Development and Characterization of a New Cylindrical Ionization Chamber for Dosimetry of ^{60}Co Beams

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The Calibration Laboratory of Instituto de Pesquisas Energéticas e Nucleares (IPEN/CNEN) offers calibration services and has developed several types of ionization chambers. The main objective in the development of these ionization chambers is to produce radiation detectors of low cost and following international recommendations. In this work, a cavity ionization chamber was developed and tested to verify its applicability as a standard dosimeter for ^{60}Co beams. This type of ionization chamber is one of the most used dosimeters for ^{60}Co beams, due to its long term stability, high precision, direct measurements, and relative ease of use. Many times, these dosimeters are homemade radiation detectors, due to the fact that it is very important to know their specifications very accurately. This ionization chamber is intended to be a new standard for the laboratory, as a secondary standard for ^{60}Co gamma radiation beams. This ionization chamber has walls made of polyvinyl chloride (PVC) coated with graphite, with a thickness of 3.0 mm. The wall has 18.00 mm length, and 9.00 mm in diameter, with a sensitive volume of 1.0 cm^3. The body and stem are made of poly(methyl methacrylate) (PMMA). The central electrode is also made of PVC coated with graphite, with a diameter of 2.0 mm. In order to characterize this new ionization chamber, several tests were made, according to international recomendations. The tests were: short- and long-term stability, linearity of response, saturation, ion collection efficiency and leakage current. A PTW electrometer, model UNIDOS E, was utilized for the ionization current measurements. A Gammatron II S 80 ^{60}Co source unit and an industrial X-ray unit, Pantak Seifert, model ISOVOLT 160HS, with the T standard therapy radiation qualities were utilized. To ensure the geometrical reproducibility of the source and ionization chamber setup, a special support of PMMA was developed. The saturation test was obtained varying the voltage from -400 V to +400 V, in steps of 50 V, which are the minimum possible variation allowed by the electrometer, and for the linearity of response, the tube current of the X-ray system was varied from 2 mA to 25 mA, for the variation in the air kerma rate. During all tests, the charge collecting time was 15 s, except for the leakage current test, in which the collecting time was 20 min. The results obtained were within those recommended internationally, showing that this homemade ionization chamber may be used as a secondary standard at the Calibration Laboratory of IPEN.