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Radiological protection — Minimum criteria for electron paramagnetic resonance (EPR) spectroscopy for retrospective dosimetry of ionizing radiation —

Part 1: General principles

Radioprotection — Critères minimaux pour la spectroscopie par résonance paramagnétique électronique (RPE) pour la dosimétrie rétrospective des rayonnements ionisants —

Partie 1: Principes généraux

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 2, *Radiological protection*.

A list of all parts in the ISO 13304 series can be found on the ISO website.

This second edition cancels and replaces the first edition (ISO 13304-1:2013), of which it constitutes a minor revision. The changes compared to the previous edition are as follows:

— inclusion of bibliographic references in the text;

— informative reference to ISO 13304-2 added;

— update of Bibliography.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Electron paramagnetic resonance (EPR) has become an important approach for retrospective dosimetry in any situation where dosimetric information is potentially incomplete or unknown for an individual. It is now applied widely for retrospective evaluation of doses that were delivered at considerable times in the past (e.g. EPR dosimetry is one of the methods of choice for retrospective evaluation of doses to the involved populations from the atomic weapon exposures in Japan and after the Chernobyl accident) and has received attention for use for triage after an incident in which large numbers of people have potentially been exposed to clinically significant levels of radiation[1] to [12]. Various materials may be analysed by EPR to provide information on dose[13] to [41]. Thus, EPR is a versatile tool for retrospective dosimetry, pertinent as well for acute exposures (past or recent, whole or partial body) and prolonged exposures. Doses estimated with EPR were mainly used to correlate the biological effect of ionizing radiation to received dose, to validate other techniques or methodologies, to manage casualties, or for forensic expertise for judicial authorities[42]. It uses mainly biological tissues of the person as the dosimeter and also can use materials from personal objects as well as those located in the immediate environment. EPR dosimetry is based on the fundamental properties of ionizing radiation: the generation of unpaired electron species (often but not exclusively free radicals) proportional to absorbed dose. The technique of EPR specifically and sensitively detects the amount of unpaired electrons that have sufficient stability to be observed after their generation; while the amount of the detectable unpaired electrons is usually directly proportional to the amount that was generated, these species can react, and therefore, the relationship between the intensity of the EPR signal and the radiation dose needs to be established for each type of use. The most extensive use of the technique has been with calcified tissue, especially with enamel from teeth[43] to [50]. An IAEA technical report was published on the use for tooth enamel[51]. To extend the possibility of EPR retrospective dosimetry, new materials possibly suitable for EPR dosimetry are regularly studied and associated protocols established. This document is aimed to make this technique more widely available, more easily applicable and useful for dosimetry. Specifically, this document proposes a methodological frame and recommendations to set up, validate, and apply protocols from sample collection to dose reporting. The application of this document to ex vivo human tooth enamel dosimetry is described in ISO 13304-2[52].

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Part 1: General principles

1 Scope

The primary purpose of this document is to provide minimum acceptable criteria required to establish a procedure for retrospective dosimetry by electron paramagnetic resonance spectroscopy and to report the results.

The second purpose is to facilitate the comparison of measurements related to absorbed dose estimation obtained in different laboratories.

This document covers the determination of absorbed dose in the measured material. It does not cover the calculation of dose to organs or to the body. It covers measurements in both biological and inanimate samples, and specifically:

a) based on inanimate environmental materials like glass, plastics, clothing fabrics, saccharides, etc., usually made at X-band microwave frequencies (8 GHz to 12 GHz);

b) in vitro tooth enamel using concentrated enamel in a sample tube, usually employing X-band frequency, but higher frequencies are also being considered;

c) in vivo tooth dosimetry, currently using L-band (1 GHz to 2 GHz), but higher frequencies are also being considered;

d) in vitro nail dosimetry using nail clippings measured principally at X-band, but higher frequencies are also being considered;

e) in vivo nail dosimetry with the measurements made at X-band on the intact finger or toe;

f) in vitro measurements of bone, usually employing X-band frequency, but higher frequencies are also being considered.

For biological samples, in vitro measurements are carried out in samples after their removal from the person or animal and under laboratory conditions, whereas the measurements in vivo are carried out without sample removal and may take place under field conditions.

NOTE The dose referred to in this document is the absorbed dose of ionizing radiation in the measured materials.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.