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American National Standard Performance Criteria for Hand-held Instruments for the Detection and Identification of Radionuclides

Accredited by the American National Standards Institute

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Secretariat

The Institute of Electrical and Electronics Engineers, Inc.

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Abstract: This standard describes the performance requirements for hand-held radionuclide identifying instruments. The requirements stated are based on instruments used in support of efforts associated with the Department of Homeland Security.
Keywords: radionuclide identifiers, restrictive mode, routine mode

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Introduction

(This introduction is not part of ANSI N42.34-2003, American National Standard Performance Criteria for Hand-held Instruments for the Detection and Identification of Radionuclides.)

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.

Participants

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

Louis Costrell, *Chair*
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American Conference of Governmental Industrial Hygienists ..... Jesse Lieberman
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At the time this standard was approved, Subcommittee N42.RPI had the following members:

Morgan Cox, *Co-Chair*
Jack M. Selby, *Co-Chair*

Dru Carson
Peter J. Chairo, Jr.
Jack Cooley
Leo Faust
Edward Groeber
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Mark M. Hoover
Ron Keyser
Joseph C. McDonald
Robert Murphy
Cheryl Olson
Mario Overhoff
Scott Rogers
Michael P. Unterweger
Ed Walker
Chuan-Fu Wu

At the time this standard was approved, the ANSI N42.34 Working Group had the following members:

Peter J. Chiaro, Jr., *Chair* and *Project Leader*

Jeff Chapman
Steve Costigan
Donald Gregory
Tom Hazlett
Sam Hitch
Jens Hovgaard
Scott Hulse
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Ron Keyser
Siraj Khan
Richard Oxford
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Andrew Ickowicz
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American National Standard Performance Criteria for Hand-held Instruments for the Detection and Identification of Radionuclides

1. Overview

1.1 Scope

This standard specifies general requirements and test procedures, radiation response requirements, and electrical, mechanical, and environmental requirements. Successful completion of the tests described in this standard should not be construed as an ability to successfully identify all isotopes in all environments.

1.2 Purpose

This standard addresses instruments that can be used for homeland security applications to detect and identify radionuclides, for gamma doserate measurement, and for indication of neutron radiation.

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.[1]

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.)[2]

[1]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/).

3. Definitions

The following definitions apply for ANSI N42.32-2003 [B11], ANSI N42.33-2003 [B12], ANSI N42.34-2003, 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 (±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.

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.

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[2]IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembé, 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.

3.13 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%.

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

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.

3.40 restricted mode: An advanced operating mode that can be accessed by an expert user (e.g.: via password) to control the parameters that can affect the result of a measurement (i.e., radionuclide library, routine function control, calibration parameters, alarm thresholds, etc.). May be called the "advanced" or "expert" mode.

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

3.42 standard deviation: The positive square root of the variance.

3.43 standard instrument or source: (A) National standard—a standard determined by a nationally recognized competent authority to serve as the basis for assigning values to other standards of the quantity concerned. In the U.S., this is an instrument, source, or other system or device maintained and promulgated by the National Institute of Standards and Technology (NIST). **(B)** Primary standard—a standard that is designated or widely acknowledged as having the highest metrological qualities and whose value is accepted without reference to other standards of the same quantity. **(C)** Secondary standard—a standard whose value is assigned by comparison with a primary standard of the same quantity. **(D)** Reference standard—a standard, generally having the highest metrological quality available at a given location or in a given organization, from which measurements made there are derived. **(E)** Working standard—a standard that is used

routinely to calibrate or check material measures, measuring instruments, or reference materials. A working standard is traceable to NIST (see ANSI N42.22-1995 and ANSI N42.23-1996).

3.44 standard test conditions: Represent the range of values of a set of influence quantities under which a calibration or a measurement of response is carried out.

3.45 test: A procedure whereby the instrument, circuit, or component is evaluated.

3.46 type test: Initial test of two or more production instruments made to a specific design to show that the design meets defined specifications.

3.47 uncertainty: The estimated bounds of the deviation from the conventionally true value, generally expressed as a percent of the mean, ordinarily taken as the square root of the sum of the square of two components: 1) Random errors that are evaluated by statistical means; and 2) systematic errors that are evaluated by other means.

3.48 upper measurement limit (UML): The UML is the maximum level at which the instrument meets the required accuracy.

3.49 variance (σ^2): A measure of dispersion, which is the sum of the squared deviation of observations from their mean divided by one less than the number of observations.

$$\sigma^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$$

4. Operating modes

— *Routine mode:* an operating mode that includes detection and identification of radionuclides, and doserate measurement. Also may be called the “simple mode.”
— *Restricted mode:* an advanced operating mode that can be accessed by an expert user (e.g., via password) to control the parameters that can affect the result of a measurement (i.e., radionuclide library, routine function control, calibration parameters, alarm thresholds, etc.). Also may be called the “advanced” or “expert” mode.

5. Test nomenclature

— *Acceptance test:* Test to ensure that the instrument meets individual conditions of its specification. These tests may be performed with the customer present at the manufacturer’s facility.
— *Routine test:* Test applied to each individual instrument in order to ascertain compliance with specified criteria.
— *Type test:* Conformity tests that are performed on two or more units of an instrument model. These tests may be done at the manufacturer’s facility or after receipt by the customer.

6. General characteristics

6.1 General

Instruments addressed by this standard are used for the detection and identification of radionuclides, for gamma doserate measurement, and for indication of neutron radiation. They typically acquire the gamma-ray spectrum and identify the radionuclide through comparison with an internal radionuclide library.

