

American National Standard Performance Criteria for Handheld Instruments for the Detection and Identification of Radionuclides

Accredited by the American National Standards Institute

Sponsored by the
National Committee on Radiation Instrumentation, N42

IEEE
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New York, NY 10016-5997
USA

ANSI N42.34-2015
(Revision of
ANSI N42.34-2006)

American National Standard Performance Criteria for Handheld Instruments for the Detection and Identification of Radionuclides

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Secretariat

Institute of Electrical and Electronics Engineers, Inc.

Approved 23 November 2015

American National Standards Institute

Abstract: Performance specifications and testing methods for the evaluation of handheld instruments (also known as radionuclide identification devices or RIDs) used for the detection and identification of radionuclides, which emit gamma rays and, in some cases, neutrons, are contained in this standard. The specifications for general, radiological, environmental, electromagnetic and mechanical performances are given and the corresponding testing methods are described. The documentation to be provided by the manufacturer is listed as part of the requirements. Normative and informative annexes that provide guidance for the implementation of this standard are also included.

Keywords: ANSI N42.34, gamma rays, homeland security, industrial radionuclides, medical radionuclides, neutrons, special nuclear material (SNM)

The Institute of Electrical and Electronics Engineers, Inc.
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PDF: ISBN 978-1-5044-0700-7 STDGTPD20803
Print: ISBN 978-1-5044-0701-4 STDPD20803

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Introduction

This introduction is not part of ANSI N42.34-2015, American National Standard Performance Criteria for Handheld Instruments for the Detection and Identification of Radionuclides.

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 general, radiological, environmental, electromagnetic, and mechanical requirements, and associated test methods for handheld radionuclide identification devices (RIDs). Successful completion of the tests described in this standard should not be construed as an ability to identify all radionuclides in all environments.

1.2 Purpose

This standard addresses instruments that are used to detect and identify radionuclides, display gamma-ray exposure rates, and when provided, indicate the presence of neutron radiation.

The identification requirements established by this standard are based on the sources and source configurations defined in this standard. When an RID is used operationally, the configuration of a source or object being analyzed is typically unknown, which may cause other radionuclides or isotopes to be identified.

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 N42.17A, American National Standard for Performance Specifications for Health Physics Instrumentation—Portable Instrumentation for Use in Normal Environmental Conditions.¹

ANSI N42.42, American National Standard Data Format Standard for Radiation Detectors Used for Homeland Security.²

IEC 60068-2-27, Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock.³

IEC 60529, Degrees of protection provided by enclosures (IP Code).

IEC 60721-3-7, Classification of environmental conditions – Part 3-7: Classification of groups of environmental parameters and their severities – Portable and non-stationary use.

IEC 61000-4-2, Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.

MIL-STD-810, U.S. Department of Defense Test Method Standard—Environmental Engineering Considerations and Laboratory Tests.⁴

UL 913, Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations.⁵

3. Definitions

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be referenced for terms not defined in this clause.⁶

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.

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

¹ ANSI N42 publications are available from the Institute of Electrical and Electronics Engineers (<http://standards.ieee.org/>) and the American National Standards Institute (<http://www.ansi.org/>).

² The ANSI N42.42 schema can be obtained from <http://www.nist.gov/pml/div682/grp04/n42.cfm>.

³ IEC publications are available from the International Electrotechnical Commission (<http://www.iec.ch/>) and in the United States from the American National Standards Institute (<http://www.ansi.org/>).

⁴ MIL publications are available from DLA Document Services (<http://quicksearch.dla.mil/>).

⁵ UL standards are available from Underwriters Laboratories (<http://www.ul.com/>).

⁶ *IEEE Standards Dictionary Online* is available at: <http://ieeexplore.ieee.org/Xplore/home.jsp>.

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.

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.

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

confidence indication: An indication provided by the instrument of the reliability assigned to the determined identification.

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

NOTE—The CTV 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.)

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.

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

effective range of measurement: Range of measurements within which the requirements of this standard are met.

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

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

false alarm: An indication of the presence of a radioactive source or increase in the measured radiation level when that radioactive source or increase is not present.

false identification: An identification attributed to a radionuclide that is not present.

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, such as temperature and humidity.

