Protocol for the EURAMET supplementary comparison "The third interlaboratory comparison of the radionuclide calibrators"

Updated 8 August 2023

1. Introduction

This technical protocol was prepared taking into account the guidelines of documents [1] and [2]. The EURAMET key comparison "The third interlaboratory comparison of the radionuclide calibrators" is a continuation of two previous projects: EURAMET Project No. 1243, "The interlaboratory comparison of the radionuclide calibrators" and EURAMET Project No. 1437, "The follow-up interlaboratory comparison of the radionuclide calibrators" that took place in Prague at the CMI in 2013 and 2018, respectively. Activities of radionuclide solutions used in nuclear medicine, such as ^{18}F, ^{67}Ga, ^{99m}Tc, ^{111}In, ^{123}I, ^{125}I, ^{131}I, ^{137}Cs, ^{201}Tl and ^{223}Ra (^{137}Cs as a check source), were measured. The results showed that consistent, safe and effective radioactivity measurement services for the medicine community are provided. To be in line with the ISO/IEC 17025 standard and to ensure the continuation of services at the necessary quality level, a new comparison was proposed in the TC-IR meeting in CIEMAT – Madrid, 2023.

A list of radionuclides to be measured in the proposed comparison is as follows: ^{18}F, ^{67}Ga, ^{90}Y, ^{99m}Tc, ^{111}In, ^{123}I, ^{131}I, ^{137}Cs, ^{153}Sm, ^{177}Lu and ^{201}Tl (^{137}Cs as a check source).

The aim of the comparison is to support current and future CMCs of the participating laboratory in terms of activity for the above listed radionuclides as well as to demonstrate capabilities for auditors.

2. Technical protocol

2.1. Pilot laboratory: Center for Physical Sciences and Technology (FTMC), Lithuania

2.2. List of participants:

- BEV, Austria
- SCK CEN, Belgium
- CMI, Czech Republic
- STUK, Finland
- BFKH, Hungary
- IFIN-HH, Romania
- SMU, Slovakia
- CIEMAT, Spain

2.3. Description of the scheme of the comparison: due to the nature of short-lived radionuclides, one possible way to measure activity of radionuclide solutions by the participants is for all of them to be in the same laboratory with their measuring instruments. The participants should bring the radionuclide calibrators (i.e., their secondary standards) to the CMI headquarters in Prague. Some radionuclide calibrators may have response functions that depend on external shielding, therefore participants should account for it when moving their instruments. Radionuclide solutions will be produced in the cyclotron facility in Prague, measured for gamma-ray emitting impurities by the CMI, and the results on impurities communicated to the participants in time for them to make corrections. Information about the sources' composition and density will be provided to the participants by the pilot institute. The solutions will be directly measured by participants' instruments during the comparison period 11-15 September 2023. No transfer standards will be used in the comparison. The solutions (volume 5 cm^3) will be provided and kept in the standard P6 vial and the Schott-type vial geometries. In each geometry, there will be the only one source prepared which is to be shared among participants for the activity measurement. Solutions with ^{67}Ga, ^{111}In, ^{131}I, ^{153}Sm, ^{177}Lu and ^{201}Tl will also be prepared in BIPM ampoules (volume 3.6 cm^3) and sent to the SIR for comparison. The mass of a radionuclide solution in each prepared vial and ampoule will be determined by the CMI.

2.4. Schedule:

Participants transport (or send via overland) their equipment to the CMI-Inspectorate for Ionizing Radiation headquarters before 10 September 2023. Measurements start 11 September 2023 (on Monday), the last day of measurements is 15 September 2023 (Friday). Airplane shipment of the equipment is not recommended.

2.5. Tests before measurements:

1. The activity of a ^{137}Cs source will be measured to check the performance of all radionuclide calibrators.
2. Background will be measured before measurement of radionuclide solutions.

2.6. Description of the calibration method:

Each instrument is to be calibrated in advance by a manufacturer or the partner laboratory, and a list of calibration factors for each radionuclide is to be stored in the device memory. When measuring the activity of a particular radionuclide, a proper calibration factor should be selected. Ten experimental readings should be taken by each instrument for each radionuclide solution. The measurand for each source is the total activity of the stated radionuclide at the assigned reference date. Each participating laboratory is responsible for determining the activity and uncertainty from their readings, including making any corrections for background, decay, impurities, etc.

2.7. List of the principal components of the uncertainty budget:

The principal components of the uncertainty are expected to include:

1. Calibration factor of the participant's device;
2. Corrections to the calibration factor of the device (volume corrections, linearity correction, background subtraction, long term stability from QC measurements);
3. Standard deviation of the mean (type A);
4. Nuclear data (half-life);
5. Correction for impurities.

The participating laboratories may include other uncertainty components as needed.

2.8. Timetable for communicating the results: the participants submit their results to the pilot institute within one month after the measurements campaign at the CMI.

15 November 2023 – draft A (preliminary report);

15 February 2024 – draft B (final report).

2.9. Principle of evaluation of the results:

Results will be evaluated taking into account uncertainty budgets provided by the participants and known reference data. The comparison reference value and its associated uncertainty will be determined using the Power-Moderated Mean (PMM) as described in [4]. The degree of equivalence for each laboratory will be defined.

2.10. Financial aspects:

Participants will cover their own costs for transportation of the instruments and all other travel costs including their living accommodations. Participants will divide costs necessary for the production of the radionuclide solutions in equal shares.

3. References

[1] EURAMET Guide on Comparisons: EURAMET Guide No. 4. Version 2.0 (04/2021)

[2] CIPM MRA-G-11: Measurement comparisons in the CIPM MRA

[3] G-OPS-FRM-009: EURAMET Project Form – Registration of Agreed and Starting Projects

[4] S. Pommé and J. Keightley, "Determination of a reference value and its uncertainty through a power-moderated mean," ***Metrologia*** **52**, 3 (2015).