

American National Standard for Performance Criteria for Alarming Electronic Personal Emergency Radiation Detectors (PERDs) for Exposure Control

Accredited by the American National Standards Institute

Sponsored by the
National Committee on Radiation Instrumentation, N42

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

ANSI N42.49A-2011

23 May 2011

American National Standard for Performance Criteria for Alarming Electronic Personal Emergency Radiation Detectors (PERDs) for Exposure Control

Sponsor

National Committee on Radiation Instrumentation, N42

Accredited by the

American National Standards Institute

Secretariat

Institute of Electrical and Electronics Engineers, Inc.

Approved 4 January 2011

American National Standards Institute

Abstract: This standard establishes minimum performance criteria and test requirements for four categories of alarming electronic radiation detectors used to manage exposure by alerting the emergency responders when they are exposed to photon radiation. The instruments provide rapid and clear indication of the level of radiation exposure and/or exposure rate and readily recognizable alarms. The alarms are both audible and visual, and distinguishable between exposure rate and exposure.

Keywords: alarming detectors, ANSI N42.49A, design criteria, exposure, exposure rate, performance specifications, pocket-sized, personal radiation detectors, photon radiation, radiation detection

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2011 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 23 May 2011. Printed in the United States of America.

IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by the Institute of Electrical and Electronics Engineers, Incorporated.

PDF: ISBN 978-0-7381-6649-0 STD97143
Print: ISBN 978-0-7381-6650-6 STDPD97143

IEEE prohibits discrimination, harassment and bullying. For more information, visit <http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html>.
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.

TERMS OF USE

Please Read Carefully

The Institute of Electrical and Electronics Engineers, Inc., ("IEEE") owns the copyright to this Document in all forms of media. Copyright of the text retrieved, displayed, or output from this Document is owned by IEEE and is protected by the copyright laws of the United States and by international treaties. The IEEE reserves all rights not expressly granted to the user.

Except as allowed by the copyright laws of the United States of America, applicable international treaties, or any license or agreement the user or the user's employer may have entered into with the IEEE or one of its authorized distributors, the user may not copy and/or distribute copies of this Document, nor significant portions of the document, in any form, nor may the user post this document on any intranet, website, or database without prior written permission from the IEEE.

Permission and/or requests for licenses should be directed to:

IEEE Standards Association
Standards Licensing and Contracts
stds.ipr@ieee.org
+1-732-562-6397

or in writing:

IEEE Standards Association
Standards Licensing and Contracts
445 Hoes Lane
Piscataway, NJ 08854

American National Standard

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic reviews and users are cautioned to obtain the latest editions.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken to affirm, revise, or withdraw this standard no later than five years from the date of publication. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

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; +1-978-750-8400. 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 N42.49A-2011, American National Standard for Performance Criteria for Alarming Electronic Personal Emergency Radiation Detectors (PERDs) for Exposure Control.

This standard is the responsibility of the Accredited American Standards Committee on Radiation Instrumentation, N42. The standard was approved on N42 letter ballot.

Notice to users

Laws and regulations

Users of these documents should consult all applicable laws and regulations. Compliance with the provisions of this standard does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

This document is copyrighted by the IEEE. It is made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making this document available for use and adoption by public authorities and private users, the IEEE does not waive any rights in copyright to this document.

Updating of IEEE documents

Users of IEEE standards should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect. In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit the IEEE Standards Association web site at <http://ieeexplore.ieee.org/xpl/standards.jsp>, or contact the IEEE at the address listed previously.

For more information about the IEEE Standards Association or the IEEE standards development process, visit the IEEE-SA web site at <http://standards.ieee.org>.

Errata

Errata, if any, for this and all other standards can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/updates/errata/index.html>. Users are encouraged to check this URL for errata periodically.

Interpretations

Current interpretations can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/interp/index.html>.

Patents

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 is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Participants

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

Michael P. Unterweger, *Chair*
Michael Kipness, *Administrative secretary*

<i>Organization represented</i>	<i>Name of representative</i>
Canberra.....	Bob Huckins
Chew, M.H.....	Jack M. Selby
Commerce Dept, U.S. NIST	Michael P. Unterweger
Computer Dependability Associates, LLC.....	Gary Johnson
Consultant.....	Frank X. Masse
Department of Homeland Security.....	Peter Shebell
Entergy-ANO.....	Ron Schwartz
Health Physics Soc.....	Sandy Perle
Harvard University	Joseph Ring
Institute of Electrical & Electronics Engineers, Inc.	Michael P. Unterweger (Alt.) Anthony Spurgin (Alt.)
International Medcom.....	Don Sythe
Lawrence Berkeley National Laboratory	Edward J. Lampo
NASA, GSFC	R. Sachidananda Babu
Nuclear Standards Unlimited.....	Al N. Tschaeche
Oak Ridge National Laboratory	Peter J. Chiaro, Jr Charles Britton (Alt.)
Ortec Corp.	Ronald M. Keyser
Pacific Northwest National Laboratory.....	Richard Kouzes
Swinth Associates	Kenneth L. Swinth
U. S. Army	Edward Groeber
U. S. Nuclear Regulatory Commission	Cynthia Jones
Members-At-Large	Morgan Cox Joseph C. McDonald Paul L. Phelps Joseph Stencil Lee J. Wagner

