Transactions of the Korean Nuclear Society Autumn Meeting
PyeongChang, Korea, October 25-26, 2007

Hot Particles Research for Nuclear Power Plant in WOLSUNG

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1. Introduction

The evaluation of the hazard posed to the skin by very small radioactive sources (diameter < 1mm) has become popularly known as the 'hot particle' problem in European and American nuclear reactor facilities.[1,2] In this study, research to detect hot particle was performed in Wolsung Nuclear power plant (NPP) in Korea.

2. Materials and Methods

The contaminated samples employed in this study were taken from 1st site of Wolsung NPP. 7 radiation management areas such as R-503 HTR, R-501 PHT, R-104 FM, R-103 FM bridge, R-112, R-112 MOD 3211, R-108 Shoe cover were considered in this study. The dose rates were identified using Frisker. The level of measured dose rates was ranged between 1.0 and 64 mR/h. Total 10 contaminated samples were taken by smearing method with industrial gluing tape. The stated areas are presented in Figure 1.

The process of treatment of contaminated samples was divided into three steps. First, the contaminated samples were assayed using the HP(Ge) detector to find out the composition for gamma nuclides. Analysis time was 1000 seconds. Second, the image distributions of radionuclides on each contaminant were acquired by using imaging plate (IP).[3] We're performed to find out the ratio between PSL and activity using the standard ^{90}Sr source. Third, the contaminants of high PSL intensity were examined with VM system to observe the shape and size at the hot particle.[4] Simultaneously, HP(Ge) analysis was conducted.

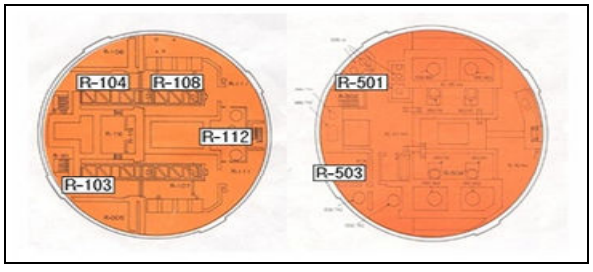

Figure 1. The spots of contaminants taken in 1st site of Wolsung NPP

2. Results

Total 15 nuclides which were ^{24}Na, ^{51}Cr, ^{54}Mn, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{99}Mo, ^{99m}Tc, ^{103}Ru, ^{106}Ru, ^{113}Sn, ^{124}Sb, ^{125}Sb, ^{137}Cs, ^{144}Ce were obtained by HP(Ge) analysis. The radioactivity for 15 nuclides are ranged between 10^{-1} and 10^{3}Bq.

The acquired images using IP are presented in Figure 2. The sample taken from R-503 HTR, R-103 FM bridge, R-108 shoe cover were employed to find out ratio between PSL and activity. The relationship between PSL intensity and radioactivity concentration was compared to quantify conversion factor of PSL to Bq in Figure 3.[5] The result of 1 PSL using standard ^{90}Sr source was 0.004308 Bq.

The table 1 is the results for integrated PSL, derived activity from ratio between PSL and activity, and activity using HP(Ge). As listed in table 1, derived radioactivity information obtained from integrated PSL was very closely appeared results taken from HP(Ge) detector. But using quantitative data was not agreements owing to large error.

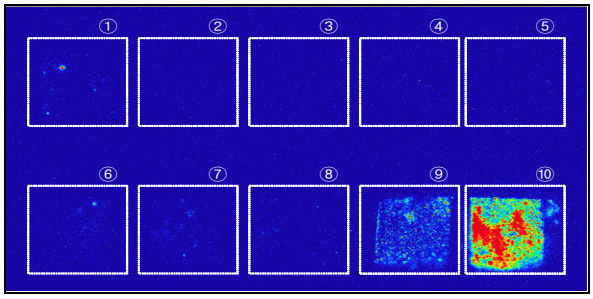

Figure 2. The images of contaminants acquired from imaging plate (1.R-108 shoe cover, 2.R-112, 3.R-104 FM, 4.R-112 MOD 3211, 5.R-112 MOD 3211, 6.R-103 FM bridge, 7.R-501 PHT, 8.R-501 PHT, 9.R-503 HTR, 10.R-503 HTR)