These instruments are hand-held and battery-powered. They shall be operable for minimum of two hours of continuous use, and be capable of operating at temperatures from –20 °C (–4 °F) to +50 °C (+122 °F). Instruments used outside of this or other stated requirements should be tested to ensure proper operation prior to use.

Other than a radiation detector, an instrument shall not require any external devices (e.g., laptop personal computer) for the detection and identification of radioactive material.

6.2 User interface

NOTE—A possible method for evaluating the user interface is provided in Annex C.

6.2.1

The instrument shall include:

a) A display that is easily readable over the required temperature range and under different lighting conditions,

b) Controls that are user-friendly for routine operation,

c) A menu structure that is simple and easy to be followed intuitively, and

d) A user-definable radionuclide library with access via the restricted mode.

6.2.2

The instrument shall have at least two different operating modes, one mode for routine operation and the other as a restricted (password protected) mode.

6.2.3

The instrument shall be capable of operation if the user is wearing gloves or if the instrument is enclosed in anti-contamination protection (e.g., plastic bag).

6.3 Communication interface

The instrument shall have the ability to transfer data to an external device, such as a computer. The transfer should be based on a bi-directional serial port that meets the requirements of Ethernet, USB, or other electronic means such as a removable media device. The technique used shall conform to applicable IEEE protocols. Communication protocols shall be described in the technical manual and proprietary formats shall not be used.

Proprietary software should not be required for remote data interpretation. It is preferred that the transferred data be of a format (e.g. ASCII) that is easily imported into common analysis programs (e.g., flat ASCII or spreadsheet). The manufacturer shall provide proprietary software for data interpretation, if needed.

6.4 Moisture protection

Instruments shall be designed to prevent water ingress from rain, condensing moisture, or high humidity. The manufacturer shall state design measures that address this requirement, such as seals or gaskets.

6.5 Markings

6.5.1 General

All external instrument controls, displays, and adjustments shall be identified as to function. Internal controls shall be identified through markings on circuit boards and identification in technical manuals.

Markings shall be easily readable and permanently fixed under normal conditions of use (including use of normal decontamination procedures).

6.5.2 Exterior markings

The following markings shall appear on the exterior of the instrument or each major subassembly (e.g., detector probe) as appropriate:

a) Manufacturer and model number,

b) Unique serial number,

c) Location of the effective center(s) or area(s) of detection, and

d) Function designation for controls, switches, and adjustments that are not menu or software driven.

6.6 Battery power

6.6.1

Instruments shall be equipped with a test circuit or other visible direct indicator of battery condition for each battery circuit.

6.6.2

The manufacturer shall state the expected continuous operating time using the recommended batteries and the conditions (functional and environmental) used to determine this time.

6.6.3

The low-battery indication shall be no lower than the minimum voltage required for proper operation.

6.6.4

The instrument shall be capable of operating from commercially available, field replaceable battery types (e.g., AA, 9-Volt).

6.6.5 External battery power

The instrument should be capable of operating from an external DC source. Adequate protection from reverse polarity, over-voltage, and electrical noise must be provided. DC power sources include:

— Nominal 12 VDC as would be obtained from a 12-volt vehicle electrical system.
— A portable battery pack, such as one that can be worn, that supplies 9–14 VDC.
— A regulated 12 VDC power supply operating from utility power.

6.7 Protection of switches

Switches and other controls should be designed to ensure that the instrument is operated properly while minimizing accidental switch operation.

6.8 Effective range of measurement

The effective gamma energy response range shall be stated by the manufacturer, and should be 25 keV to 3 MeV. The manufacturer shall also state the range for gamma doserate measurement and for neutron count rate indication.

6.9 Spectral identification

6.9.1

A displayed gamma spectrum is not required during routine operation, although it should be available without special access controls.

6.9.2

The instrument shall have the ability to store and transfer at least 50 complete (unprocessed) spectra. Each spectrum shall also contain collection and identification results information including:

a) Time and date,
b) Identified radionuclides, categories, and associated confidence levels,
c) Spectrum integration time,
d) Measured gamma doserate, and
e) Neutron count rate at the time of measurement.

6.9.3

An indication shall be displayed or otherwise provided (e.g., “not identified”) if a radionuclide cannot be identified.

6.9.4

If a reliability or confidence level is associated with the identification of a radionuclide(s), the manufacturer shall describe the meaning of the displayed value.

6.9.5

The instrument shall indicate if the doserate is too high or too low for radionuclide identification.

6.10 Personnel protection alarm

An alarm shall be provided to alert the user that indicated dose rates are above a user-selected threshold level. The alarm shall be both audible and visual, and shall be adjustable through the restricted mode. The alarm shall have an "acknowledge" or other similar control to silence the audible function.

7. General test procedures

Unless otherwise specified in the individual steps, all tests enumerated in this standard are to be considered as type tests. Certain tests may be considered as acceptance tests by agreement between the customer and manufacturer.

7.1 Reference conditions and standard test conditions

Reference conditions are given in the second column of Table 1. Except where otherwise specified, the tests in this standard shall be carried out under the standard test conditions shown in the third column of Table 1.

For those tests intended to determine the effects of variations in the influence quantities, all other influence quantities should be maintained within the limits for standard test conditions given in Table 1, unless otherwise specified in the test procedure concerned.

