Verification Method for the in Situ Measurement for Decommissioning Characterization

Sang Bum Hong*, Byung Chae Lee, Jun Ha Kim, Young Yong Ji, In Hye Hahm, and Bum Kyoung Seo
Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea
*sbhong@kaeri.re.kr

1. Introduction

The objective of radiological characterization is to provide a reliable data of the physical, chemical and radiological status for preparing the decommissioning nuclear facilities. Three kinds of in situ measurement may be used in relation to characterization: dose rate measurements, radioactive contamination measurements and measurement of relative individual radionuclide activities by spectrometry. In situ gamma spectroscopy has been shown to be cost effective and powerful tool in characterization survey for decommissioning [1-2]. The ISOCS software is capable of establishing an absolute efficiency calibration for a desired energy range based on numerical simulation and adequate knowledge of the sample geometry and chemical composition. The software provides a variety of geometry templates which covers a wide range of possible sample configurations [3].

In this study, verification method was proposed based on the dose comparison between spectrum derived dose rate and MCMP calculation dose from the radionuclide activities from spectrum analysis. The verification method was applied to the characterization survey for the pipe geometries in the Kori unit 1.

2. Verification in Situ Measurement Method for Characterization

2.1 Spectrum Derived Dose Rate Calculation

The dose rate from spectroscopy using a portable HPGe detector (ISOCS, GC4019, Canberra Inc.) was established by calculating a G-factor method through the Monte Carlo simulation. The G-factor is a dose conversion factor used to measure the ambient dose rate from the count rate at the measured energy spectrum, which was calculated using MCNP code. The response function of the detector was calculated for the vertical incident photon to the detector axis by the Monte Carlo simulation. The doe rate could be calculated of multiply the integration of the measure count rate by G-factor for the measured energy range.

$$\dot{X} = \int n(E)G(E)dE \qquad (1)$$

where $\dot{X}$ is the ambient dose rate, n(E) is the measure count rate, and E is the photon energy.

2.2 MCNP Simulation of Dose Rate Calculation

The ISOCS system couples previously proven detector hardware with innovative calibration software to produce an integrated instrument capable of quantified analysis in the field comparable to laboratory analysis. The user must fully define the geometries and chemical compositions of the system and then input this information into the ISOCS software.

The source term was measured and calculated using ISOCS system and the results of the radionuclides used for dose calculation using MCNP simulation. The ISOCS system was applied for characterization of pipes geometries in Kori unit 1, the physical characterization of the pipe was consisted of the SUS SA-240 type 316 L stainless steel with density 8.03 g/cm^3.

The measuring condition of the field measurement was adopted the 45-degree shield, so the field of view of geometry was limited the diameter is 10.2 cm, length is 60 cm. the contaminated layer is assumed 0.1 cm thickness of contamination in the pipe. Fig. 2 shows the geometry of the MCNP simulation.

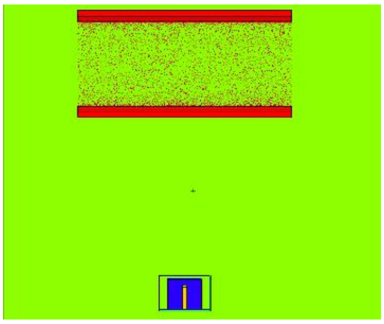

Fig. 1. MCNP simulation for pipe geometry.

2.3 Verification Methods and Results

The dose rate was calculation and compared between the G-factor method from measured spectrum and MCNP simulation from the defined source term of using ISOCS analysis method for validation of in situ measurement results for decommissioning.

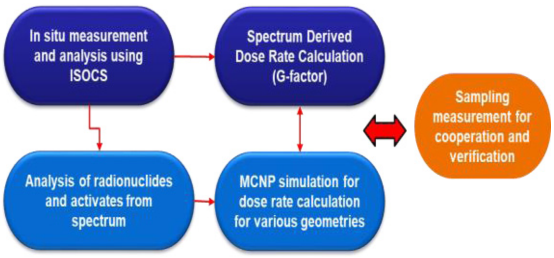

Fig. 2. Flow Sheet of verification process.

Table1. Component Documents Management

	Pipe A	Pipe B
G-factor (Sv/h)	3.31	3.31
MCNP calculation (Sv/h)	3.22	2.61
Relative error (%)	2.7	1.9

Fig. 2 shows the flow sheet of validation process by comparing the dose rate calculation.

The table show the compression results of in situ measurement for validation, the calculation results of dose rate show good agreement.

3. Conclusion

There is no better alternative NDA technique to the high resolution gamma spectrometry method with absolute calibrated such as implemented with ISOCS. In situ measurement has higher uncertainty than sampling analysis in laboratories form the measuring condition such as background of surrounding area, source position, radiation dose etc. In situ measured spectrum based dose rate calculation with compered with ISOCS and MCNP calculation could be the validation for decommissioning characterization

ACKNOWLEDGEMENT

This work was supported by a grant from the National Research Foundation of Korea (NRF), funded by the Korean government, Ministry of Science, ICT and Future Planning (No. 2017M2A8A5015143).

REFERENCES

[1] IAEA, “Radiological Characterization of shut Down Nuclear Reactors for Decommissioning Purpose”, International ATOMIC ENERGY AGENCY Technical Report Series No. 389, 1998, VIENNA.

[2] S. B. Hong, M. J. Kang, K. W. Lee, U. S. Chung, “Development of scaling factor for the activated concrete of the KRR-2," Applied radiation and Isotopes, 67, 1530-1533 (2009).

[3] V. Nizhnik, A. Belian, A. Shephard and A. Lebrun, “In Situ Object Counting System (ISOCSTM) Technique: a Cost-Effective Tool for NDA Verification in IAEA Safeguards, IEEE, 2011.