Metrological Laboratory of Ionizing Radiation

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The Metrology Laboratory of Ionising Radiation (LMRI) develops work in the following activity areas:

- Research and training in metrology of ionising radiations.
- Maintenance of the ionising radiation national standards, under a protocol with the Portuguese Institute for Quality (IPQ).
- International cooperation with EUROMET, BIPM, IAEA, WHO and EA, in the field of interlaboratory comparison of standards and measurements.
- Collaboration and support of other research groups performing measurements or irradiations.
- Services of metrological control of measuring instruments, according to national regulation (Portaria 423/98).

The LMRI, since 2000, has implemented a Quality System (QS) according to the ISO 17025 standard. Again, this year, a great effort was made in order to ensure that the LMRI QS agrees with the requirements of the standard.

The LMRI participates in the Mutual Recognition Agreement (MRA), an international process leading to the mutual recognition of national measurements standards of calibration and measurement certificates issued by the national metrology laboratories and is being implemented among the Metre Convention Member States. From March 2005, the LMRI "Calibration and Measurements Capabilities" (CMC) are published in the BIPM database. These CMC's characterize the LMRI measurement capabilities describing the method of calibration, the uncertainty of the calibration, the traceability of the measurement standard and much more information. At the moment, the LMRI has 43 entries in his CMC file, corresponding to 43 different services provided in the laboratory. These CMC's are published in the site of BIPM and can be consulted in the following link; http://kcdb.bipm.org/appendixC/search.asp?reset=1&met=RI.

For the first time, the primary standard of air kerma for Co-60 radiation went to BIPM for an intercomparison with their primary standard. This was a very important intercomparison exercise because it gives recognition of equivalence to the primary standards of other countries. It was an objective that was being pursuit for several years and finally was done.

The LMRI also participate in an intercomparison, promoted by EUROMET, for the quantity personal dose equivalent, $H_p(10)$, for the X-ray radiation qualities N-30, N-60 and N-120, described in the standard ISO 4037-1. Intercomparisons of doses at radiotherapy level were performed in programmes run by IAEA/WHO.

Collaboration with other research groups, outside ITN, is maintained, and again this year the LMRI provided irradiation conditions and experimental facilities to several research groups outside ITN.

Calibration services were provided to the community mainly for industry, universities, hospitals, armed forces and departments of ITN.

Metrological control of instruments for measurement of ionising radiation is being carried out under a contract with Portuguese Institute of Quality and is the enforcement of Portaria 423/98 from 21 of July. Metrological control includes calibration and type testing. During 2005 were calibrated 62 dosemeters and about 500 TLD dosimeters were irradiated. The following figures can quantify the work done in this particular area.

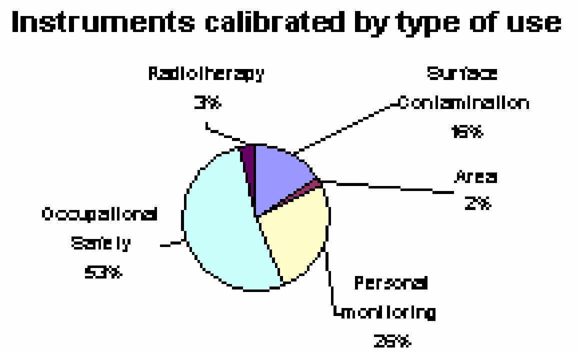

Figure 1. Distribution of calibrated instruments by type of use.

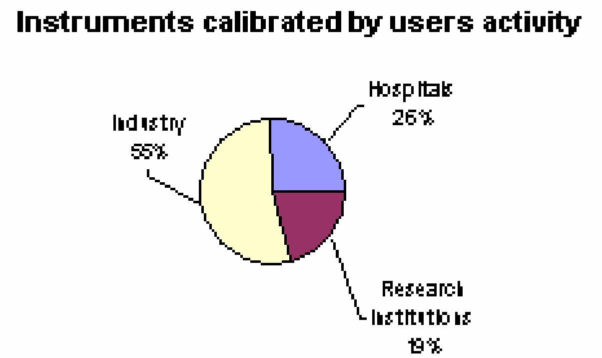

Figure 2. Distribution of calibrated instruments by area of activity.

