Transactions of the Korean Nuclear Society Spring Meeting
Gwangju, Korea, May 30-31, 2013

The Environmental Radiation Analysis on the Residential Area around Nuclear Power Plants

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1. Introduction

The objective of this project is to prepare a systematic data set on environmental radiation/radioactivity distribution in our country, which can be used as criteria for assessing public health. The data is important for preserving national safety and the environment in the event that a radiological emergency situation should occur. It is necessary to know how much and what kind of radioactive substances are present in our region. This requires laboratory analyses on the samples collected by special equipments. where the measurement devices should detect even the smallest amounts of radioactive substances and changes due to the radiation.

2. Methods and Results

At a regional monitoring station in Ulsan, gross beta activities in the airborne dust and, precipitation were measured from August 1st to December 31st 2012. The obtained samples were deformed to fit the detector using a method such as concentration by evaporation, dry and ashes. It must be very helpful to make accurate measurements. We used 2-types of detector: a Low Background System for gross Beta, and a High-Purity Germanium Detector for gamma. These detectors must be calibrated before analysis.

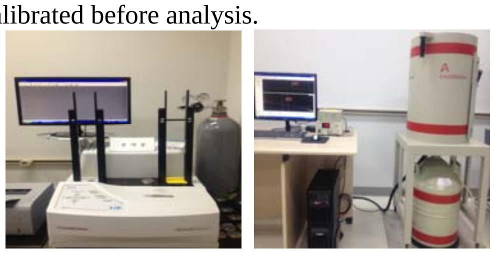


Fig.1. Low Background system and HPGe detector

2.1 Low Background System

The calibration method is shown as below.

$$Eff = \frac{(n_k - n_b)}{N_k} \times 100$$

$$N_k = Natural\ abundance \times Emit\ ratio \times \lambda \times A$$

Where, Eff : The counting efficiency of the standard sample
nk : gross counting rate of the standard sample (cpm)
nb : background count rate (cpm)
Nk : Standard samples(Kcl) of radioactive (dpm)

Table I: The instrument calibration results.

Instrumentation and operating conditions	Planchette			Planchette +Air Filter	
	KCl (mg)	counting time (min.)	Eff.(%)	**KCl** (mg)	Eff.(%)
Counting time (Planchette+Filter) : 60 min× 3 time period : Jul. 30th ～ Dec. 31st	20.1	600	54.1±0.8	0.9972	52.7±0.7
	51.1	180	47.7±0.4	1.4968	52.9±0.6
	99.7	180	48.6±0.3	1.9885	51.6±0.5
	149.4	120	50.6±0.2	average efficiency	52.4
	199.7	60	51.3±0.2	Distilledwater: 20.1112g KCl:1.544g 63.065376dpm/g	
	401.8	60	46.4±0.1		
	599.8	60	42.5±0.1		
	801.5	60	40.0±0.1		
	1001.2	60	39.5±0.08		

2.2 HPGe detector

Table Ⅱ: Characteristics of HPGe detector.

Model No.	GC3019-7500SL(CANBERRA Co.)	
Detector	Relative Efficiency	30%
	FWHM Resolution	1.93keV at 1.33MeV
	Peak/Compton Ratio	60.5
	Diameter	56.5mm
	FWTM/FWHM	1.85
Bias Voltage	~ 4000V	

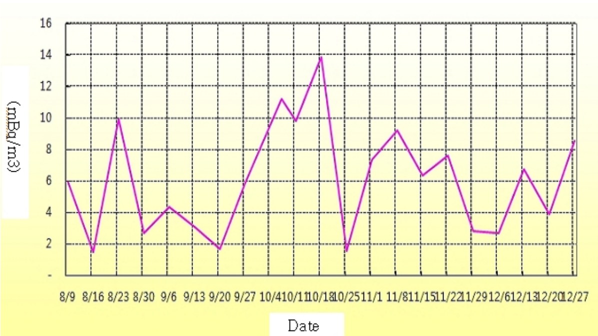
Table Ⅲ: The information of Standard liquid. (U-8 bottle)

