

IAEA Subprogramme on Dosimetry and Medical Radiation Physics (DMRP) Report on Activities 2003-2005

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Introduction

The IAEA Subprogramme on Dosimetry and Medical Radiation Physics (DMRP) contributes to improving the quality of the IAEA's system to measure ionising radiation by disseminating traceable standards for radiation measurements, conducting dose quality audits and comparisons, developing and disseminating dosimetry techniques, assisting Member States in designing and implementing national Quality Assurance (QA) programmes, and organizing education programmes and training courses for medical physicists, radiation metrologists and other staff at hospitals and Secondary Standards Dosimetry Laboratories (SSDLs). In addition, technical support is provided to IAEA Technical Co-operation projects.

A standing Scientific Committee established by the Directors General of the IAEA and WHO reviews and evaluates the work of the Dosimetry and Medical Radiation Physics Section and advises the Director General of the IAEA on the strategies of the Dosimetry Subprogramme of the IAEA that will meet the needs of the Member States. During its 8th meeting in 1998, the Committee endorsed the expansion of DMRP activities to include metrology in nuclear medicine, including radioactivity standardization. Activities in this programme began in early 2003.

The areas of emphasis for the programme in nuclear medicine metrology are currently:

- Promotion of Quality Assurance practices in nuclear medicine, with particular emphasis on radioactivity measurement and SPECT imaging;
- Extension of activities of the existing Secondary Standards Dosimetry Laboratory network to include laboratories that will provide calibration services for radioactivity; and
- Development of Agency capability to calibrate radioactivity sources and disseminate them as measurement standards.

Establishment of Agency laboratory for radioactivity standardization in nuclear medicine

A search for potential locations for the radioactivity standardization laboratory was conducted in 2003-2004. Two laboratories in Seibersdorf that are currently used as bioassay sample preparation and analysis laboratories were identified and are to be renovated following the relocation of those activities to new facilities at Agency Headquarters in Vienna. It is forecasted that renovations will be able to begin in early 2006, but a schedule has not yet been fixed. Most measurement and sample preparation equipment has already been purchased in anticipation of the commencement of activities.

In addition to being able to provide calibration services and standards to Member States, the laboratory is also expected to support a new initiative aimed at providing Fellowship training in gamma camera maintenance and quality assurance. Being the only laboratory in the Agency's Laboratories, Seibersdorf that will be classified for work with MBq and GBq levels of radioactivity, it will be also be used to prepare phantoms for use with the gamma camera.

Development of Guidance on implementing QA/QC programmes for nuclear medicine radioactivity measurements

Nuclear medicine continues to be a growing field all over the world, due in part to a number of successful programmes carried out by the International Atomic Energy Agency to enhance the use of nuclear medicine techniques in the Member States. The implementation of quality assurance and quality control programmes (QA/QC) to ensure the safe application of radiopharmaceuticals has,

unfortunately, been slow to evolve. One possible reason for this is the lack of a unified guidance on how such programmes should be established.

Because of its importance in controlling the safety and effectiveness of the use of radiopharmaceuticals, a group of experts consulted by the IAEA recommended in 2002 that such guidance on QA/QC procedures for radioactivity measurement in nuclear medicine be developed. The IAEA, in consultation with experts in the fields of radionuclide metrology, medical physics, and radiopharmacy, has recently drafted a new document entitled “Quality Assurance for Radioactivity Measurement in Nuclear Medicine” to try to meet this need.

This guidance can be considered to be a more detailed and updated version of the Agency’s popular TECDOC-602, “Quality control of nuclear medicine instruments (1991)” that focuses solely on the factors affecting radioactivity measurement and the implementation of QA/QC programmes to ensure accurate and consistent results. A companion document is being prepared that will provide a similar update for the medical imaging aspects discussed in TECDOC-602.

The document is based on the QA principles described in ISO/IEC standard 17025, but provides information specific to implementing that standard at both the end-user (clinic) and secondary radioactivity standards laboratory levels. If adopted to its greatest extent, it will provide the user with all of the information (including measurement procedures) necessary to carry out most tasks associated with routine radioactivity measurement, including maintaining the necessary documentation.

The document is currently undergoing external review and is expected to be published as an IAEA TECDOC before the end of 2005.

Cooperative Research Project on harmonization of nuclear medicine radioactivity measurement practices

An important component of the development of guidance for establishing QA/QC programmes in nuclear medicine radioactivity metrology is the need to learn how such programmes are actually implemented in practice. A Cooperative Research Project (CRP) entitled “Harmonization of Quality Assurance Practices for Nuclear Medicine Radioactivity Measurements (E2.10.05)” was initiated in December 2004 and is expected to run for 4 years exactly for this purpose. The main goals of the CRP are to:

- Gather information about the current status of QA/QC programmes and metrology in nuclear medicine metrology and how they were developed in order to develop a strategy for introducing these concepts into Member States;
- Obtain baseline radioactivity measurement performance data for secondary standards radioactivity laboratories and clinical sites and perform comparison exercises to determine the degree of effectiveness of quality programme implementation; and
- Perform radioactivity measurement comparisons to enable laboratories not already having traceability to international standards for certain radionuclides to establish it.

The participating institutions are:

1. Instituto de Radioproteção e Dosimetria (IRD), Brazil
2. Centro de Isótopos (CENTIS), Cuba
3. Czech Metrology Institute (CMI)
4. Bhaba Atomic Research Centre (BARC), India
5. Nuclear Research Center for Agriculture and Medicine (NRCAM), Iran
6. National Institute of R&D for Physics and Nuclear Engineering “Horia Hulubei” (IFIN-HH), Romania
7. Korea Food and Drug Administration (KFDA)
8. Ankara University Faculty of Medicine, Turkey

The first Research Coordination Meeting will be held in June 2005 to finalize the work plan.

