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A Research on Uncertainty Evaluation in Verification and Calibration on LSC facility

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1. Introduction

Compared with environmental sample existing around Nuclear Power Plant, the uncertainty due to geometry difference when the calibration about Liquid Scintillation Counter using the solid H-3 Standard Source of 200,000 DPM(Disintegration Per Minute) is executed exists. Therefore, this paper intends to investigate the root cause of uncertainty due to geometry difference using Quantulus 1220 instrument and H-3 Standard source of solid and liquid form. And Teflon vial was used as a measurement cell.

In this paper, it is judged that main factors which can bring about uncertainty about geometry difference are a plastic cell existing into Teflon vial and activity difference, the configuration difference of H-3 Standard Source, and evaluation on these factors are performed through experiment and measurement.

2. Methods and Results

For investigating the underlying cause of uncertainty, after samples for calibration by using H-3 standard source and the mixing ratio of 8:12 were manufactured, measurement on samples by using Sensitivity Study result to increase accuracy and precision was performed, also, Radioactivity-Error-Analysis Method was used in order to verify measurement results on samples in this paper, and the effect by geometry difference based on verification result was evaluated quantitatively.

According to the result of Sensitivity Study[1,2], in case of using the exposure time of 75sec and Repeat method, the measurement accuracy of about 1-3% was increased in comparison with that of 15sec and Replicate method. Therefore, Repeat method and the exposure time of 75sec were used for evaluating uncertainty. Main variables used for evaluating uncertainty are CPM(Count Per Minute), SQP(E), Error, and the criterion of amount of these variables is the value of CPM, SQP(E), Error when plastic cell does not exist into Teflon vial.

2.1 Effect by a Plastic Cell

For evaluating effect by a plastic cell, samples were manufactured by using Liquid Standard source of 30,000 DPM. Plastic cells of cylinder form were put into Teflon vial, and measurement result on samples manufactured was displayed in Figure 1. By Figure 1, according as the number of plastic cells increase, the amount of variations of Error and CPM increases but that of SQP(E) is almost same. From these result, it can be derived that error is not affected by SQP(E) but largely by CPM.

It is judged that this trend appears because a plastic cell existing into Teflon vial plays the role of reflector rather than quencher. That is, if photons flown out from scintillator meet with plastic cells before arriving at PMT(Photo Multiplier Tube), parts of photons are reflected by plastic cells. After all, the amount of variation of CPM increases as photons reflected are measured by the opposite PMT, and by these phenomena, it is judged that error increases according as the number of plastic cells increases.

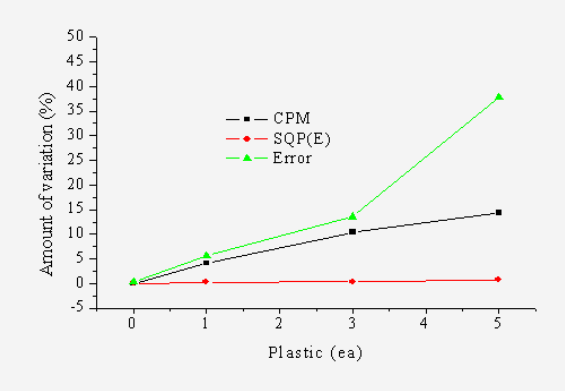

Figure 1. Trend of SQP(E), CPM and Error according to the number of plastic cell

2.2 Effect by Activity

For evaluating effect by activity when a plastic cell exists into Teflon vial, after samples were made by using Liquid H-3 Standard Source of 1,000, 30,000, 200,000 dpm, a plastic cell was put into each sample and measurement results on samples manufactured were displayed in Figure 2. By below Figure 2, according as activity increases, the amount of variation of CPM and Error decreases, on the other hand, that of SQP(E) is almost same, and it is judged that these trends can be explained below.

Because the activity of 200,000 DPM is large compared with 1,000 and 30,000 DPM, it is judged that effect by the activity of 200,000 DPM is neglected in comparison with other activity. That is, according as activity increases, role as a reflector decreases, and it is

judged that CPM and error decrease also because of these physical phenomena

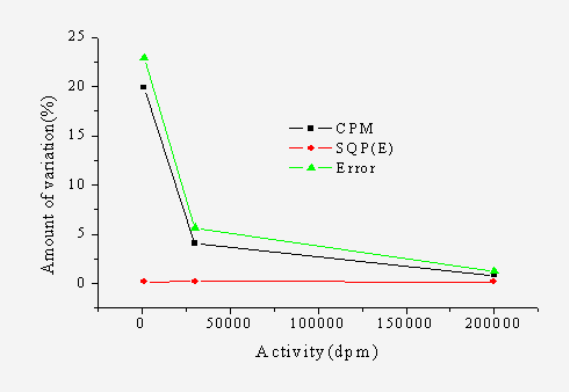

Figure 2. Trend of CPM, SQP(E) and Error according to activity when plastic cell exists

2.3 Effect by Source Configuration

For evaluating effect by H-3 Standard Source configuration, after samples were made by using Liquid and Solid H-3 Standard Source of 200,000 dpm, a plastic cell was put into two of four samples manufactured and measurement results on samples manufactured were displayed in Table 1.

By below Table 1, on the occasion of Liquid 200,000 dpm, whether a plastic cell exists or don't exist into Teflon vial, CPM and SQP(E) and error do not almost change. However, in case of Solid 200,000 dpm, it can be seen numerically through Table 1 that although a plastic cell doesn't exist into Teflon vial, error itself is considerably large. From these result, in this paper, it is judged that Solid H-3 Source itself may have several problems, and that when verification and calibration on LSC facility are performed periodically, Liquid H-3 Standard Source have to be used.

Table 1. Evaluation result on source configuration

Section	CaseA	CaseB	CaseC	CaseD
STD (DPM)	Liquid 200,000	Liquid 200,000	Solid 200,000	고상 200,000
Plastic existence	×	O(1ea)	×	O(1ea)
SQP(E)	736.8 (0.00%)	735.7 (0.15%)	738.1 (0.00%)	736.5 (0.22%)
CPM	47,121 (0.00%)	46,748 (0.58%)	38,805 (0.00%)	38,732 (0.19%)
EFF(%)	25.13	24.99	25.32	24.92
Error(%)	0.53	1.21	18.7	17.4

3. Conclusion

By means of analysis result on geometry difference, a plastic cell did play role as a reflector into Teflon vial, and the more the number of it which were put into Teflon vial increases, the more CPM increases. Due to the increment of CPM, Error increases. Also, the more activity increase, the less effect by a plastic cell decreases, and effect by a plastic cell and activity difference can be neglected at the activity of 20000dpm.

However, Error by Solid Standard Source itself appeared large even 200,000dpm, from this result, it is judged that there may be several matters at Solid H-3 Standard Source itself in this paper, and that Liquid Standard Source above 10,000dpm have to be used when calibration and verification on LSC facility are performed.

REFERENCES

[1] Eung-Seop Park, Sang-Jun Han, Seung-Jin Lee, Hee-Gang Kim, Na-Young Lee, Ji-Yeon Mun, Research on Measurement Condition Establishment of a Liquid Scintillation Counter System, Journal of the Korean Association for Radiation Protection, Vol. 31, No. 3, pp. 155-164, 2006.

[2] Yeong Gwang Nuclear Power Plant Supervisory Center, A Research on Development and Correction of Standard Source of Liquid Scintillation Counter for Analyzing Environment Sample, Ministry of Commerce, Industry and Energy, Final Report, R-2005-0-005, 2007.