International Standard

ISO 18090-1

First edition
2026-05

Radiological protection — Characteristics of reference pulsed radiation —

Part 1: Photon radiation

Radioprotection — Caractéristiques des rayonnements pulsés de référence —

Partie 1: Rayonnements photoniques

Reference number
ISO 18090-1:2026(en)

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Published in Switzerland

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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).

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This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 2, *Radiological protection*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 430, *Nuclear energy, nuclear technologies, and radiological protection*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces the first edition of ISO/TS 18090-1:2015, which has been technically revised.

The main changes are as follows:

— clarification of the scope, which covers only the single pulse;

— introduction of examples of other suitable instruments in 4.4.2.

A list of all parts in the ISO 18090 series can be found on the ISO website.

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.

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Introduction

The specification and determination of the special characteristics required for electronic radiation protection dosemeters to be used in pulsed fields of ionizing radiation have been laid down in International Standards, for example IEC/TS 62743 and IEC/TS 63050. A prerequisite for IEC/TS 63050 is the availability of the required reference fields for pulsed radiation. This document provides the necessary information for such reference fields.

The concept is based on the existing standards for radiation qualities defined in ISO and IEC standards. It only adds the parameters of the pulsed field and gives some guidance for their determination. Therefore, no new radiation qualities are defined, only the link between the parameters for pulsed radiation and the parameters for continuous radiation are given. The main required parameters for pulsed radiation fields are the following[2]:

— radiation pulse duration, t_{pulse};

— radiation pulse air kerma rate, $\dot{K}_{\mathrm{a,pulse}}$;

— air kerma per radiation pulse, $K_{\mathrm{a,pulse}}$;

— for repeated pulses, their pulse repetition frequency, f_{pulse}.

The pulse parameters were determined by using an equivalent trapezoidal radiation pulse, which is equivalent with respect to air kerma and air kerma rate. Reference pulsed radiation is characterized by specified maximum deviations of the given pulse from the equivalent trapezoidal radiation pulse and by requirements concerning the change of radiation quality during the given radiation pulse.

The pulse parameters with respect to the phantom related quantities were determined using conversion coefficients according to ISO 4037 (all parts).

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Radiological protection — Characteristics of reference pulsed radiation —

Part 1: Photon radiation

1 Scope

This document is directly applicable to pulsed X-radiation with pulse duration of 0,1 ms up to 10 s. This range covers the whole range used in medical diagnostics at the time of publication. Some specifications can also be applicable for much shorter pulses; one example is the air kerma of one pulse. Such a pulse can be produced, e.g. by X-ray flash units or high-intensity femtosecond-lasers. Other specifications are not applicable for much shorter pulses; one example is the time-dependent behaviour of the air kerma rate. This cannot be measurable for technical reasons as no suitable instrument is available, e.g. for pulses produced by a femtosecond-laser.

This document specifies the characteristics of reference pulsed radiation for calibrating and testing radiation protection dosemeters and dose rate meters with respect to their response to pulsed radiation. At this point, it is only concerned with the characteristics of single pulses. Single pulses are the most difficult for dosemeters to measure. Determining the dose for repeated pulses is easier, but still more difficult than for continuous radiation, i.e. the performance of the dosemeters when measuring repeated pulses lies between these extremes. The radiation characteristics includes the following:

a) time-dependent behaviour of the air kerma rate of the pulse;

b) time-dependent behaviour of the X-ray tube high voltage during the pulse;

c) uniformity of the air kerma rate within a cross-sectional area of the radiation beam;

d) air kerma of one radiation pulse;

e) air kerma rate of the radiation pulse;

f) repetition frequency.

This document does not define new radiation qualities but uses those radiation qualities specified in existing ISO and IEC standards. Instead, this document gives the link between the parameters for pulsed radiation and the parameters for continuous radiation specifying the radiation qualities. It does not specify specific values or series of values for the pulsed radiation field but specifies only those limits for the relevant pulsed radiation parameters that are required for calibrating dosemeters and dose rate meters and for determining their response depending on the said parameters.

The pulse parameters with respect to the phantom-related quantities were determined using conversion coefficients according to ISO 4037 (all parts). This is possible as the radiation qualities specified in existing ISO and IEC standards are used.

A given reference pulsed X-ray facility is characterized by the parameter ranges over which the full specifications and requirements according to this document are met. Therefore, not all reference pulsed X-ray facilities can produce pulses covering the same parameter ranges.

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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.

ISO 4037-1, *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 1: Radiation characteristics and production methods*

ISO 4037-2:2019, *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 2: Dosimetry for radiation protection over the energy ranges from 8 keV to 1,3 MeV and 4 MeV to 9 MeV*

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

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
air kerma per radiation pulse
$K_{a,\,pulse}$
air kerma value of one radiation pulse at a point in the photon radiation field

3.2
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

3.3
dose equivalent per radiation pulse
H_{pulse}
dose equivalent value of one radiation pulse at a point in the photon radiation field

3.4
equivalent trapezoidal radiation pulse
trapezoidal radiation pulse considered to be equivalent to the given radiation pulse

3.5
field uniformity
F_{uni}
uniformity of the air kerma distribution determined across a defined area

$$F_{uni} = 1 - \frac{K_{a,pulse,max} - K_{a,pulse,min}}{0,5 \times \left(K_{a,pulse,max} + K_{a,pulse,min} \right)}$$

where

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