Safety Assessment Tools and Case Studies of the Decommissioning Waste Disposal

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1. Introduction

Decommissioning wastes can be classified into VLLW (Very Low Level Waste), LLW (Low Level Waste), ILW (Intermediate Level Waste). And the spent fuels can be classified into HLW (High Level Waste) if they are determined to fall into disuse. They have to be disposed in the appropriate disposal facilities depending on the radiological characteristics to protect human and the environment. The disposal methods of decommissioning wastes can be a landfill disposal, a shallow land burial, and a deep geological disposal. The safety assessment is the prerequisite for the safe management of decommissioning waste disposal. In this paper, we proposed the appropriate safety assessment tools and analyzed example safety assessment results.

2. Method and Results

2.1. Disposal methods of decommissioning waste

The regulatory body in Korea, NSSC (Nuclear Safety and Security Commission) released a notice related to the classification of radioactive wastes [1]. According to this notice, radioactive wastes are classified into 4 categories (HLW, ILW, LLW, VLLW) and also the clearance levels are described. In addition, the appropriate disposal methods are suggested for each radioactive waste class, which are shown in Fig. 1.

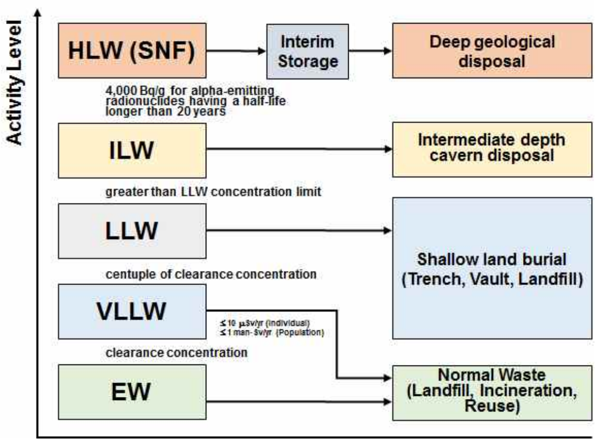

Fig.1. Classification of radioactive wastes

2.2. Safety assessment tools for disposal facilities of decommissioning wastes

We consider three kinds of disposal methods for the disposal of decommissioning wastes; landfill, shallow land burial, and deep geological disposal. And we suggested appropriate safety assessment tools for each disposal method.

We consider the RESRAD code [2] for the safety assessment of a landfill disposal. This RESRAD code has been used widely in many government agencies and institutions in several countries including Korea as well as in USA. The exposure pathways in RESRAD code for the estimation of exposure doses are shown in Fig. 2.

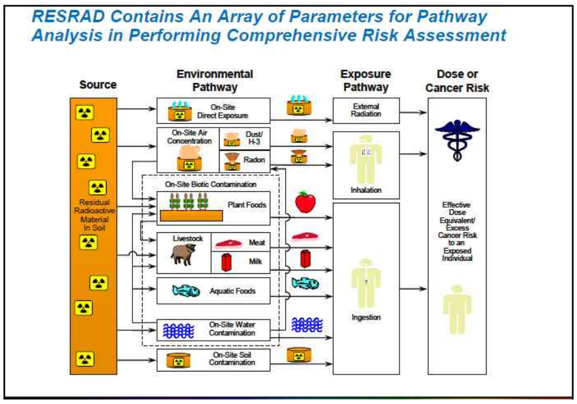

Fig.2. Illustration of exposure pathways in RESRAD code.

We suggest the GSTRENCH code [3] for the safety assessment of a trench-type surface disposal system. It can be used for the safety assessment of a trench-type repository for low and intermediate level radioactive waste disposal under various nuclide release scenarios. The schematic diagram of GSTRENCH code is shown in Fig.3.

