



SLOVENSKI STANDARD SIST EN ISO 20785-2:2020

01-oktober-2020

Nadomešča:

SIST EN ISO 20785-2:2017

Dozimetrija za merjenje izpostavljenosti kozmičnemu sevanju v civilnem letalskem prometu - 2. del: Karakterizacija odziva instrumenta (ISO 20785-2:2020)

Dosimetry for exposures to cosmic radiation in civilian aircraft - Part 2: Characterization of instrument response (ISO 20785-2:2020)

Dosimetrie zu Expositionen durch kosmische Strahlung in Flugzeugen der zivilen Luftfahrt - Teil 2: Charakterisierung des Antwortverhaltens von Messinstrumenten (ISO 20785-2:2020)

Dosimétrie pour l'exposition au rayonnement cosmique à bord d'un avion civil - Partie 2: Caractérisation de la réponse des instruments (ISO 20785-2:2020)

Ta slovenski standard je istoveten z: EN ISO 20785-2:2020

ICS:

17.240	Merjenje sevanja	Radiation measurements
49.020	Letala in vesoljska vozila na splošno	Aircraft and space vehicles in general

SIST EN ISO 20785-2:2020

en,fr,de

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN ISO 20785-2:2020](https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020)

<https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020>

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN ISO 20785-2

August 2020

ICS 13.280; 49.020

Supersedes EN ISO 20785-2:2017

English Version

**Dosimetry for exposures to cosmic radiation in civilian
aircraft - Part 2: Characterization of instrument response
(ISO 20785-2:2020)**

Dosimétrie pour l'exposition au rayonnement
cosmique à bord d'un avion civil - Partie 2:
Caractérisation de la réponse des instruments (ISO
20785-2:2020)

Dosimetrie für die Belastung durch kosmische
Strahlung in Zivilluftfahrzeugen - Teil 2:
Charakterisierung des Ansprechvermögens von
Messinstrumenten (ISO 20785-2:2020)

This European Standard was approved by CEN on 30 June 2020.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents	Page
European foreword.....	3

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN ISO 20785-2:2020](https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020)
<https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020>

European foreword

This document (EN ISO 20785-2:2020) has been prepared by Technical Committee ISO/TC 85 "Nuclear energy, nuclear technologies, and radiological protection" in collaboration with Technical Committee CEN/TC 430 "Nuclear energy, nuclear technologies, and radiological protection" the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2021, and conflicting national standards shall be withdrawn at the latest by February 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 20785-2:2017.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

iTeh STANDARD PREVIEW

(standards.iteh.ai)

Endorsement notice

The text of ISO 20785-2:2020 has been approved by CEN as EN ISO 20785-2:2020 without any modification.

SIST EN ISO 20785-2:2020
<https://standards.iteh.ai/catalog/standards/sist/155318fe-11b5-4085-918a-40057ced9513/sist-en-iso-20785-2-2020>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN ISO 20785-2:2020](https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020)

<https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020>

INTERNATIONAL
STANDARD

ISO
20785-2

Second edition
2020-07

**Dosimetry for exposures to cosmic
radiation in civilian aircraft —**

**Part 2:
Characterization of instrument
response**

iTeh STANDARD PREVIEW
*Dosimétrie pour l'exposition au rayonnement cosmique à bord d'un
avion civil —*
(standards.iteh.ai)
Partie 2: Caractérisation de la réponse des instruments

[SIST EN ISO 20785-2:2020](https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020)

<https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020>



Reference number
ISO 20785-2:2020(E)

© ISO 2020

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST EN ISO 20785-2:2020](https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020)

<https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
3.1 General terms.....	1
3.2 Terms related to quantities and units.....	5
3.3 Atmospheric radiation field.....	7
4 General considerations	8
4.1 The cosmic radiation field in the atmosphere.....	8
4.2 General considerations for the dosimetry of the cosmic radiation field in aircraft and requirements for the characterization of instrument response.....	9
4.3 General considerations for measurements at aviation altitudes.....	10
5 Calibration fields and procedures	12
5.1 General considerations.....	12
5.2 Characterization of an instrument.....	14
5.2.1 Determination of the dosimetric characteristics of an instrument.....	14
5.2.2 Reference radiation fields.....	16
5.2.3 Scattered radiation.....	16
5.2.4 Effect of other types of radiation.....	16
5.2.5 Requirements for characterization in non-reference conditions.....	17
5.2.6 Use of numerical simulations.....	17
5.3 Instrument-related software.....	17
5.3.1 Software development procedures.....	17
5.3.2 Software testing.....	18
5.3.3 Data analysis using spreadsheets.....	18
6 Uncertainties	18
7 Remarks on performance tests	18
Annex A (informative) Representative particle fluence energy distributions for the cosmic radiation field at flight altitudes for solar minimum and maximum conditions and for minimum and maximum vertical cut-off rigidity	19
Annex B (informative) Radiation fields recommended for use in calibrations	25
Annex C (informative) Comparison measurements	29
Annex D (informative) Charged-particle irradiation facilities	31
Bibliography	32

ISO 20785-2:2020(E)

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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](http://Foreword - Supplementary information (standards.iteh.ai))

For an explanation on 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 the following URL: 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, *Radiation protection*.

This second edition cancels and replaces the first edition (ISO 20785-2:2011), which has been technically revised. The main changes compared to the previous edition are as follows:

- revision of the definitions of the terms;
- updated references.

A list of all the parts in the ISO 20785 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.

