Verification of Representative Sampling in RI waste

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1. Introduction

For evaluating the radionuclide inventories for RI wastes, representative sampling is one of the most important parts in the process of radiochemical assay. Sampling to characterized RI waste conditions typically has been based on judgment or convenience sampling of individual or groups. However, it is difficult to get a sample representatively among the numerous drums. In addition, RI waste drums might be classified into heterogeneous wastes because they have a content of cotton, glass, vinyl, gloves, etc. In order to get the representative samples, the sample to be analyzed must be collected from selected every drum. Considering the expense and time of analysis, however, the number of sample has to be minimized.

In this study, RI waste drums were classified by the various conditions of the half-life, surface dose, acceptance date, waste form, generator, etc. A sample for radiochemical assay was obtained through mixing samples of each drum. The sample has to be prepared for radiochemical assay and although the sample should be reasonably uniform, it is rare that a completely homogeneous material is received. Every sample is shredded by a 1 ~ 2 cm^2 diameter and a representative aliquot taken for the required analysis. For verification of representative sampling, classified every group is tested for evaluation of "selection of representative drum in a group" and "representative sampling in a drum".

2. Status of RI waste drums

RI wastes drums have collected from RI utilizing instate and stored in the interim storage facility of KMAC. As of December 2005, the amount of RI waste drums was 10,470 drums, which is showed in Table 1. In Table 1, the waste forms are mostly classified into a combustible, incombustible, non-compressible and Filter waste. Most drums, which is a ratio of 82.5 %, belong to the combustible type waste. The content of combustible type wastes are mainly cotton, paper, vinyl, plastic, etc., and in case of incombustible and non-compressible type wastes are individually including glass and metal-kind materials. Also, the filter means mainly HEPA or charcoal filters.

Table 1. Status of RI waste drum in the interim storage facility

	No. of generator	No. of drum
Combustible	215	8,636
Incombustible	68	981
Non-compressible	139	683
Filter	22	170
Total	241	10,470

3. Methods and Results

3.1 Sampling Scheme

Opened drums for Sampling were selected by $\sqrt{N}$ from among several drums of a group, which is classified based on the factor of half-life, surface dose, acceptance date, waste form, generator, etc. About 30 % of drums in the classified RI waste drums were opened. The sample was collected from every selected drum, shredded at a suitable size, and mixed to make the analyzed sample.

3.2 Verification Methods

Adequacy and propriety of the chosen drums and their number can be evaluated by using the total quantity of the open drums. Also, the nuclides for an examination are selected as β emitting nuclides (^{3}H, ^{35}S) and γ emitting nuclides (^{60}Co, ^{137}Cs). A representative verification is carried out by using relative standard deviation of assay results in a group through the outlier test and compared analysis with the population average. At an upper and lower control limit, every data, which are met within the range of a confidence level of 95 %.

One of the most important properties of an analytical method is that it should be free from systematic error. This means that the data value which it gives for the amount of the analyte should be the true value. This property of an sampling method may be tested by applying the method to a standard test portion containing a known amount of analyte.

In Equation 1, the means T and uncertainty u_A in a group are obtained through opening almost all the drums in a group and analyzing radiochemically the

mixing samples. So, the T value is nearly closed to the true value. Otherwise, the average A and its uncertainty u_A calculated from a drum selected at the same group with mean T and its uncertainty u_T.

$$E_n = \frac{\overline{A} - \overline{T}}{\sqrt{u^2{}_A + u^2{}_T}} \qquad \text{(eq. 1)}$$

Taking the null hypothesis that the two sampling methods give the same result, that is H0:$u_A = u_T$, we need to test whether (average A – average T) differs significantly from zero. If the two samples have standard deviations which are not significantly different, a pooled estimate, s, of the standard deviation can be calculated from the two individual standard uncertainties. Finally, selection of representative drum can be verified through comparison of the true mean and its uncertainty with specific value analyzed from a drum. En values are usually considered to be acceptable within ± 2.

3.3 Evaluation of representative sampling s

Table 1 shows the means radioactivity of a group and average radioactivity of an evaluation drum. To obtain the value closed to true, 9 drums were opened from among total 12 drums of a group, and each 3 drums was mixed. Eventually, analysis of H-3 was carried out 3 times with different sample at the same group. Also, evaluation drum is opened and analyzed from another drum.

In Table 1, we know the radioactivity for H-3 is not big on the difference between the samples because RSDs of the samples are calculated within 30%. Also, En value is obtained to 1.63, so that the result is not significant at the 5% level, that is, radiochemical result of evaluation drums is equal to the result of the population at the 95 % confidence level.

Table 1. Comparison of true value and tested value

sample	H-3				En
	Activity (Bq/g)	Ave.	SD	RSD	
#1	37.9				
#2	39.2	34.1	7.8	22.9	1.63
#3	25.0				
Evaluation drum	-	19.7	4.1	20.8	

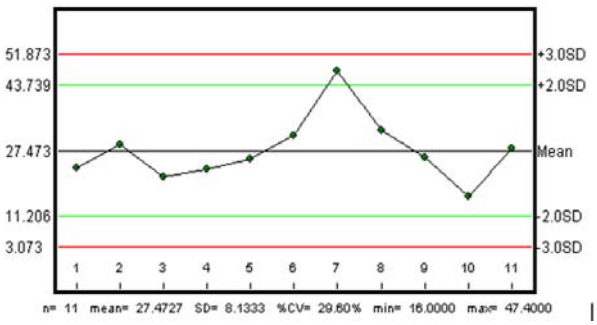

Figure 1. RSD control charts for sampling lot

Another method, the representative sampling was verified by using RSD control charting as shown in Figure 1. RSD means the value dividing the average by the standard deviation. Figure 1 show the RSD data analyzed for H-3 at specific date and the data is arranged according to the sampling date.

In figure 1, most of data values were located within 2 sigma. 7th data, however, is deviated from the limit of 2 sigma, and located between 2 and 3 sigma. So, Grubbs' test was carried out for the suspected data. In the result of Grubbs' test, the data was judged to outlier. If the specific data is determined to outlier through the Grubbs' test, every sampling and radiochemical method are reexamined according to the manual.

Although the sample was inhomogeneous, the sampling method has been newly developed for obtaining the representative radioactivity in the samples.

4. Conclusions

Through the development of sampling method in a drum (group), the representative radioactivity of the group can be obtained by radiochemical assay. Also, representative sampling in RI waste was verified by En or Grubbes' test

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