

# International Intercomparisons for Radioactivity Measurements of Environmental Samples during Past Decade

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## 1. Introduction

During the period 1985~1994, our laboratory participated in a series of international intercomparison activities of radioactivity measurements sponsored respectively by WHO IRC, IAEA AQCS and IAEA MEL, with 20 samples measured in total. This paper describes the intercomparison activities concerned during past decade, methods of analysis and measurement, and measurement results. Some problems involved in measurements was discussed.

## 2. Samples

Among these 20 intercomparison samples, there were 12 samples from WHO IRC and 8 from IAEA. WHO IRC samples were liquid milk (No. 42L300), liquid effluent (No. 43E300), aquatic plant (No. 45V300), dry may blossom (No. 48V300), ground water (No. 56P300), mineral water spring (No. 49SH300), river sediment (No. 55SR300), white mine (No. 57VI300), pasteurized milk (No. 58L300), mineral water spring (No. 60SH300), liquid effluent (No. 59E300) and water (No. 61E300), which were required to analyses  $^3\text{H}$ ,  $^{90}\text{Sr}$ ,  $^{58}\text{Co}$ ,  $^{60}\text{Co}$ ,  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{106}\text{Ru}$ ,  $^{124}\text{Sb}$ ,  $^{110\text{m}}\text{Ag}$ ,  $^{226}\text{Ra}$ ,  $^{210}\text{Po}$ ,  $^{40}\text{K}$ , U and Th respectively. IAEA samples were Russian soil (IAEA-375), Russian grass (IAEA-373), Irish sea cockl flesh (IAEA-134), Irish Sea sediment (IAEA-135), Baltic Sea sediment (IAEA-300), Arabian Sea sediment (IAEA-315), black soil (IAEA-326) and Podssolic soil (IAEA-327), which were required to analyse transuranium elements,  $\gamma$  emitters and  $\beta$  emitters and to be given analysis of trace elements.

## 3. Analytical methods

Analytical methods used in the laboratory for measurement intercomparisons are shown in Table 1. Ge(Li) and HPGe gamma spectrometer were used for measurements of gamma rays emitting nuclides. Sample containers were employed according to the magnitude and shape of samples, including the original containers containing sample, 600 ml Marinelli Beaker, and  $\phi$  75 mm polyethylene container, about 25, 50 75 mm high respectively. For analyses of U, Th and K, chemical analytical methods were used in addition to Ge gamma spectrometer. To determine  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  in samples, direct measurement was firstly made by Ge gamma spectrometer and then so did again after radiological separation.

## 4. Reference sources and samples

Reference sources were from different laboratories in different countries as shown in Table 2. Standard point sources and reference point sources, containing  $^{241}\text{Am}$ ,  $^{57}\text{Co}$ ,  $^{60}\text{Co}$ ,  $^{133}\text{Ba}$ ,  $^{203}\text{Hg}$ ,  $^{137}\text{Cs}$ ,  $^{54}\text{Mn}$ ,  $^{22}\text{Na}$ ,  $^{88}\text{Y}$  and  $^{152}\text{Eu}$ , were purchased from China Institute of Atomic Energy, Britain Amersham Corporation and China National Institute of Metrology respectively. Standard solution and reference solution were from China Institute of Atomic Energy, WHO IRC and Amersham. Standard U, Th, U-Ra ore powder were received from Beijing Institute of Uranium Mine Geology.

**Table 1. Analytical methods used in the laboratory for intercomparison**

Nuclids	Methods
Gamma emitters	Ge(Li) or HPGe gamma spectrometer
$^3\text{H}$	Liquid scintillation counter
U, Th	HPGe gamma spectrometer
U	Laser fluorescence or photospectrometry
Th	N-235 extraction photospectrometry, chromatography
$^{226}\text{Ra}$	HPGe spectrometer, radon emanation measurement
$^{90}\text{Sr}$	HDEHP chromatography or cation ion exchange chromatography, and beta measurement
$^{234}\text{U}$ , $^{235}\text{U}$ , $^{238}\text{U}$	Alpha spectrum analysis after evaporation and depletion
$^{210}\text{Po}$	Alpha measurement after evaporation and depletion
$^{134}\text{Cs}$ , $^{137}\text{Cs}$	Ge gamma spectrum measurement after HPGe gamma measurement or radiochemical analysis.