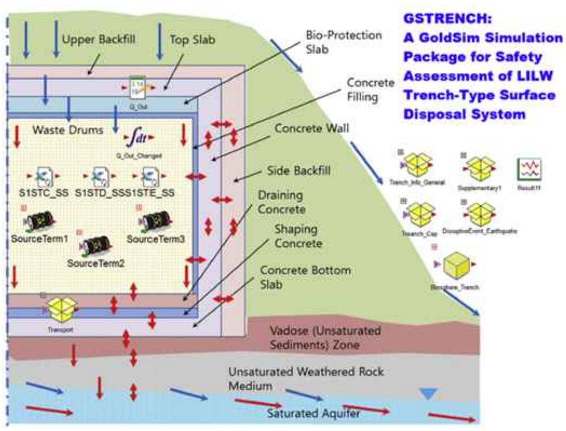

Fig. 3. Schematic diagram of GSTRENCH code.

We suggest the K-PAM (KAERI Performance Assessment Model) code [4] for the safety assessment of a deep geological disposal system. It is a risk-based safety assessment model developed by coupling MATLAB and GoldSim for the total system performance of a deep geological disposal system for radioactive wastes from pyro-processing based on the KURT environment. The schematic diagram of K-PAM code is shown in Fig. 4.

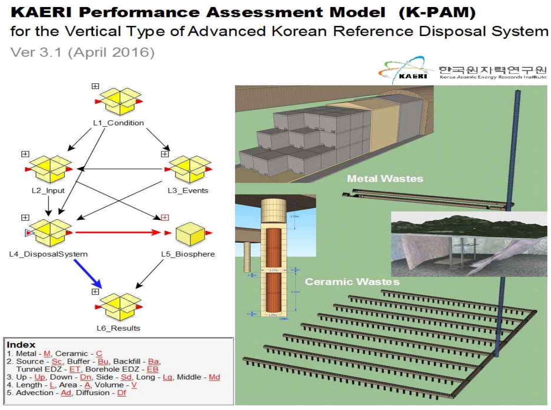

Fig. 4. Schematic diagram of K-PAM code.

2.3. Example analyses of safety assessment

Jeong et al. [5] estimated the exposure doses resulting from the landfill disposal of NORM wastes. They estimated maximum exposure doses for three scenarios: a reference scenario, an ingestion exclusion scenario and a low leach rate scenario. And they analyzed the contribution of each exposure pathway to exposure deses. They also estimated exposure doses as a function of activity level and the disposal amount of wastes containing U series, Th series, and ^{40}K. The exposure doses as a function of activity level and the disposal amount of wastes containing U series are shown in Fig. 5.

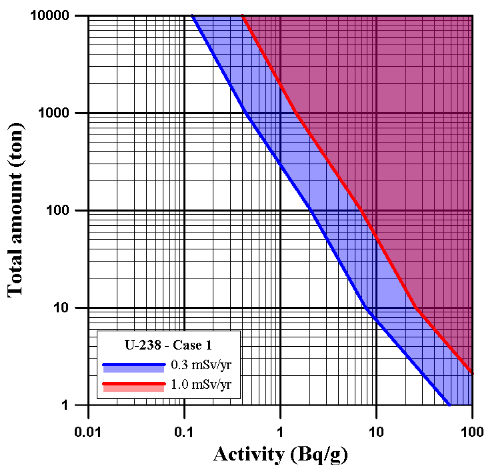

Fig. 5. Exposure doses as a function of activity level and the disposal amount of wastes containing U series.

Lee et al. [3] estimated the nuclide release and transport through various pathways possible in near-and far-fields of the conceptual repository system under some alternative scenarios as well as the reference scenario. The estimated exposure doses for each scenario are shown in Fig. 6. Although these illustrative results are made for the conceptual design of the trench type LILW repository system, they can be informative and GSTRENCH can be used for the safety assessment of a disposal system of low and intermediate level decommissioning wastes.

