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General requirements to implement the personal dose equivalent Hp(10) in Brazil

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Abstract: To update the dosimetry quantity with the international community, Brazil is changing the Individual Dose Hx to the Personal Dose Equivalent Hp(10). A bibliographical survey on the technical and administrative requirements of nine countries that use Hp(10) was carried out to obtain the most relevant ones. All of them follow IEC and ISO guidelines for technical requirements, while administrative requirements change from country to country. Based on countries experiences, this paper presents a list of important general requirements to implement Hp(10) and to prepare the Brazilian requirements according to the international scientific community.

Keywords: Personal dose equivalent Hp(10), dosimetry laboratory, requirements.

1. INTRODUCTION

In Brazil, occupationally exposed workers can only use personal dosimeters provided by services approved by the National Commission of Nuclear Energy (CNEN). The responsibility to provide the formal approval of operation for External Individual Monitoring Services has been delegated to the Institute of Radiation Protection and Dosimetry (IRD/CNEN) since 1995 by CNEN. A formal Committee named "Committee for the Evaluation of Services of Essays and Calibration" (CASEC/IRD) has the responsibility of defining the requirements for approval, auditing the laboratories, organizing inter-comparison exercises, certifying the technical heads of the laboratories and recommending the approval or cessation of laboratories activities to the Director of the Institute.

The External Individual Monitoring Services (SMIE) must comply with a series of management and specific requirements to obtain the approval. Ten laboratories in Brazil are approved to provide dosimetry services using Film Badge, TLD and OSLD, with around 183,000 radiation workers.

The problem is that the dosimetric quantity used in Brazil is the Individual Dose (Hx), which is an operational quantity for photons obtained by multiplying the value obtained in the detector, calibrated in kerma in the air, by the factor f=1.14 Sv/Gy (CNEN, 2011). Internationally, the main operational quantity, defined by ICRU and adopted by ICRP, is the Personal Dose Equivalent Hp(d). This is the dose equivalent in soft tissue below a specified point on the body, at an appropriate depth d (10 millimetres) (IAEA, 1999).

To become update with the international community, Brazil is changing the old quantity H(x) to the useful quantity Hp(10) for effective dose and making a review of general requirements to implement the Hp(10). As the technical requirements are generally based on and follow the IEC and/or ISO guidelines (IEC,

2012; ISO, 1999), the main objective of this paper is to suggest a list of the most important general requirements to implement the personal dose equivalent Hp(10) in Brazil, based on the countries experiences. A bibliographical survey was made of the technical regulations of nine (9) countries, which use Hp(10), highlighting the required technical and administrative criteria. Administrative requirements are usually developed in accordance with the regulations and laws of each country and have differences from one to the other.

2. INTERNATIONAL TECHNICAL REQUIREMENTS

There are two most important international technical standard that provides requirements applied to dosimetry system: the IEC 62387:2012 "Radiation protection instrumentation – Passive integrating dosimetry systems for personal and environmental monitoring of photon and beta radiation" (IEC, 2012) and the ISO 4037:1999 "X and gamma reference radiation for calibrating dosimeters and doserate meters and for determining their response as a function of photon energy" (ISO, 1999).

The IEC 62387 is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies. Many countries conduct testing for system evaluation following guidelines recommended in this standard. Two tests can be highlighted: the radiation energy and angle of incidence for Hp(10) and the non-linearity test.

The ISO 4037 - Part 3 describes procedures for calibrating and determining the response of dosimeters and doserate meters in terms of the ICRU operational quantities for radiation protection purposes. It also describes the reference angles and quality of energies used in the evaluation tests described in IEC.

3. INTERNATIONAL MANAGEMENT REQUIREMENTS

Based on technical regulations of nine (9) countries, which use Hp(10) in the dosimetry system, a selection of some management requirements was done to support a new Brazilian regulation.

In the Spanish technical regulation the highlight is about dosimeter reading that must have the following automatically operations: dosimetric identification, reading, recording and data storage for elaboration of thermoluminescent emission curves, application of correction factors, verification of system stability, estimation and allocation of doses (CSN, 2006).

According to Canadian Requirements, for routine performance tests, the dosimetry service shall comply with the following requirements: irradiate test dosimeters to known doses, usually under standard exposure conditions (e.g., at normal incidence with the calibration radiation); treat test dosimeters in the same way as routine dosimeters; if processing is required, provide test dosimeters without identifying them to the processing laboratory (CNSC, 2006).

Metrological tests are carried out in Germany for investigate whether the response or the indication of the dosimeter varies by no more than the permitted maximum values if an influence quantity is changed from its reference value to any other value within its rated range of use (PTB, 2013).

