# Development of Gamma Scanning System for Irradiated Materials

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## 1. Introduction

Various post-irradiation examination (PIE) of fuels and materials irradiated in HANARO research as well as commercial reactor have been performed in Irradiated Materials Examination Facility (IMEF). In particular, there is steady PIE demand for materials irradiated a commercial reactor to analyze defects or produce basic data for decontamination and decommissioning.

A gamma scanning is one of the basic non-destructive test and it is used to analyze gamma emission nuclides and a specific activity. The existing gamma scanning system installed in IMEF is separated into a detector part and a specimen part because of a high radioactivity of an irradiated fuel [1]. However, the gamma scanning system is not suitable for measuring irradiated materials which have relatively low radioactivity because the hotcell wall which separate the two parts is too thick. Therefore the gamma scanning system for the irradiated materials was developed.

The gamma scanning system for the irradiated materials and test results using the system are introduced in this paper.

## 2. Methods and Results

### *2.1 Gamma Scanning System*

Fig. 2 shows the gamma scanning system for the irradiated materials. The system is composed of the HPGe detector, the shielding material, the collimator, and the shielding for specimen. The shielding materials and the collimator were made of a lead to reduce a radiation exposure of a researcher. And it can reduce an influence of a background caused by contaminants in the service area. The system was designed to adjust a dead time of the detector using the collimator and to able to measure by position using bench that can move in X,Y,Z-axis.

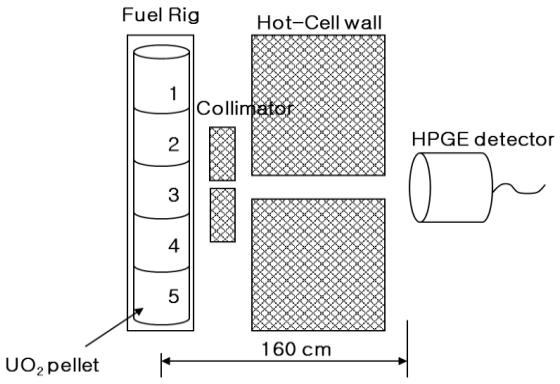


Fig.1. Schematic diagram of existing gamma scanning system installed in IMEF.

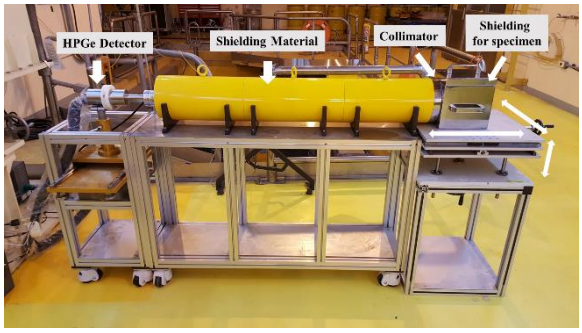


Fig. 2. Gamma scanning system for irradiated materials.

### *2.2 Evaluation of background influence*

The shielding materials were used to minimize the influence of the background caused by contaminants

in the service area. Gamma scanning was performed to compare the background effects before and after use of the shielding materials.

An energy calibration was performed using standard sources of Co-60 and Cs-137 before the measurement. The measurement was carried out for 3,600 s (Live time) and the gamma scanning results of the background before and after use of the gamma scanning system are shown in Table 1. Although some gamma emission nuclides were still detected, the background effects were reduced by more than 97%.

Table 1. Gamma scanning results of background

| Nuclide | Energy | without system | with system |
|---|---|---|---|
| Co-60 | 1173.23 keV | 57197±277 | 1416±44 |
| Co-60 | 1332.51 keV | 52777±250 | 1415±40 |
| Cs-137 | 661.62 keV | 65369±308 | 1632±65 |

*2.3 Measurement of radioactive sample*

Gamma scanning of a radioactive sample was performed for 3,600 s (Live time). The radioactive sample is a filter collected from a spent fuel pool of a nuclear power plant using an ultrasonic cleaner and it has various gamma emission nuclides.

As the results of the gamma scanning, Co-57, Co-58, Co-60, Mn-54, Nb-95 and so on were detected as shown in Fig. 3. The detected radionuclides are mainly found in a primary coolant of a nuclear power plant. Especially, Co-58, Co-60, Mn-54 and so on are main factors that increase the dose rate of a reactor system and they are main source of radiation exposure when workers approach the system for maintenance and inspection in a radiation area. Also, Co-60 which has a long half-life is nuclide that require a special attention when handling and disposing of a radioactive wastes.

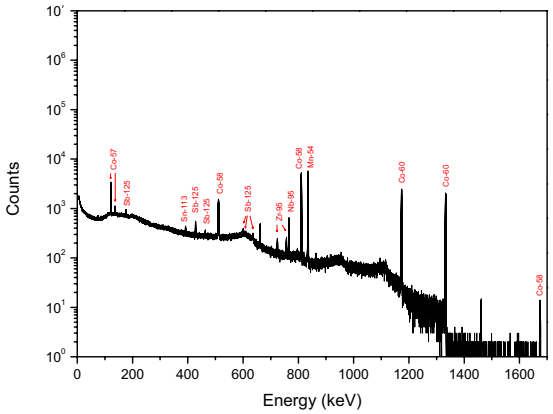


Fig. 3. Gamma scanning result of radioactive sample.

## 3. Conclusion

The gamma scanning system was developed for various PIE demand of materials irradiated in the commercial reactor. The gamma scanning system was designed to minimize the background influence and produce the reliable data. As the results of measuring the radioactivity sample, gamma emission nuclides can be clearly confirmed without the background influence. In the future, the specific activity measurement of a radioactive sample will be performed by establishing an efficiency calibration procedures appropriate to the gamma scanning system.

## REFERENCES

[1] H.M.Kim, S,J,Baik, B.O.Yoo, Y.S.Choo, and W.S.Ryu, “Technical Development of Gamma Scanning for Irradiated Fuel Rod after Upgrade of System in Hot-cell”, KAERI/TR-3425/2007.