Table 1—Reference conditions and standard test conditions

Influence quantity	Reference conditions (unless otherwise indicated by the manufacturer)	Standard test conditions (unless otherwise indicated by the manufacturer)
Stabilization time	As stated by the manufacturer.	As stated by the manufacturer.
Ambient temperature	20 °C (68 °F)	18 °C to 22 °C (64 °F to 72 °F)
Relative humidity	65%	50% to 75%
Atmospheric pressure	101.3 kPa (29.9 inches of mercury at 0 °C)	70 kPa to 106.6 kPa (20.7 to 31.5 inches of mercury at 0 °C)
Battery voltage	Nominal voltage.	Battery used up to half of its useful life.
Angle of incidence of radiation	Reference direction given by the manufacturer.	Direction given ± 5°.
Electromagnetic field of external origin	Negligible.	Negligible.
Magnetic induction of external origin	Negligible.	Negligible.
Instrument controls	Set up for normal operation.	Set up for normal operation.
Radiation background	Less than ambient dose equivalent rate of 25 μR/h (0.25 μSv/h) in air.	Ambient dose equivalent rate of 10 μR/h (0.1 μSv/h) in air or less if practical.
Contamination by radioactive elements	Negligible.	Negligible.

8. Radiation detection, minimum requirements

Unless stated otherwise, when radiation dose rates are required the positioning of an instrument for testing shall be based on the doserate measurement from an independent gamma measurement instrument, such as a microrem meter or ionization chamber

8.1 Response

8.1.1 Requirements

Significant changes in the measured radiation level shall be indicated visually and shall be proportional to the field's intensity. A mutable audible indication proportional to the field's intensity shall also be available.

8.1.2 Test method

Expose the instrument to an instantaneous increase in the ambient radiation field of 50 μR/h (^{137}Cs) above the ambient background level. The instrument shall indicate an increase in the level of radiation within 1 second. The displayed doserate indication shall be within ±50% of the new radiation level within five seconds of the change.

Return the radiation field to its original level; the instrument shall indicate a decrease in the radiation level within 1 second. The displayed doserate indication shall be within ±50% of the changed radiation level within five seconds of the change.

8.2 Gamma doserate indication

8.2.1 Requirements

The relative intrinsic error in the response of the instrument to the reference gamma radiation from ^{137}Cs shall not exceed ±30% for dose rates from 0.1 mR/h to the manufacturer-stated maximum doserate.

8.2.2 Test method

The test shall be performed using ^{137}Cs to produce gamma fields of 0.1 mR/h, 5 mR/h, and 80% of the manufacturer-stated response range. The mean indicated doserate shall be within 30% of each doserate.

8.3 Alarm

8.3.1 Requirement

The instrument shall alarm when exposed to a radiation field that is greater than the alarm threshold.

8.3.2 Test method—gamma

Set the alarm threshold to 1 mR/h and expose the instrument to a 2 mR/h radiation field produced by ^{137}Cs. The alarm shall activate within three seconds of the increased exposure.

8.3.3 Test method—neutron

Expose the instrument to a ^{252}Cf neutron field that is equivalent to the flux emitted from an unmoderated 0.01 μg ^{252}Cf source placed approximately 25 cm from the instrument. The neutron alarm shall activate within two seconds.

NOTE—A 0.01 μg ^{252}Cf source placed approximately 25 cm from the instrument produces approximately 0.3 mRem/h.

8.4 Radionuclide identification

When identifying radionuclides, test results are considered acceptable when an instrument identifies the radionuclide(s) of interest, or that radionuclide(s) and expected daughter(s). It is considered not acceptable if the instrument identifies unexpected radionuclides or only the daughter(s) of the radionuclide(s) of interest.

If a library is used as part of the identification process, it shall contain the radionuclides listed in 8.4.1 for test purposes as a minimum, and it shall not be altered during the entire testing process.

Manufacturers shall specify which analysis modes are available for instrument operation.

a) Region summing,

b) Peak fitting,

c) Least squares analysis of library spectra (both manufacturers and user supplied),

d) Automatic switching,

e) Operation of user supplied spectral analysis software, and/or

f) Other manufacturer spectral analysis software.

Test requirements shall be applied to each available mode, unless the instrument selects the analysis mode automatically.

8.4.1 Radionuclide categorization

The radionuclides of greatest interest and those most likely to be encountered are listed in four different categories.

NOTE—This is an informative list and should not be considered as all-inclusive.

— *Special nuclear materials:* Uranium (used to indicate ^{233}U, ^{235}U), ^{237}Np, Pu.
— *Medical radionuclides:* ^{67}Ga, ^{51}Cr, ^{75}Se, ^{99m}Tc, ^{103}Pd, ^{111}In, Iodine (^{123}I, ^{125}I, ^{131}I), ^{201}Tl, ^{133}Xe.
— *Naturally occurring radioactive materials (NORM):* ^{40}K, ^{226}Ra, ^{232}Th and daughters, ^{238}U and daughters.
— *Industrial radionuclides:* ^{57}Co, ^{60}Co, ^{133}Ba, ^{137}Cs, ^{192}Ir, ^{204}Tl, ^{226}Ra, and ^{241}Am.

8.4.2 Requirements

The manufacturer shall state the radionuclides that the instrument can identify and their category. The categories selected should be based on the list shown in 8.4.1.

The instrument shall display the identified radionuclide(s) and its category, and store the results as stated in 6.9.2.

8.5 Single radionuclide

8.5.1 Requirements

The instrument shall be able to identify the following radionuclides within the time specified by the manufacturer. The manufacturer shall provide radionuclide-specific test results.

— *Unshielded:* ^{40}K, ^{57}Co, ^{60}Co, ^{67}Ga, ^{99m}Tc, ^{125}I, ^{131}I, ^{133}Ba, ^{137}Cs, ^{192}Ir, ^{201}Tl, ^{226}Ra, ^{232}Th, ^{233}U, ^{235}U, ^{238}U, Pu [Reactor grade plutonium (> 6% ^{240}Pu)], ^{241}Am.
— *Behind 5-mm steel shielding:* ^{40}K, ^{57}Co, ^{60}Co, ^{67}Ga, ^{99m}Tc, ^{125}I, ^{131}I, ^{133}Ba, ^{137}Cs, ^{192}Ir, ^{201}Tl, ^{226}Ra, ^{232}Th, ^{233}U, ^{235}U, ^{238}U, Pu [Reactor grade plutonium (> 6% ^{240}Pu)], ^{241}Am.

