

American National Standard Inspection, Test, Construction, and Performance Requirements for Direct Reading Electrostatic/Electroscope Type Dosimeters

Sponsor

National Committee on Radiation Instrumentation, N42

Accredited by the

American National Standards Institute

Secretariat

Institute of Electrical and Electronics Engineers, Inc.

Approved 6 February 1997

American National Standards Institute

Abstract: Inspection, test, construction and performance requirements for direct reading electrostatic/electroscope type dosimeters designed to measure the personal dose equivalent or ambient exposure delivered by external sources of ionizing radiation (X-rays or gamma-rays) are given.

Keywords: dose equivalent, environmental monitoring, exposure, ionizing radiation, personnel dosimeter, radiation dosimeter, radiation instrumentation, specifications

The Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street, New York, NY 10017-2394, USA

Copyright © 1997 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 1997. Printed in the United States of America.

ISBN 1-55937-904-9

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Board. Members of the committees serve voluntarily and without compensation. They are not necessarily members of the Institute. The standards developed within IEEE represent a consensus of the broad expertise on the subject within the Institute as well as those activities outside of IEEE that have expressed an interest in participating in the development of the standard.

Use of an IEEE Standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation. When a document is more than five years old and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of all concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration.

Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE Standards Board
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
USA

Note: Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The IEEE shall not be responsible for identifying patents for which a license may be required by an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Authorization to photocopy portions of any individual standard for internal or personal use is granted by the Institute of Electrical and Electronics Engineers, Inc., provided that the appropriate fee is paid to Copyright Clearance Center. To arrange for payment of licensing fee, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; (508) 750-8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Introduction

(This introduction is not part of ANSI N322–1997, American National Standard Inspection, Test, Construction, and Performance Requirements for Direct Reading Electrostatic/Electroscope Type Dosimeters.)

This standard is the responsibility of the Accredited Standards Committee N42 on Radiation Instrumentation. Committee N42 delegated the development of this standard to its Subcommittee N42.RPI. Drafts were reviewed by Committee N42, Subcommittee N42.RPI, and other interested parties, and the comments received were utilized in producing the standard as finally approved. The standard was approved by N42 letter ballot of 2 April 1996.

Subhead (if required)

At the time it approved this standard, the Accredited Standards Committee on Radiation Instrumentation, N42, had the following members:

Louis Costrell, Chair		Luigi Napoli, Administrative Secretary	
<i>Organization Represented</i>		<i>Name of Representative</i>	
American Conference of Governmental Industrial Hygienists.....		Jesse Lieberman	
Battelle Pacific Northwest Laboratories		Joseph C. McDonald	
Health Physics Society.....		George Campbell	
		Joseph R. Stencil (<i>Alt.</i>)	
Institute of Electrical and Electronics Engineers		Louis Costrell	
		Julian Forster (<i>Alt.</i>)	
		Anthony J. Spurgin (<i>Alt.</i>)	
Lawrence Berkeley Laboratory.....		Edward J. Lampo	
Lawrence Livermore National Laboratory.....		Paul L. Phelps	
MIT, Bates Linear Accelerator Center		Frank X. Masse	
Oak Ridge National Laboratory.....		Charles L. Britton	
Swinth Associates		Kenneth L. Swinth	
US Department of the Army		Edward Groeber	
US Department of Commerce,			
National Institute of Standards and Technology.....		Louis Costrell	
		Michael P. Unterweger (<i>Alt.</i>)	
US Department of Energy		Gerald Goldstein	
US Federal Emergency Management Agency		Carl R. Siebentritt	
Members-at-Large.....		Joseph C. Bellian	
		Ernesto A. Corte	
		Morgan Cox	
		John M. Gallagher	
		Jack M. Selby	
		Al N. Tschaeché	
		Edward J. Vallario	
		Lee J. Wagner	
		Sanford Wagner	

At the time this standard was approved, Subcommittee N42.RPI had the following members:

Jack M. Selby, Chair		
Joseph G. Bellian	Michele L. Johnson	C. R. Siebentritt
Morgan Cox	R. L. Kathren	Al N. Tschaeché
Dale Fleming	Jimmy Little	E. J. Vallario

The working group for this standard had the following members:

Joseph McDonald, *Chair*

Darryl Charbonneau
Leo Faust
Hy Glasser

Frank Manning
Kevin Predmore
Dan Redman

D. M. Schaeffer
Carl Siebentritt
E. F. Williams

The following persons were on the balloting committee that approved this document for submission to the American National Standards Institute:

Joseph G. Bellian
Charles L. Britton
George Campbell
Ernesto A. Corte
Louis Costrell
Morgan Cox
Julian Forster
John M. Gallagher

Gerald Goldstein
Edward Groeber
Edward J. Lampo
Jesse Lieberman
Frank X. Masse
Paul L. Phelps
Jack M. Selby
Carl L. Siebentritt

Anthony J. Spurgin
Joseph R. Stencil
Kenneth L. Swinth
Al N. Tschaeche
Michael Unterweger
Edward J. Vallario
Lee J. Wagner
Sanford Wagner