Nuclide	Energy (keV)	Ref. Radioactivity (γ/s/g)	Dilution	Dilution of source weight (g)	After dilution Radioactivity (γ/s total)
Am-241	59.54	4377	0.2874	1.2443	297.9279
Cd-109	88.03	5962			405.8136
Co-57	122.03	3130			213.0488
Ce-139	165.86	4412			300.3103

Hg-203	279.2	10560			718.7843
Sn-113	391.7	6180			420.6522
Sr-85	514.01	11980			815.4390
Cs-137	661.66	4273			290.8490
Y-88	898.04	14830			1009.4291
Co-60	1173.24	7507			510.9767
Co-60	1332.5	7507			510.9767
Y-88	1836.06	15710			1069.3278

2.3 Result

The counting range of gross beta activities after 48 hours was 1.45～13. 9 mBq/㎥ (The average annual gross-beta radioactivity for the airborne-dust was measured to be 5.935 ± 2.318 mBq/㎥), and the range of precipitation was 13.1～694 mBq/L (The average annual gross-beta radioactivity for the precipitation was measured to be 131 ± 146 mBq/L)



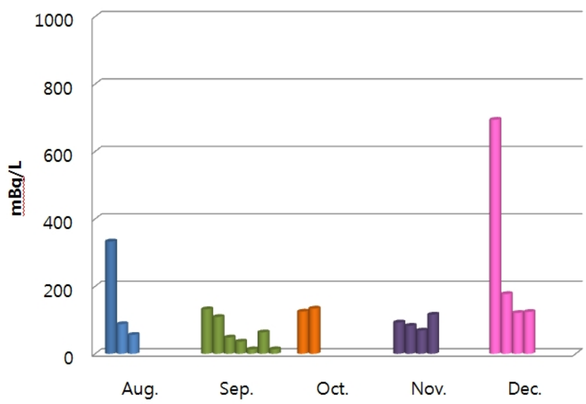


Fig.2.The graph of airborne-dust and precipitation

In the gamma analysis for the airborne-dust, the radioactivity concentrations of 7Be were in the range of 1.5 ～ 3.48 mBq/m3. The radioactivity concentrations of 40K and 7Be from the gamma analysis were measured to be in the range of <0.479～1.18 Bq/m2·30days and 4.22～23.1 Bq/m2·30days for the fallout, ＜1.590～2.29 mBq/L and 340～958 mBq/L for the precipitation.

The radioactivity concentrations of 134Cs, 137Cs and 131I from the gamma analysis were not measured from the accident at the Fukushima nuclear power plant. The gamma analysis for the soil, rice, Chinese cabbage, and pine needles, to obtain the basic data of nation-wide environmental radioactivity, showed that there were no artificial radionuclides except 137Cs in some samples. The result of radioactivity analysis concentrations of 137Cs were 11.4 Bq/kg.dry from pine needles on the surface of soil and 143.9 Bq/kg.dry from the pine needles.

Table Ⅳ:

sample	^{137}Cs (mBq/kg.fresh)	^{7}Be (Bq/kg.fresh)	^{40}K (Bq/kg.fresh)
pine needles	143.9 ± 12.4	24.32 ± 0.58	88.45 ± 2.2
cabbage	<30	0.211 ± 0.04	85.03 ± 2.0
rice	<57.9	<0.512	15.64 ± 0.6

3. Conclusions

The environmental radioactivity measurements were carried out the living-environment sample for the airbone-dust, fallout, precipitation, and tap water of Ulsan Metropolitan City and North Gyeongnam regions from August to December in 2012. It was thought that analyses for gross beta activities, gamma exposure rate, artificial radio-nuclide, and gamma isotopes have not shown unusual radiological pollution marks.

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Acknowledgments

This work was supported by the Korea Institute of Nuclear Safety (KINS) & the Nuclear safety and Security Commission (NSSC)