The Portuguese accreditation body audits the services, outside the evaluation program, to verify compliance with the accreditation decision and inter-laboratory comparisons are mandatory to demonstrate the competence and performance for some accredited evaluations (IPAC, 2016).

Approval criteria to dosimetry services in Ireland are based on European Commission

Technical Recommendations for Monitoring Individuals Occupationally Exposed to External Radiation (EC, 2009) and it is mandatory to pay fees before the request is submitted (EPA, 2015).

Approval of Dosimetry Services (ADS) in United Kingdom will be granted for an indefinite period of time. Approved Body (HSE) will, however, carry out a reassessment of the dosimetry service, usually at intervals of 5 or 7 years depending on the nature of the dosimetry service. Fees are payable for all applications, whether or not they are successful (HSE, 2006, 2008, 2010).

In France, laboratories which provide dosimetry services, private or public sector, are obliged to be both accredited and approved. Performance tests are "announced" and the dosimeter is irradiated under defined conditions, the laboratory carries out the analysis "blind", the result obtained is compared with international standards, either ISO or IEC (depending on the techniques) (HPA, 2006).

In the USA there are two dosimetry service assessment programmes: The National Voluntary Laboratory Accreditation Program (NVLAP), and the Department of Energy Laboratory Accreditation Program (DOELAP). They are both designed to test the proficiency of processors of personal dosimetry and to grant them accreditation after successful approval of a performance test and a site visit by an audit team. The accreditation is granted for a period of two years in both programmes (HPA, 2006).

At present, in European Commission, there is increasing pressure for accreditation/certification of dosimetry services (ADS), and in particular, demonstration of conformity with ISO/IEC 17025:2005 (ISO, 2005). Dosimetry services in different EU Member States do not have to comply with the same legal or approval requirements, and these requirements are not always based to the same degree on standards or documents of relevance. Nevertheless, many dosimetry services in the EU are accredited according to ISO/IEC 17025:2005 and this provides a certain uniformity of quality in individual monitoring services in Europe (EC, 2009).

4. BRAZILIAN MANAGEMENT REQUIREMENTS

The External Individual Monitoring Services (SMIE), to be approved by the CASEC/IRD, must comply with one general requirement and three specific requirements. Some items of the "General Requirements to Approval Individual Monitoring Services" - RT N° 001/1995 (IRD, 1999) to be followed by the SMIE are: dosimetry procedures and QA program must be evaluated and approved by CASEC/IRD; a specialized staff with a technical officer, a quality manager and dosimetry technicians must be organized. The technical officer must be submitted a qualify certification made by CASEC/IRD and after approved, the SMIE receives a Three Years Certification and must participate in a monthly CASEC/IRD Follow-up Performance Program in which the SMIE are required to send 5 dosimeters to be irradiated by SSDL/IRD for a blind test. The SMIE are evaluated in the Trumpet Curves and 90% of the dosimeters have to be within it. After three years new audit is done for renovation.

5. RESULTS AND DISCUSSION

Based on the countries experiences to approval dosimetry services, a list of ten relevant general requirements are presented, as result of this bibliographic survey. This list shows some requirements to be added in the new Brazilian requirement and others that are the same. The Brazilian requirements showed in item 4 are not in this list.

The top 10 aspects are: (1) Private or public laboratories, which provide dosimetry services, are accredited according to ISO/IEC 17025 and approved by the National Requirement and these processes are generally paid; (2) Performance dosimetry tests are carried out for several irradiation condition to confirm the accuracy system; (3) Independent inter-comparison test can be done by the dosimetry service at least once every two years; (3) The results of performance tests and of inter-comparisons are evaluated using the Trumpet Curves; (4) The performance of the approved dosimetry services are evaluated by an "announced test" made by the approval body; (5) The accreditation and approval are granted for a period of two years maximum; (6) The reference calibration of the dosimetry system should be repeated at regular intervals of two years; (7) All reported doses are stored for an appropriate period, in conformity with ISO/IEC 17025; (8) Annual doses are sent to a National Dose Register by the dosimetry service and (10) Review, annually, the dosimetry process to optimize, to have under control and produce accurate results to be comply with the requirements.

6. CONCLUSION

The main objective of this paper is to suggest a list of the most important general requirements to implement the personal dose equivalent Hp(10) in Brazil, based on experiences of nine countries. It was observed that some countries requirements must be taking into account in the new Brazilian requirement. These requirements must be analysed if they can be applied in Brazil. For other side, it was found some countries requirements that are the same of the Brazilian requirements. It shows that the Brazilian processes are updated on international one. The main conclusion is that with the requirements from the countries the new Brazilian general requirement will be in accord to the international scientific community.

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