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IEEE Standards

# **N42.17A**

## **American National Standard for Performance Specifications for Health Physics Instrumentation—Portable Instrumentation for Use in Normal Environmental Conditions**

**Accredited by the American National Standards Institute**

Sponsored by the  
National Committee on Radiation Instrumentation, N42



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**American National Standards Institute**

Secretariat

**The Institute of Electrical and Electronics Engineers, Inc.**

Approved 29 September 2003

**American National Standards Institute**

**Abstract:** This standard establishes the minimum performance criteria for health physics instrumentation for use in ionizing radiation fields. Testing methods are included to establish the acceptability of each type of instrumentation.

**Keywords:** health physics, instrumentation, normal environment, portable survey, survey

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## Introduction

(This introduction is not part of ANSI N42.17A-2003, Performance Specifications for Health Physics Instrumentation-Portable Instrumentation for Use in Normal Environmental Conditions.)

This standard is the responsibility of the Accredited American National Standards Institute Committee on Radiation Instrumentation, N42, which delegated its development to Subcommittee N42.RPI on Radiological Protection Instrumentation. N42 was the balloting group and approved the standard on N42 letter ballot of 23 December 2002.

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# American National Standard for Performance Specifications for Health Physics Instrumentation- Portable Instrumentation for Use in Normal Environmental Conditions

## 1. Scope

This standard establishes the minimum performance criteria for health physics instrumentation for use in ionizing radiation fields. Testing methods are included to establish the acceptability of each type of instrumentation. This standard does not specify which instruments or systems are required, nor does it consider the number of specific applications of such instruments.

### 1.1 Introduction

The object of this standard is to provide basic performance requirements and verification test methods for *portable instruments used in normal environmental conditions* for radiation protection of personnel.

As used in this standard, health physics instrumentation provides direct readout of, or readout related to, dose and dose-equivalent rate, or activity-per-unit area (i.e., effective probe area). Included are portable rate and integrating devices for beta, photon, and neutron radiation and monitors for surface contamination (alpha, beta, and photon). Instruments used to measure the presence of low-energy beta emitters (i.e., less than 200 keV maximum energy) are not addressed in this standard. Personnel dosimeters; instruments designed to be used as individual or personal monitors, or warning devices; environmental monitoring instruments; and air monitors are outside the scope of this standard. Special purpose instrumentation, such as emergency post-accident radiological monitors, may also fall under the scope of one or more related ANSI standards. This standard is intended to supplement rather than replace these.

In general, health physics instrumentation is considered to cover the dose and dose-equivalent rate ranges for survey meters of 0.1 mrad/h to 1000 rad/h (1  $\mu$ Gy/h to 10 Gy/h) and 0.1 mrem/h to 1000 rem/h (1  $\mu$ Sv/h to 10 Sv/h). It covers activity-per-unit-area ranges for surface contamination monitors of 50 disintegrations per minute (dpm)/cm<sup>2</sup> to 10<sup>4</sup> dpm/cm<sup>2</sup> (0.83 Bq/cm<sup>2</sup> to 167 Bq/cm<sup>2</sup>) for beta/photon radiation and 1dpm/cm<sup>2</sup> to 10<sup>4</sup> dpm/cm<sup>2</sup> (0.02 Bq/cm<sup>2</sup> to 167 Bq/cm<sup>2</sup>) for alpha radiation.

For specific characteristics, test requirements will vary with the use of the instrument. For example, the requirements for a laboratory instrument are not as demanding as requirements for an instrument to be used in an uncontrolled environment. Table B.1 lists the characteristics in the standard and the associated clause where the requirements and test can be found.

This standard specifies general characteristics; general test procedures; radiation characteristics; and electrical, mechanical, safety, and environmental characteristics. Throughout this standard, three verbs have been used to indicate the degree of rigor intended for each specific criterion. The word *shall* is used to denote a requirement, the word *should* to denote a recommendation, and the word *may* to denote a permissible practice.

