RADIATION METROLOGY AND REFERENCE SYSTEMS

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The main objectives of the research group of the Calibration Laboratory of IPEN are to develop, improve and establish methods and reference systems (FIG.1) for radiation dosimetry and calibration of instruments utilized in diagnostic radiology, radiation therapy and radioprotection levels, following national and international recommendations. Another objective of this group is to develop simple dosemeters for gamma high-doses to be used as routine reference systems.

Diagnostic radiology level A double-faced ionization chamber was developed and tested in standard X-ray beams. It has collecting electrodes of different materials, that leads to different energy response of the two faces of the chamber. This fact allowed the establishment of a tandem system that is useful for the checking of beam qualities constancy and for the determination of air kerma values. The main application of this kind of ionization chamber will be in quality control programs of diagnostic X-ray equipments. The chamber presented a very good level of performance. The development of another plane parallel ionization chamber as a reference instrument for standard computed tomography X-ray beams is in progress. Tandem systems of dose calibrators (activimeters) were established and characterized using four cylindrical absorbers of different materials for an additional quality control test in Nuclear Medicine. The main utility of this new test in the possibility of impurity detection in radiopharmaceuticals. An intercomparison program among 50 mammographic systems of the São Paulo State is in progress related to mean glandular dose evaluations.

Radiation therapy level Special ionization chambers were developed for therapeutic radiation beams. A tandem double-faced ionization chamber (0.6cm^{3}volume) presenting good dosimetric characteristics was manufactured for use in quality control programs of low and medium energy X-ray equipments. Another plane-parallel ionization chamber, with variable volume, called extrapolation chamber, was developed for calibration of ^{90}Sr+^{90}Y dermatological and ophthalmic applicators. Highly satisfactory results were obtained. The thermoluminescence and thermally stimulated exoelectron techniques were utilized to study Brazilian natural topaz from Minas Gerais State for use in dosimetric applications in the therapeutic range. Composites of topaz-teflon and topaz-glass were produced, and they present good response to gamma, beta, alpha and X-radiation. The establishment of a calibration methodology of well type ionization chambers for brachytherapy sources is in progress.

Radioprotection level The dosimetric characteristics of three types of $CaSO_4$:Dy+Teflon pellets produced at IPEN were studied for an appropriate choice of the material to be used for individual beta monitoring of workers at Nuclear Medicine Services. Pellets with different mass (50 and 20mg) and with addition of 10%C (20mg) were tested. All kinds of materials proved their applicability, but the thin ones were better for skin dose determination, in beta radiation fields of ^{90}Sr + ^{90}Y, ^{204}Tl, ^{147}Pm, ^{153}Sm and ^{32}P. A wrist badge for beta individual monitoring was developed for workers that handle beta radiopharmaceuticals in Nuclear Medicine Services. In one clinic an application of this kind of dosemeter was realized during a period of handling of ^{153}Sm source, with good results. The development of an ionization chamber is in progress for use as a reference system to determine the incident radiation energy and the personal dose equivalent Hp (10) at a phantom.

High doses Silicates are very interesting materials for high-dose dosimetry. Commercial glasses (transparent and colored) produced by Cebracê, São Paulo, and sand samples of different Brazilian beaches were studied, due to their low cost and easy handling, to verify the possibility of their use in high-dose dosimetry. The main dosimetric characteristics were determined using the techniques of optical absorption (OA), thermoluminescence (TL) and electron paramagnetic resonance (EPR). An optical absorption band was observed at 420nm in the glass samples. The TL glow curves presented peaks at 205ºC, 135ºC, 150ºC and 145ºC for the transparent, bronze, brown and green glass samples, respectively. All EPR spectra of the glasses showed Fe^{3+} characteristic signal at g=4.27 and 2.01. The gamma irradiated sand samples presented two peaks at 110ºC and 170ºC, and an EPR signal at g=1.999. However, these materials present a pronounced thermal fading at room temperature after irradiation.The glass and sand samples showed their applicability for high-dose dosimetry and as Yes/No irradiation detectors, with great advantages in relation to imported dosemeters and indicators, due to their extreme low cost and possibility of reutilization. Green samples acquired as jade from New Zeland, Austria, USA and Brazil were studied in relation to their dosimetric characteristics. Composites of jade-teflon were tested using the TL technique in the dose range of 10Gy to 10kGy that meets industrial, agricultural and medical areas, where high doses are utilized.

FIGURE 1 - Ionization chambers developed at IPEN.