Concept of Clearance Level and Its Application

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Abstract

In radioactive waste management, the discussion on clearance level for solid radioactive waste is very important because of getting a reasonable "cut-off" level on the deep consideration of radiation safety. The clearance level will be used in the radioactive waste management of reactor and large accelerator decommissioning. In this paper the recent Japanese discussion of clearance level decision is presented and the key issue in it are reviewed.

1. INTRODUCTION

Radioactive wastes are classified into three categories in Japan: High-Level Radioactive Waste (HLW), Low-Level Radioactive Waste (LLW) and Wastes below Clearance Level. HLW is now under discussion for a deep geological disposal with incorporating public opinions. LLWs are undertaking in Rokkasyo Village Repository. The relating regulations for LLW disposal have already prepared except those on Relatively High Concentration LLW and TRU waste.

After the experience of more than 40 years reactor operations Japan entered into the period of reactor decommissioning. For the successful accomplishment of the decommissioning of reactor and large accelerator facilities, the well organized radioactive waste management is inevitable. For the reasonable disposal of very low level radioactive waste or reuse of these materials, the setting of clearance level is quite important.

Several countries like Germany have already started the application of the clearance level for the "cut-off" of radioactivity of very low level wastes. As a generic clearance level, IAEA-TECDOC-855 is frequently referred. For the real application to Japanese situation the government committee is continuing the calculations and estimations to make up the Japanese level of clearance. This committee was assigned from 1997 under the Nuclear Safety Commission to examine the clearance level of low level radioactive waste.

In the field of large accelerator, the discussion on the clearance level is not yet started in Japan. So the anther would like to express the situation in the reactor field as a reference.

2. METHOD AND RESULT

The target individual dose for radiation safety to general public is 10 μSv/y. This value was used to each considering scenario to keep radiation safety. The selection of 20 major nuclides were also done for the performance of the migration and dose calculations.

The first route of cleared materials is disposal. The cleared radioactive waste will be transported to the land disposal site. The first estimation is land fill at seashore or inland. Repository site reuse, flow of ground water and river water were assumed for the calculation. The 41 pass ways were considered and the 9 important pass ways were selected.

The second route is Recycle/Reuse. The cleared radioactive wastes are directly reused like pumps etc., or transported to the scrap treatment plant for the recycle. In this case the 32 pass ways were selected for the industrial and home applications of the recycling materials. Finally the 12 pass ways were listed as an important pass ways.

In these calculations the selections of the various parameters are very important and sometimes the most conservative values are selected. But this kind of imaginary value may give too much "safe" value far beyond the reality. To avoid this kind of special situation the parameters are investigated to get typical values and the extreme case was estimated by sampling calculation from the probability density function of each parameter (stochastic analysis). The 95 percentile was used for the candidate of clearance level including safety margin.

Another extreme values are obtained in case of low probability or unlikely scenarios. This will be handled by classifying the scenarios probability. The results will give us several acceptable dose levels for clearance. This issue is discussed in the committee.

The procedures of comparison with the other regulations of radiation dose levels like discharge limits and methodology development of confirmation technique of final waste form to guarantee the

Table 1 Clearance level examples for solid materials arising from nuclear reactors:(Bq/g)

Radionuclide	Derived value	Range in IAEA-TECDOC-855
H-3	200	1000-10000
Mn-54	1	0.1-1
Co-60	0.4	0.1-1
Sr-90	1	1-10
Cs-134	0.5	0.1-1
Cs-137	1	0.1-1
Eu-152	0.4	0.1-1
Eu-154	0.4	--
Total α emitters	0.2	0.1-1 (Pu-239,Am-241)

Table 2 Result of clearance level

Range of Radioactivity Levels (Bq/g)	Recommended Range in IAEA-TECDOC-855	Results		
		Disposal	Recycle/Reuse	Overall
>= 0.1 < 1.0	Mn-54 Co-60 Zn-65 Nb-94 Cs-134 Cs-137 Eu-152 Pu-239 Am-241	Co-60 Nb-94 I-129 Cs-134 Eu-152 Eu-154	Co-60 Nb-94 Cs-134 Cs-137 Eu-152 Eu-154 Pu-239 Am-241	Co-60 Nb-94 I-129 Cs-134 Cs-137 Eu-152 Eu-154 Pu-239 Am-241
>= 1.0 < 10	Sr-90	Cl-36 Mn-54 Zn-65 Sr-90 Tc-99 Cs-137 Pu-239 Am-241	Mn-54 Zn-65 I-129	Cl-36 Mn-54 Zn-65 Sr-90 Tc-99
>= 10 < 100	I-129	H-3 C-14	Cl-36 Sr-90 Tc-99	H-3 C-14
>= 100 <1000	C-14 Cl-36 Fe-55 Tc-99	Ca-41	H-3 C-14	Ca-41
>= 1000 < 10000	H-3 Ni-63	Ni-59 Ni-63	Ca-41 Fe-55 Ni-59	Fe-55 Ni-59 Ni-63

* Used scenarios, models and data are based on the Japanese experience (e.g. food consumption rates)

**The underlined nuclides are smaller intwo orders of magnitude than the value of IAEA-TECDOC-855.

clearance level will be discussed.

The severest case will give us the radioactivity level of clearance. The result of clearance level of radioactivity from power reactor is shown in Table 1. The radioactivity is classified following the IAEA-TECDOC-855. I-129, Cl-36, Tc-99 and H-3 are smaller in two orders of magnitude than the values of IAEA-TECDOC-855. This was caused by the difference of the scenarios, models, and data derived from Japanese experience, e.g. food consumption rates.

3. DISCUSSION POINTS

The first point is the uncertainty of parameter values. The first step of calculation of clearance level is a deterministic model calculation by using typical parameters. In this stage the fluctuations of the level are estimate by introducing stochastic analysis based on the selection of parameters from the probability density function.

Second point is a collective dose. In the new Publication of ICRP77 (Radiological Protection Policy for the Disposal of Radioactive Waste) the use of collective dose concept to the radioactive waste is indicated. The guided value of collective dose appears in BSS (IAEA-SS-115) and ICRP Publ.46. The value is 1 man·Sv. But is this value really applicable to a very low level dose rate situations like 10 μSv/y? This issue will be also discussed.

The third point is an unlikely or very low probability scenario. In ICRP Publ.46 the concept of risk derived from the multiplication between annual dose and the probability is shown as an effective method to grasp this kind situation. Or the concept of potential exposure (e.g. ICRP Publ.76) may be effective to understand this kind of low probable scenario. The risk concept scarcely appeared in Japanese regulatory system under Nuclear Safety Commission. How to handle this kind of problem, will be needed to discuss.

4. CONCLUSION

The present status of discussion on the clearance level in Japan is presented. As a result of the clearance level for each radioactive material fro power reactor was sown. The distribution of calculated radiation doses are estimated by the stochastic analysis by selecting parameters from the probability density functions. These values of clearance level will be greatly useful for the real scene of reactor decommissioning. For large accelerator facilities, nearly same procedure will be requested to establish the clearance level for accelerator facilities. This is eagerly desired for the reasonable management of accelerator radiation protection.

5. REFERENCES

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