

Study of Validity Criteria for Radionuclide-Analysis of Low- and Intermediate-Level Radioactive Waste

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1. Introduction

Waste generator's self-test, preliminary inspection by Korea Radioactive waste Management Corporation (KRMC), and repository inspection are carried out during Low- and Intermediate-Level radioactive Waste (LILW) disposal process. Literature survey on the deviation of the measuring equipment and statistical analysis on the measured data of domestic LILW were performed in order to set evaluation criteria quantitatively when comparing the result of each test and inspections. This study provided opportunity to increase credibility and re-assure validity of Waste Acceptance Criteria (WAC).

2. Methods and Results

In this study, comparative evaluation points were optimized and the deviation for measurements of domestic LILW was specified to present the evaluation criteria of the waste drum assay during the waste inspection. To determine the acceptable range of deviation of comparative evaluation points, measurements of 1,536 drums commissioned to disposal from Ulchin and Wolsung Nuclear Power Plant(NPP) in 2011 were statistically analyzed. 97 drums were used for sample check, and 63 drums were used for characterization.

2.1 Check the Measurement Accuracy of Waste Drum Assay System

The measurement accuracy of Waste Drum Assay System was maximum-169.9 %, minimum-7.2 % measured by Canberra Industries, Inc. and maximum-1,617 %, minimum-20.4 % by Los Alamos National Laboratory. When the concentration of transuranic (TRU) radionuclide inside of waste drum is as low as 0 ~ 370 Bq/g(10 nCi/g), the deviation of the measurement accuracy is very large. Therefore, it is reasonable to evaluate comparison of the measurement accuracy when the concentration of TRU radionuclide is greater than certain level.

Based on the criteria of calibration verification check for the domestic Waste Drum Assay System, maximum deviation is expected to be 60 % when confidence level

of the measurement uncertainty is 1σ . Extending the confidence level to 3σ , the total measurement uncertainty increased up to 120 % for TGS and 210 % for SGS. However, considering density of material within the waste drum is up to 3.0 g/cc, the measurement uncertainty increased up to higher than 300 %.

2.2 Selecting Comparative Evaluation Points

The measurement accuracy was confirmed for the nuclide analysis results of domestic LILW depending on the waste generation date, birthplace, medium type, density of drum, surface dose rate and specific activity. As a result, the distribution of measurement accuracy of the specific activity of Co-60 and Cs-137 that are the basis of gamma-ray measurement was found to be maintained at a constant level. Therefore, specific activity of Co-60 and Cs-137 as evaluation point is reasonable.

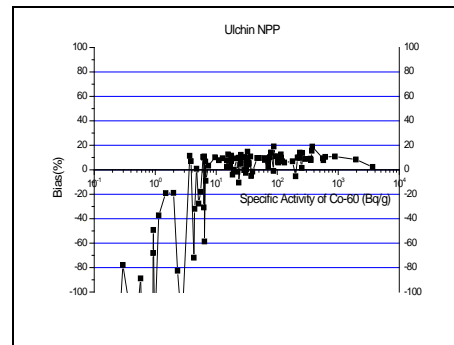


Fig. 1. The distribution of measurement accuracy depending on the specific activity of Co-60 at Ulchin NPP.

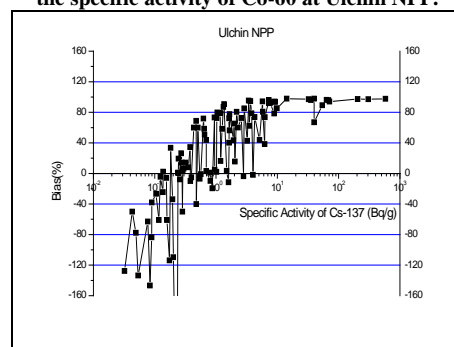


Fig. 2. The distribution of measurement accuracy depending on the specific activity of Cs-137 at Ulchin NPP.