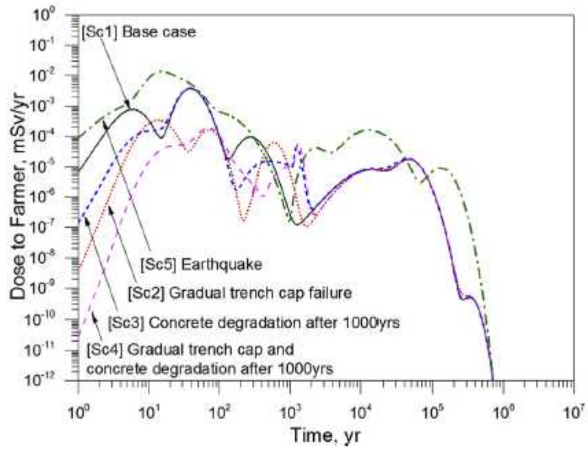

Fig. 6. The exposure dose rates for each scenario estimated using the GSTRENCH code.

Kim et al. [4] applied the K-PAM code for the safety assessment of the conceptual repository system for the disposal of pyro-processed waste. It was demonstrated using three scenarios: the reference scenario, the deterministic complex scenario, and the probabilistic complex scenario. The results for the reference scenario and the deterministic complex scenario are shown in Figs. 7 and 8.

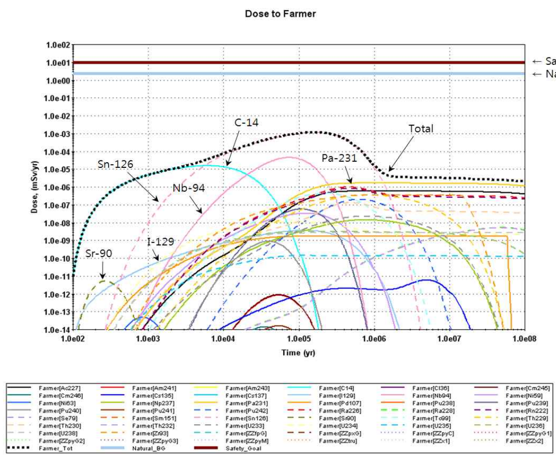

Fig. 7. The exposure dose rates for the reference scenario estimated using the K-PAM code.

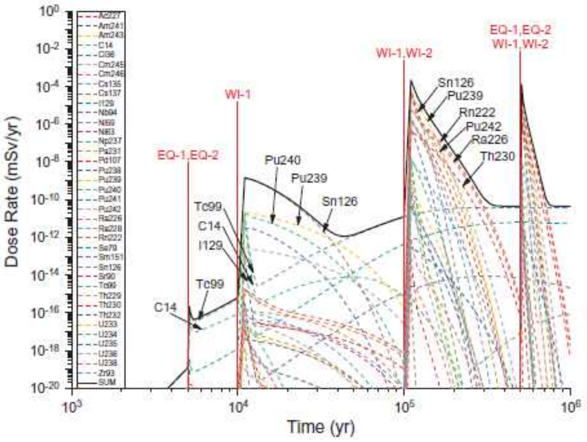

Fig. 8. The exposure dose rates for deterministic complex scenario estimated using the K-PAM code.

Although the K-PAM code was applied to the conceptual repository system for the disposal of pyro-processed waste, it can be used for the safety assessment of a HLW repository including the spent fuels.

3. Summary and Conclusions

During the decommissioning of a nuclear power plant, a wide range and quantity of radioactive waste with different radiological characteristics will be generated. Therefore, the development and implementation of appropriate strategies for the processing and disposal of decommissioning waste are the prerequisite for the safe management of decommissioning wastes. We proposed a landfill disposal, a shallow land burial, and a deep geological disposal as methods for the disposal of decommissioning waste. In addition, we suggested RESRAD, GSTRENCH, and K-PAM as safety assessment tools for these disposal methods and analyzed example safety assessment results using these tools. The disposal methods and safety assessment tools for disposal facilities of decommissioning waste can be used for the estimation of disposal feasibility of decommissioning wastes.

REFERENCES

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[5] Jongtae Jeong et al., "Estimation of Exposure Doses for the Safe Management of NORM Waste Disposal", Radiation Protection Dosimetry 181(4), 394-402 (2018).