

# MODIFICATION OF NPL-CRC SECONDARY STANDARD RADIONUCLIDE CALIBRATOR HOLDER TO SUIT FOR IPEN VIALS

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## ABSTRACT

The procedure followed by the Laboratório de Metrologia Nuclear (LMN) at the IPEN - CNEN/SP, in São Paulo, for modifying the NPL-CRC radionuclide sample holder in order to adapt for IPEN vials is presented. For the quality assurance of the results using the IPEN vials, the influence of variation in dimensions and volume of solution has been investigated and suitable correction factors were applied. The solutions used in the present work were  $^{51}\text{Cr}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{153}\text{Sm}$ , and  $^{201}\text{Tl}$ .

## I INTRODUCTION

The Nuclear Metrology Laboratory of the IPEN has a NPL-CRC secondary standard radionuclide calibrator for measuring radioactive solutions. The system consists of a well-type ionization chamber connected to a computer-controlled measuring device and has a calibration certificate by the National Physical Laboratory (NPL) from UK. The ionization chamber was designed by NPL with strict tolerances to ensure that all calibrators possessed the same characteristics within known uncertainties, as that of the master chamber held at NPL[1].

The secondary standard NPL-CRC was calibrated for standards ampoules type BS 5 ml and BS 2 ml and penicillin vial type P-6 from AMERSHAM for routine measurements. The source holder provided with the chamber is a cylinder specially built in Perspex for those standards.

To achieve the necessary level of accuracy given by the secondary standard NPL-CRC, the geometry of samples and chamber should be kept constant. However, as the vials used by the production and distribution of radiopharmaceutical solutions in IPEN are of different type (here called type IPEN), it was necessary to built a source holder as similar as possible to the original one. A geometry correction factor has been determined by means of relative measurements with respect to the standard geometry.

For the assurance of measurements using the IPEN vials, the influence of variation in dimensions and volume of solution has been investigated.

In the present study solutions of  $^{51}\text{Cr}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{153}\text{Sm}$ , and  $^{201}\text{Tl}$  were used.

## II EXPERIMENTAL METHOD

**Source preparation**  $^{51}\text{Cr}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{153}\text{Sm}$ , and  $^{201}\text{Tl}$  solutions supplied by Radioisotope Center of IPEN were used. Aliquots of the radioactive solution were deposited in flame-sealed ampoules type BS 5 ml, filled with 3.6 g of solution and in vial type IPEN with 4.0 g of solution.

In order to check the vials quality, an investigation of the variation in dimensions has been performed by preparing six vials with 4 ml each from a master solution having masses determined with an uncertainty lower than 0.1%.

The influence of volume of solution vial was made with  $^{153}\text{Sm}$  solution. One vial was prepared with the radioactive solution, the first volume was 1 ml and additional quantities of inactive solution were added in steps of 1 ml up to 7 ml.

The accurate source mass determination was performed using the picnometer technique [2].

### NPL-CRC Calibrator measurements

The measurements were carried out in the sample holder type NPL for ampoules and in the sample holder type IPEN. The position with respect to the center and to the vertical direction were kept the same.

Before each measurement the daily test and the constancy test were performed using the  $^{137}\text{Cs}$  check source. The linearity of the chamber has been verified by following the decay of a  $^{99\text{m}}\text{Tc}$  sample.

### III RESULTS AND DISCUSSION

Table 1 shows the results of measurements with ampoules using the sample holder S-NPL and S-IPEN. It can be observed that the results agree within the experimental uncertainties.

Table 1. Measurements of ampoules using the sample holder S-NPL and S-IPEN.

Radionuclide	S-NPL MBq g <sup>-1</sup>	S-IPEN MBq g <sup>-1</sup>	Δ %
<sup>153</sup> Sm	270.9 ± 2.1	269.9 ± 2.8	0.4
<sup>51</sup> Cr	619.4 ± 2.9	619.6 ± 2.4	0.03
<sup>201</sup> Tl	168.60 ± 0.54	168.06 ± 0.54	0.32

Figure 1 shows the comparison of measurements performed with six different vials. As can be seen the results are in agreement indicating that the variation in dimensions did not yield significant difference in the results.

