Derivation of Surface Soil $DCGL_w$ for Kori-1 NPP Reuse Scenario

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1. Introduction

Kori Nuclear Power Plant Unit 1, the first NPP in S. Korea, will be permanently suspended in June, 2017. The decommissioning procedure and related preparations are ongoing. By selecting less conservative but a realistic Industrial worker scenario for surface and subsurface exposure, the scope of the strategies according to the scenario type is condensed intensively. A derived, radionuclide-specific activity concentration within a survey unit corresponding to the release criterion, DCGL is based on the spatial distribution of the contaminant and hence is derived differently for the nonparametric statistical test ($DCGL_w$) and the Elevated measurement comparison ($DCGL_{EMC}$) [1]. For $DCGL_w$, which is a DCGL with a mean concentration over a wide area used with statistical tests, suite of radionuclide and peak of the mean dose have to be found using DandD ver.2.4.0 and RESRAD-ONSITE ver.7.2.

2. DCGLw Calculation

2.1 Classification of Radionuclides

Potential radionuclides suite selection is based on methodology which was used on the US NPPs decommissioning. For unified assumptions of radionuclides, Table 5.13 and 5.15 of NUREG-3474, Attatchment 8.2 of DTBD-04-001 were used. Discounted radionuclides were classified as nuclides which concentration contribute less than 0.1 percent of the total activity, with half-life less than 2 years [2,3]. Final selection and classification of radionuclides is shown in Table 1.

2.2 Potential dose from discounted radionuclides

Total discounted dose from discounted radionuclides is calculated by DandD Code ver.2.4.0. Radionuclides and inert gases not supported by DandD were excluded. Because of insufficiency of site-specific radionuclide concentrations of KORI Unit 1, initial concentrations assumption was based on total activity fraction. By running the DandD code with Industrial worker scenario, potential dose from discounted radionuclides was derived as 1.82E-04 mSv/yr.

Table 1. Classification of potential radionuclides

Concerned		Discounted		
H-3	Co-60	Cl-36	Eu-154	Tc-99
C-14	Ni-63	Ar-39	Eu-155	Sn121m
Co-60	Eu-152	Ca-41	Tb-158	I-129
Ni-63	Pu-239	Mn-53	Ho-166m	Ba-133
Fe-55	Ni-59	Se-79	Hf-178m	Cs-134
		Kr-81	Pb-205	Cs-135
		Kr-85	U-233	Cs-137
		Sr-90	Sm-151	Pm-145
		Zr-93	Mo-93	Sm-146

2.3 Peak of the mean dose consideration

Probabilistic dose modeling should use the “peak of the mean” dose distribution for demonstrating compliance with 10 CFR Part 20, Subpart E. The “peak of the mean” analysis is based on the time at which the average dose is maximum. [1] To calculate “peak of the mean” dose using RESRAD-ONSITE ver 7.2, the site condition for KORI Unit 1 with variable site-specific parameter values are needed. [4] 1 pCi/g of each concerned radionuclide and parameter distributions are entered for probabilistic run. More accurate values of “peak of the mean” dose can be obtained by entering assigned values through sensitivity test. The result is shown in Table 2.

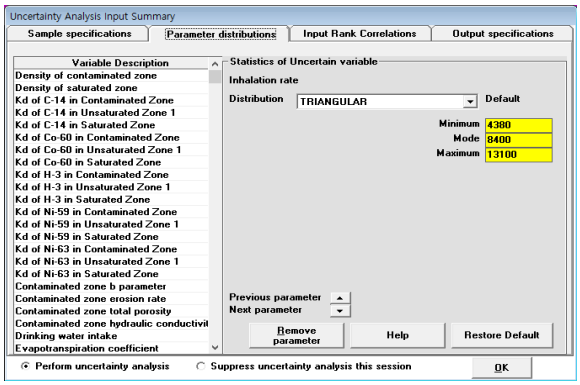

Fig. 1. RESRAD-ONSITE for probabilistic run.

2.4 DCGLw

Now, DCGLw of the site-specific radionuclides can be derived by [3]:

$$DCGL_w = \frac{Regulatory\ dose\ limit - Potential\ dose}{Peak\ of\ the\ mean\ dose} \quad (1)$$

The current proposed site release criteria for either restricted or unrestricted reuse is 0.1 mSv/yr [4]. By substituting dose limit, potential dose from discounted radionuclides and "peak of the mean" dose, the result is shown in Table 3.

3. Results & discussion

Table 2. Peak of the mean dose for selected radionuclides

Radionuclide	Peak of the mean dose (mSv/y per pCi/g)
H-3	1.836E-04
C-14	1.176E-03
Fe-55	1.367E-07
Ni-59	3.383E-06
Ni-63	8.079E-06
Co-60	2.032E-02
Nb-94	2.330E-02
Ag-108m	3.594E-02
Eu-152	9.198E-03
Pu-239	7.199E-05

Table 3. Surface soil DCGLw

Radionuclide	DCGLw (pCi/g)
H-3	5.43E+02
C-14	8.48E+01
Fe-55	7.30E+05
Ni-59	2.95E+04
Ni-63	1.23E+04
Co-60	4.91E+00
Nb-94	4.28E+00
Ag-108m	2.77E+00
Eu-152	1.08E+01
Pu-239	1.38E+03

In order to apply DCGLw to the underground soil, it is necessary to determine the mixture concentration using 'unity rule' by measuring accurate site-specific concentration, then considered through assessment of contamination layer thickness changes and depth contamination [3].

4. Conclusion

The derived DCGLw can be a criterion of survey unit, and also essential for deriving area factor classifying classes of impacted areas. For exact value of DCGLw, the concentration of each radionuclide in KORI Unit 1 and more site-specific parameter values are needed. Then, the applicability of surface soil DCGLw to sub-surface soil can be considered.

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