



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

STANDARDS

Accredited by the American National Standards Institute

Developed by the
National Committee on Radiation Instrumentation, N42

ANSI N42.17AC-2022

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Secretariat

Institute of Electrical and Electronics Engineers, Inc.

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Abstract: The minimum performance criteria for portable radiation protection instrumentation are established in this standard for use in ionizing radiation fields under both normal and extreme environmental conditions, i.e., all environmental conditions. The testing methods verify that the performance criteria are met over the range of operating conditions for 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.

Keywords: ANSI N42.17AC, detection, dose rate, extreme conditions, handheld, health physics, instrumentation, normal conditions, performance, portable, radiation, survey, test methods

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Introduction

This introduction is not part of ANSI N42.17AC-2022, American National Standard—Performance Specifications for Health Physics Instrumentation-Portable Survey Instrumentation for Use in Normal and Extreme Environmental Conditions.

This standard is the responsibility of the National Committee on Radiation Instrumentation, N42. The standard was approved by N42 letter ballot.

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American National Standard

Performance Specifications for Health Physics Instrumentation-Portable Survey Instrumentation for Use in Normal and Extreme Environmental Conditions

1. Overview

1.1 Scope

This standard establishes the minimum performance criteria for portable radiation protection instrumentation for use in ionizing radiation fields under both normal and extreme environmental conditions, i.e., all environmental conditions. For the portable radiation detection instrumentation addressed in this standard, the radiological ranges for the performance tests are as follows: the dose rate range of operation taken as background to 10 Gy/h (1000 rad/h); the activity-per-unit-area range for surface contamination monitors taken as 0.01 Bq/cm²- α (60 dpm/100 cm²) or 0.05 Bq/cm²- β (300 dpm/100 cm²) to 200 Bq/cm² (1.2×10^6 dpm/100 cm²). The testing methods verify that the performance criteria are met over the range of operating conditions for 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.

1.2 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).^{6, 7}

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

1.3 Introduction

This standard defines the basic performance requirements and the verification test methods for *portable instruments to be used in either normal or extreme environmental conditions* for radiation protection of

⁶ The use of *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

⁷ The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

personnel. Table 1 provides the ranges of normal and extreme environments for which these instruments are tested. 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.

Table 1—Normal and extreme environmental performance requirements

Parameters	Normal	Extreme
Operation temperature	−10 °C to 50 °C	−30 °C to 65 °C
Storage temperature	−10 °C to 50 °C	−60 °C to 70 °C
Relative humidity (%RH)	14% to 75% (non-condensing)	3% to 100% (non-condensing)
Shock (peak acceleration)	50 gn	100 gn
Vibration	2 g	3.5 g
Ambient pressure ^a	70 kPa to 101.3 kPa	55 kPa to 108 kPa
Average daily temperature variation (used for instrument durability)	17 °C	37 °C
Radiation resistance	None	10 000 rad
Drop	None	1 m onto concrete floor
Rain	None	0.25 in/h
Fog	None	6-h exposure
Battery	8 h	8 h

^a Operational ambient pressure based on values defined in MIL-STD-810G.

For specific characteristics, test requirements 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 and Table C.1 (found in Annex B and Annex C, respectively) list the characteristics in the standard and the associated clause where the requirements and test can be found for normal and extreme conditions, respectively.

This standard specifies general characteristics; general test procedures; radiation characteristics; and electrical, mechanical, safety, and environmental characteristics.

If the operational conditions for an instrument are more 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.

1.4 Military specifications

PRF-JPM-RND-RDS-001, Performance Specification for the Radiological Detection System, 27 April 2015, details the performance specification needed for portable radiation detection equipment for the US Military. PRF-JPM-RND-RDS-001 includes both the environmental specifications as well as detailed accuracy specifications.⁸

⁸ Information on references can be found in Clause 2.

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 N323AB, American National Standard Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments.⁹

Code of Federal Regulations, Title 47 Part 15—Radio Frequency Devices.¹⁰

ICRU Report 12, Certification of Standardized Radioactive Sources.¹¹

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

IEC 61000-4-2, Electrostatic Discharge Immunity Test.¹²

IEC 61187, Electrical and electronic measuring equipment—Documentation.

ISO 6980-1, Nuclear energy—Reference beta-particle radiation—Part 1: Methods of production.¹³

ISO 6980-2, Nuclear energy—Reference beta-particle radiation—Part 2: Calibration fundamentals related to basic quantities characterizing the radiation field.

