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INTERNATIONAL STANDARD

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Radiation protection instrumentation – X-ray systems for the security screening of persons

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RADIATION PROTECTION INSTRUMENTATION – X-RAY SYSTEMS FOR THE SECURITY SCREENING OF PERSONS

FOREWORD

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IEC 62463 has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation. It is an International Standard.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) title modified;
b) the main dose quantity was updated from ambient dose equivalent (H*(10)) to the operational quantities recommended in ICRU Report 95:2020;
c) the scope has been updated from X-ray systems for screening persons to X-ray systems that deliberately expose persons to X-rays for security purposes, which clarifies the ambiguity of whether occupied vehicle scanners are within scope;

d) the scheme for classifying systems was changed from one based on whether the system is backscatter, transmission or a combination to a classification system based on the dose level and administrative controls;

e) numerous electrical, environmental, electromagnetic, and mechanical safety requirements were updated.

The text of this International Standard is based on the following documents:

Draft	Report on voting
45B/1058/FDIS	45B/1068/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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

This document concerns the radiation safety of security screening systems where persons are intentionally exposed to X-rays. The document is applicable to a wide range of system designs, X-ray spectra, and irradiation geometries, and while current screening systems can be divided into X-ray backscatter, X-ray transmission, and combination systems, the methods in the document are general enough to be applicable to other systems too. The document sets dose limits in terms of effective dose and uses the operational quantities described in ICRU Report 95 to estimate the effective dose per screening. The document also specifies other requirements related to the electrical, environmental, electromagnetic, and mechanical safety of the systems.

RADIATION PROTECTION INSTRUMENTATION – X-RAY SYSTEMS FOR THE SECURITY SCREENING OF PERSONS

1 Scope

This document is applicable to security screening systems designed to expose persons to X-rays. In particular, the document applies to systems where the body is exposed to the primary beam of X-rays. It is common to divide currently used systems into three types: backscatter systems, transmission systems and combination backscatter/transmission systems. Some examples of systems that fall within the scope of this document are backscatter X-ray scanners; transmission X-ray scanners; occupied vehicle scanners.

The purpose of this document is to provide standardized requirements and test methods to ensure the safe operation of X-ray personnel screening systems, from a radiation protection point of view. In particular, the document specifies requirements related to the radiation protection of the persons being screened, persons who are in the vicinity of the equipment and the operators. Standard methods are provided to estimate the effective dose to the persons being screened. There are several simplifying assumptions inherent in such procedures that limit their accuracy. Nevertheless, there is value in having simple standard methods for dose estimation, e.g. for regulatory use. When highly accurate dose estimates are needed, different methods should be used that account for the particular characteristics of the X-ray system and persons being screened.

The document does not address image quality or detection performance.

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 60721-3-3:2019, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

IEC 61187:1993, *Electrical and electronic equipment – Documentation*

IEC 61326-1:2020*, Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety related systems*

IEC 62061:2021, *Safety of machinery – Functional safety of safety-related control systems*

ISO 4037-1:2019, *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 1: Radiation characteristics and production methods*

ISO 13849-1:2023, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

ICRU Report 95:2020, *Operational Quantities for External Radiation Exposure*

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:

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

NOTE The general terminology concerning X-ray screening systems is given in IEC 60050-395:2014.

3.1
ambient dose
H*
ambient dose at a point in a radiation field is defined as:

$$H^{*} = K \times h^{*}_{E_{\max}}$$

where

K is the air kerma at the point, and

$h^{*}_{E_{\max}}$ is a conversion coefficient relating air kerma to the maximum value of effective dose, $E_{\max}$, for various irradiation conditions

Note 1 to entry: See ICRU Report 95 for more details. H^{*} corresponds to the maximum effective dose that could be received by a person if they were uniformly irradiated by an equivalent field of radiation. More specifically, it is the maximum effective dose as calculated by exposure of the whole-body ICRP/ICRU adult reference phantoms (ICRP, 2009) for broad uniform parallel beams of the radiation field incident in irradiation geometries antero-posterior (AP), posterior-anterior (PA), left lateral (LLAT), right lateral (RLAT), rotational (ROT), isotropic (ISO), superior hemisphere semi-isotropic (SS-ISO), and inferior hemisphere semi-isotropic (IS-ISO).

3.2
constant potential X-ray unit
unit in which the ripple of the high voltage does not exceed ±10 %

3.3
effective dose
dose quantity intended to reflect the whole body stochastic health risk due to radiation exposure (see ICRP Report 103)

Note 1 to entry: It is calculated based on the sum of the equivalent doses in various organs multiplied by the appropriate tissue weighting factors.

3.4
general-use system
X-ray screening system that is configured to deliver an effective dose of less than 0,25 µSv per screening (using the dose estimation methods defined in this document) and operating using the administrative controls specified in this document. Given proper justification and certain restrictions, general-use systems may be operated without specific controls that would limit the number of individuals scanned or the number of scans per individual in a year

Note 1 to entry: This definition was reproduced, with the permission of the Health Physics Society (HPS), from ANSI/HPS N43.17-2009 (R2018)

3.5
half value layer
HVL
HVLx
thickness of the specified material which attenuates the X-ray beam so that the air kerma rate is reduced to one half of its original value

Note 1 to entry: The measurement should be made in narrow-beam geometry, meaning the contribution of all scattered radiation, other than any which might initially be present in the beam, is excluded.

3.6
filtration
total filtration is made up of the fixed filtration and any additional filtration used by the manufacturer. The fixed filtration comprises the inherent filtration of the tube, plus that due to the monitor ionisation chamber

Note 1 to entry: The inherent filtration of the tube is due to the various constituent elements (glass of the bulb, oil, window, etc.) and is expressed, for a given high voltage, as the thickness of an aluminium filter which, in the absence of the constituent elements of the tube, would supply a radiation having the same first HVL.

3.7
limited-use system
personnel screening system that is configured to deliver an effective dose of less than 10 μSv per screening (using the dose estimation methods defined in this standard) and which does not meet the definition of a general-use system. Limited-use systems require additional controls and documentation to ensure that annual individual dose limits are not exceeded

Note 1 to entry: This definition was reproduced, with the permission of the Health Physics Society (HPS), from ANSI/HPS N43.17.

3.8
occupied zone
volume in which a person could be exposed to the primary X-ray beam while the SOP is being followed. This volume uses the same frame of reference as a person being scanned

3.9
operator
person that controls one or more aspects of the screening procedure. An operator is authorized to perform their duties, appropriately trained, and performs their duties according to the SOP

3.10
personal dose
H_p
personal dose at a point in a radiation field is defined as:

$$H_p = K \times h_p$$

where

K is the air kerma at the point, and

h_p is a conversion coefficient relating air kerma to the personal dose, H_p, that is appropriate for the spectrum and irradiation geometry

Note 1 to entry: See ICRU Report 95 for more details.

3.11
primary beam
consists of X-rays that have exited the beam-defining aperture but have not been absorbed or scattered