CIPM Key Comparison CCRI(II)-K2.Y-90 for ^{90}Y

International comparisons of radioactivity measurements are traditionally carried out with radionuclides having long half-lives (e.g. > 14 d) in order to obviate problems associated with transportation and customs clearances. In addition, most of these comparisons are performed with nuclides that emit one or more gamma rays so that they can be measured in the Système International de Référence (SIR) ionization chamber, thereby providing a link to all of the results. The pure beta emitter ^{90}Y has become increasingly important in the field of radionuclide therapy and as a result, is expected to present demands on National Metrology Institutes (NMIs) for accurate measurement standards for this radionuclide. As part of the need by the NMIs to establish equivalence for the measurement of ^{90}Y in support of their calibration and measurement capabilities (CMC) claims, a comparison between the laboratories and the Bureau International des Poids et Mesures (BIPM) was proposed.

The comparison was organized by the International Atomic Energy Agency (IAEA) as a follow-up to a pilot comparison conducted by the Life Sciences Working Group of the International Committee on Radionuclide Metrology in late 2002. The full key comparison was carried out during the last quarter of 2003 according to a protocol that was agreed to by all of the participants in July 2003. A total of 7 NMIs and the BIPM took part in the exercise.

Logistics played an important role in the success of the comparison because of the short half-life of ^{90}Y (2.7 d) and the wide geographical distribution of the participants. A single master solution containing nominally $80 \text{ MBq}\cdot\text{g}^{-1}$ of ^{90}Y (as of the shipping date, 22 October 2003) in $1 \text{ mol}\cdot\text{L}^{-1}$ HCl and approximately $50 \mu\text{g}$ of YCl_3 per gram of solution was prepared by the National Institute of Standards and Technology (NIST) in the USA and divided into 5 mL aliquots that were subsequently distributed in the form of a flame-sealed NIST-style ampoule. As each laboratory performed measurements on aliquots of the same solution, the results could be easily compared.

The arithmetic mean of the reported values from the participants is $8664 \text{ kBq}\cdot\text{g}^{-1}$; $u = 4 \text{ kBq}\cdot\text{g}^{-1}$, where the uncertainty is the standard deviation of the mean of the final results from the 8 laboratories. This mean activity value was adopted by the CCRI(II) as the Key Comparison Reference Value, x_R .

The analysis of possible radionuclidic impurities was not performed uniformly. Several laboratories analysed only for gamma-emitting radionuclides, despite the fact that the most common impurity associated with ^{90}Y is the pure beta-emitter ^{90}Sr . The data show that the impurity ratios are spread over a range having a factor of 100 between the smallest and largest values. There are insufficient data to draw definite conclusions but there is at least a suggestion that the determination of the $^{90}\text{Sr}/^{90}\text{Y}$ ratio is somewhat method-dependent. This warrants further investigation. The uncertainty of the ratio, and indeed the level of ^{90}Sr impurity in the sample, is unlikely to influence the LS counting results as long as the ^{90}Y solution has not decayed significantly. In this regard, there does not appear to be any dependence of the results on the mean measurement date.

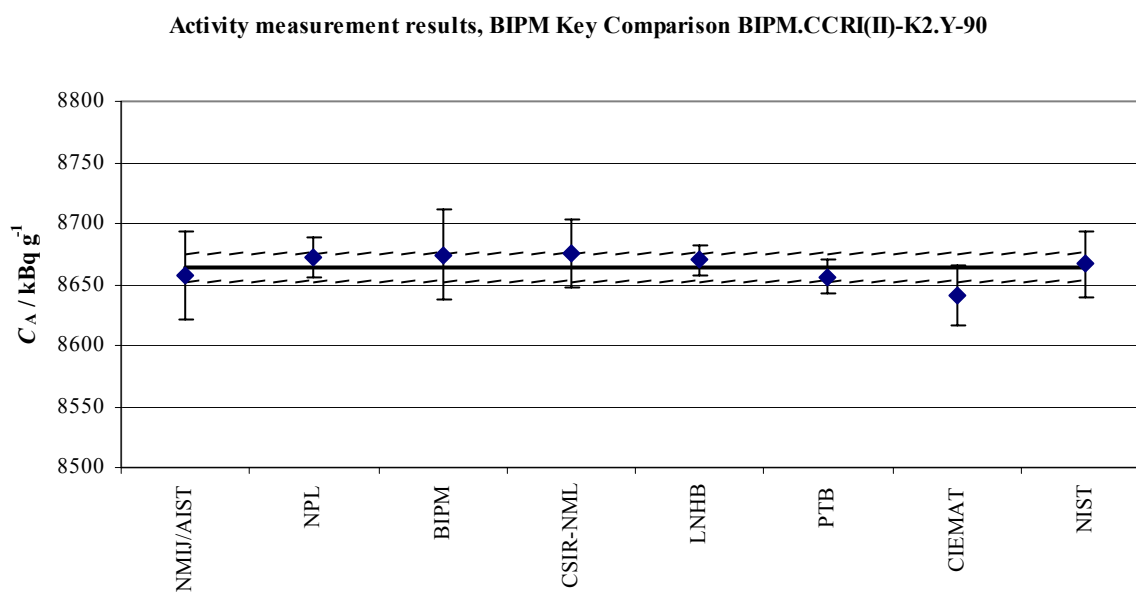


Figure 1. Plot of results from the participants of Key Comparison BIPM.RI(II)-K2.Y-90. The uncertainty bars represent the standard uncertainties on the measured activity concentration, C_A , as reported by each laboratory. The solid line represents the mean value of the comparison results and the dashed lines correspond to one standard uncertainty interval on the comparison mean.