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TECHNICAL SPECIFICATION

colour inside

Radiation protection instrumentation – Dosemeters for pulsed fields of ionizing radiation

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RADIATION PROTECTION INSTRUMENTATION – DOSEMETERS FOR PULSED FIELDS OF IONIZING RADIATION

FOREWORD

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 63050, which is a technical specification, has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
45B/903/DTS	45B/925A/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The specification and determination of the special characteristics required for dosemeters to be used in pulsed fields of ionizing radiation have been excluded from all standards for direct reading personal and environmental dosemeters issued before 2015 for radiation protection purposes. These standards only specify characteristics for continuous radiation. This Technical Specification provides the necessary information for the measurement of one single radiation pulse, which is the most difficult situation to be measured. The characteristics of a dosemeter for repeated pulses is expected to be better than for one single radiation pulse with the same parameters but worse than for continuous radiation, i.e., in between of the characteristics for these two extreme conditions.

The concept is similar to the concept used for other influence quantities, e.g., radiation energy. The workplace is characterized by the parameter range occurring at that workplace, i.e., in the case of energy the expected possible values of radiation energy. It can then be determined if the dosemeter under consideration can be used. The required parameters for a workplace where pulsed radiation occurs are:

– the maximum dose rate during the radiation pulse, $\dot{H}_{\mathrm{pulse,max}}$, occurring at the workplace,
– the maximum dose per radiation pulse, $H_{\mathrm{pulse,max}}$, occurring at the workplace,
– the minimum radiation pulse duration, $t_{\mathrm{pulse,min}}$, occurring at the workplace, and
– the range of the pulse repetition frequency, f_{pulse}, occurring at the workplace.

The instrument parameters to be determined during type test of the dosemeter are:

– the maximum measurable dose rate in the pulse, $\dot{H}_{\mathrm{meas,max}}$,
– the maximum measurable dose in the pulse, $H_{\mathrm{meas,max}}$,

– the minimal pulse duration, $t_{\mathrm{meas,min}}$, and
– the range for the pulse repetition frequency, $f_{\mathrm{meas,min}}$ to $f_{\mathrm{meas,max}}$.

NOTE These parameters may be inter-related depending on the detector used.

In principle, the parameters resulting from the type test could be determined using continuous radiation fields if the detector is connected to simple, linear and straight forward electronics. But nearly any dosemeter exhibits one or more of the following properties. It:

– has a finite dead time,
– uses internal range switching,
– uses software to correct for known deficiencies, e.g., the dead time or the radiation energy,
– uses special, proprietary algorithms,
– adjusts the measurement cycle time, T_{cycle}, to the dose rate, $\dot{G}_{\mathrm{dose}}$, measured by the dosemeter,
– mitigates the effect of EMC-pulses and mechanical drops.

All these properties could affect the results when determining the characteristics for pulsed radiation fields by using continuous radiation fields. The conclusion is that measurements using pulsed radiation fields are required for testing of dosemeters.

As a help to the user to judge whether or not the dosemeter under consideration can be used, Table A.1 in the informative Annex A gives some parameter values for typical workplaces where pulsed radiation occurs. They are based on the knowledge available in 2019 and may change with the next generation of pulsed radiation generating equipment.

This Technical Specification is a generalized version of IEC TS 62743 and not limited to dosemeters using pulse counting techniques. This Technical Specification might replace IEC TS 62743 in the future. This Technical Specification contains much information for which worldwide experience is not available at the date of its development. Therefore, it was decided to publish it as a Technical Specification. It is expected that within the next years this experience will be gained and then maintenance of this publication could lead to an International Standard.

RADIATION PROTECTION INSTRUMENTATION – DOSEMETERS FOR PULSED FIELDS OF IONIZING RADIATION

1 Scope

This document applies to all types of dosemeters, irrespective of the type of radiation intended to be measured. Tests according to this document determine whether a single radiation pulse can be measured correctly even if the dosemeter is in the internal state relevant for measuring background or environmental radiation. The characteristics of the dosemeter for repeated pulses is expected to be better than for one single radiation pulse with the same parameters but worse than for continuous radiation, i.e., in between of the characteristics for these two extreme conditions.

The pulsed radiation source is characterized by the parameters:

– the maximum dose rate during the radiation pulse, $\dot{H}_{\text{pulse,max}}$, occurring at the workplace,

– the maximum dose per radiation pulse, $H_{\text{pulse,max}}$, occurring at the workplace,

– the minimum radiation pulse duration, $t_{\text{pulse,min}}$, occurring at the workplace, and

– the range of the pulse repetition frequency, f_{pulse}, occurring at the workplace.

Annex A gives some parameter values for typical workplaces where pulsed radiation occurs.

This document considers the pulsation of the radiation field as an additional influence quantity like particle energy and direction of radiation incidence. Therefore, the tests described are additional to all the tests in the instrument specific standards.

This document describes methods to determine the following characteristic parameters of the dosemeters:

– the maximum measurable dose rate in the pulse, $\dot{H}_{\text{meas,max}}$,

– the maximum measurable dose in the pulse, $H_{\text{meas,max}}$,

– the minimal pulse duration, $t_{\text{meas,min}}$, and

– the range for the pulse repetition frequency, $f_{\text{meas,min}}$ to $f_{\text{meas,max}}$.

NOTE These parameters may be inter-related depending on the detector used.

It is applicable to photon radiation but basically can be adapted to all types of radiation for which a suitable pulsed reference field is available. The term dose is used in this document in the sense of dose equivalent, but the requirements can also be adapted to air kerma, exposure or other quantities expressing the amount of radiation.

The parameter pulse repetition frequency, f_{pulse}, is included in the testing procedures, but for this inclusion additional work has to be done. Especially, reference fields for radiation conditions in surrounding fields of accelerators are missing (high pulse repetition frequency, ultra-short pulses).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-395, *International Electrotechnical Vocabulary (IEV) – Part 395: Nuclear instrumentation – Physical phenomena, basic concepts, instruments, systems, equipment and detectors*

IEC 61267:2005, *Medical diagnostic X-ray equipment – Radiation conditions for use in the determination of characteristics*

ISO 4037-3:2019, *Radiological protection – X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy – Part 3: Calibration of area and personal dosemeters and the measurement of their response as a function of energy and angle of incidence*

ISO TS 18090-1:2015, *Radiological protection – Characteristics of reference pulsed radiation – Part 1: Photon radiation*

3 Terms and definitions, abbreviated terms and symbols, quantities and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-395, ISO TS 18090-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
continuous radiation
<area and individual dosimetry> ionizing radiation with a constant dose rate at a given point in space for time intervals longer than 10 s

[SOURCE: ISO TS 18090-1:2015, 3.2]

3.1.2
dose equivalent per radiation pulse
H_{pulse}
dose equivalent value of one radiation pulse at a point in the radiation field

[SOURCE: ISO TS 18090-1:2015, 3.3 modified: The term “photon radiation field” has been replaced by “radiation field”.]

3.1.3
dose indication
G_{dose}
indication of the dosemeter in terms of dose