, and with the magnitude of the associated radiological risks.

2.2 Classification of the SSCs based on their importance to safety

According to the safety analysis report for the radioactive waste storage facilities, which are one of the RWMFs in Korea [3], the SSCs of the radioactive waste storage facilities are classified as Quality Class–S (Industrial Standard Items), which refers to items manufactured and inspected in accordance with industrial standards. The SSCs also belong to Safety Class 5 (Non-Nuclear Safety).

2.3 Results for the Analysis of Maximum Hypothetical Accident

The application of the concept of the graded approach for PSR of the radioactive waste storage facilities begins with the analysis of the maximum hypothetical accident (MHA). Initiating events should include any accident that could affect the safety of the radioactive waste storage facilities. According to the Safety Analysis Report (SAR) [3], the MHA for radioactive waste storage facilities is currently the fire accident. In cases of the fire accidents for radioactive waste storage facilities, it is assumed that the accident mitigation strategies are not taken by any mitigation and operator action.

As the results of dose calculations for radioactive waste storage facilities, it was confirmed that the population doses are about 0.02 person-Sv and 0.00005 person-Sv within 10 km, respectively [3]. The doses are below the acceptable limits (3,130 person-Sv/y, 10CFR100.11 [4]). In other words, radioactive waste storage facilities don't affect the environment in terms of radiation dose.

2.4 Review of application of the graded approach for PSR of the RWMFs

In the case of radioactive waste storage facilities, there is no impact on the safety of the storage due to internal and external hazards. Additionally, in the event of the MHA, no significant environmental damage is expected due to the release of radioactive materials. Furthermore, radioactive waste storage facilities do not require safety-related SSCs to mitigate accidents.

Given that the radioactive waste storage facilities do not pose significant hazards to the public or the environment, and do not require safety-related SSCs to mitigate accidents, a new PSR methodology is needed for these facilities. This methodology should take into account the specific hazards, complexity of the facilities and activities, and characteristics of the waste.

In other words, it is necessary to improve, such as applying only a simple evaluation in part, rather than conducting a detailed evaluation for all 12 safety factors. Table 3 is one example of the graded approach application.

Table 3. An example of the application of the graded approach methods for PSR of the radioactive waste storage facilities.

No.	Safety factors	Evaluation method	Remarks
1	Design	Detailed	-
2	Actual condition of SSCs important to safety	Simple	No safety-related SSCs
3	SA (Safety analysis)	Detailed	-
4	Hazard analysis	Simple	No safety-related SSCs
5	Equipment qualification	Simple	No safety-related SSCs
6	Ageing	Simple	No safety-related SSCs
7	Safety performance, use of experience from other facilities and research findings	Detailed	-
8	Procedures of operation and maintenance	Detailed	-
9	Organization, the management system and safety culture	Detailed	-
10	Emergency planning	Detailed	-
11	Radiological impact on the environment	Detailed	-
12	Decommissioning	Detailed	-

3. Conclusions

In order to apply the graded approach method to the periodic safety review of the predisposal radioactive waste management facilities, the concept of the graded approach without compromising safety was reviewed and their effects were evaluated.

The evaluation results for the application of the graded approach method for PSR of the radioactive waste storage facilities confirm the necessity and appropriateness of a new PSR methodology, which is different from the existing method for nuclear power plants. This review of the graded approach method can be valuable in assessing and enhancing the overall safety of RWMFs.

REFERENCES

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[3] Korea Atomic Energy Research Institute, “Safety Analysis Report for the Radioactive Waste Storage Facilities”, KAERI, 2020.
[4] 10CFR 100.11, “Determination of Exclusion Area, Low Population Zone and Population Center Distance”.