

American National Standard for Performance Criteria for Spectroscopy-Based Portal Monitors Used in Homeland Security

Accredited by the American National Standards Institute

Sponsored by the
National Committee on Radiation Instrumentation, N42

IEEE
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USA

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Secretariat

Institute of Electrical and Electronics Engineers, Inc.

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Abstract: The performance requirements for spectroscopy-based portal monitors are described in this standard. The requirements stated are based on portal monitors used in support of efforts associated with the U.S. Department of Homeland Security.

Keywords: ANSI N42.38, portal monitor, spectrometric, spectroscopy

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Introduction

This introduction is not part of ANSI N42.38-2015, American National Standard for Performance Criteria for Spectroscopy-Based Portal Monitors Used 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.

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1. Overview

1.1 Scope

This standard specifies the operational and performance requirements for spectroscopy-based portal monitors (SRPMs) used in homeland security applications. SRPMs have the ability to detect radioactivity and identify radionuclides that may be present in or on persons, vehicles, or containers through the use of gamma spectroscopy techniques.

Operational requirements established by this standard include radiation detection and radionuclide identification, and those requirements associated with the expected electrical, mechanical, and environmental conditions when a SRPM is deployed. The test methods described in this standard provide a means to ensure that a SRPM meets the requirements stated. Successful completion of the tests described in this standard should not be construed as an ability to successfully detect and identify all radionuclides in all environments.

This standard does not address portal monitors that may have the ability to reduce the effects caused by the presence of naturally occurring radioactive material (NORM) without the ability to identify specific radionuclides. Monitors with this capability are addressed by ANSI N42.35.

1.2 Purpose

The purpose of this standard is to specify the performance criteria and test methods for SRPMs used for homeland security. Testing is conducted under a set of conditions to determine if an SRPM meets the requirements of this standard. Special applications, which could include an SRPM's operation under weather conditions not addressed by this standard, shall require additional testing. Detection needs not addressed by this standard shall also require additional testing, e.g., estimation of the background depression due to vehicle presence, masking, or shielding configurations.

Obtaining operating performance that meets or exceeds the specifications stated in this standard depends upon properly installing the SRPM, establishing appropriate operating parameters, providing security for the systems, maintaining calibration, implementing a suitable routine testing and maintenance program, auditing compliance with quality requirements, and providing proper training for operating personnel.

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 C63.4, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.¹

ANSI N42.22, 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, American National Standard Measurement and Associated Instrumentation Quality Assurance for Radioassay Laboratories.

ANSI N42.42, American National Standard Data Format Standard for Radiation Detectors Used for Homeland Security.³

ANSI/TIA-232-F-1997, Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.⁴

ANSI/TIA/EIA-485-A-1998, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.

FCC Rules, U.S. Code of Federal Regulations, Title 47 Part 15 (47 CFR 15), Telecommunication—Radio Frequency Devices.⁵

IAEA Safety Guide No. RS-G-1.9, Categorization of Radioactive Sources.⁶

¹ ANSI C63 and ANSI N42 publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (<http://standards.ieee.org/>).

² See footnote 1.

³ The ANSI N42.42 schema can be obtained from <http://www.nist.gov/pml/div682/grp04/n42.cfm>.

⁴ TIA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA (<http://global.ihs.com/>).

⁵ CFR publications are available from the U.S. Government Publishing Office, P.O. Box 979050, St. Louis, MO 63197-9000, USA (<http://www.ecfr.gov/>).

IEC 60050, Chapter 395, International Electrotechnical Vocabulary.⁷

IEC 60068-1, Environmental Testing—Part 1: General and Guidance.

IEC 60068-2-11, Basic environmental testing procedures—Part 2-11: Test Ka—Salt mist.

IEC 60068-2-18, Environmental Testing—Part 2-18: Tests—Test R and Guidance: Water.

IEC 60068-2-75, Environmental Testing—Part 2-75: Tests—Test Eh: Hammer Tests.

IEC 60529, Degrees of Protection Provided by Enclosures (IP Code).

IEC 60721-4-4, Classification of Environmental Conditions—Part 4-4: Guidance for the Correlation and Transformation of Environmental Condition Classes of IEC 60721-3 to the Environmental Tests of IEC 60068—Stationary Use at Non-Weatherprotected Locations.

IEC 61000-4-1, Electromagnetic Compatibility (EMC)—Part 4-1: Testing and Measurement Techniques—Overview of IEC 61000-4 Series.

IEC 61000-4-2, Electromagnetic Compatibility (EMC)—Part 4-2: Testing and Measurement Techniques—Electrostatic Discharge Immunity Test.

IEC 61000-4-3, Electromagnetic Compatibility (EMC)—Part 4-3: Testing and Measurement Techniques—Radiated, Radio-Frequency, Electromagnetic Field Immunity Test.

IEC 61000-4-4, Electromagnetic Compatibility (EMC)—Part 4-4: Testing and Measurement Techniques—Electrical Fast Transient/Burst Immunity Test.

IEC 61000-4-5, Electromagnetic Compatibility (EMC)—Part 4-5: Testing and Measurement Techniques—Surge Immunity Test.