ISO 8529-1, Reference neutron radiations—Part 1: Characteristics and methods of production.

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

JCGM 100:2008, Evaluation of measurement data — Guide to the expression of uncertainty in measurement (GUM).¹⁴

MIL-HDBK-344A, Environmental Stress Screening (ESS) of Electronic Equipment, 16 August 1993.¹⁵

MIL-STD-461G, Department of Defense Interface Standard – Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, 11 December 2015.

MIL-STD-810G, Department of Defense Test Method Standard –Environmental Engineering Considerations and Laboratory Tests, 31 October 2008.

PRF-JPM-RND-RDS-001, Performance Specification for the Radiological Detection System.¹⁶

⁹ ANSI publications are available from the American National Standards Institute (<https://www.ansi.org>).

¹⁰ Code of Federal Regulations documents are available from the U.S. Government Printing Office (<https://www.access.gpo.gov>).

¹¹ ICRU publications are available from the National Council on Radiation Protection and Measurements (<https://ncrponline.org/>).

¹² IEC publications are available from the International Electrotechnical Commission (<https://www.iec.ch>) and the American National Standards Institute (<https://www.ansi.org>).

¹³ ISO publications are available from the International Organization for Standardization (<https://www.iso.org/>) and the American National Standards Institute (<https://www.ansi.org/>).

¹⁴ JCGM 100 is available from BIPM (Bureau International des Poids et Mesures) (<https://www.bipm.org>).

¹⁵ MIL Standards are available from <http://quicksearch.dla.mil>.

¹⁶ Specification needed for portable radiation detection equipment for the US Military, which includes environmental specifications as well as detailed accuracy specifications.

3. Definitions

For the purpose of this standard, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.¹⁷

acceptable source: Source of radiation that meets the specification in ICRU Report 12.

NOTE—See Table 4.¹⁸

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

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.

accuracy: The degree of agreement of the observed value with the known value of the quantity being measured.

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

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

NOTE—Some agencies use the term *detection alarm*, *alert*, or *detection event* to mean what this standard calls an alarm.

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

assembly: An assembled unit designed to be incorporated with other units in a finished product.

background: A measure of the ionizing radiation present in the environment, which is typically a value less than 25 $\mu\text{R/h}$.

beta cut-off energy: The minimum energy required for a beta particle to travel a specific distance through a known medium.

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 as described in ANSI N323AB 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.

NOTE—Initial calibration is required to provide specifications such as range, accuracy, precision, and linearity by the manufacturer as part of the type test and for each instrument prior to initial use.

coefficient of variation: The standard deviation expressed as a percentage of the mean.

condensing environment: Exposure to cycles of cool and warm humid atmospheres that cause condensation on equipment.

¹⁷*IEEE Standards Dictionary Online* is available at: <https://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

¹⁸Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

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

conventionally true value of a quantity: The commonly accepted best estimate of the value of that quantity.

NOTE—This value and its associated uncertainty is normally 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).

cross talk: For survey instruments that respond and record multiple radiation particle types, it is the level of response to one particle type in the response channel of the opposing particle type, normally expressed as a percentage of the initial particle-type source intensity.

decade: A range of values for which the upper response limit is a power of 10 above the lower limit.

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

detection limit: The maximum level to which the instrument meets the required accuracy.

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

detection threshold: The minimum statistically quantifiable instrument response or reading.

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

dose: The total amount of absorbed dose resulting from an exposure.

dose equivalent: An estimate of the biological effect of a dose of ionizing radiation, calculated by multiplying the dose received by a factor depending on the type of radiation. It is measured in Sieverts.

dose rate: The radiation dose delivered per unit time, measured in rad (radian) or Gy (gray) per hour.

drift: Change in readout, usually gradual, without concomitant change in the influence quantity.

durability: A cycle of temperature, humidity, shock, and vibration to simulate environmental exposure in an accelerated mode.

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 that point.

effective energy: The energy used to characterize a heterogeneous radiation field that behaves under specified conditions, as if it were a monoenergetic radiation field of the same energy.

energy dependence: A change in instrument response with respect to radiation energy for a constant dose-equivalent or dose-equivalent rate.

evaluation: Interpretation of measurements and observations, including determination of compliance with applicable specifications.

exposure: A measure of the amount of ionizations produced in air by gamma radiation or X-rays.

NOTE—The special unit of exposure is the roentgen, abbreviated in this standard as R.