8.5.2 Test method

One at a time, expose the instrument to the radionuclides listed in 8.5.1. The gamma doserate at the detector from each source, unshielded or shielded, shall be 50 μR/h. The test shall consist of 10 trials for each radionuclide. The instrument shall be reset between each trial, if appropriate. The performance is acceptable when the instrument correctly identifies the radionuclide in 8 out of 10 consecutive trials.

8.6 Simultaneous radionuclide identification

8.6.1 Requirement

The instrument shall be able to identify at least two radionuclides simultaneously.

8.6.2 Test method

Expose the instrument to ^{133}Ba and Pu (reactor grade) simultaneously. Each radionuclide shall produce a gamma radiation doserate of approximately 50 μR/h at the detector. The test shall consist of 10 trials. The performance is acceptable when the instrument correctly and simultaneously identifies both of the two test radionuclides in 8 out of 10 consecutive trials.

8.7 Interfering ionizing radiation (gamma)

8.7.1 Requirement

The instrument shall be able to identify the radionuclide of interest in the presence of an increased gamma background from natural thorium.

8.7.2 Test method

Expose the instrument to a natural thorium gamma doserate measured at the detector of 50 μR/h. Place an ^{241}Am source at a location that provides an increase of 50 μR/h at the detector. The instrument shall be able to identify the radionuclide of interest (^{241}Am) within 1 minute. The test shall consist of 10 trials and the performance is acceptable when the instrument correctly identifies the radionuclide of interest in 8 out of 10 consecutive trials. The test shall be repeated using ^{60}Co as the radionuclide of interest.

8.8 Interfering ionizing radiation (beta)

8.8.1 Requirement

The instrument shall identify a radionuclide of interest when exposed to the radiation emitted from a shielded pure beta-emitting radionuclide.

8.8.2 Test method

Expose the instrument to a shielded beta emitter (^{32}P or ^{90}Sr/^{90}Y). The photon (x-rays, bremmstrahlung, etc.) radiation shall be 50 μR/h at the detector. Expose the instrument to a 50 μR/h ^{137}Cs gamma doserate.

The test shall consist of 10 individual trials and is acceptable when the instrument correctly identifies ^{137}Cs in 8 out of 10 consecutive trials.

Remove the ^{137}Cs source and with the instrument exposed only to the shielded beta emitter, perform an identification. The identification results shall not include any unexpected radionuclides and should indicate the presence of a "not identified" radionuclide. To be acceptable, this shall occur in 8 out of 10 consecutive trials.

8.9 False identification

8.9.1 Requirement

The instrument shall not identify a radionuclide that is not present when operated in a stable and low ambient radiation background. A shielded box or enclosure may be required to perform the test.

8.9.2 Test method

Perform a radionuclide identification with the instrument in a stable background of not more than 10 μR/h with no radiation sources present. No unexpected radionuclides shall be identified. The test shall consist of 10 trials and the performance is acceptable when the instrument does not identify a radionuclide in 8 out of 10 consecutive trials.

If naturally occurring radionuclides such as ^{40}K are identified, actions should be taken to reduce or eliminate the source prior to performing the test. If the radionuclide is expected and cannot be removed, the test result shall be acceptable when the expected naturally occurring radionuclide is identified.

8.10 Interference from surrounding material

8.10.1 Requirements

The instrument shall be able to identify radionuclides in the presence of backscattered radiation.

8.10.2 Test method

Expose the instrument to a ^{137}Cs source that produces a 500 μR/h radiation field at the detector. The source shall be placed between a steel plate that is approximately 1 cm thick and the detector. This test is acceptable if ^{137}Cs is correctly identified in 8 out of 10 consecutive trials.

8.11 Variation of identification based on angle of incidence

8.11.1 Requirements

The identification of radionuclides shall be acceptable over incident angles from 0° to ±45°.

8.11.2 Test method

Expose the instrument to an ^{241}Am source that provides a doserate of 50 μR/h at the detector at an incident angle of 0° and perform a radionuclide identification. Repeat the process with the incident angle at +45° and –45° in each of two orthogonal planes. Repeat the test using ^{60}Co and ^{137}Cs. The test shall consist of 10 trials for each orientation and the performance is acceptable when the instrument correctly identifies each radionuclide in 8 out of 10 consecutive trials.

8.12 Neutron response

8.12.1 Requirement

The instrument shall indicate the presence of neutron radiation. If the instrument responds in count rate, no further testing other than that stated in 8.3.3 is required.

If the instrument provides a dose equivalent rate response, the response shall be linear over its range.

8.12.2 Test method, dose equivalent rate only

The test shall be performed using neutron fields that are equivalent to 20, 50, and 80% of the manufacturer-stated response range. The mean indicated dose equivalent rate shall be within 50% of each dose equivalent rate.

8.13 Overload characteristics for identification

8.13.1 Requirements

The manufacturer shall state the maximum gamma doserate (relative to ^{137}Cs) for identification.

8.13.2 Test method

Increase the ambient doserate using ^{137}Cs to 90% of the maximum doserate for radionuclide identification as stated by the manufacturer and perform a radionuclide identification. The instrument shall correctly identify ^{137}Cs. This test is acceptable if the results are the same in 8 out of 10 trials.

8.14 Over-range characteristics for doserate indication

8.14.1 Requirements

The instrument shall indicate that an over range condition exists when the ambient doserate is greater than the manufacturer-stated maximum doserate.

