

Dosimetry for exposures to cosmic radiation in civilian aircraft - Part 1: Conceptual basis for measurements (ISO 20785-1:2012)

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

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English Version

**Dosimetry for exposures to cosmic radiation in civilian
aircraft - Part 1: Conceptual basis for measurements (ISO
20785-1:2012)**

Dosimétrie pour l'exposition au rayonnement
cosmique à bord d'un avion civil - Partie 1: Fondement
théorique des mesurages (ISO 20785-1:2012)

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European foreword

The text of ISO 20785-1:2012 has been prepared by Technical Committee ISO/TC 85 “Nuclear energy, nuclear technologies, and radiological protection” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 20785-1:2017 by 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of an identical text or by endorsement, at the latest by April 2018, and conflicting national standards shall be withdrawn at the latest by April 2018.

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Endorsement notice

The text of ISO 20785-1:2012 has been approved by CEN as EN ISO 20785-1:2017 without any modification.

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Terms and definitions	1
2.1 General.....	1
2.2 Quantities and units.....	2
2.3 Atmospheric radiation field.....	8
3 General considerations	10
3.1 General description of the cosmic radiation field in the atmosphere.....	10
3.2 General calibration considerations for the dosimetry of cosmic radiation fields in aircraft.....	11
3.3 Conversion coefficients.....	13
4 Dosimetric devices	13
4.1 Introduction.....	13
4.2 Active devices.....	14
4.3 Passive devices.....	17
Annex A (informative) Representative particle fluence rate 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 [80]	20
Bibliography	24

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] which included exposure to natural sources of ionizing radiation, including cosmic radiation, as occupational exposure. The Directive requires account to be taken of the exposure of aircraft crews liable to receive more than 1 mSv per year. It then identifies the following four protection measures: (i) to assess the exposure of the crew concerned; (ii) to take into account the assessed exposure when organizing working schedules with a view to reducing the doses of highly exposed crews; (iii) to inform the workers concerned of the health risks their work involves; and (iv) to apply the same special protection during pregnancy to female crews 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 Joint Aviation Authorities and 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 crews, 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 fold these values with flight and staff roster information to obtain estimates of effective doses for individuals. This approach is supported by guidance from the European Commission and the ICRP in Publication 75.^[4]

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. The effective dose is not directly measurable. The operational quantity of interest is 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. The validation of calculations of ambient dose equivalent for a particular calculation method may be taken as a validation of the calculation of the effective dose by the same computer code, but this step in the process may 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 radiation workers. Ambient dose equivalent rate as a function of geographic location, altitude and solar cycle phase is then calculated and folded with flight and staff roster information.

The radiation field in aircraft at altitude is complex, with many types of ionizing radiation present, with energies ranging up to many GeV. The determination of ambient dose equivalent for such a complex radiation field is difficult. 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 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 must be performed using accurate and reliable methods that ensure the quality of readings provided to workers and regulatory authorities. This part of ISO 20785 gives a conceptual basis for the characterization of the response of instruments for the determination of ambient dose equivalent in aircraft.

Requirements for the determination and recording of the cosmic radiation exposure of aircraft crews 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 part of ISO 20785 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 crews.

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Dosimetry for exposures to cosmic radiation in civilian aircraft —

Part 1: Conceptual basis for measurements

1 Scope

This part of ISO 20785 gives the conceptual basis for the determination of ambient dose equivalent for the evaluation of exposure to cosmic radiation in civilian aircraft and for the calibration of instruments used for that purpose.

2 Terms and definitions

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

2.1 General

2.1.1

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 may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

Note 2 to entry: Calibration should not be confused with adjustment of a measuring system, often mistakenly called “self-calibration”, or with verification of calibration.

Note 3 to entry: Often, the first step alone in the above definition is perceived as being calibration.

2.1.2

calibration coefficient

N_{coeff}

quotient of the conventional quantity value to be measured and the corrected indication of the instrument

Note 1 to entry: The calibration coefficient is equivalent to the calibration factor multiplied by the instrument constant.

Note 2 to entry: The reciprocal of the calibration coefficient, N_{coeff} , is the response.

Note 3 to entry: For the calibration of some instruments, e.g. ionization chambers, the instrument constant and the calibration factor are not identified separately but are applied together as the calibration coefficient.

Note 4 to entry: It is necessary, in order to avoid confusion, to state the quantity to be measured, for example: the calibration coefficient with respect to fluence, N_ϕ , the calibration coefficient with respect to kerma, N_K , the calibration coefficient with respect to absorbed dose, N_D .