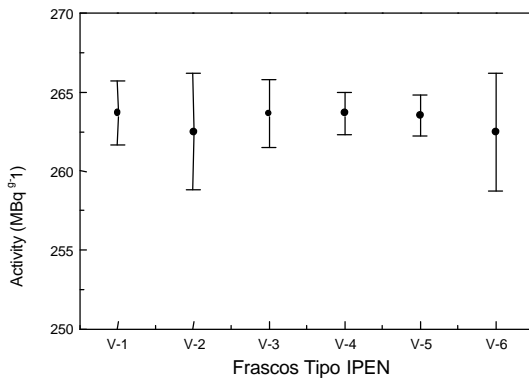


Figure 1. Comparison of measurements performed with six different vials

Figure 2 shows the comparison of results obtained with different volumes inside the vials, applying the correction factor given by Woods 1999. It can be observed that the results are in agreement indicating that the same factor can be applied to the IPEN holder. From 3 to 5 ml the differences can be considered negligible.

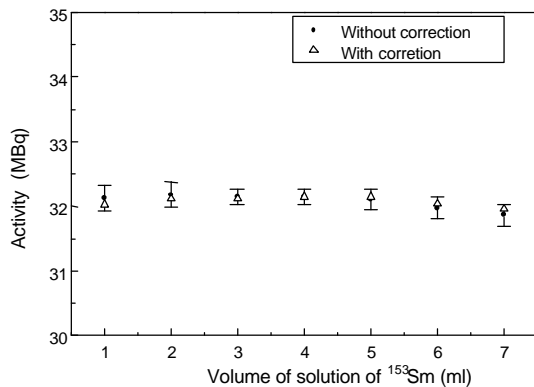


Figure 2. Influence of the variation in volume for different vials.

Table 2 gives the results obtained in measurements of ampoules using the sample holder S-NPL as compared to measurements of vials using the sample holder S-IPEN.

Table 2. Comparison of measurements using ampoules and vials inside the sample holder S-NPL and S-IPEN.

Radionuclide	Ampoule 5BS in S-NPL MBq g <sup>-1</sup>	Vial IPEN in S-IPEN MBq g <sup>-1</sup>	Correction Factor
<sup>153</sup> Sm	270.9 ± 2.1	277.0 ± 2.0	1.022
<sup>51</sup> Cr	619.4 ± 2.9	616.2 ± 2.4	0.995
<sup>99m</sup> Tc	96.2 ± 0.3	97.1 ± 0.5	1.0096
<sup>201</sup> Tl	168.60 ± 0.54	172.97 ± 0.57	1.026

The ratio between the two results gives the correction factor to be applied for the IPEN vial holder. The difference of 2.2% for <sup>153</sup>Sm may be due to variations in bremsstrahlung effects between NPL and IPEN vial holders. Additional measurements will be performed in order to verify this assumption.

The figure 3 shows the results of linearity of the chamber verified by following the decay of a <sup>99m</sup>Tc sample. The resulting half-life was (0,1149 ± 0,0015) h<sup>-1</sup> which agrees with (0,1151 ± 0,0002) h<sup>-1</sup> from Lagoutine, F. et alli.,1982[3].

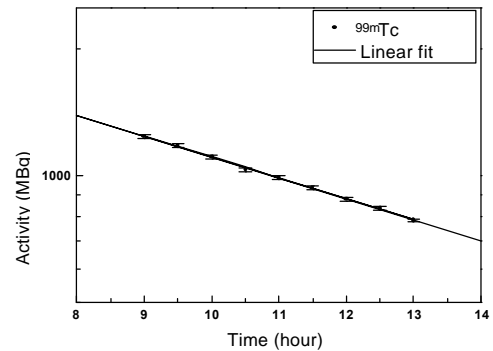


Figure 3. Following of decay of a <sup>99m</sup>Tc sample.

The present work has shown that S-IPEN sample-holder and the IPEN vials are suitable and keeps the reliability and traceability of the NPL-CRC secondary standard radionuclide calibrator.

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