

N42.33

American National Standard for Portable Radiation Detection Instrumentation for Homeland Security

Accredited by the American National Standards Institute

Sponsored by the
National Committee on Radiation Instrumentation, N42



Published by
The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

30 January 2004

Print: SH95204
PDF: SS95204

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Secretariat

The Institute of Electrical and Electronics Engineers, Inc.

Approved 23 December 2003

American National Standards Institute

Abstract: This standard describes design criteria, performance requirements and performance tests for portable radiation survey instruments.

Keywords: design criteria, performance requirements, performance tests, portable radiation detectors

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Print: ISBN 0-7381-3938-6 SH95204
PDF: ISBN 0-7381-3939-4 SS95204

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Introduction

(This introduction is not part of ANSI N42.33-2003, American National Standard for Portable Radiation Detection Instrumentation 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 of July–August 2003.

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American National Standard for Portable Radiation Detection Instrumentation for Homeland Security

1. Overview

1.1 Purpose

The purpose of this standard is to specify technical performance requirements and performance testing requirements for those purchasing and using portable radiation survey meters and portable radiation detectors for Homeland Security applications.

1.2 Scope

This standard establishes design and performance criteria, test and calibration requirements, and operating instruction requirements for portable radiation detection instruments. These instruments are used for detection and measurement of photon emitting radioactive substances for the purposes of detection and interdiction and hazard assessment. The informative annexes of this standard provide reference information.

The standard covers portable instruments used for:

- Detection of radioactive substances on or in people, containers, and vehicles, including:
 - Photon (gamma- and x-ray) emitting radionuclides.
 - Other types of radiation and radionuclides will be considered in other standards.
- Determination of exposure rate with alarming capability for Homeland Security personnel including:
 - Fire fighters,
 - Police,
 - Customs and border officials,
 - Additional emergency personnel.
- This standard includes:
 - Design and performance requirements for specific instrument types and applications;
 - Type testing and certification requirements for these instruments;
 - Calibration and test intervals;
 - Required calibration standards; and
 - Required documentation, including the instrument instruction manual.

1.3 Applicability

This standard is to be used as part of a comprehensive Homeland Security radiation detection and protection program. The comprehensive program shall include a field manual that specifies when, where, and how the instruments shall, should, or may be used to detect and quantify the radiation or radioactive material of concern. The comprehensive program shall include a training manual that specifies how users shall become proficient on the use of the instruments for their intended purposes.

This standard may not be universally applicable to all programs. When selecting instrumentation the buyer and user should exercise professional judgment in the application of these requirements and should explicitly document the detection and protection objectives and the reasons for any exceptions to the requirements of this standard.

1.4 Relationship to other standards

This standard is one of a family of standards along with ANSI N42.32-2003 [B11], ANSI N42.34-2003 [B12] and ANSI N42.35 [B13]¹ that deal with other radiation detection, measurement and radionuclide identification instrumentation for Homeland Security applications. This standard is generally consistent with standards being developed by Subcommittee 45B (SC 45B) of IEC Technical Committee 45 (IEC TC45) on Nuclear Instrumentation and SC 2 of ISO TC 85 on Nuclear Energy, but it does not use the International Commission on Radiation Units and Measurements (ICRU) operational quantities given in those documents because they have not yet been adopted in the United States.

This standard does apply to the performance of portable health physics instrumentation that is also covered in ANSI N42.17A-1989 [B16], N42.17C-1989 [B18] and N42.20-2003 [B19]. The instruments covered by this standard are intended to measure exposure rate and are not intended to measure the dose equivalent rates for radiation workers. This standard does not supersede ANSI N42.17A-1989, ANSI N42.17C-1989, and ANSI N42.20-2003.

This standard does not include instruments for spectroscopic identification of radionuclides or devices that are covered in ANSI N42.34-2003 or portal monitors that are covered in N42.35-2004. It also does not include personnel dosimeters for Homeland Security that are covered in ANSI N42.32-2003. It does not include personnel dosimeters for legal dose of record, electronic versions of which are covered in ANSI N42.20-2003. It does NOT include integrated exposure measurements.

Other related standards are listed in the bibliography in Annex A. Document numbers for all relevant standards, federal guidance documents, and regulatory requirements are identified. Included are ANSI N323A-1997 [B20], ANSI N323B-2003 [B21], ANSI N42.17A-1989 and ANSI N42.17C-1989.

1.5 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 “may” signifies an acceptable method or an example of good practice.
- The word “should” signifies a recommended specification or method.

