Progress Report on Radioactivity at the VNIIM

I A Kharitonov, T.I.Shilnikova, A.V.Zanevsky, E.E.Tereschenko
D I Mendeleyev Institute for Metrology (VNIIM)
St. Petersburg, Russian Federation

Introduction

This is a short overview of the D.I. Mendeleyev Institute for Metrology (VNIIM) activities in the field of radioactivity measurements for the last 2 years.

The main directions of activities are improvement of national primary standards, calibration and verification of measuring instruments, approval of measuring instruments type, and development of Quality System regulations. Results of international cooperation and a list of publications and talks are also included.

National primary standards development

In accordance with the program of development of the standardization methods and equipment of the national primary standard in the field of radioactivity measurements a new setup of the "sandwich" type has been developed for the 4πγ-counting method. This setup is based on two NaI(Tl) detectors. Dimensions of the detectors located one over the other are 200 mm in diameter and 100 mm in height. The bottom crystal has a well of 10 mm in depth and 40 mm in diameter.

The detection efficiency for several radionuclides within the energy range of photons from 0 to 3 MeV was calculated by the Monte Carlo method. Results of comparisons of the 4πγ-counting method with other standardization methods are presented in the Table 1.

Table 1.

Nuclide	4πγ-detection efficiency calculated by Monte-Carlo method	Other methods and expanded uncertainty, % (k=2)		Difference, %
Co-57	0.948	4π(KX+e⁻)-γ-coincidence counting	1.0	0.9
Ba-133	0.996	4π(KX+e⁻)-γ-coincidence counting	1.0	0.1
Sn-113	0.6605	HPGe spectrometer	2.0	0.1
Cs-137	0.843	4πβ-counter	1.0	0.6
Cs-134	0.996	4πβ-γ-coincidence counting	1.0	0.1
Mn-54	0.900	4π(KX+e⁻)-γ-coincidence counting	1.0	0.1
Eu-152	0.979	4πβ-γ-coincidence counting	1.0	0.3
Eu-154	0.937	4πβ-γ-coincidence counting	1.0	1.0
Co-60	0.975	4πβ-γ-coincidence counting	0.5	0.1
Y-88	0.967	KX-γ-coincidence counting	1.0	0.1
Na-22	1.000	4πβ-γ-coincidence counting	0.5	0.1

Therefore, the measurements results of the 4πγ-counting method and other standardization methods agree within the expanded uncertainty.

VNIIM 4πγ-counting results in key comparisons are shown in Table 2.

Table 2.

Nuclide	Comparison identifier	4πγ-counting	KCRV
Cs-134	BIPM.RI(II)-K1.Cs-134 APMP.RI(II)-K2.Cs-134	10062(25)[1]	10116(13) [1]
Eu-152	COOMET.RI(II)-K2.Eu-152	14911(75)	14942(26) [2]
Cs-137	COOMET.RI(II)-K2.Cs-137	27275(120) [3]	27549(44) [3]

Uncertainty evaluation of the detection efficiency calculated by the Monte Carlo method is not completed as yet; estimation of an upper limit of the uncertainty value is taken to be equal to the deviation of the 4πγ-counting method with other standardization methods.

International activities

In accordance with the Technical Supplement to the MRA the regional key comparisons are carried out to provide for the traceability of measurements obtained by the NMIs that did not participate in the CCRI key comparisons, to KCRV. COOMET participants in CCRI key comparisons are the VNIIM, PTB and SMU. The BelGIM (Belarus'), NMC (Ukraine) and CENTIS-DMR (Cuba) did not participate in the CCRI key comparisons.

At the COOMET TC 1.9 IR meeting that took place at the PTB in 2005, project of a COOMET key comparison has been discussed in order that their results can be used by the NMIs to cover their CMC's.

The COOMET TC 1.9 IR members supported the project of comparisons and made a proposal for the VNIIM to take upon itself the functions of a pilot laboratory as a primary laboratory with a great experience of participation in the CCRI key comparisons.

An analysis of needs to standardize nuclides, which was performed at the VNIIM taking into account information presented by the NMIs, potential participants of the comparisons, showed that at the first stage it was useful to carry out the standardization of the Cs-137, Am-241 and Eu-152 solutions that are used at the NMIs for calibrating ionization chambers and gamma-spectrometers.

