Development of Gamma/Neutron Combined Counter for Small SF Sample Application

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1. Introduction

Nuclear material accounting in the spent fuel handling facilities is indispensable to the safeguards, and various measuring methods are used for it. Several non-destructive accounting methods such as gamma-ray spectrometry, neutron counting, calorimetry, K-Edge/K-XRF, and so on can be employed in a case of wet processing products without fission products[1]. But if the gamma emitting fission products include in the processing materials, the above-mentioned methods are limited to use of nuclear material accounting. In this study, a gamma/neutron combined system was designed for neutron coincidence counting and gamma isotopic analysis for small spent fuel samples before measuring pyro-processing products.

2. Design of Gamma and Neutron Counter

2. 1. Gamma Detection System

Gamma detection system is consisted of HPGe detector, collimation assembly, and electronic equipment for spent fuel measurement. A gamma-ray collimator placed between HPGe detector and spent fuel sample plays an important role in the shield and passage of gamma radiation. The detector has to detect all of the incident gamma rays from disc-typed spent fuel sample for correct data acquisition because of different isotopic distribution according to the sectional position of the sample. Then a double cone-shaped collimator as shown in Fig.1 was devised to accomplish its purpose on the extension of solid angle and radiation shield.

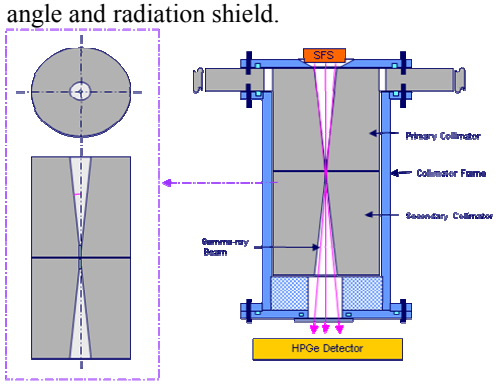

Fig.1. Schematic Drawing of Double Cone-Shaped Collimator and Assembly.

2.2. Neutron Counter

Neutron counter is consisted of He-3 detectors, high density polyethylene (HDPE) neutron moderator, gamma-ray shielding material, electronic equipment such as preamplifier/amplifier unit, a shift register, and a PC loaded with INCC software. The size of the counter was determined to consider a size of shielded glove-box to be installed and an easiness of spent fuel sample remote handling. After deciding a basic model of neutron counter as shown in Fig.2, neutron counting efficiency was evaluated by MCNPX code. The input data and the result were listed in Table 1.

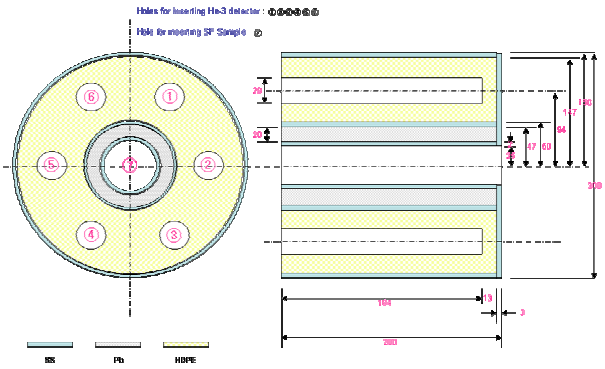

Fig.2. Basic model of neutron counter.

Table 1. Some input data and result for MCNPX calculation

He-3 detector		He-3 Gas pressure	Neutron moderator	Gamma shield	Hole radius for detector	Efficiency, %
Length	Dia.					
15.4cm	2.5cm	4 atm	HDPE	Pb	1.45 cm	10.7

2.3. Shielded Glove-Box

A shielded glove-box for the installation of gamma detection system and neutron counter was partially modified. A hole was punctured on the bottom of glove-box for inserting the double cone-shaped collimator assembly. And an padirac cask adapter connected on the sample inlet/outlet door is under designed to transfer the spent fuel samples. Fig.3 shows a schematic drawing of shielded glove-box to be installed with gamma detection system and neutron counter.

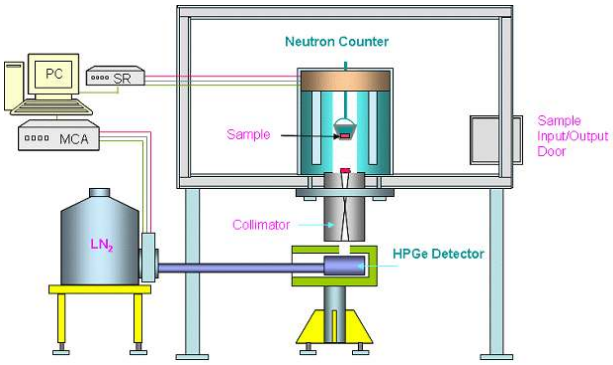

Fig.3. Schematic drawing of shielded glove-box for gamma and neutron counter

3. Conclusions

A gamma/neutron combined counter was designed for small spent fuel sample application, and main components of gamma detection system and neutron counter are under fabrication and construction. This combined counter will be installed in a shielded glove-box, and then an active performance test will be carried out in the near future.

REFERENCES

[1] Wayne D. Ruhter, R. Stephen Lee, Herbert Ottmar and Sergio Guardini, "Nondestructive assay measurements applied to reprocessing plants", Proceedings of the tripartite seminar on Nuclear Material Accounting and Control at Radiochemical Plants, Obninsk, Russia, 135-155(1988).