2.3 Setting Acceptance Criteria

Because of very low specific activity under threshold, the effective count value is not enough, and the deviation of measurement accuracy was very large in the distribution of measurement accuracy depending on specific activity of Co-60 and Cs-137. The threshold is a value below 10^{-5} of Disposal Concentration Limit (DCL) and unlikely to be exceeded DCL if the waste drum assay system is complied with the quality assurance activities. Therefore, the concentration of specific activity Co-60 and Cs-137 was separated into 3 sections 0 ~ 10 Bq/g, 10 ~ 10,000 Bq/g, 10,000 Bq/g ~ DCL and acceptance criteria set.

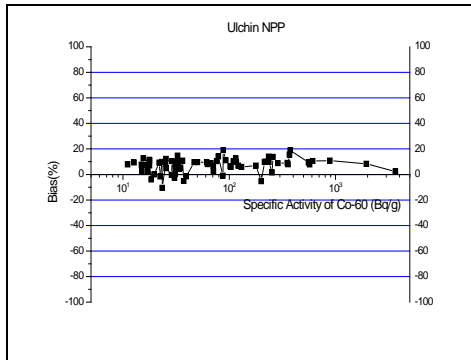


Fig. 3. The distribution of measurement accuracy depending on the specific activity of Co-60 at Ulchin NPP. Except under 10 Bq/g.

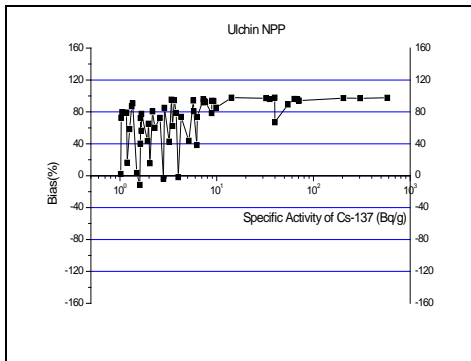


Fig. 4. The distribution of measurement accuracy depending on the specific activity of Cs-137 at Ulchin NPP. Except under 1 Bq/g.

Acceptance criteria was set to have the broadest range by comparing the overseas criteria, calibration verification checks, total measurement uncertainty and domestic LILW characterization when extend the confidence level to 3σ .

3. Conclusions

Through the statistical analysis for deviation of measurement by comparing repository inspection with generator self-test, the quantitative acceptance criteria were set depending on specific activity of Co-60 and

Cs-137. The acceptance criteria is a relative bias of KRMC result to generator result and set from low 50 % to high 150 % for Co-60, from low 30 % to 250 % for Cs-137. In this study, because the statistical analysis results of the waste drum assay are not enough representing whole range specified at WAC, an additional research that include characteristic analysis of LILW generated other birthplace should be done.

Table 1. Acceptance criteria for KRMC inspection (Co-60).

Specific Activity of Co-60 (Bq/g)	Overseas Criteria	Domestic LILW Characterization	Inspection Criteria ²⁾
0 ~ 10	Low : 75 % High : 125 %	Non	Acceptable
10 ~ 10,000	Low : 50 % High : 150 %	Low : 89 % High : 120 %	Low : 50 % High : 150 %
10,000 ~ DCL ¹⁾	Low : 50 % High : 150 %	No Data	Low : 50 % High : 150 %

1) Disposal Concentration Limit
2) Confidence Level : 3σ

Table 2. Acceptance criteria for KRMC inspection (Cs-137).

Specific Activity of Cs-137 (Bq/g)	Overseas Criteria	Domestic LILW Characterization	Inspection Criteria ²⁾
0 ~ 1	Low : 40 % High : 175 %	Non	Acceptable
1 ~ 1,000	Low : 30 % High : 200 %	Low : 89 % High : 197 %	Low : 30 % High : 250 %
1,000 ~ DCL ¹⁾	Low : 30 % High : 200 %	No Data	Low : 30 % High : 250 %

1) Disposal Concentration Limit
2) Confidence Level : 3σ

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