IEC 61000-4-6, Electromagnetic Compatibility (EMC)—Part 4-6: Testing and Measurement Techniques—Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields.

IEC 61000-4-8, Electromagnetic Compatibility (EMC)—Part 4-8: Testing and Measurement Techniques—Power Frequency Magnetic Field Immunity Test.

IEC 61000-4-12, Electromagnetic Compatibility (EMC)—Part 4-12: Testing and Measurement Techniques—Ring Wave Immunity Test.

IEC 61000-4-14, Electromagnetic Compatibility (EMC)—Part 4-14: Testing and Measurement Techniques—Voltage Fluctuation Immunity Test for Equipment With Current Not Exceeding 16 A per Phase.

IEC 61000-4-28, Electromagnetic Compatibility (EMC)—Part 4-28: Testing and Measurement Techniques—Variation of Power Frequency, Immunity Test for Equipment With Input Current Not Exceeding 16 A per Phase.

IEC 61455:1995 (withdrawn), Nuclear Instrumentation—MCA Histogram Data Interchange Format for Nuclear Spectroscopy.⁸

⁶ IAEA publications are available from the International Atomic Energy Agency, P.O. Box 100, Wagramer Strasse 5, A-1400 Vienna, Austria (<http://www.iaea.org/>).

⁷ IEC publications are available from 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 American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

Manual for Railway Engineering, American Railway Engineering and Maintenance-of-Way Association, Mira Digital Publishing, Inc., 2015.⁹

NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).¹⁰

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this standard, the following terms and definitions apply. *The IEEE Standards Definition Database* should be consulted for terms not defined in this clause.¹¹

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 instrument reading 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.

alarm: An audible, visual, or other signal activated when the instrument reading, response, or identification result exceeds a preset value, falls outside of a preset range, or indicates the presence of a radionuclide of interest, respectively.

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.

category: A subdivision of radionuclides. Examples include, but are not limited to, special nuclear material (SNM), medical, industrial, and naturally occurring radioactive material (NORM).

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

coefficient of variation (COV) (%): Ratio of the standard deviation, s , to the arithmetic mean, $\bar{x}$ of a set of n measurements, x_i given by the following formula:

$$COV = \frac{s}{\bar{x}} = \frac{1}{\bar{x}} \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

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

NOTE—This estimate 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 interaction with the National Institute of Standards and Technology (NIST) or an accredited organization.¹²

⁸ IEC 61455:1995 has been withdrawn; however, copies are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA (<http://global.ihs.com/>).

⁹ AREMA publications are available from AREMA, 10003 Derekwood Lane, Suite 210, Lanham, MD 20706-4362, USA (<http://www.arena.org>).

¹⁰ NEMA publications are available from the National Electrical Manufacturers Association, 6300 Interfirst Drive, Ann Arbor, MI, 48108, USA (<http://www.nema.org/>).

¹¹ *IEEE Standards Definition Database* is available at: <http://dictionary.ieee.org>.

decade: A range of values for which the upper value is ten times greater than the lower value.

detection assembly: The monitor enclosure that includes the detector, the associated electronics and the mounting components.

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.

detection zone: The region that is either located between opposing detection assemblies or adjacent to a detection assembly over which the detection requirements are satisfied.

NOTE—Annex B shows a diagram of the detection zone.

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.

efficiency: The number of counts in a region corresponding to the energy of the emitted gamma rays minus the background counts in the same region registered by the detector per unit time divided by the number of photons of that energy originating from the radioactive source that is being measured during the same unit of time.

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

NOTE—The special 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 of 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.

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

manufacturer: The organization, typically including the designer or developer, that produces the equipment and software.

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

NOTE—The term may also be used for the real-time measurement of radioactivity or exposure rate.

occupancy: When an object (person, vehicle, package, etc.) being monitored is in the detection zone.

over-range response: The response of an instrument when exposed to radiation intensities that are greater than the upper measurement limit. *Syn:* **overload response.**

¹² Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

portal monitor: A radiation measurement device designed to detect changes in the measured exposure rate as an object passes through or is placed in an area that is adjacent to a radiation detection assembly or assemblies.

purchaser: The organization, including the user, that buys the equipment.

radioactive material: A material of which one or more constituents' exhibit radioactivity. In this standard, radioactive material includes special nuclear material unless otherwise specifically noted.

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 some influence quantity.

remote station: A computing system or subsystem used for data archiving, control, annunciation, printing, or other functions for portal monitor assemblies, typically located at a distance from the portal monitors.

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

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

routine test: Test that applies to each independent instrument to ascertain compliance with specified criteria.

spectroscopy-based portal monitor (SRPM): A portal monitor that uses gamma spectroscopy techniques for the identification of radionuclides.

standard deviation: The 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.

3.2 Acronyms and abbreviations

COV	coefficient of variation
DU	depleted uranium
EM	electromagnetic
ESD	electrostatic discharge
HDPE	high density polyethylene
HEU	highly enriched uranium
HPGe	high purity germanium
LEU	low enriched uranium
NORM	naturally occurring radioactive material
PMMA	polymethyl methacrylate
RF	radio frequency
RGPu	reactor grade plutonium