8.14.2 Test method

Expose the instrument to a step change in the radiation field from ambient to 10 times the manufacturer-stated maximum doserate. The instrument shall indicate that an over-range condition exists within five seconds of the step change and shall remain in that condition for the entire exposure period (minimum of five minutes). After a minimum of five minutes, reduce the radiation field to the pretest value. The instrument shall operate normally within 30 minutes.

8.15 Neutron indication in the presence of photons

8.15.1 Requirements

The neutron indication shall be insensitive to gamma radiation at gamma dose rates up to the manufacturer-stated maximum gamma doserate.

The instrument shall indicate the presence of neutron radiation in the presence of gamma radiation.

8.15.2 Test method

Increase the ambient gamma doserate using a ^{60}Co source to the manufacturer-stated maximum doserate level. There shall be no indication of neutron radiation.

With the instrument exposed to the gamma source, expose the instrument to a neutron field as described in 8.3. The instrument shall indicate the presence of neutron radiation.

9. Electrical and environmental performance requirements

9.1 Warm-up time

9.1.1 Requirement

The manufacturer shall state the time required for the instrument to become fully functional from either a dead start or when in a standby mode. The maximum time shall be less than 10 minutes.

9.2 Power supplies–battery

9.2.1 Requirement

The instrument shall be fully operational for a minimum of two hours after warm-up under standard test conditions.

9.2.2 Test method

Ensure that the batteries are fully charged and after allowing the instrument to warm up, perform a simultaneous radionuclide identification using ^{241}Am and ^{60}Co. The instrument shall also be tested using an unmoderated neutron source (neutron indication test). Leave the instrument on and after a period of two hours perform another radionuclide identification and neutron indication test. This final identification test shall consist of 10 trials. The instrument shall produce the same results (correctly identifying each radionuclide) in 8 out of 10 consecutive trials.

9.3 Moisture protection

9.3.1 Requirements

Instruments shall be designed to prevent water ingress from rain, condensing moisture, or high humidity.

9.3.2 Test method

The instrument shall be exposed to a ^{137}Cs source that is of sufficient intensity to minimize the effect of the statistical fluctuations of the instrument readings. The instrument shall then be exposed to a fine water spray at 4 L/m for a period of two minutes. The spray nozzle should be located approximately 2 meters from the instrument. The instrument shall respond to the presence of radiation throughout the test and after the test. The temperature of the water and the instrument shall be 20°C ± 5°C.

Following exposure, the instrument including the battery compartment shall be inspected to ensure that moisture did not penetrate into the instrument.

9.4 Vibration

9.4.1 Requirements

The instrument shall withstand exposure to vibrations of 2 g applied for 15 min in the frequency range from 10–33 Hz. The physical and functional condition of the instrument shall not be affected by exposure (e.g., solder joints shall hold, nuts and bolts shall not come loose).

9.4.2 Test method

Conduct an external examination (visual inspection) and ensure that the instrument is functioning properly. Subject the instrument to vibrations of 2 g for 15 min in each of three orthogonal directions at a minimum of one frequency in each of the following ranges: 10–21 Hz and 22–33 Hz. After each 15 min vibration interval, perform a 10-trial radionuclide identification using ^{137}Cs and verify that the instrument responds to neutron radiation. The instrument shall correctly identify ^{137}Cs in 8 out of 10 trials. After the tests, check the instrument for mechanical damage and loose components.

9.5 Mechanical shock

9.5.1 Requirements

The instrument shall withstand exposure to 10 shock pulses of 50 g peak acceleration, each applied for a nominal 18 ms in each of three mutually orthogonal axes. The physical condition of instruments shall not be affected by these shocks (e.g., solder joints shall hold; nuts and bolts shall not come loose).

9.5.2 Test method

Conduct an external examination (visual inspection) and ensure that the instrument is functioning properly. Subject the instrument to 10 pulses of peak acceleration of 50 g (half-sine-wave pulse), each over a nominal time interval of 18 ms in three orthogonal directions. After each set of 10 shocks, perform a 10-trial radionuclide identification using ^{137}Cs and verify that the instrument responds to neutron radiation. The instrument shall correctly identify ^{137}Cs in 8 out of 10 trials. After the tests, check the instrument for mechanical damage and loose components.

9.6 Ambient temperature influence

9.6.1 Requirements

The instrument shall be operational at temperatures from –20 °C to +50 °C (–4 °F to +122 °F).

9.6.2 Test method

^{241}Am and ^{60}Co placed in a location that provides a doserate of 50 μR/h (from each) at the detector shall be used to determine compliance.

A series of doserate readings and a 10-trial radionuclide identification shall be performed at the reference temperature of 22 °C (72 °F), at the upper and lower temperature limits (+50 °C and –20 °C, or +122 °F and –4 °F), and at each 10 °C soak temperature (–10, 0, 10, 30, and 40 °C). Sources shall be removed during each temperature ramp cycle and re-inserted for each required test. The sources shall be placed at the same location as used for the reference readings and identification performed at 22 °C.

Temperature ramp rates shall be 10 °C/h and soak times shall be 1.5 hrs for each 10 °C soak interval and eight hours for the upper and lower temperature limit. The ten doserate readings as well as the 10-trial radionuclide identification and neutron response verification shall be performed during the last 30 minutes of each soak point, including the upper and lower temperature limits.

The instrument is fully compliant (unit is operational) when the mean doserate readings remain with ±20% of the mean doserate obtained at 22 °C (72 °F) and the instrument correctly identifies each radionuclide in 8 out of 10 consecutive trials for each 10-trial test.