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

Morgan Cox, *Co-Chair*
Jack M. Selby, *Co-Chair*

Dru Carson
Peter J. Chairro, Jr.
Jack Cooley
Leo Faust
Edward Groeber

Jerry Hiatt
Mark M. Hoover
Ron Keyser
Joseph C. McDonald
Robert Murphy
Cheryl Olson

Mario Overhoff
Scott Rogers
Michael P. Unterweger
Ed Walker
Chuan-Fu Wu

At the time this standard was approved, the ANSI 42.49A Working Group had the following members:

Morgan Cox, *Co-Chair*
Scott Rogers, *Co-Chair*

Brooke Buddemeier
John Darrin
Arthur Desrosiers
Ron Disrud
Mark Henry
Mark M. Hoover
Michelle Johnson

Gladys Klemic
Mark Maiello
Joseph C. McDonald
George Miller
Ryan Nash
Sandy Perle
Leticia Pibida

Richard Schlueck
Jack Selby
Keith Spero
Paul Steinmeyer
Michael P. Unterweger
June Wang
Bill Zimmermann

Contents

1. Overview	1
1.1 Scope	1
1.2 Purpose	2
2. Normative references.....	2
3. Definitions, acronyms, and abbreviations	4
3.1 Definitions	4
3.2 Acronyms and abbreviations	6
4. General considerations	7
4.1 Standard test conditions.....	7
4.2 Units, quantities, and uncertainties	8
4.3 Special word usage	9
4.4 Categories of PERDs	9
5. General requirements.....	10
5.1 Test sample size.....	10
5.2 Type of radiation detector.....	11
5.3 Size	11
5.4 Weight	11
5.5 Marking	11
5.6 Reference point marking.....	12
5.7 Case design.....	12
5.8 Switches.....	12
5.9 Power supply	13
5.10 Alarm indications	13
5.11 Audible alarm	14
5.12 Visual alarm.....	14
5.13 Vibration alarm.....	14
5.14 Alarm setting range	15
5.15 Display.....	15
5.16 Hardware and firmware	16
5.17 Configuration.....	16
5.18 Communication interface.....	17
5.19 Warm-up or stabilization time	18
5.20 Retention of exposure rate and exposure data	18
5.21 Calibration	19
5.22 Explosive atmospheres	19
6. Radiological requirements.....	20
6.1 Energy response.....	20
6.2 Response to other types of radiation.....	20
6.3 Alarm range(s).....	21
6.4 Time to alarm.....	22
6.5 Exposure rate range and accuracy	22
6.6 Total exposure range and accuracy.....	22
6.7 Angular response	23
6.8 Over-range.....	23
7. Pre-, during-, and post-test response.....	24

7.1 Pre-test and post-test response	24
8. Electrical and electronic requirements	25
8.1 Battery life	25
8.2 Radiated emissions	27
8.3 Magnetic field	28
8.4 Electrostatic discharge (ESD)	28
8.5 Radio frequency susceptibility	29
9. Mechanical requirements	29
9.1 Submersion	29
9.2 Flame resistance	30
9.3 Vibration	31
9.4 Drop test	31
9.5 Impact (microphonics)	31
10. Environmental requirements	32
10.1 Temperature	32
10.2 Temperature shock	33
10.3 Relative humidity	34
11. Documentation	35
11.1 Type-test report	35
11.2 Report	35
11.3 Operation and maintenance manual	36
Annex A (informative) A comprehensive test program	37
A.1 Classes of tests	37
Annex B (informative) Bibliography	42

American National Standard for Performance Criteria for Alarming Electronic Personal Emergency Radiation Detectors (PERDs) for Exposure Control

IMPORTANT NOTICE: This standard is not intended to ensure safety, security, health, or environmental protection. Implementers of the standard are responsible for determining appropriate safety, security, environmental, and health practices or regulatory requirements.

This IEEE document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notice" or "Important Notices and Disclaimers Concerning IEEE Documents." They can also be obtained on request from IEEE or viewed at <http://standards.ieee.org/IPR/disclaimers.html>.

