Safety Analysis of Radwastes Storage Buildings in KAERI : Earthquake Case

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1. Introduction

Safety concerns for radioactive waste storage have increased. And the Nuclear Safety Commission (NSC) is asking nuclear agencies to conduct a safety evaluation for their radwastes storages under disasters such as fire and earthquake.

Korea Atomic Energy Research Institute, Korea Hydro & Nuclear Power Co., Korea Nuclear Fuel Co., Ltd., and KORAD are conducting safety evaluations for their respective storages.

In this paper, we discuss the method and results of the safety evaluation of the radioactive waste storage at the Korea Atomic Energy Research Institute for earthquake situation.

2. Safety Analysis Method

The accident analysis of the storage consists of three steps. In the first stage, Hazard Definition is used to identify potential hazards that could lead to an accident. In the second stage, Hazard assessment of unmitigated event, which includes event selection process, is performed. In the third step, the accident scenarios were established for the high-risk events identified in the non-audit audit potential risk assessment, and a quantitative accident assessment was conducted accordingly.

Generally, the potential exposures due to radioactive waste of the storage can be broadly categorized as on-site workers and out-of-bounds boundaries. However, in this study, the decision-maker for the accident impact assessment is defined as an individual at the boundary of the storage restricted area.

The internal effective dose by breathing can be calculated using following equation 1.

$$H_{th} = X/Q \times Br \times \sum(Q_i DCF_{thi}) \qquad (1)$$

Where, X/Q is atmospheric dispersion factor for 2hrs at the boundary of restricted area (sec/m^3), and Qi is the amount of released radio nuclide i for 2 hrs (Bq), and DCF_{thi} is the dose conversion factor of radio nuclide i(mSv/Bq), and Br is breathing rate, NRC usually used 3.47E-04m^3/sec for average individual breathing rate after 0~8hrs after accident.

The effective dose by external exposure can be calculated by equation 2.

$$H_{ed} = X/Q \times \sum(Q_i DCF_{edi}) \qquad (2)$$

Where, X/Q is atmospheric dispersion factor for 2hrs at the boundary of restricted area (sec/m^3), and Qi is the amount of released radio nuclide i for 2 hrs (Bq), and DCF_{edi} is the dose conversion factor of external exposure from semi-finite radioactive source (mSv/Bq).

The radioactive source can be calculated using equation (3)

$$\mathrm{Q} = \mathrm{MAR} \times \mathrm{DR} \times \mathrm{ARF} \times \mathrm{RF} \times \mathrm{LPF} \qquad (3)$$

Where :

MAR = Material at Risk, DR = Damage Ratio

ARF = Airborne release fraction

RF = Respirable Fraction

LPF = Leakpath factor

The material at risk is the amount of radioactive material (in grams or curies of radioactivity for each radionuclide) available to be acted on by a given physical stress. The damage ratio is the fraction of the material at risk impacted by the actual accident-generated conditions under evaluation. The airborne release fraction is the coefficient used to estimate the amount of a radioactive material that can be suspended in air and made available for airborne transport under a specific set of induced physical stresses. It is applicable to events and situations that are completed during the course of the event. The respirable fraction is the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system and is commonly assumed to include particulate matter less than or equal to 10 micrometers in diameter.

We used average value of destructive analysis results of operational radwastes with gaseous radioactive nuclides and average concentration values for decommissioning radwastes with gaseous radioactive nuclides. KAERI has 3 storage builds for operational radwastes and 2 for radwastes from decommissioning. The maximum storage capacities are 11,010, 1,404 and 3,320 drums for operational radwastes storage, 2,250 and 2067m^3 for decommissioning, respectively.

We assumed the radwastes were fully stored as maximum capacity and multiply 5 for conservative evaluation. The damage ratio is 10% for earthquake case and ARF*RF is 0.001. The LPF usually 1 for conservative evaluation.

For the internal dose conversion factor [1], we adopted the value from ICRP publication 119[2] "Compendium of Dose Coefficients based on ICRP Publication 60". For external dose coefficients, we adopted from EPA parameters.[3] And we used 7.38E-02 as the atmosphere dispersion factor (50m, 2hrs)

3. Results and Discussion

The analysis results are summarized in table 1 and 2

Table 1. Results of operational radwastes storage

Storage	1	2	2-1
Effective Dose (mSv)	6.22E-04	3.32E-05	2.52E-05
% vs 25mSv	2.49E-03	1.33E-04	1.01E-04

Table 2. Results of decommissioning radwastes storage

Storage	1	2
Effective Dose (mSv)	1.75	1.92
% vs 25mSv	7.0E+00	8.2E+00

4. Conclusion

We performed safety analysis for the radwastes storage buildings at KAERI for the earthquake case. All calculation performed with conservative assumption and expectation. The results of operational radwastes storage shows much lower effective dose than regulation criteria. (less than 1E-04%). While, the effective dose of the decommissioning radwastes storage higher than that of operational radwastes but still lower than regulation criteria. Thus, all storage buildings in the KAERI are safe in case of earthquake. The direct exposure will be considered for the further safety analysis.

REFERENCES

[1] H. Smith, Age-Dependent Doses from Intake of Radionuclides, ICRP 72, 1997.

[2] C. H. Clement, Compendium of Dose Coefficients based on ICRP Publication 60, 119, 2012.

[3] K. F. Eckerman and J. C. Ryman, External Exposure to Radionuclides in Air, Water, and Soil. EPA-402-R-93-08, 1993.