If the operational conditions for an instrument are less severe than the requirements of this standard, then the instrument manufacturer and the purchaser may agree upon the instrument performance specifications; however, the instrument should be tested using the testing protocol of this standard.

## 2. References

This standard shall be used in conjunction with the following publications:

ANSI Z540.2-1997, U.S. Guide to the Expression of Uncertainty in Measurement.<sup>1</sup>

ICRU Report 12, Certification of Standardized Radioactive Sources, 1968.<sup>2</sup>

ICRU Report 20, Radiation Protection Instrumentation and Its Application, 1971.

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

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

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

ICRU Report 57, Conversion Coefficients for Use in Radiological Protection Against External Radiation, 1998.

ICRU Report 60, Fundamental Quantities and Units for Ionizing Radiation, 1998.

IEC 61187-1993, Electrical and electronic measuring equipment—Documentation.<sup>3</sup>

IEEE Std C62.41-1991, IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.<sup>4,5</sup>

<sup>1</sup>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/>).

<sup>2</sup>ICRU publications are available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Suite 800, Bethesda, MD 20814, USA.

<sup>3</sup>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, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

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ISO Guide to the Expression of Uncertainty in Measurement, 1993 rev., ISBN 92-67-10188-9.<sup>6</sup>

ISO 4037-1:1996, X and gamma reference radiation for calibrating dosimeters and doserate meters and for determining their response as a function of photon energy—Part 1: Radiation characteristics and production methods.

ISO 4037-2:1997, X and gamma reference radiation for calibrating dosimeters and doserate meters and for determining their response as a function of photon energy—Part 2: Dosimetry for radiation protection over the energy ranges 8 keV to 1,3 MeV and 4 MeV to 9 MeV.

ISO 4037-3:1999, X and gamma reference radiation for calibrating dose meters and doserate meters and for determining their response as a function of photon energy—Part 3: Calibration of area and personal dosimeters and the measurements of their response as a function of energy and angle of incidence

ISO 6980:1984, Reference Beta Radiations for Calibrating Dosimeters and Doserate meters and for Determining Their Response as a Function of Beta Radiation Energy.

ISO 6980-2:2000, Reference beta radiations for calibrating dosimeters and doserate meters and for determining their response as a function of beta-radiation energy.

ISO 8529-1:2001, Neutron reference radiations for calibrating neutron-measuring devices used for radiation protection purposes and for determining their response as a function of neutron energy.

ISO 8529-2:2000, Radiation protection—Reference neutron radiations, Part 2: Calibration fundamentals related to the basic quantities characterizing the radiation field.

ISO 8769-2:1996, Reference sources for the calibration of surface contamination monitors—Beta-emitters (maximum beta energy greater than 0,15 MeV) and alpha-emitters.

ISO 10647:1996, Procedures for calibrating and determining the response of neutron-measuring devices used for radiation protection purposes.

ISO/IEC 17025:1999, General requirements for the competence of testing and calibration laboratories.<sup>7</sup>

NCRP Report 50, Environmental Radiation Measurements, 1976.<sup>8</sup>

NCRP Report 57, Instrumentation and Monitoring Methods for Radiation Protection, 1978.

NCRP Report 58, A Handbook of Radioactivity Measurements Procedures, 2nd ed., 1985.

NCRP Report 112, Calibration of Survey Instruments Used in Radiation Protection for the Assessment of Ionizing Radiation Fields and Radioactive Surface Contamination, 1991.

<sup>6</sup>ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO 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/>).

<sup>7</sup>ISO/IEC publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO/IEC publications are also available in the United States from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://global.ihs.com/>). Electronic copies are available in the United States from the American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

<sup>8</sup>NCRP publications are available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Suite 800, Bethesda, MD 20814, USA.

Shleien, Bernard, Lester A. Slaback, Jr., and Brian Birky, eds., *Handbook of Health Physics and Radiological Health*, 3rd ed., Lippincott Williams & Wilkins, 1998.<sup>9</sup>

### 3. Definitions

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

**3.1 acceptable source:** Source of radiation that meets the specification in ICRU report 12.

NOTE—See Table 4.