1. Overview

1.1 Scope

The scope of this standard is to establish minimum performance criteria and test requirements for four categories of alarming electronic radiation measurement instruments used to manage exposure by alerting the emergency responders when they are exposed to photon radiation. The instruments provide rapid and clear indication of the level of radiation exposure and/or exposure rate and readily recognizable alarms. The alarms are both audible and visual, and distinguishable between exposure rate and exposure. Vibratory alarms are optional. Emergency responders include fire and rescue services, law enforcement, and medical services. Other possible users include Critical Infrastructure Key Resources (CIKR) such as heavy equipment, transportation, and utilities personnel.

1.2 Purpose

The purpose of this standard is to specify technical performance requirements and performance testing requirements to guide those purchasing and using a Personal Emergency Radiation Detector (PERD) for Homeland Security and other radiological emergency applications.

The users of PERDs are responders performing time-sensitive critical missions such as saving lives, property, and/or otherwise mitigating the effects of radiological emergencies.

PERDs are not used to monitor personnel exposure for the purposes of confirming compliance with regulatory exposure limits (i.e., their indications are not intended to be used for an individual's dose monitoring records).

For the purposes of this standard, PERDs are subdivided into two types, alarming and non-alarming. Both types of PERDs have radiation response ranges appropriate for radiation emergencies. Non-alarming PERDs are addressed in ANSI N42.49B.¹

This standard provides a graded approach to assessing the performance of several categories of alarming electronic PERDs. The applicability of each category for specific use should be evaluated by the user. Category 1 PERDs alarm on both exposure rate and total exposure in extreme environmental and mechanical conditions. Category 2 PERDs alarm on both exposure rate and total exposure in non-extreme conditions. Category 3 PERDs alarm only on exposure rate in non-extreme conditions. Lastly, Category 4 PERDs alarm only on total exposure in non-extreme conditions. Generally throughout this standard, any requirement with no category notation applies to all categories, while requirements for specific categories will list the applicable categories immediately after the requirement.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI N13.11-2009, Criteria for Testing Personnel Dosimetry Performance.²

ANSI N323A-1997, Radiation Protection Instrumentation: Test and Calibration, Portable Survey Instruments.

ANSI N42.17A-2003, American National Standard for Performance Specifications for Health Physics Instrumentation—Portable Instrumentation for Use in Normal Environmental Conditions.

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

ANSI N42.20-2003, American National Standard for Performance Criteria for Active Personnel Radiation Monitors.

ANSI N42.32-2006, American National Standard for Performance Criteria for Alarming Personal Radiation Detectors for Homeland Security.

ANSI N42.33-2006, American National Standard for Portable Radiation Detection Instrumentation for Homeland Security.

¹ At the time this standard was published, ANSI N42.49B was under development.

² ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

ANSI N42.37-2006, American National Standard for Training Requirements for Homeland Security Purposes Using Radiation Detection Instrumentation for Interdiction and Prevention.

ANSI N42.42-2006, American National Standard Data Format Standard for Radiation Detectors Used for Homeland Security.

DHS 2006 Preparedness Directorate; Protective Action Guides for Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Incidents; Notice 71FR174.

IAEA EPR-FIRST RESPONDERS 2006, Manual for First Responders to a Radiological Emergency.³

IAEA-TECDOC-1432 (2005), Development of an Extended Framework for Emergency Response Criteria.

ICRP Publication 96 (2006), Protecting People Against Radiation Exposure in the Event of a Radiological Attack.

IEC 60846-1:2009, Radiation protection instrumentation—Ambient and/or directional dose equivalent (rate) meters and/or monitors for beta, X and gamma radiation—Part 1: Portable workplace and environmental meters and monitors.⁴

IEC 60846-2:2007, Radiation protection instrumentation—Ambient and/or directional dose equivalent (rate) meters and/or monitors for beta, X and gamma radiation—Part 2: High range beta and photon dose and dose rate portable instruments for emergency radiation protection.

IEC 61526:2005, Radiation protection instrumentation—Measurement of personal dose equivalent HP(10) and HP(0,07) for x-gamma, neutron and beta radiations—Direct reading personal dose equivalent meters and monitors.

NCRP Commentary No. 19 (2005), “Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism.”

NCRP Report No. 138 (2001), “Management of Terrorist Events Involving Radioactive Material.”

NFPA 1971 (2007), Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting.⁵

NFPA 1982 (2007), National Fire Protection Association Standard on Personal Alert Safety Systems (PASS).

NFPA 472: (2008), Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents.

UL 94 (2010), Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.⁶

UL 913 (2010), Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1 Hazardous (Classified) Locations.

