

American National Standard Performance Criteria for Backpack- Based Radiation-Detection Systems Used for Homeland Security

Accredited by the American National Standards Institute

Sponsored by the
National Committee on Radiation Instrumentation, N42

IEEE
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USA

ANSI N42.53-2013

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Secretariat

Institute of Electrical and Electronics Engineers, Inc.

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Abstract: The operational and performance requirements for backpack-based radiation-detection systems (BRDs) used in homeland security applications are specified in this standard. BRDs are typically worn by the user during operation to detect and possibly identify radiological and nuclear material.

Keywords: ANSI N42.53, backpack-based radiation-detection systems

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Introduction

This introduction is not part of ANSI N42.53-2013, American National Standard Performance Criteria for Backpack-Based Radiation-Detection Systems Used for Homeland Security.

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

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1. Overview

1.1 Scope

This standard specifies the basic performance requirements for backpack-based radiation-detection systems (BRDs) used in homeland security applications. BRDs shall detect gamma radiation and may include neutron detection and/or the identification of gamma-ray emitting radionuclides. They are typically worn by the user during operation but may also be used as temporary area monitors.

This standard establishes the radiological performance and testing requirements and those requirements associated with the expected electrical, mechanical, and environmental conditions while in use.

1.2 Purpose

This standard specifies the performance criteria and test methodologies for BRDs that are used to detect gamma-ray emitting radioactive material, detect neutron emitting radioactive material, and/or identify radionuclides. Successful completion of the radiation tests described in this standard should not be construed as an ability to successfully detect gamma radiation, detect neutron radiation, and/or identify radionuclides in all environments.

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/HPS N13.11, Personnel Dosimetry Performance—Criteria for Testing.¹

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

Brookhaven National Laboratories, Evaluated Nuclear Structure Data File (ENSDF).²

IEC 60068-2-27, Environmental Testing—Part 2-27: Tests—Test Ea and Guidance: Shock.

IEC 60068-2-64, Environmental Testing—Part 2-64: Tests—Test Fh: Vibration, Broadband Random and Guidance.

IEC 60068-2-75, Environmental Testing—Part 2-75: Tests—Test Eh: Hammer Tests.

IEC 60529, Degrees of Protection Provided by Enclosures (IP Code).

IEC 61000-4-2, Electromagnetic Compatibility (EMC)—Part 4-2: Testing and Measurement Techniques—Electrostatic Discharge Immunity Test.

IEC 61000-4-3, Electromagnetic Compatibility (EMC)—Part 4-3: Testing and Measurement Techniques—Radiated, Radio-Frequency, Electromagnetic Field Immunity Test.

IEC 61000-4-8, Electromagnetic Compatibility (EMC)—Part 4-8: Testing and Measurement Techniques—Power frequency magnetic field immunity test.

MIL-STD-810, Environmental Engineering Considerations and Laboratory Tests.³

¹ 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/>).

² The ENSDF is available at the Brookhaven National Laboratories website. (<http://www.nndc.bnl.gov/ensdf/>).

³ MIL publications are available from Customer Service, Defense Printing Service, 700 Robbins Ave., Bldg. 4D, Philadelphia, PA 19111-5094, USA.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁴

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 accepted true value of the quantity being measured.

adjust: To alter the reading of an instrument by means of a built-in variable (hardware or software) control.

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

area monitor: A radiation measurement system that is designed to detect increases in the ambient radiation level within an area surrounding or adjacent to the detector.

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 not-necessarily calibrated source that is used to confirm the continuing functionality of an instrument.

coefficient of variation (COV): Ratio of the standard deviation, s , to the arithmetic mean, $\bar{x}$, of a set of n measurements, x_i , given by the following formula:

$$V = \frac{s}{\bar{x}} = \frac{1}{\bar{x}} \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

conventionally true value (CTV): The commonly accepted best estimate of the value of a 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.⁵

detection limits: The extremes of detection or quantification for the radiation of interest.

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

⁴ *IEEE Standards Dictionary Online* subscription is available at:
http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html.

⁵ See ANSI N42.22 and ANSI N42.23.

detector: A device or component designed to produce a quantifiable response to ionizing radiation, normally measured electronically.

exposure: A measure of ionization produced in air by x-ray or gamma-ray radiation.

NOTE—The special unit of exposure rate is the roentgen per hour, abbreviated in this standard as R/h.

false alarm: Alarm NOT caused by a radioactive source under the specified background conditions.

fluence rate (flux density): the number of particles that interact with a defined cross sectional area of a sphere (cm^2) over a defined period time (s^{-1}).

NOTE—May also be the number of particles from the source that traverse a cross sectional area at the face of the detector.

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

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: To continuously indicate the state or condition of a system or assembly.

NOTE—May also be used to describe 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 measurement limit.

radioactive material: Material where one or more constituents exhibit radioactivity (radioactive decay). In this standard, radioactive material includes special nuclear material unless otherwise specifically noted.

range: All values lying between the lower and upper detection limits.

reading: The indicated or displayed value.

response time: The time interval required for the instrument reading to change from 10% to 90% of the final reading or vice versa following a step change in the radiation level at the detector.

restricted mode: An advanced operating mode that can be accessed by an expert user (e.g., via password) to control the parameters that can affect the result of a measurement (e.g., radionuclide library, routine function control, calibration parameters, alarm thresholds).

NOTE—May also be called the “advanced” or “expert” mode.

standard deviation: The positive square root of the variance.

standard test conditions: The range of values of a set of influence quantities under which a calibration or a measurement of response is carried out.

test: A procedure whereby the instrument, circuit, or component is evaluated.

type test: Initial test of two or more production instruments made to a specific design to show that the design meets defined specifications.

uncertainty: The estimated bounds of the deviation from the conventionally true value, generally expressed as a percent of the mean, ordinarily taken as the square root of the sum of the squares of two components: 1) random errors that are evaluated by statistical means and 2) systematic errors that are evaluated by other means.

variance (σ^2): A measure of dispersion, which is the sum of the squared deviation of observations from their mean divided by one less than the number of observations.

$$\sigma^2 = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2$$

3.2 Acronyms and abbreviations

BRD	backpack-based radiation-detection system
COV	coefficient of variation
CTV	conventionally true value
DU	depleted uranium
ESD	electrostatic discharge
FIFO	first-in, first out
HEU	highly enriched uranium
ICRU	International Commission of Radiological Units and Measurements
MQA	measurement quality assurance
NIST	National Institute of Standards Technology
NORM	naturally occurring radioactive material
PMMA	poly methyl methacrylate
RF	radio frequency
RH	relative humidity
WGPu	weapons-grade plutonium