

American National Standard Performance Criteria for Active Personnel Radiation Monitors

Sponsor

National Committee on Radiation Instrumentation, N42

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Secretariat

Institute of Electrical and Electronics Engineers, Inc.

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Abstract: Performance and design criteria are provided for monitors that are worn on the trunk of the body to measure the personal dose equivalent or the dose equivalent rate from external sources of ionizing radiation.

Keywords: design criteria, ionizing radiation, monitors, performance criteria, personnel radiation monitors, radiation, radiation instrumentation, radiation monitors

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Introduction

(This introduction is not a part of ANSI N42.20-1995, American National Standard Performance Criteria for Active Personnel Radiation Monitors.)

This standard is the responsibility of the Accredited Standards Committee N42 on Radiation Instrumentation. Committee N42 delegated the development of this standard to its Subcommittee N42.RPI2. Drafts were reviewed by Committee N42, Subcommittee N42.RPI, and other interested parties, and the comments received were utilized in producing the standard as finally approved. The standard was approved by N42 letter ballot of 22 April 1994.

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

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American National Standard Performance Criteria for Active Personnel Radiation Monitors

1. Overview

1.1 Purpose

The purpose of this standard is to specify performance and design criteria for personal electronic monitors used for the determination of the personal dose equivalent, or the dose equivalent rate, from external sources of radiation. It is necessary to standardize the performance and design of devices used for this important purpose so that inappropriate instruments are not used to evaluate the personal dose equivalent or the dose equivalent rate. Recent developments in this area of instrumentation have necessitated the development of a standard for these devices. This standard should be used in conjunction with ANSI N42.17A-1989.¹

1.2 Scope

This standard applies to the following types of active electronic devices that are worn on the trunk of the body for the purpose of measuring the personal dose equivalent, or the dose equivalent rate, from external sources of radiation. The types of dosimeters include those designed for measuring

Type 1—X, gamma, and high-energy beta radiation

Type 2—Neutron radiation

Type 3—X, gamma, high-energy beta, and neutron radiation (i.e., total dose)

The standard specifies the design and performance criteria for the personal electronic dose monitors and, if supplied, the associated readout system. It applies to devices used for the measurement of the personal dose equivalent (rate) from photon radiations (x-rays and gamma-rays) of energies 50 keV to 1.5 MeV, beta radiation of maximum energies greater than 2.0 MeV, neutron radiation from thermal energies to approximately 15 MeV.

This standard does not include instruments referred to as “chirpers,” which are described in ANSI N13.27-1981. This standard does not specify methods for the proficiency testing and accreditation of dosimetry systems. The standard does not include instruments with telemetric capability. It also does not address passive devices such as thermoluminescent dosimeters, photographic film dosimeters, or quartz fiber electroscope dosimeters. This standard specifies the following items for active personal electronic dosimeters: required general characteristics; general testing procedures; radiation characteristics; and electrical, mechanical,

¹Information about references can be found in clause 2.

safety, and environmental characteristics. The standard specifies the criteria for validating the accuracy of stored dosimetry information. This standard should be used for the evaluation of active personal electronic dosimeters as part of a type-testing program or as qualification of the devices for purchase and subsequent use in a radiation protection program. The proficiency testing or accreditation of these devices is covered in related standards developed by Accredited Standards Committee (ASC) N13.

1.3 Relationship to international standards

This standard is consistent with standards being developed by IEC TC45/SC45B. In addition to ANSI definitions, it utilizes definitions from IEC SC45B and ISO standards on reference radiations, but it does not use the ICRU operational quantities given in the IEC SC45B documents because they have not yet been adopted in the United States.

2. References

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

ANSI N13.11-1993, American National Standard Criteria for Testing Personnel Dosimetry Performance.²

ANSI N13.27-1981 (Reaff. 1992), American National Standard Performance Requirements for Pocket-Sized Alarm Dosimeters and Alarm Ratemeters.

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

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

ANSI N319-1976 (Reaff. 1984), American National Standard for Personnel Neutron Dosimeters (Neutron Energies Less Than 20 MeV).

ANSI N323-1978 (Reaff. 1993), American National Standard for Radiation Protection Instrumentation Test and Calibration.

ICRU Report 33-1980, Radiation quantities and units.³

ISO 4037-1979, X and gamma reference radiations for calibrating dosimeters and dose ratemeters and for determining their response as a function of photon energy.⁴

ISO 6980-1984, Reference beta radiations for calibrating dosimeters and dose ratemeters and for determining their response as function of beta radiation energy.

ISO 8529: 1989, Neutron reference radiations for calibrating neutron-measuring devices used for radiation protection purposes and for determining their response as a function of neutron energy.

²ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

³ICRU publications are available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Suite 800, Bethesda, MD 20814, USA.

⁴ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse. ISO 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.

NIST Special Publication 250-1989, Calibration Services User's Guide.⁵

3. Definitions

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

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

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

3.3 accuracy: The degree of agreement of the observed value with the conventionally true value of the quantity being measured. This degree of agreement can be quantified by computing the difference between the indicated value of a quantity and the correct (conventionally true) value of the quantity at the point of measurement. In the case of dose equivalent, it is expressed as $H_i - H_t$, where H_i is the indicated value and H_t is the conventionally true value.

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

3.5 alarm: An audible and/or visible signal activated when the instrument reading exceeds a preset value or falls outside of a preset range.

3.6 angular dependence: The dependence of the response of an instrument upon the direction of the incident radiation.

3.7 conventionally true value: The best estimate of the value determined by a primary or secondary standard, or by a reference instrument that has been calibrated against a primary or secondary standard.

3.8 dose equivalent: The product, H , of the absorbed dose, D , and the quality factor, Q , at the point of interest in tissue.

$$H = DQ \quad (1)$$

The shallow and deep dose equivalents, H_s and H_d , are the dose equivalents at depths in tissue of 0.07 mm and 10 mm, respectively.

The SI unit of dose equivalent has been given the special name of sievert (Sv).

$$1\text{Sv} = 1\text{J/kg} \quad (2)$$

Note—For photon and beta radiation, Q may be taken as equal to unity for external radiations.

3.9 dose equivalent rate: The quotient ($\dot{H}$) of dH by dt , where dH is the increment of dose equivalent in the time interval dt .

$$\dot{H} = dH/dt \quad (3)$$

⁵NIST publications are available from the Superintendent of Documents, US Government Printing Office, P.O. Box 37082, Washington, DC 20013-7082, USA.