9.7 Temperature shock

9.7.1 Requirements

The instrument shall be fully functional within one hour of exposure to rapid temperature changes from 22 to –20, –20 to 22, 22 to 50, and 50 to 22 °C (72 to –4, –4 to 72, 72 to 122, and 122 to 72 °F) with each change being made in less than five minutes. The instrument shall provide an indication if it is not fully functional.

9.7.2 Test method

Place the instrument in an environmental chamber and allow it to stabilize at 22 °C (72 °F) then perform a simultaneous radionuclide identification of ^{241}Am and ^{60}Co placed in a location that provides a doserate of 50 μR/h (from each) at the detector.

The instrument and radioactive sources shall then be exposed to a temperature of 50 (+0, –5) °C (122 °F) with the temperature change being made in less than five minutes.

The instrument shall be observed continuously. Every 15 minutes, a radionuclide identification consisting of three trials shall be performed as stated previously, and a series of doserate readings shall be recorded. A neutron response verification shall also be performed.

After one hour, the instrument shall correctly identify each radionuclide in two out of three trials. In addition, the mean indicated gamma doserate from each temperature extreme shall be within ±20% of the mean doserate obtained at 22 °C (72 °F) and the instrument shall respond to neutron radiation.

If the instrument is unable to perform a radionuclide identification after the first hour, continue the test at 15-minute intervals for an additional hour at the temperature with the time required for recovery noted.

If the instrument recovers within the first hour, data does not need to be taken during the second hour; however, the instrument should remain in this environment to reach temperature stabilization.

Following the stabilization period, expose the instrument to a temperature of 22°C (72 °F) ± 2°C. This change shall be performed in less than five minutes and the analysis process stated above repeated.

The entire process shall be repeated for the 22 °C to –20 (+5, –0) °C and –20 (+5, –0) °C to 22 °C.

9.8 Relative humidity

9.8.1 Requirements

The instrument shall be fully functional over the range of humidity up to 93% at 35 °C (95 °F).

9.8.2 Test method

Place the instrument in an environmental chamber and allow it to stabilize at 20 °C (72 °F) and 40% relative humidity for two hours then perform a simultaneous radionuclide identification of ^{241}Am and ^{60}Co placed in a location that provides a doserate of 50 μR/h (from each) at the detector.

The humidity level shall then be increased at a rate not exceeding 10% RH per hour until attaining 93% ± 3%. Over the same time interval, the temperature shall also be increased to 35 °C. The humidity and temperature shall be maintained at these values for at least 16 hours. A 10-trial radionuclide identification shall be performed and the mean indicated gamma doserate recorded during the last 30 minutes of this period. At the same time, the neutron response shall be verified.

The humidity shall then be reduced to 40% while maintaining the temperature at 35°C (95 °F) ± 2°C. After allowing the instrument to stabilize in those conditions for a minimum of two hours, a 10-trial radionuclide identification shall be performed, the mean indicated gamma doserate recorded, and the neutron response shall be verified.

The instrument shall correctly identify each radionuclide in 8 out of 10 consecutive trials at each test point. In addition, the mean indicated gamma doserate from each test point shall be within ±20% of the mean doserate obtained prior to the humidity exposure, and the instrument shall respond to neutron radiation when exposed.

9.9 Electromagnetic compatibility

Special precautions must be taken to ensure proper operation in the presence of electromagnetic disturbances, particularly radio-frequency fields.

9.10 Electrostatic Discharge (ESD)

9.10.1 Requirement

The instrument shall be function properly after exposure to electrostatic discharges at intensities of up to 6 kV for contact and 8 kV for air.

9.10.2 Test method

In order to evaluate an instruments' immunity to ESD, the "contact discharge" technique for conductive surfaces and coupling planes and the "air discharge" technique for insulating surfaces shall be used. Discharge points shall be selected based on user accessibility.

There shall be ten discharges per discharge point with a one-second-recovery time between each discharge. The maximum intensity of each discharge is based on the technique used, 6 kV for contact, and 8 kV for air discharge. The instrument shall be able to perform a radionuclide identification of ^{241}Am and ^{60}Co placed in a location that provides a doserate of 50 μR/h (from each) at the detector after exposure to the ESD test, and the instrument shall indicate the presence of neutron radiation when exposed to an unmoderated neutron source. No alarms or false identifications such as the presence of neutrons when no source is present shall occur when exposed to each discharge.

9.11 Radio frequency (RF)

9.11.1 Requirement

The instrument should not be affected by RF fields over the frequency range of 20 MHz to 1000 MHz at an intensity of 10 volts per meter (V/m).

9.11.2 Test method

Place the instrument in a RF controlled environment and expose it to a RF field of 20 V/m measured without an instrument present in the irradiation area over a frequency range of 20 MHz to 1000 MHz that is 80% amplitude modulated with a 1 kHz sine wave. The test should be performed using an automated sweep at a frequency change rate not greater than 1% of the fundamental.

NOTE—20 V/m is selected so that the test can be performed in one orientation. If susceptibility is indicated, the test should be repeated at the frequencies of susceptibility at 10 V/m in at least three orthogonal orientations relative to the emission source.

If susceptibilities are indicated by substantial changes in the displayed doserate or other operational changes such as alarm activation, perform a radionuclide identification of ^{241}Am and ^{60}Co placed in a location that provides a doserate of 50 μR/h (from each source) at the detector at those frequencies. No alarms or other spurious indications shall occur and there should be no change in radionuclide identification. The indicated doserate should remain within ±20% of the initial indicated value throughout the RF exposure.

9.12 Radiated emissions

9.12.1 Requirement

RF emissions from an instrument shall be less than that which can interfere with other equipment located in the area of use. RF emissions when measured at three meters shall be less than those shown in Table 2.