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

**3.3 accredited testing laboratory:** A testing laboratory that has been accredited by an authoritative body with respect to its qualifications to perform tests on the type of instruments covered by this standard.

**3.4 accuracy:** The degree of agreement of the observed value with the conventionally true value of the quantity being measured.

**3.5 adjust:** To alter the response by means of a variable, built-in control such as a potentiometer.

**3.6 alarm:** An audible and/or visual signal activated when the instrument reading or response exceeds a pre-set value or falls outside of a preset range.

**3.7 angular dependence:** Response of the detector as a function of the angle of incidence of the radiation being detected and a reference orientation.

**3.8 calibrate:** (A) To adjust or determine the response or reading of an instrument relative to a series of conventionally true values. (B) To determine the activity of a radiation source relative to a standard or conventionally true value.

**3.9 coefficient of variation:** The standard deviation, expressed as a percentage of the mean [i.e., standard deviation ( $\bar{x}$ ) • (100) ].

**3.10 contamination meter:** An assembly, including one or several radiation detectors and associated subassemblies, designed to measure radioactivity-per-unit surface area associated with the contamination of the examined object.

**3.11 conventionally true value of a quantity:** The commonly accepted best estimate of the value of that quantity. This and its associated uncertainty will normally 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 measurement quality assurance (MQA) with the National Institute of Standards and Technology (NIST).

**3.12 decade:** A range of values for which the upper response limit is a power of ten above the lower limit.

**3.13 detection axis:** A specific imaginary line through the effective center of the detector to which the radiation field direction can be referenced.

**3.14 detection limit:** The minimum (lower detection limit) or maximum (upper detection limit) radiation level that can be quantifiably measured by the instrument.

<sup>9</sup>This publication available from [www.amazon.com](http://www.amazon.com).

- 3.15 detector:** A material or device that produces a signal suitable for measurement or analysis.
- 3.16 dose:** A generic term that means absorbed dose or dose equivalent as appropriate.
- 3.17 dose equivalent:** The product of the absorbed dose, quality factor, and all other necessary modifying factors at the point of interest in tissue. The units of dose equivalent are the rem and sievert (Sv).
- 3.18 dose rate:** The radiation dose delivered per unit of time measured in rem or Sv per hour.
- 3.19 drift:** Change in readout, usually gradual, without concomitant change in the influence quantity.
- 3.20 effective center:** The point within a detector that produces, for a given set of irradiation conditions, a response equivalent to that which would be produced if the entire detector were located at the point.
- 3.21 effective energy:** The energy used to characterize a heterogeneous radiation field that behaves under specified conditions as it were a monoenergetic radiation field of the same energy.
- 3.22 energy dependence:** A change in instrument response with respect to radiation energy for a constant dose equivalent or dose-equivalent rate.
- 3.23 evaluation:** Interpretation of measurements and observations, including determination of compliance with applicable specifications.
- 3.24 extracameral:** Pertaining to that portion of the instrument exclusive of the detector.
- 3.25 geotropism:** A change in instrument reading with a change in instrument orientation as a result of gravitational effects.
- 3.26 homogeneity coefficient:** The ratio of the first to second half-value layers; usually applied to a heterogeneous X-ray beam.
- 3.27 indicated value:** A scale or decade reading or displayed value.
- 3.28 instrument:** A complete system designed to quantify one or more characteristics of ionizing radiation or radioactive material.
- 3.29 overload response:** An instrument's response when exposed to radiation intensities greater than its upper limit.
- 3.30 photon:** Ionizing electromagnetic radiation, irrespective of origin.
- 3.31 portable:** An instrument that is capable of being carried by hand to a specific facility or location for use and usually less than 22.5 kg.
- 3.32 portable survey meter:** An instrument intended to be operated while being carried by a person.
- 3.33 precision:** The degree of agreement of repeated measurements of the same parameter.
- 3.34 probe sensitivity:** The response of a given probe to a uniform area source.
- 3.35 rad:** Unit of absorbed dose.
- 3.36 range:** All values lying between the upper and lower indicated limits.