Research Team

Technical Personnel

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Study of the Spatial Variation of the Air Kerma Backscatter Factor on the Standard ISO Phantom: Experimental and Simulation Evaluations

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The evaluation of effective dose received by exposed workers to ionizing radiation is done by personal dosimeters who perform measurements in the operational quantity, personal dose equivalent, $H_p(10)$, which estimates the effective dose. In agreement with the definition of $H_p(10)$, the calibration of instruments in this quantity is performed with a ISO water phantom. In the phantom front face can be positioned several dosemeters allowing a simultaneous irradiation, and to do this, is possible to define an area which boundary is the isodose contour of 95% of the dose in the centre of the front face. So, the diameter of this circular area, d_F, define the region where the radiation field is uniform and where must be positioned the dosemeters. The main goal of this work is the determination of d_F for 95% of the dose in the centre of the phantom front surface. For this purpose, the spatial distribution of the air kerma backscatter factor, *B*, in the phantom surface, was determined. The air kerma backscatter factor is defined as,

$$B = \frac{K_a\,(\text{phantom present})}{K_a\,(\text{free in air})}$$

In order to determine *B*, two complementary approaches are purposed: the experimental approach and the numerical simulation by Monte-Carlo method applying the MCNP code. The simulated and the experimental work have been performed for ^{60}Co and ^{137}Cs gamma sources and for the X-ray narrow spectrum ISO series for 30 kV, 40 kV, 60 kV, 80 kV, 100 kV and 120 kV.

Results

The dispersion of the photons in the phantom that increases the number of photons in the front surface of the phantom and also changes the photon spectra in that region as it can be seen in figure 1 for N-120 radiation quality. The values for the diameter of the circular area, d_F, that defines the region where the radiation field is uniform and where must be positioned the dosimeters, which corresponds to 98% of the dose in the centre of the phantom front surface, obtained in his work and those from the ISO 4037 can be seen in figure 2.

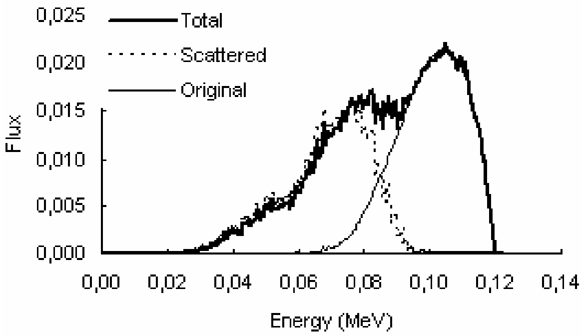

Figure 1: Photon spectra in the front surface of the ISO water phantom for N-120 radiation quality.

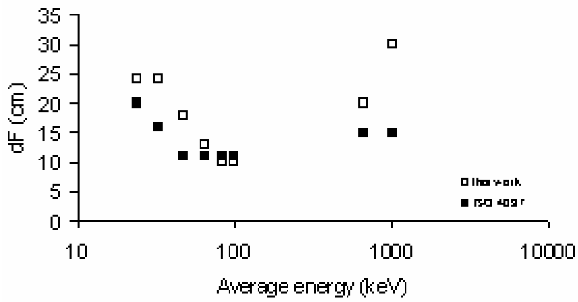

Figure 2: Values for d_F obtained for the radiation qualities presented in this work.

Conclusions

Some differences were found for the value of B calculated from the experimental method and by the simulation method. These differences reached the 7% value, with a tendency of higher B values for the simulation results. Comparing the results obtained in this work to those described in ISO 4037-3 it is clear that our results provide larger areas for positioning the personal dosimeters in the front surface of the ISO water phantom.