Preliminary Evaluation for the Nuclide Inventory of the RCP Suction Leg for Decommissioning of Kori Unit 1

Jonghoa Kim*, Homin Jeon, Yongsik Kim, Jaejoon Song, Kyeongho Han, and Jangsoo Seo
Sae-An Engineering Co., Ltd, 184 Gasan Digital 2-ro, Geumcheon-gu, Seoul, Korea
*jhkim4198@sae-an.co.kr

1. Introduction

The methods for evaluating the gamma nuclide inventory present on the inner surface of component subject to decommissioning Nuclear Power Plant are LABSOCS (Laboratory SOurceless Calibration Software) that indirectly measures a sample that can demonstrate the representativeness of component subject to decommissioning, ISOCS (In Situ Object Counting System) that measures directly from the surface of a component subject to decommissioning, and MicroShield® computer program that estimates the nuclide inventory on the inner surface of component using the dose rate of component subject to decommissioning and the radioactivity of the sample[1,2,3,4].

In this study, ISOCS was used to evaluate the direct nuclide inventory for the RCP Suction Leg B of Kori unit 1. The contact dose rate was calculated by MicroShield® ver. 10.03 computer program and compared with the direct measurement by Teletector.

2. Materials and Methods

2.1 ISOCS

Unlike fixed semiconductor detectors, ISOCS does not use standard calibration sources for calibration. ISOCS performs the efficiency calibration by modeling the measurement object with the source. ISOCS can evaluate nuclides and radioactivity quantitatively regardless of the size of the target. The ISOCS detector used in this study is a high purity germanium detector manufactured by CANBERRA. The detector relative efficiency is 20% and the energy resolution is 1.8 keV at ^{60}Co of 1.33 MeV[1, 2].

2.2 MicroShield Computer Program

The MicroShield® computer program uses 16 fixed geometry models for radiation shielding evaluation of point sources, line sources, and volume sources using the Point Kernel method. The basic concept of the Point Kernel method is to divide the volume source into a large number of small point sources and regard each as a point source, and add up the respective contributions. The fixed geometry model approach reduces the effort required to express the geometry numerically for shielding evaluation, and can be applied to most problems, except when an accurate evaluation of complex geometry is required[3,4].

2.3 RCP Suction Leg B

The length of the RCP Suction Leg B measured by ISOCS is 184 cm, the radius is 39.25 cm, the thickness is 7.62 cm, and the material is carbon steel. The inside of the pipe is 100% drained and the inside is filled with air.

2.4 Measurements Methods

The contact dose rate of RCP Suction Leg B was estimated to be 2 mSv/h at maximum, and the detector was located 254 cm from the surface of RCP Suction Leg B as shown in Fig. 1 to satisfy dead time within 10%. And an absorber of 3.95 cm (lead: 2.75 cm, stainless steel: 1.2 cm) was placed in front of the detector and measured for 1,000 seconds.

Fig. 1. Measurement position of ISOCS.

3. Results and Discussions

The nuclide inventory of RCP Suction Leg B measured by ISOCS were ^{58}Co 3.87×10^9 Bq, ^{60}Co 3.19×10^{10} Bq, and ^{65}Zn 3.01×10^9 Bq. And the spectrum is shown in Fig. 2.

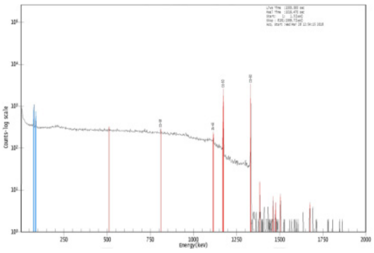

Fig. 2. Spectrum of RCP Suction Leg B.

The contact dose rate of the RCP Suction Leg B nuclide inventory was estimated to be 2.85 mSv/h using a MicroShield computer program. Therefore, the relative error of 2 mSv/h directly measured by Teletector was 0.43.

When the contact dose rate of RCP Suction Leg B was 2 mSv/h, the radioactivity of ^{60}Co single nuclide was evaluated by MicroShield computer program as 2.36×10^{10} Bq. Therefore, the relative error to 3.19×10^{10} Bq directly measured by ISOCS was 0.26.

4. Conclusion

In this study, the stock of nuclide stocks was evaluated by ISOCS and MicroShield ver. 10.03 computer program for Kori Unit 1 RCP Suction Leg B. The ^{60}Co radioactivity evaluated by ISOCS and MicroShield is 3.19×10^{10} Bq and 2.36×10^{10} Bq. Therefore, the relative error was 0.26. On the other hand, since the components subject to decommissioning have complicated shape and various materials, optimal modeling for this is important. In addition, for accurate error range and applicability, it is necessary to verify the validity of ISOCS and LABSOCS by performing radioactivity measurement and mutual comparison and analysis.

Acknowledgments

This study was conducted as part of the "Development of Decontamination Technology of Reactor Coolant System and Dismantled Equipment foe NPP Decommissioning" project supported by the MOTIE (Ministry of Trade, Industry and Energy) and the KETEP (Korea Institute of Energy Technology Evaluation and Planning (Project Number: 20141510300310).

REFERENCES

[1] CANBERRA, In-Situ Object Counting Systems, 2012.

[2] CANBERRA, Genie 2000 Spectroscopy Software Operation Manual, 2013.

[3] Grove Software, "MicroShield ver. 10.03", 2015.

[4] Grove Software, "MicroShield® User's Manual", 2015.