**XVIII IMEKO WORLD CONGRESS**
**Metrology for a Sustainable Development**
**September, 17 – 22, 2006, Rio de Janeiro, Brazil**

# SOME METROLOGICAL CHARACTERISTICS OF THE NEW SECONDARY STANDARD FOR BETA RADIATION

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**Abstract:** In Brazil, beta radiation metrology was based on a 30-years-old irradiation system. Aiming to fulfill a regional metrological gap and safety requirements, a new secondary standard for beta radiation – the BSS2- was installed at the CDTN/CNEN. Results of three metrological characteristics of the BSS2 are presented.

**Keywords:** beta radiation secondary standard, beta radiation metrology.

## 1. INTRODUCTION

The need of accurate dose measurements due to beta radiation was emphasized by either some nuclear and radiological accidents or during some practices where beta radiation sources are handled. In both cases, beta radiation exposure and contamination were relevant to be determined for risk assessment of the biological radiation effects.

The first secondary standard system for beta radiation – the BSS1- was designed 30 years ago aiming to calibrate personal dosimeters and area survey instruments for radiation protection purpose. Beta radiation sources of $^{204}$Tl and $^{147}$Pm are no longer actives and they cannot be replaced any more.

New metrological requirements and the advanced technology requested a new standard system that was made commercially available. The Centro de Desenvolvimento da Tecnologia Nuclear (CDTN) acquired and installed a new beta radiation secondary standard – the BSS2 – that has a new irradiation set-up, handling safe $^{90}$Sr/$^{90}$Y, $^{85}$Kr and $^{147}$Pm radiation sources and an automated dose control unit [1]. Figure 1 and 2 show the BSS2 and the BSS1, respectively.

For the sake of reliability, many performance tests had to be done in the BBS2 to confirm their compliance with international standard requirements [2-5].

This work shows the results of three performance tests: the influence of the shutter on the irradiation procedure, the field radiation uniformity in air and an comparison between absorbed dose in air values from the BSS2 and the BSS1.

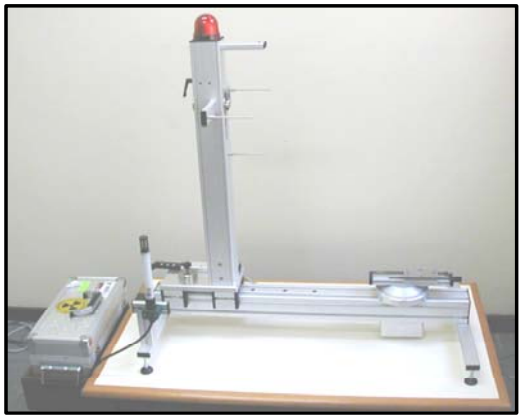

**Fig.1 – The new beta radiation secondary standard (BSS2).**

**Figure 2 – The old beta secondary standard (BSS1)**

## 2. RESULTS AND DISCUSSION

### *2.1. Influence of the shutter on the irradiation procedure*

When irradiation time is too short, the time for open or close the radiation shutter becomes relevant to be known since it may have a significant influence on the desirable

dose. The determination of this influence allows establishing the minimum irradiation time for an acceptable error.

Measurements were carried out with a 600cc high sensitive thin-window ionisation chamber in the $^{90}Sr/^{90}Y$ beta radiation field, at 30 cm distance from the beta sources (1850 MBq and 460 MBq), with the presence of the homogeneiser filters.

Results showed that for 10 s of irradiation time the shutter movement causes a dose shift of 0.24% in the BSS1 and 2.2% in the BSS2.

This is an expected result since, for safety reason, the BSS2 shutter is heavier than the BSS1 and it is attached in each source shielding (Figure 2). In the BSS1 the shutter is fixed on the stem and it is independent of the source.

**Fig.2 – Source shielding with attached shutter.**

### *2.2 Field radiation uniformity in air*

The determination of the uniformity of the beta radiation field allows establishing the adequate field size where radiation detectors are to be calibrated. A beta radiation field is considered to be uniform if absorbed dose rate on it changes within ± 5% for the $^{90}Sr/^{90}Y$ e $^{85}Kr$ and ±10% for $^{147}Pm$ radiation sources [3].

Absorbed dose rates of the beta radiation sources of the BSS2 were measured with thin window ionisation chamber Radcal 10X5-6M that has a small sensitive volume and small dimensions (3 cm diameter) and it was designed for measurements at low energy x-ray beams.

Table 1 shows the diameter of the beta radiation field from the three sources that has uniformity of 95% at standard source-detector distances of 20, 30 and 50 cm with and without the presence of standard homogeneiser filters.

In all cases, the presence of the homogeneiser filter improved significantly the uniformity of the beta radiation field. Such values must be taken into account when detectors are to be placed in such beta fields for calibration purpose.

**Table 1 – Uniformity of the beta radiation field at standard distances with and without the homogeneiser filter.**

| Radiation source | Field diameter (cm) with 95% uniformity at | | |
|---|---|---|---|
| | 20 cm | 30 cm | 50 cm |
| $^{90}Sr/^{90}Y$ | 5.6 | 8.6<br>12.9* | 10.8 |
| $^{85}Kr$ | - | 8.8<br>20.9* | - |
| $^{147}Pm$ | 7.2<br>19.2* | - | - |

* with the homogeneiser filter.

### *2.3 Absorbed dose in air comparison*

A comparison in terms of absorbed dose in air between the BSS2 and the BSS1 was done at 30 cm distance, without the homogeneiser filter, in the beta radiation field from the $^{90}Sr/^{90}Y$ source.

Ten measurements were performed with the Radcal 10X5-6M ionisation chamber at both the BSS2 and BSS2 that indicated 1.092 mGy (±0.14%) and 1.058 mGy (±0.21%), respectively (the uncertainy refers to the standard deviation only). The difference of –3.16% is not relevant for dosimeter calibrations for radiation protection purpose.

## CONCLUSION

Preliminary performance tests performed in the new beta secondary standard – the BSS2 – allow to know its metrological characteristics. The absorbed dose comparison against the BSS1 showed an acceptable metrological coherence.

Additional tests should be done for the sake of reliability.

## ACKOWLEDGEMENTS

We are grateful to the CNPq for the financial support through the TIB project that allows us to buy and implemented the BSS2 and to have Ms. D. Floresta as a fellow.

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