Introduction

Aircraft crews are exposed to elevated levels of cosmic radiation of galactic and solar origin and secondary radiation produced in the atmosphere, the aircraft structure and its contents. Following recommendations of the International Commission on Radiological Protection in Publication 60^[1], confirmed by Publication 103^[2], the European Union (EU) introduced a revised Basic Safety Standards Directive^[3] and International Atomic Energy Agency (IAEA)^[4] issued a revised Basic Safety Standards. Those standards included exposure to natural sources of ionizing radiation, including cosmic radiation, as occupational exposure. The EU Directive requires account to be taken of the exposure of aircraft crew liable to receive more than 1 mSv per year. It then identifies the following four protection measures:

- a) to assess the exposure of the crew concerned;
- b) to take into account the assessed exposure when organizing working schedules with a view to reducing the doses of highly exposed crew;
- c) to inform the workers concerned of the health risks their work involves; and
- d) to apply the same special protection during pregnancy to female crew in respect of the “child to be born” as to other female workers.

The EU Council Directive has already been incorporated into laws and regulations of EU member states and is being included in the aviation safety standards and procedures of the European Air Safety Agency. Other countries, such as Canada and Japan, have issued advisories to their airline industries to manage aircraft crew exposure.

For regulatory and legislative purposes, the radiation protection quantities of interest are the equivalent dose (to the foetus) and the effective dose. The cosmic radiation exposure of the body is essentially uniform, and the maternal abdomen provides no effective shielding to the foetus. As a result, the magnitude of equivalent dose to the foetus can be put equal to that of the effective dose received by the mother. Doses on board aircraft are generally predictable, and events comparable to unplanned exposure in other radiological workplaces cannot normally occur (with the rare exceptions of extremely intense and energetic solar particle events). Personal dosimeters for routine use are not considered necessary. The preferred approach for the assessment of doses of aircraft crew, where necessary, is to calculate directly the effective dose per unit time, as a function of geographic location, altitude and solar cycle phase, and to combine these values with flight and staff roster information to obtain estimates of effective doses for individuals. This approach is supported by the ICRP in Publications 75^[5] and 132^[6] and in guidance from the European Commission.

The role of calculations in this procedure is unique in routine radiation protection, and it is widely accepted that the calculated doses should be validated by measurement^[7]. Effective dose is not directly measurable. The operational quantity of interest is the ambient dose equivalent, $H^*(10)$. In order to validate the assessed doses obtained in terms of effective dose, calculations can be made of ambient dose equivalent rates or route doses in terms of ambient dose equivalent, and values of this quantity determined by measurements traceable to national standards and taking instrument responses and related uncertainties properly into account. The validation of calculations of ambient dose equivalent for a particular calculation method may be taken as a validation of the calculation of effective dose by the same computer code, but this step in the process might need to be confirmed. The alternative is to establish, a priori, that the operational quantity ambient dose equivalent is a good estimator of effective dose and equivalent dose to the foetus for the radiation fields being considered, in the same way that the use of the operational quantity personal dose equivalent is justified for the estimation of effective dose for ground-based radiation workers.

The radiation field in aircraft at altitude is complex, with many types of ionizing radiation present, with energies ranging up to many GeV. The instrument response to particles and energies of the atmospheric radiation field that are not covered by reference fields are carefully taken into account in the evaluation of measurement results. While, in many cases, the methods used for the determination of ambient dose equivalent in aircraft are similar to those used at high-energy accelerators in research laboratories. Therefore, it is possible to recommend dosimetric methods and methods for

ISO 20785-2:2020(E)

the calibration of dosimetric devices, as well as the techniques for maintaining the traceability of dosimetric measurements to national standards. Dosimetric measurements made to evaluate ambient dose equivalent should be performed using accurate and reliable methods that ensure the quality of readings provided to workers and regulatory authorities. The purpose of this document is to specify procedures for the determination of the responses of instruments in different reference radiation fields, as a basis for proper characterization of instruments used for the determination of ambient dose equivalent in aircraft at altitude.

Requirements for the determination and recording of the cosmic radiation exposure of aircraft crew have been introduced into the national legislation of EU member states and other countries. Harmonization of methods used for determining ambient dose equivalent and for calibrating instruments is desirable to ensure the compatibility of measurements performed with such instruments.

This document is intended for the use of primary and secondary calibration laboratories for ionizing radiation, by radiation protection personnel employed by governmental agencies, and by industrial corporations concerned with the determination of ambient dose equivalent for aircraft crew.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN ISO 20785-2:2020](https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020)

<https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020>

Dosimetry for exposures to cosmic radiation in civilian aircraft —

Part 2: Characterization of instrument response

1 Scope

This document specifies methods and procedures for characterizing the responses of devices used for the determination of ambient dose equivalent for the evaluation of exposure to cosmic radiation in civilian aircraft. The methods and procedures are intended to be understood as minimum requirements.

2 Normative references

The following five 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/IEC Guide 98-1, *Uncertainty of measurement — Part 1: Introduction to the expression of uncertainty in measurement*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

STANDARD PREVIEW
(standards.iteh.ai)
SIST EN ISO 20785-2:2020
<https://standards.iteh.ai/catalog/standards/sist/135318fe-1fb5-4085-9f8a-40057ced9513/sist-en-iso-20785-2-2020>

3 Terms and definitions

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

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

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

3.1 General terms

3.1.1

angle of radiation incidence

α

angle between the direction of radiation incidence and the reference direction of the instrument

3.1.2

calibration

operation that, under specified conditions, establishes a relation between the conventional quantity, H_0 , and the indication, G

Note 1 to entry: A calibration can be expressed by a statement, calibration function, calibration diagram, calibration curve or calibration table. In some cases, it can consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

Note 2 to entry: It is important not to confuse calibration with adjustment of a measuring system, often mistakenly called “self-calibration”, or with verification of calibration.