At the beginning of the project, in 2005 the VNIIM had registered and non-overdue results of the CCRI key comparisons on radionuclides Am-241 and Eu-152, which could be used to establish the traceability of the NMIs results obtained in the regional COOMET comparisons.

The VNIIM, as the pilot laboratory, adopted a decision to perform SIR comparisons on each of these nuclides before the beginning of the COOMET project, and in case of confirming the correctness of measurements just this result would be used in the COOMET key comparisons as a link for the results of other participants to the KCRV.

The COOMET key comparisons of the activity of the same solutions of Am-241, Cs-137 and Eu-152 were carried out within the period from 2006 to 2009. The NMIs of three countries were their participants: BelGIM (Belarus'), CENTIS-DMR (Cuba) and SMU (Slovakia).

The plan of the comparisons in every case corresponded the same algorithm. At the VNIIM the radionuclide solution was prepared in 6 NBS-type glass ampoules in accordance with the instruction for standardizing at SIR. One ampoule was used at the VNIIM to measure the radionuclide specific activity by standardization as well as to finally determine potential admixtures.

Another ampoule was sent to the BIPM with a measurement protocol for the SIR standardization. After confirmation of the correctness of the VNIIM measurements on the basis

of the SIR comparisons, three ampoules were sent to the comparison participants. The last ampoule was kept up to the end of the comparison cycle as a reserve.

The COOMET.RI(II)-K2.Am-241 key comparisons, project COOMET №359/RU/06, were completed in 2006. The results of the comparisons were published [5].

The COOMET.RI(II)-K2.Cs-137 key comparisons, project COOMET № 386/RU/07, were completed in 2006. The results of the comparisons were published [3].

The first stage of COOMET.RI(II)-K2.Eu-152 key comparisons, project COOMET №423/RU/08, i.e. the VNIIM SIR comparisons were completed. At present three ampoules are being sent to the participants of the comparisons. The comparisons will be finished in 2009.

The regional comparison results were used by the BelGIM (Belarus') and CENTIS-DMR (Cuba) within a regional review to confirm the CMC's which they had claimed. The VNIIM and SMU (Slovakia) used the comparison results to confirm the CMC's for which the established legitimate time period had expired.

Secondary standard calibration

Ionizing chamber was calibrated for several radionuclides as that Cs-137, Ba-133, Co-57, Am-241, I-125, Tc-99m, Eu-152 in some types of ampoule used by the Russian enterprises producing reference solutions.

There are a number of tasks in metrological practice where is necessary to measure a high-energy photons fluence rate. Usually spectrometers have a well-known energy dependence of sensitivity in energy region from 20 to 3000 keV. Using (n,2γ)- and (n, γ)-reactions we have calibrated our HPGe-spectrometer in energy region up to 9 MeV.

Publications and talk

1. Update of the BIPM comparison BIPM.RI(II)-K1.Cs-134 of activity measurements of the radionuclide ^{134}Cs to include the 2005 results of the BARC (India) and the CNEA (Argentina), the 2006 result of the IFIN-HH (Romania) and the link for the 2005 regional comparison APMP.RI(II)-K2.Cs-134 to include the VNIIM and the INER. G Ratel *et al* 2007 *Metrologia* 44 06004

2. BIPM comparison BIPM.RI(II)-K1.Eu-152 of activity measurements of the radionuclide ^{152}Eu and links for the international comparison CCRI(II)-K2.Eu-152. G Ratel and C Michotte 2004 *Metrologia* 41 06003

3. Measurement of activity concentration of radionuclide Cs-137 in a solution (COOMET Project no 386/RU/06). I A Kharitonov *et al* 2008 *Metrologia* 45 06005

4. I.A Kharitonov *et al* Measurement of the activity concentration of the radionuclide Am-241 in a solution, 2007, *Metrologia* 44, Technical Supplement, 06001

5. Update of the BIPM comparison BIPM.RI(II)-K1.Am-241 of activity measurements of the radionuclide ^{241}Am to include the 2006 VNIIM result, links for the 2003 international comparison CCRI(II)-K2.Am-241 and links for the 2006 regional comparison COOMET.RI(II)-K2.Am-241. G.Ratel, C.Michotte, L.Johansson, S.Judge, I.A.Kharitonov 2007 *Metrologia* 44 06007