Preliminary Evaluation of DCGLs for Site Release After Decommissioning of Korean Research Reactor 1 & 2

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1. Introduction

The decommissioning project of Korean Research Reactor (KRR) 1&2 was introduced in the preparation stage for site release in 2017. Korean government legislated NSSC (Nuclear Safety and Security Commission) Notice No.2016-33 in 2016. Article 4 of the Notice states that dose criteria for site reuse should not exceed 0.1 mSv per year. DCGL (Derived Concentration Guideline Levels) should be assessed to demonstrate that dose criteria are met. Article 2 of the Notice states that not only commercial reactor but also research reactors should be evaluated. Therefore, we performed preliminary evaluation of DCGLs for site release after decommissioning of KRR 1 & 2.

2. Material and Methods

2.1 Evaluation of DCGLs

Korea Institute of Nuclear Safety (KINS) suggested a method to evaluate DCGLs. Radiological evaluations according to exposure scenarios are performed for each nuclide and thus deriving DCGL values. The DCGL evaluation procedure is as follows: (1) selection of radionuclides in a site, (2) selection of representative exposure scenarios, (3) assessment of radiation dose per unit radioactivity (1 Bq/g) for each radionuclide, (4) derivation of DCGLs by dividing personal dose (assessed in the 3 step) by dose criteria (0.1 mSv/year), and (5) confirmation whether radiation dose according to each scenario satisfies dose criteria.

2.2 Selection of radionuclides at KRR-1&2 sites

Radionuclides at KRR-1&2 sites were selected based on NUREG-3474, NUREG-4289, NUREG-0130, ORIGEN code, and historical site assessment (HSA) [1]. The NUREG documents describe the activation products for the commercial reactors in the US. Since radioactivity concentration varies depending on reactor type and the operation period of the nuclear facility, ORIGEN code was used to evaluate the radioactivation. Among the radionuclides derived from the procedure, radionuclides with a half-life less than 3 years were excluded because KRR-1&2 was permanent shutdown 22 years ago. Table 1 shows radionuclides that are considered in this study.

Table 1. Radionuclides considered in this study

Radio-nuclide	Half-life (years)	Radio-nuclide	Half-life (years)
^{14}C	5.73×10^{3}	^{133}Ba	10.5
^{36}Cl	3.01×10^{5}	^{137}Cs	3.02×10^{5}
^{60}Co	5.27	^{152}Eu	13.6
^{79}Se	1.13×10^{6}	^{154}Eu	8.59
^{90}Sr	28.6	^{158}Tb	1.80×10^{2}
^{108m}Ag	4.18×10^{2}	^{178m}Hf	30.0
^{121m}Sn	5.00	^{237}Np	2.14×10^{6}
^{129}I	1.57×10^{7}		

2.3 Investigation of the RESRAD input data

Personal radiation doses were calculated using RESRAD program. For RESRAD program calculation, we used preferentially domestic data if the data were available. If the domestic data were not available, we used international data or RESRAD default value. The volume of contamination in the site was set at 7,112 m^3, derived by multiplying the land area of 47,417 m^2 and the surface soil thickness of 0.15 m. The evaluation period for the radiation dose was set at 1,000 years according to NSSC Notice No.2016-33.

3. Results and Discussion

Radiation doses by calendar time after site release are given in Fig. 1. The radiation dose was calculated assuming unit radioactivity (1 Bq/g). Radiation doses initially increased with time, reached the maximum in 3 years after site release, and then decreased rapidly with time. The maximum radiation dose was about 13 mSv/year assuming radioactivity of 1 Bq/g.

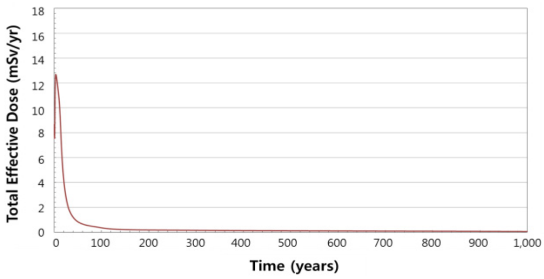

Fig. 1. Radiation doses by calendar time after site release.

Fig. 2 shows radiation dose by radionuclide when the radiation dose is the maximum (3 years after site release). The iodine-129 contributed the highest radiation dose (about 4.3 mSv/year). It was followed by ^{178m}Hf, ^{60}Co, ^{14}C, etc.

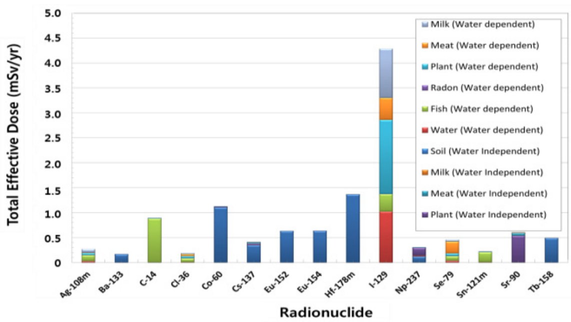

Fig. 2. Radiation doses by radionuclide when the radiation dose is the maximum.

Table 2 shows DCGLs derived based on the radiation dose assessment. DCGLs were 0.241 Bq/g for ^{137}Cs and 0.0888 Bq/g for ^{60}Co.

Table 2. DCGLs derived in this study

Radio-nuclide	DCGL (Bq/g)	Radio-nuclide	DCGL (Bq/g)
^{14}C	0.11	^{133}Ba	0.60
^{36}Cl	0.52	^{137}Cs	0.24
^{60}Co	0.089	^{152}Eu	0.16
^{79}Se	0.22	^{154}Eu	0.16
^{90}Sr	0.17	^{158}Tb	0.20
^{108m}Ag	0.37	^{178m}Hf	0.073
^{121m}Sn	0.45	^{237}Np	0.33
^{129}I	0.023		

4. Conclusion

In this study, DCGLs in the KRR-1&2 sites were evaluated for site release after decommissioning. Specific input data for nuclide selection and RESRAD input factor are insufficient because site release for KRR-1&2 is still in preparation stage. Therefore, we performed preliminary evaluation using the currently available data. Based on the preliminary study, DCGLs for ^{137}Cs and ^{60}Co were 0.241 Bq/g and 0.0888 Bq/g, respectively. The procedures and methods in this study can be applied to derive DCGLs for not only research reactors but also commercial reactor decommissioning.

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