Assessment of Radiation Dose by Applying Cover Depth for the Site Reuse After NPP Decommissioning

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1. Introduction

The oldest Nuclear Power Plant (NPP) in South Korea, Kori-1, will be decommissioned starting in 2017. When all facilities are removed and the site is opened, the soil within the site will be contaminated. To determine doses from the contaminated soil, RESRAD-ONSITE code has been used. There are many parameters to calculate dose from the various pathways, and it is necessary to identify what parameter influences significantly the results, and if it is adjustable, it can be applied for dose reduction. Therefore, in this study, we perform a sensitivity analysis by adjusting the parameters and observe the effect on dose results.

2. Methods

2.1 Exposure Pathways

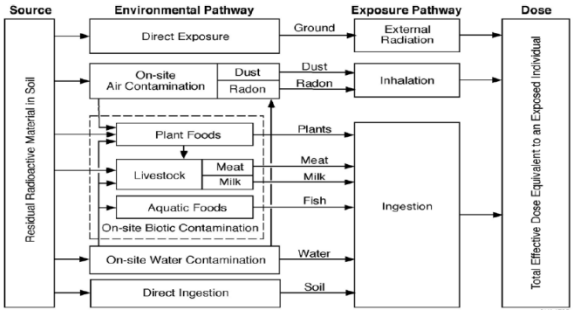

Fig. 1. Schematic Diagram of RESRAD Pathways [1].

Major pathways used to derive on-site dose in RESRAD-ONSITE are illustrated in Fig. . The exposure pathway consists largely of external, inhalation, and ingestion, which are received through routes such as ground, dust, radon, plants, meat, milk, fish, water, and soil. The food pathways can be classified as water-independent or water-dependent.

2.2 Exposure scenarios

Exposure scenarios are the human life patterns that can be affected by the release of radioactivity from the contaminated area. Since the residential farmer scenario is expected to result in the highest dose, we assume the land use as the resident farmer.

2.3 Key parameters

As the major radionuclides at the site, we assumed the representative radionuclides (^{137}Cs and ^{90}Sr) and set the radioactivity as shown in Table 1. The input radioactivity value are referenced to the Derived Concentration Guideline Levels (DCGLs) reflecting the decommissioning experience of Connecticut Yankee [2]. Since the DCGLs are derived from 0.25 mSv/y, which is the land reuse limit in the United States, it needs to be converted to the corresponding value considering 0.1 mSv/y in Korea [3]. In determining RESRAD-ONSITE parameter values, the site specific data such as the geological and hydrological data of Kori unit 1 was obtained from the research report [4] and other values are used by default.

Table 1. Input Radionuclides

Radionuclide	Concentration (Bq/g)
^{137}Cs	1.16×10^{-1}
^{90}Sr	2.40×10^{-2}

2.4 Sensitivity Analysis

Sensitivity analysis has been performed by multiplying or dividing the parameters by 2 and the results were compared against each other. Dose difference was observed over a period of 1,000 years, and the maximum of the differences was selected for comparison.

3. Results & discussion

As a result of sensitivity analysis, the cover depth found to be the most important for exposure dose and

can be modified during NPP decommissioning. By default, the resident farmer scenario use a value of cover depth as 0. As can be seen in Fig. 2, the dose rates of ^{137}Cs and ^{90}Sr were found to be lower than the limit of 0.1 mSv/y.

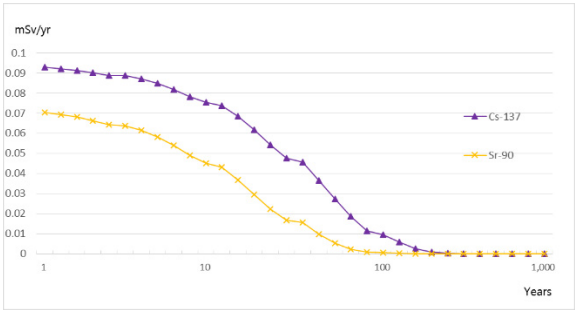

Fig. 2. Dose of Resident Farmer.