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

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

reading: The indicated or displayed value of the readout.

readout: The portion of the instrument that provides a visual display of the response of the instrument or the displayed value, with units, displayed and/or recorded by the instrument as a result of the instrument's response to quantity being measured.

reference point: Physical mark, or marks, on the outside of an instrument used to position it at a point where the conventionally true value of a quantity is to be measured, unless the position is clearly identifiable from the construction of the instrument.

response: Ratio of the instrument reading to the conventionally true value of the measured quantity.

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

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

routine mode: An access mode that enables the user to perform detection and identification of radionuclides, measure exposure or dose equivalent rate, and if applicable, detect the presence of neutrons.

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 square of two components: 1) random errors that are evaluated by statistical means and 2) systematic errors that are evaluated by other means.

user interface: The features of the radionuclide identification device (RID) with which the user interacts (e.g., controls, displays).

3.2 Acronyms and abbreviations

COV	coefficient of variation
cps	counts per second
CTV	conventionally true value
CZT	cadmium zinc telluride
DU	depleted uranium
ESD	electrostatic discharge
FWHM	full width-half max
HPDE	high density polyethylene
HEU	highly enriched uranium
HPGe	high purity germanium
MCNP	Monte Carlo N-particle transport code
MQA	measurement quality assurance

NaI	sodium iodide
NBC	nuclear, biological, and chemical
PMMA	polymethyl methacrylate
PVT	polyvinyl toluene
RF	radio-frequency
RID	radionuclide identification device
SNM	special nuclear material
WGPu	weapons-grade plutonium

4. General considerations

4.1 Standard test conditions

Except where otherwise specified, the tests in this standard shall be carried out under the standard test conditions shown in Table 1.

For those tests intended to determine the effects of variations in the influence quantities, all other influence quantities should be maintained within the limits for standard test conditions given in Table 1, unless otherwise specified in the test method.

Table 1—Standard test conditions^a

Influence quantity	Standard test conditions
Ambient temperature	18 °C to 25 °C
Relative humidity (RH)	≤75%
Atmospheric pressure	70–103.3 kPa (525–775 mmHg at 0 °C)
Electromagnetic field of external origin	Natural conditions without the presence of man-made generators
Magnetic induction of external origin	Natural conditions without the presence of man-made generators
Gamma background	≤25 μR/h
Neutron background	≤200 n/s/m ² (note that this neutron background is considerably higher than at sea level)

^a Uncertainties are stated in 4.2.

4.2 Units and uncertainties

For the purposes of this standard the radiological unit of exposure rate, R/h, is used. Radiation test fields established by measurement shall be made using devices traceable to NIST or equivalent recognized organizations. Other than ambient background, measured radiation test fields shall be determined at an uncertainty of ±20% with a coverage factor (k) of 1. When radiation fields are determined through calculation, the technique used shall be described in the test record.

Measurement of test fields for climatic, dynamic, and electromagnetic conditions shall be made using equipment traceable to NIST or equivalent organizations.

4.3 Special word usage

The following word usage applies:

- The word “shall” signifies a mandatory requirement (where appropriate a qualifying statement is included to indicate that there may be an allowable exception).
- The word “should” signifies a recommended specification or method.
- The word “may” signifies an acceptable method or an example of good practice.

5. Design

5.1 General

RIDs shall be handheld and battery-powered. They shall be capable of operating at temperatures from -20°C to $+50^{\circ}\text{C}$. RIDs used outside of the stated temperature range or other stated electromagnetic or mechanical (dynamic) requirements should be tested to verify proper operation prior to use.

Other than possibly the radiation detector, RIDs shall not require any external devices (e.g., laptop personal computer) for the detection and identification of radioactive material.

Viewing characteristics of the display (e.g., legibility, readability) while wearing a protective mask or at different visual angles should be considered as part of the design of the RID.

5.2 Test preparation

NOTE—Step 5.2.1 through step 5.2.7 should be used when preparing to perform a test based on this standard.

5.2.1 Manufacturer, model, and serial number

Record the manufacturer’s name along with the model, serial number, and software and firmware numbers of the RID and detector, if separate.

5.2.2 Documentation supplied

Verify that instructions for operating and checking the operation of the RID have been supplied and record the result of this verification. Check for all items listed in Clause 10.

5.2.3 Type of radiation detector

Identify and record the type of radiation measured (gamma only or gamma/neutron) and the radiation detector types used (e.g., sodium iodide [NaI], cadmium zinc telluride [CZT], high purity germanium [HPGe], ^3He).

5.2.4 Size

Note the dimensions specified by the manufacturer. Measure the dimensions (height, width, and length) of the RID and record.