Preliminary Study on the Analysis of Alpha Emitters at Working Places in Nuclear Power Plants

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1. Introduction

Oversea nuclear power plants have been reported cases of internal contamination by alpha nuclides. In many cases, stations encountered significant alpha contamination when aged/legacy equipment was disturbed or handled. Under normal operating conditions, transuranic radionuclides are contained within the fuel rods and therefore are not a contributor to radioactive contamination within a facility. However, transuranic radionuclides result from the presence of tramp-uranium contamination on the exterior of fuel elements. Fuel failures may develop during operating cycles due to a variety of causes, ranging from manufacturing defects to mechanical or abrasive damage [1].

In case of domestic nuclear power plants, the pressure tube replacements in Wolseong Unit 1 and steam generator replacements in Kori Unit 1 were done. Due to deterioration of equipment in accordance with the long-term operation, the domestic nuclear power plants are expected to improve the facilities and the probability of internal exposure from alpha emitters is increasing. The domestic nuclear power plants are only keeping alpha radionuclides of the effluent from the exterior under constant surveillance. The representative areas of CV are just carried out continuous alpha monitoring in during a unit outage. So far, there is no other case with alpha nuclides analysis.

As the domestic nuclear power plants are expected to improve the facilities, it is the time to take proactive measures to deal with internal contamination by alpha emitting radioactive elements. In this paper, the possible risk of internal exposure is based on preliminary experiments on the analysis of alpha emitting radioactive elements at working places in nuclear power plants.

2. Methods and Results

This paper analyzed an appropriate samples of system/area associated with alpha contamination, smear and atmospheric measurements.

2.1 Sample preparation

Alpha contamination is most commonly associated with systems and components associated with fuel, and radioactive waste systems associated with the reactor coolant system and spent fuel pool. Experiments were carried out in a domestic PWR power plant. Sampling to evaluate alpha emitting radionuclides was carried out surface and volume samples with glass fiber filter(Watman., USA., 1.2 ㎛ pore size and 47 mm diameter) in a unit outage of the domestic PWR power plant(Table I).

Table I: Measurements of beta/alpha count

No	Measurement point	Beta contamination (Bq/Unit)	Alpha contamination (Bq/Unit)
SA-01	RCP 100ft nozzle dam work waiting room floor	28.67	0.012
SA-02	RCP 100ft interior floor (entrance)	174.87	< MDA
SA-03	RCP 100ft interior wall (inside)	0.57	0.006

SA-01, SA-02 were carried out smear, SA-03 was carried out air sampling. The air flow of SA-03 is 800L.

2.2 Chemical Separation

Containing a lot of organic matter and matrix components in glass fiber filters combined with radionuclides to remove from most other interfering elements are necessary to complex chemical pretreatment process. This procedure includes sample digestion and dissolution, chemical separation, electro-deposition followed by alpha spectrometry analysis.

Glass fiber filters can be dissolved with hydrofluoric acid, nitric acid and perchloric acid, then evaporate the digest solution to incipient dryness. Uranium isotopes were purified with an UTEVA resin. Uranium isotopes were sequentially deposited with H_2SO_4 and NH_4OH onto counting disc [2]. The measurement of Uranium isotopes was carried out by an alpha

spectrometer(Alpha Analyst Integrated Alpha Spectrometer, Model 7200-06, CANBERRA, U.S.A.).

2.3 Alpha spectrometry of the samples

Three samples were dissolved in step using a mixture of HNO_3+$HClo_4$+HF. Achieved by chemical separation of the uranium nuclides by subsequent electrolytic deposition. Finally counting is carried out and counting time was usually 200,000 sec. Fig 1, 2 shows spectra obtained after the chemical process of the sample SA 01-03.

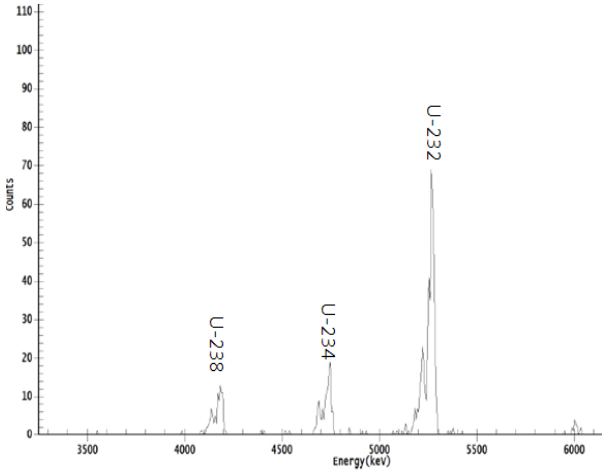

Fig. 1. Alpha-spectra of uranium from a sample of RCP 100ft nozzle dam work waiting room floor(SA-01).

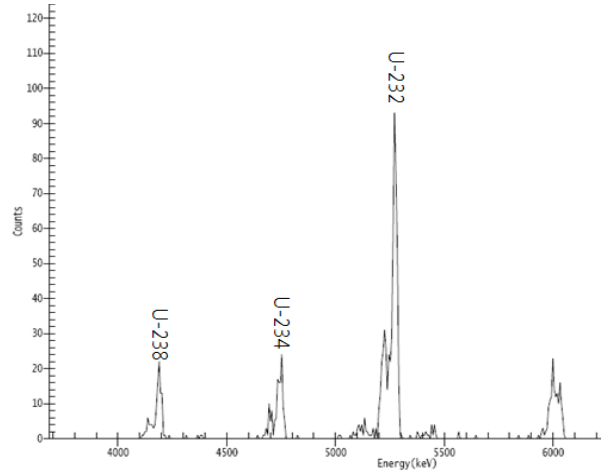

Fig. 2. Alpha-spectra of uranium from a sample of RCP 100ft interior wall(inside) (SA-03).

The chemical recovery for Uranium determined by ^{232}U tracer was 71.8%, 87.0%, 90.2% respectively. The peaks of ^{238}U , ^{234}U and ^{218}Po were observed [3]. The peaks of uranium for three samples were higher than background sample.

Table II shows the analysis of the uranium. The results of this experiment were able to identify ^{234}U and ^{238}U peaks in PWR of the system/area associated with possible alpha contamination.

Table II: Result of uranium alpha spectrometry for three samples

No	Nuclides	Activity (mBq/Unit)
SA-01	U-234	3.71
	U-238	2.79
SA-02	U-234	2.45
	U-238	1.96
SA-03	U-234	3.15
	U-238	2.56

SA-01, SA-02 were carried out smear, SA-03 was carried out air sampling. The air flow of SA-03 is 800L.

This study describes preliminary experiments on the analysis of alpha emitting radioactive elements at working places in nuclear power plants. In this experiment, the period of the air sampling and amount of the samples may not be enough. In order to clarify alpha contamination, further experiments are needed to be confirmed by determining the presence alpha emitting radioactive elements. Improving the accuracy of the measurements and carrying out complement analysis of Pu, Am, Cm would increase the reliability for alpha analysis.

3. Conclusions

Determination of the alpha emitting radionuclides of samples in the domestic power plants was performed using alpha spectrometry. It was based on system/area associated with the possible alpha contamination by carrying out smear tests, air sampling.

In the future, more experiments on the transuranic elements in the domestic PWR plants will be needed for an accurate risk assessment of internal exposure by alpha emitters. If work planning criteria and work controls for alpha information were appropriately provided, this study can contribute to management of the internal dose assessment by alpha emitters,

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