**Table 2. Reference sources and samples**

Type	Nuclide	Provided by
Point source	$^{241}\text{Am}$ , $^{57}\text{Co}$ , $^{60}\text{Co}$ , $^{133}\text{Ba}$ , $^{208}\text{Hg}$ , $^{137}\text{Cs}$ , $^{54}\text{Mn}$ , $^{22}\text{Na}$ , $^{88}\text{Y}$	China Institute of Atomic Energy
Point source	$^{241}\text{Am}$ , $^{57}\text{Co}$ , $^{60}\text{Co}$ , $^{133}\text{Ba}$ , $^{208}\text{Hg}$ , $^{137}\text{Cs}$ , $^{54}\text{Mn}$ , $^{22}\text{Na}$ , $^{88}\text{Y}$	Amersham, Britain
Point source	$^{152}\text{Eu}$	China National Institute of Metrology
Solution	$^{60}\text{Co}$ , $^{137}\text{Cs}$ , $^{152}\text{Eu}$ , $^{241}\text{Am}$	China Institute of Atomic Energy
Solution	$^{58}\text{Co}$ , $^{137}\text{Cs}$ , $^{60}\text{Co}$ , $^{226}\text{Ra}$ , U	WHO IRC
Solution	$^{90}\text{Sr}$ , $^{137}\text{Cs}$	Amersham, Britain
Ore powder	U, Th, U-Ra	Beijing Institute of Uranium Mine Geology
Soil	U, Th, Ra, K	China Institute of Radiation Protection
Spike sample (powder)	U, Th, Ra, K	China Institute for Radiation Protection
Spike sample (solution)	$^{60}\text{Co}$ , $^{137}\text{Cs}$ , $^{152}\text{Eu}$	China Institute for Radiation Protection
Spike sample (powder)	$^{60}\text{Co}$ , $^{137}\text{Cs}$ , $^{152}\text{Eu}$	China Institute for Radiation Protection

Radioactive point source is a basis of transferring national or international laboratory standard radioactivity quantity value, which transfers standard quantity value to reference materials or reference samples[1]. The first step for our laboratory transfers radioactivity quantity value is to check standard solution and reference solution. Measurement is made using Ge gamma spectrometer that was calibrated with standard and reference point sources to ensure system to have the capability of transferring standard quantity value.

In measurement intercomparison, radioactive standard solution and reference solution from various national laboratories are directly used as calibration standards of radiochemical analysis and  $^3\text{H}$  measurements. Soil reference samples prepared by our laboratory were taken

from natural soils in Hengyang, Hunan Province, in which natural radioactive nuclide contents were determined by laboratories of the China Institute of Radiation Protection and the National Environmental Protection Agency. Additionally, our laboratory prepared soil spike samples and solution spike samples, which be directly used for measurement of gamma spectra. In measurements of solution sample, sediment samples and soil samples, ore powder separately containing U, Th, R-Ra and spike samples containing  $^{137}\text{Cs}$  and  $^{152}\text{Eu}$  were used.

## 5 Results

During these intercomparisons, the laboratory received 9 summary reports, 6 from WHO IRC and 3 from IAEA. Results shown a deviation within 10% of our reported value from WHO IRC reference values, with a few in exceed of 10%. There also were some data that shown no deviation from the WHO IRC value. Examples are  $^{90}\text{Sr}$  and Ca in No. 42L300 milk in 1985,  $^{235}\text{U}$  in No. 49SH300 mineral spring water in 1988, and U in No. 60SH300 milk in 1993. During the intercomparisons of IAEA samples, the laboratory reported the analytical results of gamma spectrometry, which were within the acceptable range. But no data were given for gamma emitting nuclides with low content in sample. Analyses of transuranium nuclides were not done.

## 6. Discussion

In the WHO IRC sponsored intercomparison, IRC presented reference values. Data from various laboratories were for quality assessment on the basis of a comparison with reference value. IAEA AQCS and MEL organized intercomparison haven't presented reference value, but taking median or total average as recommended value or informative value. So IAEA organized measurement intercomparison, in fact, was the measurements for determining value, which raised higher requirements to those laboratories participating in intercomparison. In particular, reference sources or reference samples used for calibration must be national or international standards or traceable to national or international standards. Careful analyses of measurement errors and correction factors will result in acquisition of reliable data which may be used as recommended or reference values.

## References

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