The graph of the component effect by the pathways is shown in Fig. 3 to Fig. 4. This indicates that the external and plants pathways are the dominant sources of ^{137}Cs and ^{90}Sr, respectively.

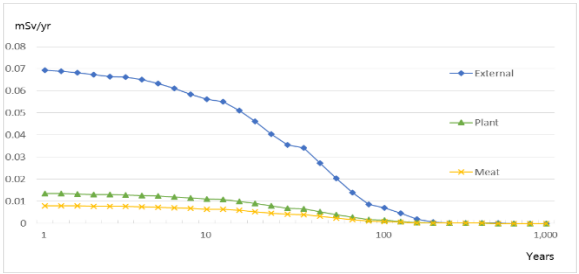

Fig. 3. Component Pathways Dose of ^{137}Cs.

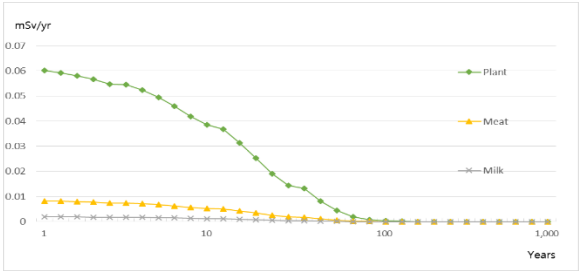

Fig. 4. Component Pathways Dose of ^{90}Sr.

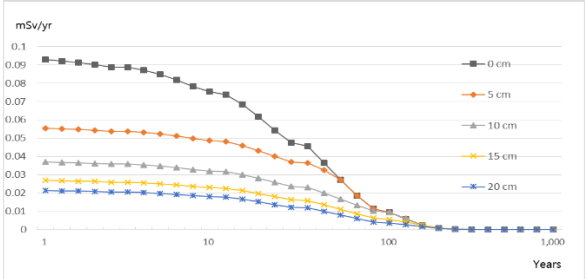

Fig. 5. Dose of ^{137}Cs by Cover Depth.

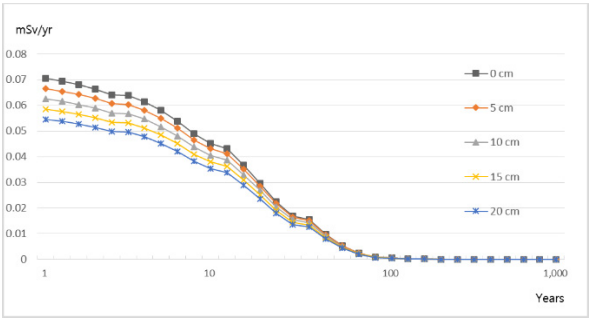

Fig. 6. Dose of ^{90}Sr by Cover Depth.

In the case of applying soil as a cover, the dose was found to be considerably reduced by increasing the depth as shown Fig. 5 to Fig. 6.

4. Conclusion

In this paper, dose assessment has been carried out for the site release after NPP decommissioning. Exposure doses were calculated assuming radionuclides and concentrations in resident farmer scenarios. Also, through the sensitivity analysis, it was found that the cover depth was the most significant parameter affecting the dose. Based on this information, applying cover depth will contribute to dose reduction when the site is opened to the public or reused for other purposes.

Acknowledgements

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REFERENCES

[1] Environmental Assessment Division Argone National Laboratory, U.S. Department of Energy, User's Manual for RESRAD Version 6, July 2001.
[2] EPRI, Connecticut Yankee Decommissioning Experience Report, 2006.
[3] Nuclear Safety and Security Commission, Criteria for Reuse of Site and Remaining Buildings after Completion of Decommissioning of Nuclear Facilities, No. 2016-33, 2016.
[4] KINS, Development of Technology in Radiation Safety Regulations, KINS/GR-297, 2005.