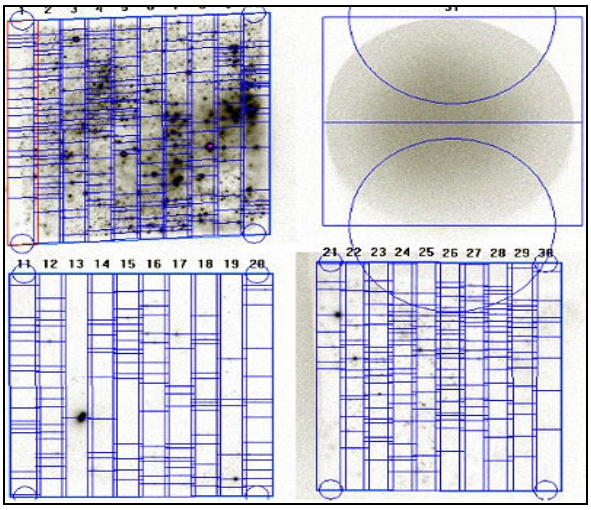

Figure 3. The image to find the ratio between PSL and activity (a)Right top, ^{90}Sr (b)Right bottom, FM bridge (c)Left bottom, shoe cover (d)Left top, HTR

Table 1. Comparison for integrated PSL and converted radioactivity results taken from integrated PSL and radioactivity result obtained from HP(Ge) detector

Acquired spot	Integrated PSL	derived activity using conversion factor from PSL (Bq) : A	Activity using HP(Ge) (Bq) : B	A/B
HTR	308,007	1,327	5,250	0.25
Shoe cover	9,814	39.3	111	0.35
FM bridge	16,803	72.4	121	0.60

Figure 4. The image× (150) of an video microscope obtained by separated particles from contaminated samples

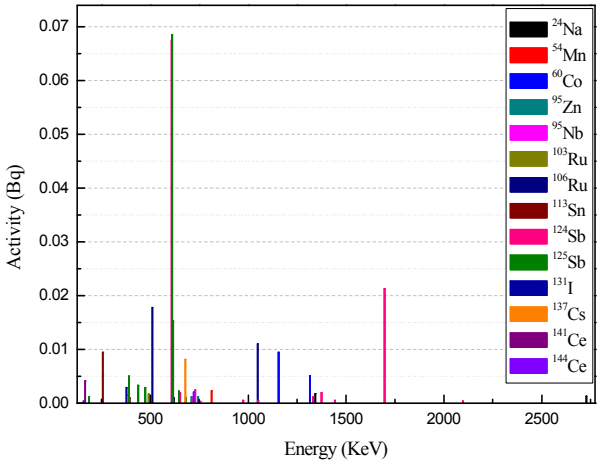

Figure 5. The radioactivity for 14 nuclides which were ^{24}Na, ^{54}Mn, ^{60}Co, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{106}Ru, ^{113}Sn, ^{124}Sb, ^{125}Sb, ^{131}I, ^{137}Cs, ^{141}Ce, ^{144}Ce

The results of VM for areas which have very high radioactivity in IP are presented in Figure 4. The contaminants had ellipsoidal shape and its size was 300~1200 μm. Radioactivity was approximately 10^{-2} ~10^{-3} Bq and identified nuclides were ^{24}Na, ^{54}Mn, ^{60}Co, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{106}Ru, ^{113}Sn, ^{124}Sb, ^{125}Sb, ^{131}I, ^{137}Cs, ^{141}Ce, and ^{144}Ce. The stated radioactivity is presented in Figure 5.

3. Conclusion

This study was performed to find out the hot particle. Although several particles originated from fuel and activation production were founded, the results showed that particles taken from contaminants have relatively low activity. It is difficult to classify the hot particle for the particles taken from contaminants used in this study. Therefore, next study using a variety of contaminated samples taken from several NPPs will be carried out for find out the hot particle. In addition, it will be using the transmission electron microscope (TEM) to get the sophisticated composition data from the particles in the experiment.

ACKNOWLEDGEMENT

The authors thank for the aid of the KOREA HYDRO & NUCLEAR POWER (KHNP) Co. Ltd. of Korea.

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