Radiation Shielding Analysis for Conceptual Design of Reactor Coolant System Decontamination Equipment of Kori Unit 1

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1. Introduction

Kori Unit 1 was permanently shutdown suspended at 24:00 on June 18, 2017. KHNP will conduct chemical decontamination of the reactor coolant system in order to minimize worker dose and radioactive waste in decommissioning of Kori Unit 1. In this study, radiation shielding analysis was performed on ISOCS and MicroShield® computational program for the filter which primarily removes the crud particles after chemical decontamination of the reactor coolant system of Kori Unit.1.

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 Design Guidelines for the Shields

In this study, the design guidelines for the shields are 2.50E-02 mSv/h specified in the Nuclear Safety Commission Notice No. 2017-36 (Radiation Protection Standards).

3. Results and Discussions

3.1 Kori Unit 1 Reactor Coolant System Radioactive Inventory

As of March 27, 2018, the total radioactivity inventory of the Kori Unit 1 reactor coolant system, calculated using the ISOCS and MicroShield® computational programs, is 4.1930×10^{11} Bq. The nuclide inventories are ^{58}Co 58 4.2703×10^{11} Bq, ^{60}Co 3.4385×10^{12} Bq and ^{65}Zn 3.2748×10^{11} Bq.

3.2 Radiation Shielding Analysis of Filter

Fig. 1 shows the geometry model for the radiation shielding analysis of the filter with the MicroShield® computer program.

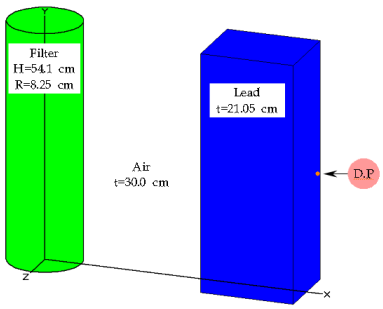

Fig. 1. Filter schematics showing models built in Microshield® Computer Program.

The contact exposure rate of the filter calculated by the MicroShield® computer program is 2.817E+05 mSv/h. The minimum shielding thickness of lead satisfying the design criteria of shielding 2.50E-02 mSv/h is 21.05 cm. The results of the radiation shielding analysis for the filter are shown in Fig. 2.

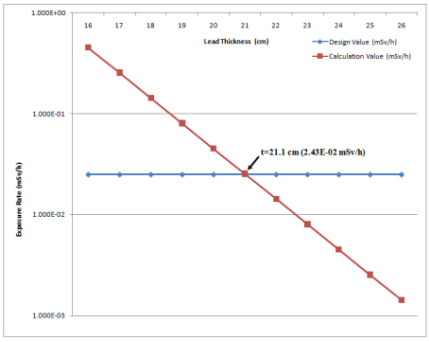

Fig. 2. Lead thickness vs. exposure rate.

4. Conclusion

In this study, the radiation shielding analysis was performed on the filter which is one of the decontamination equipment components of the Kori unit 1 reactor coolant system.

The total nuclide inventories of the Kori Unit 1 reactor coolant system are ^{58}Co 58 4.2703×10^{11} Bq, ^{60}Co 3.4385×10^{12} Bq and ^{65}Zn 3.2748×10^{11} Bq. The minimum shield thickness of lead for filters meeting the design criteria of shielding material 2.50E-02 mSv/h when calculated with the MicroShield® computer program is 21.05 cm. Verification of the evaluation results will be made using ISOSHLD or EasyQAD computer program.

ACKNOWLEDGEMENT

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