¹The numbers in brackets correspond to those of the bibliography in Annex A.

2. References

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

ANSI N42.22-1995 (R2002), American National Standard—Traceability of Radioactive Sources to the National Institute of Standards and Technology (NIST) and Associated Instrument Quality Control.²

ANSI N42.23-1996, American National Standard Measurement and Associated Instrumentation Quality Assurance for Radioassay Laboratories.

IEC 61000-4, Electromagnetic Compatibility (EMC)—Part 4: Testing and Measurement Techniques. (All Sections.)³

3. Definitions

The following definitions apply for ANSI N42.32-2003 [B11], ANSI N42.33-2003, ANSI N42.34-2003 [B12], and ANSI PN42.35 [B13] that have been developed at the request of the Department of Homeland Security (DHS) for instruments to be used by DHS and emergency responders.

3.1 A-weighted sound level: The frequency weighting of an acoustic spectrum according to a standardized frequency response curve based on the frequency response of the human ear.

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

3.3 accepted ambient photon background: The background radiation as measured using a high pressure ionization chamber, an energy compensated Geiger-Mueller (G-M) tube, an energy compensated proportional counter, a tissue equivalent plastic scintillator, a scintillator with spectral operator, or any other exposure rate meter having a nearly constant energy response ($\pm 30\%$ in the energy range from 200 keV to 1.5 MeV).

3.4 accredited testing laboratory: 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.

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

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

3.7 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.

3.8 calibrate: To adjust and/or determine the response or reading of a device relative to a series of conventionally true values.

²ANSI 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/>).

³IEC 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.

3.9 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.

3.10 check source: A not necessarily calibrated source that is used to confirm the continuing functionality of an instrument.

3.11 conventionally true value (CTV): The commonly accepted best estimate of the value of that quantity. This and the associated uncertainty will preferably be determined by a national or transfer standard, or by a reference instrument which 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 N42.22-1995 and ANSI N42.23-1996.)

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

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

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

3.15 effective center: For a given set of irradiation conditions, the point within a detector where the response is equivalent to that which would be produced if the entire detector were located at the point.

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

3.17 energy dependence: Variation in instrument response as a function of radiation energy for a constant radiation type and exposure rate referenced to air.

3.18 exposure: The measure of ionization produced in air by x or gamma radiation. The sum of electrical charges of all ions of either sign produced in air when all electrons liberated by photons in a volume element of air are completely stopped in air, divided by the mass of the air in the volume element. The special unit of exposure is the roentgen per hour, abbreviated in this standard as R/h for exposure rate.

NOTE—In this standard, the Standard International (SI) unit Sievert, or Sv, follows in parentheses the Roentgen value R, though the two units are not physically equivalent.

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

3.20 functional check: A frequently used qualitative check to determine that an instrument is operational and capable of performing its intended function. Such checks may include, for example, battery check, zero setting, or source response check.

3.21 indicated value: (A) A scale or decade reading. (B) The displayed value of the readout. *See also:* reading.

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

3.23 influence quantity: Quantity that may have a bearing on the result of a measurement without being the subject of the measurement.

3.24 innocent alarm: An alarm resulting from an actual increase in radiation level, but for reasons that are not due to the detection of illicit radioactive materials.

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

3.26 instrument-hour: The number of operating instruments multiplied with the amount of time they are operating (e.g. 8 instruments operating for 3.75 hours is equivalent to 30 instrument hours).

3.27 interdiction: Stopping the illicit or inadvertent movement of radioactive material that has been discovered as a result of radiation detection or measurement.

3.28 monitoring: Means provided to continuously indicate the state or condition of a system or assembly.

NOTE—The real time measurement of radioactivity or radiation level.

3.29 overload response: The response of an instrument when exposed to radiation intensities greater than the upper measurement limit.

3.30 performance test: An evaluation of the performance of an instrument in response to a given influence quantity.

3.31 point of measurement: Place at which the conventionally true values are determined and at which the reference point of the instrument is placed for test purposes.

3.32 precision: Degree of agreement of repeated measurements of the same parameter.

3.33 range: All values lying between the detection limit and the upper measurement limit.

3.34 reading: The indicated or displayed value of the readout.

3.35 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 some influence quantity.

3.36 reference point of an instrument: 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.

3.37 relative error (ϵ_{REL}): The difference between instrument's reading, M , and the conventionally true value, CTV , of the quantity being measured divided by the conventionally true value multiplied by 100%.

$$\epsilon_{REL} = [(M - CTV)/(CTV)] \times 100\%$$

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

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