Rochelle L. Stern
IEEE Standards Project Editor

Contents

CLAUSE	PAGE
1. Overview	1
1.1 Introduction.....	1
1.2 Scope.....	1
1.3 Purpose.....	1
2. References.....	2
3. Definitions.....	2
4. Conditions for dosimeter tests	4
4.1 Reference conditions.....	4
4.2 Standard test conditions	5
4.3 Position of instrument for purposes of tests.....	5
4.4 Minimum irradiation time.....	5
4.5 Specifications of irradiation room and calibration devices.....	5
4.6 Use of phantoms	5
4.7 Dosimeter charging pin.....	5
5. Quantities and units for radiations in specifications and tests	6
5.1 Radiation quantities and units specified and measured by dosimeters	6
6. Specifications and test requirements.....	6
6.1 General	6
6.2 Optical system.....	7
6.3 Charging and reading	7
6.4 Mechanical integrity	14
6.5 Radiological specifications and test requirements	14
6.6 Effects of environmental conditions on radiation response.....	17
7. Certification	18

American National Standard Inspection, Test, Construction, and Performance Requirements for Direct Reading Electrostatic/Electroscope Type Dosimeters

1. Overview

1.1 Introduction

The direct reading dosimeter is an instrument whose principles of operation can be briefly described as follows. The direct reading dosimeter is composed of a capacitor connected in parallel to an electroscope, where the moving element of the electroscope forms the central electrode of an ionization chamber. The ionization chamber is the radiation-sensitive element of the device. The capacitor and electroscope are usually charged in the range of 140 V to 195 V using an external charging unit. When the dosimeter is exposed to ionizing radiation, the electrical discharge of the capacitor is proportional to the total quantity of radiation deposited in the ionization chamber. The change in total electrical charge is measured by the electroscope. A visual display is provided by a built-in optical system that can be read using ambient light. This type of instrument can be manufactured to measure exposure, absorbed dose, or dose equivalent. The visual display will indicate a reading of the appropriate quantity.

1.2 Scope

The standard describes the requirements and the procedures for testing such dosimeters against these requirements. The requirements apply to direct reading dosimeters designed to measure ionizing electromagnetic radiation (X-rays or gamma-rays) with energies from approximately 20 keV to 3 MeV. Procedures are given for the testing of any accessory electrometers or chargers that are used to operate, or read-out, these dosimeters.

1.3 Purpose

The purpose of this standard is to specify the procedures to be used for the inspection, test, construction, and performance evaluation of direct reading dosimeters of the electrostatic/electroscope type.

2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply:

ANSI N42.17A-1989 (Reaff 1994), American National Standard Performance Specifications for Health Physics Instrumentation—Portable Instrumentation for Use in Normal Environmental Conditions.¹

ANSI N42.17C-1989 (Reaff 1994), American National Standard Performance Specifications for Health Physics Instrumentation—Portable Instrumentation for Use in Extreme Environmental Conditions.

ICRP 26 (1977), Recommendations of the International Commission on Radiological Protection.²

ICRU 33 (1980), Radiation Quantities and Units.³

ICRU 39 (1985), Determination of Dose Equivalents Resulting from External Radiation Sources.

ICRU 43 (1988), Determination of Dose Equivalents from External Radiation Sources—Part 2.

ICRU 47 (1992), Measurement of Dose Equivalents from External Photon and Electron Radiations.

IEC CD 45B (1991), Direct reading personal dose equivalent and/or dose equivalent rate monitors for X, gamma and high-energy beta radiations.⁴

ISO/DIS 11934 (1996), Indirect or direct reading capacitor-type pocket dosimeters.⁵

NIST Special Publication 250-16-1988, Calibration of X-Ray and Gamma-Ray Measuring Instruments.⁶

3. Definitions

For the purpose of this document, the following definitions apply to this standard:

3.1 absorbed dose (D): The quotient of $d\bar{E}$ by dm , where $d\bar{E}$ is the mean energy imparted by ionizing radiation to matter of mass, dm .

3.2 accuracy: The difference between the indicated, or measured value, of a quantity and the conventional true value of that quantity.

3.3 calibration: A quantitative determination under a controlled set of standard test conditions, of the indication given by a dosimeter as a function of the value of the quantity to be measured.

¹ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

²ICRP publications are available from Elsevier Science, Inc., 655 Avenue of the Americas, New York, NY 10010, USA.

³ICRU publications are available from International Commission on Radiation Units and Measurement, 7910 Woodmont Avenue, Suite 800, Bethesda, MD 20814, USA.

⁴IEC publications are available from IEC Sales Department, Case Postale 131, 3, rue de Varembe, CH—1211, Genève 20, Switzerland/Suisse. IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

⁵ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH—1211, Genève 20, Switzerland/Suisse. ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

⁶NIST publications are available from the National Institute for Science and Technology, US Dept. of Commerce, Washington, DC 20234, USA.