Table 2—Radiated RF emission limits

Emission frequency range (MHz)	Field Strength (micro volts/meter)
30–88	100
88–216	150
216–960	200
Above 960	500

9.12.2 Method of test

Place the instrument in a shielded room or chamber, as appropriate. Place an antenna three meters from the assembly. With the instrument off, collect a background spectrum using a bandwidth of 50 kHz.

Switch the instrument on and perform a RF scan. Repeat the test with the instrument performing a radionuclide identification. RF emissions shall be less than those shown throughout the test.

9.13 Conducted immunity

9.13.1 Requirement

The instrument should not be affected by RF fields that can be conducted onto the instrument through an external conducting cable. Instruments that do not have at least one external conducting cable are excluded.

9.13.2 Test method

Place an ^{241}Am and ^{60}Co source in a location that provides a doserate of 50 μR/h (from each) at the detector and expose the instrument to a conducted RF field over the frequency range of 150 kHz to 80 MHz at an intensity of 140 dB (μV) 80% amplitude modulated with a 1 kHz sine wave. The test should be performed using an automated sweep at a frequency change rate not greater than 1% of the fundamental.

The test is acceptable if no alarms or other spurious indications such as an indication of neutrons occur, there is no substantial change in doserate response (> ± 20% of the initial indicated value), and no spurious indications of neutron radiation.

9.14 Magnetic fields

9.14.1 Requirements

The instrument should be fully functional when exposed to DC magnetic fields in two orientations relative to a 10 Gauss magnetic field.

9.14.2 Test method

Place an ^{241}Am and ^{60}Co source in a location that provides a doserate of 50 μR/h (from each) at the detector and expose the instrument to a 10 Gauss magnetic field. The test is acceptable if no alarms or other spurious indications such as an indication of neutrons occur, and there is no substantial change in doserate response (> ± 20% of the initial indicated value).

10. Documentation

10.1 Certificate

A certificate shall accompany each hand held nuclide identifier, giving at least the following information:

a) Manufacturer's name or registered trademark,

b) Type of the instrument and serial number,

c) List of radionuclides to which the instrument was tested,

d) Doserate range, and

e) Tests performed.

11. Operation and maintenance manual

Each instrument shall be supplied with an appropriate instruction manual.

Annex A

(informative)

Bibliography

A.1 General

[B1] IEC 60068-2, Basic Environmental Testing Procedures—Part 2: Tests. (All Sections.)

[B2] IEEE Std C62.41™-1991, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.[3, 4]

[B3] UL 913– 2002, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.[5]

A.2 Detectors

[B4] ANSI N42.12-1994, American National Standard for Calibration and Usage of Thallium-Activated Sodium Iodide Detector Systems for Assay of Radionuclides.

[B5] ANSI N42.13-1986 (R1993), American National Standard for Calibration and Usage of "Dose Calibrator" Ionization Chambers for the Assay of Radionuclides.

[B6] ANSI N42.14-1999, American National Standard for Calibration and Use of Germanium Spectrometers for the Measurement of Gamma-Ray Emission Rates of Radionuclides.

[B7] ANSI N42.31-2003 American National Standard – Measurement Procedures for Resolution and Efficiency of Wide-Bandgap Semiconductor Detectors of Ionizing Radiation.

[B8] IEEE Std 300™-1988, IEEE Standard Test Procedures for Semiconductor Charged-Particle Detectors.

[B9] IEEE Std 309™-1999/ANSI N42.3-1999, IEEE Standard Test Procedures and Bases for Geiger-Mueller Counters.

[B10] IEEE Std 325™-1996 (R2002), IEEE Standard Test Procedures for Germanium Gamma-Ray Detectors

A.3 Detection and identification instruments

[B11] ANSI N42.32-2003, American National Standard Performance Criteria for Alarming Personal Radiation Detectors for Homeland Security.

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[3]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/).

[4]The IEEE standards referred to in Annex A are trademarks belonging to the Institute of Electrical and Electronics Engineers, Inc.

[5]UL standards are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (http://global.ihs.com/).

[B12] ANSI N42.33-2003, American National Standard for Portable Radiation Detection Instrumentation for Homeland Security.

[B13] ANSI PN42.35, Draft American National Standard for Evaluation and Performance of Radiation Detection Portal Monitors for Use in Homeland Security.[6]

[B14] IEC WD62327, Radiation Protection Instrumentation—Hand-held Instruments for the Detection and Identification of Radioactive Isotopes and additionally for the Indication of Ambient Dose Equivalent Rate from Photon Radiation (Draft).[7]

[B15] ISO/DIS 22188:2002, Monitoring for Inadvertent Movement and Illicit Trafficking of Radioactive Material.[8]

A.4 Radiological protection instruments

[B16] ANSI N13.27-1981 (R1992), American National Standard Performance Requirements for Pocket-Sized Alarm Dosimeters and Alarm Ratemeters.

[B17] ANSI N42.17A-1989 (R1994), American National Standard Performance Specifications for Health Physics Instrumentation—Portable Instrumentation for Use in Normal Environmental Conditions.

[B18] ANSI N42.17B-1989 (R1994), American National Standard Performance Specifications for Health Physics Instrumentation—Occupational Airborne Radioactivity Monitoring Instrumentation.

[B19] ANSI N42.17C-1989 (R1994), American National Standard Performance Specifications for Health Physics Instrumentation—Portable Instrumentation for Use in Extreme Environmental Conditions.

[B20] ANSI N42.20-2003, American National Standard Performance Criteria for Active Personnel Radiation Monitors.

[B21] ANSI N323A-1997, American National Standard Radiation Protection Instrumentation Test and Calibration Portable Survey Instruments.