³ IAEA publications are available from the International Atomic Energy Agency (<http://www.iaea.org/>).

⁴ IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

⁵ NFPA publications are available from Publications Sales, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, USA (<http://www.nfpa.org/>).

⁶ UL standards are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA (<http://global.ihs.com/>).

3. Definitions, acronyms, and abbreviations

3.1 Definitions

The following terminology applies to this standard, which has been developed at the request of the U.S. Department of Homeland Security (DHS) for instruments to be used by the DHS and emergency responders. *The IEEE Standards Dictionary: Glossary of Terms & Definitions* should be referenced for terms not defined in this clause.⁷

A-weighted sound level: The frequency weighting of an acoustic spectrum according to a standardized frequency response curve based on the frequency response of the human ear.

acceptance test: Evaluation or measurement of performance characteristics to verify that certain stated specifications and contractual requirements are met.

accuracy: The degree of agreement between the observed value and the conventionally true value of the quantity being measured.

NOTE—In this standard accuracy is equivalent to bias.⁸

alarm: An audible, visual, or other signal activated when the detector reading or response exceeds a preset value or falls outside of a preset range.

alarming instruments: For the purpose of this standard alarming instruments have audible and visual indications and may have other alarm indications.

NOTE—A non-alarming instrument is a device that requires inspection by the user to determine if a limit has been exceeded.

ambient photon background: The background radiation as measured using a high-pressure ionization chamber, an energy compensated Geiger-Mueller (G-M) tube, an energy compensated proportional counter, a tissue equivalent plastic scintillator, a scintillator with spectral compensation, or any other exposure rate meter having a nearly constant energy response ($\pm 30\%$ in the energy range from 60 keV to 1.5 MeV).

calibrate: To adjust and/or determine the response or reading of a device relative to a series of conventionally true values.

calibration: A set of operations under specified conditions that establishes the relationship between values indicated by a measuring instrument or measuring system, and the conventionally true values of the quantity or variable being measured.

check source: A radioactive source, not necessarily calibrated, that is used to confirm the continuing functionality of an instrument.

conventionally true value (CTV): The commonly accepted best estimate of the value of that quantity.

NOTE—This and the associated uncertainty will preferably be determined by a national or transfer standard, or by a reference instrument that has been calibrated against a national or transfer standard, or by a measurement quality assurance (MQA) interaction with the National Institute of Standards and Technology (NIST) or an accredited calibration laboratory. (See ANSI N42.22 and ANSI N42.23.)

⁷ *The IEEE Standards Dictionary: Glossary of Terms & Definitions* is available at <http://shop.ieee.org/>.

⁸ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

coefficient of variation, COV (%): The square root of the variance, σ^2 , divided by the mean value of “n” number of observations times 100.

decade: A range of values for which the upper value is a power of ten above the lower value.

detector: A device or component designed to produce a measurable response to ionizing radiation.

DHS Protective Action Guide (PAG): The projected dose to a reference individual from an accidental or deliberate release of radioactive material at which a specific protective action to reduce or avoid that dose is recommended.

effective center: For a given set of irradiation conditions, the point within a detector where the response is equivalent to that which would be produced if the entire detector were located at the point.

energy dependence: Variation in instrument response as a function of radiation energy for a constant radiation type.

exposure: The measure of ionization produced in air by x-ray or gamma-ray radiation. The special unit of exposure rate is the roentgen, abbreviated in this standard as R.

functional check: A frequently used qualitative check to determine that an instrument is operational and capable of performing its intended function. Such checks may include, for example, battery check, zero setting, or source response check.

indication value: (A) Scale or decade reading. (B) The displayed value of the readout. *See also:* **reading**.

indication: Displayed signal from the instrument to the user conveying information such as scale or decade, status, malfunction, or other critical information.

influence quantity: Quantity that may have a bearing on the result of a measurement without being the subject of the measurement.

instrument: A complete system consisting of one or more assemblies designed to quantify one or more characteristics of ionizing radiation or radioactive material.

monitoring: Means provided to continuously indicate the state or condition of a system or assembly.

NOTE—This term may also be used for the real time measurement of radioactivity or radiation levels.

over-range response: The response of an instrument when exposed to radiation intensities greater than the upper detection limit.

performance test: An evaluation of the performance of an instrument in response to a given influence quantity.

range: All measured values between the detection threshold and the detection limit.

NOTE—The detection threshold is the minimum statistically quantifiable instrument response or reading. The detection limit is the maximum level at which the instrument meets the required accuracy.

reader: A device used to obtain or record a readout of an instrument.

reading: The indicated or displayed value of the readout.