[B22] ANSI N323B-2003, American National Standard for Radiation Protection Instrumentation Test and Calibration, Portable Survey Instrumentation for Near Background Operation.[9]

[B23] IEC 60395 (1972), Portable X or Gamma Radiation Exposure Rate Meters and Monitors for Use in Radiological Protection.

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[6]This ANSI standards project was not approved at the time this publication went to press. For information about obtaining a draft, contact the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/).

[7]This IEC standards project was not approved at the time this publication went to press. For information about obtaining a draft, contact the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (http://www.iec.ch/).

[8]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/).

[9]This approved ANSI standard will be available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/), in early 2004.

A.5 Electromagnetic compatibility

[B24] 47 CFR 0-19: 2002, Telecommunication.[10, 11]

[B25] IEC 61000-6-2 (1999), Electromagnetic Compatibility (EMC)—Part 6-2: Generic Standards—Immunity for Industrial Environments.

A.6 Units, quantities, calibrations

[B26] ISO 4037-1:1996, X and Gamma Reference Radiation for Calibrating Dosemeters and Doserate Meters and for Determining their Response as a Function of Photon Energy—Part 1: Radiation Characteristics and Production Methods.

[B27] ISO 4037-2:1997, X and Gamma Reference Radiation for Calibrating Dosemeters and Doserate Meters and for Determining their Response as a Function of Photon Energy—Part 2: Dosimetry for Radiation Protection over the Energy Ranges from 8 keV to 1,3 MeV and 4 MeV to 9 MeV.

[B28] ISO 8529-1:2001, Reference Neutron Radiations—Part 1: Characteristics and Methods of Production."

[B29] ISO 8529-2:2000, Reference Neutron Radiations—Part 2: Calibration Fundamentals Related to the Basic Quantities Characterizing the Radiation Field.

[B30] NIST SP 250-98 ED, NIST Calibration Services User's Guide, 1998 Edition.[12]

[10]Supersedes FCC P15: 1976, Radio Frequency Devices.

[11]CFR publications are available from the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013-7082, USA (http://www.access.gpo.gov/).

[12]Information on NIST Special Publications may be obtained from the National Institute of Standards and Technology at http://www.nist.gov/.

Annex B

(informative)

Detector tests

This standard and ANSI N42.32-2003 [B11], ANSI N42.33-2003 [B12], and ANSI PN42.35 [B13] utilize some of the following types of detectors:

— *Sodium Iodide (NaI) Scintillation detectors:* These detectors are available in large sizes such that they have both high efficiency and moderate energy resolution. They are operated at room temperature. Test procedures are given in ANSI N42.12-1994 [B4].
— *CZT Semiconductor detectors:* CZT and other wide-bandgap semiconductor detectors are semiconductor detectors that can be operated at room temperatures. At this time they are small physically and therefore have low efficiency. They have good energy resolution though somewhat poorer than that of Germanium detectors. Standard test procedures for these detectors are given in ANSI N42.31-2003 [B7].
— *Germanium Gamma-ray detectors:* These detectors have very high energy resolution and are currently of sufficient size to have also high efficiency. They must be operated at cryogenic temperatures. Test procedures for these detectors are given in IEEE Std 325-1996 [B10].
— *Semiconductor charged-particle detectors:* These detectors are capable of high resolution measurements of charged particles. Test procedures for these detectors are given in IEEE Std 300-1988 [B8].
— *Geiger-Mueller Counters:* These are widely used for radiation detection and intensity measurements. They are avalanche detectors, the output signals of which are independent of the radiation energy. Test procedures for these detectors are given in IEEE Std 309-1999/ANSI N42.3-1999 [B9].
— *Ionization chambers:* These are highly accurate detectors for gross measurement of radiation intensity. They are operated at room temperature. Test procedures for these detectors are given in ANSI N42.13-1986 [B5].
— *Plastic Scintillator detectors:* These detectors are particularly useful for portal monitors. Standards and standard measurement procedures have not yet been developed.

Annex C

(informative)

Sample user interface evaluation technique

Controls

1.	Was the on/off switch easy to find?	Y/N
2.	Were all the controls labeled?	Y/N
3.	Were all the labeled controls easy to read/interpret?	Y/N
4.	Were all the controls easy to operate without gloves?	Y/N
5.	Could all the controls be operated with gloves?	Y/N
6.	On a scale of 0 to 10 (10 being the best, 0 being unacceptable), rate the controls	

Interface

7.	Was brightness/contrast adjustable, either manually or automatically, to compensate for light levels?	Y/N
8.	Was everything readable in low light levels	Y/N
9.	Was everything readable in high light levels	Y/N
10.	Could the display be read when it was in a plastic bag?	Y/N
11.	Did the display contain abbreviations or icons? (If no, skip next question.)	Y/N
12.	Were the abbreviations or icons easy to interpret or understand?	Y/N
13.	Was the time and date displayed?	Y/N
14.	On a scale of 0 to 10 (10 being the best, 0 being unacceptable), rate the interface	

Operation

15.	Did the instrument convey it's state-of-health at start-up (e.g., battery life, detector present and working, memory available, mode of operation)?	Y/N
16.	Did you have to refer to the instruction manual more than once to complete the test?	Y/N
17.	Was the menu structure simple and intuitive?	Y/N
18.	At any time during the test did the instrument prompt you for action?	Y/N
19.	Did the instrument issue any cautions or warning? (If no, go to question 21.)	Y/N
20.	Did the instrument provide information on the nature of the cautions or warning and a corresponding course of action?	Y/N
21.	On a scale of 0 to 10 (10 being the best, 0 being unacceptable), rate the ease of operation.	