



American National Standard Performance Specifications for Instrumentation Systems Designed for Measuring Radon Progeny in Air

Accredited by the American National Standards Institute

Developed by the
National Committee on Radiation Instrumentation, N42

ANSI N42.50-2022

STANDARDS

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Secretariat

Institute of Electrical and Electronics Engineers, Inc.

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Abstract: Minimum performance requirements and performance testing requirements are specified in this standard for instruments designed to measure radon progeny in air. Inasmuch as the health effects of exposure to radon progeny, and hence regulatory control, are quantified relative to the ultimate dose delivered by the complete decay of all the radon progeny in the monitored air, the principle measurand of interest is therefore the potential alpha energy concentration, expressed in units of either working level (WL) or joules m⁻³ given that primary measurements characterize activity. The needs of users, manufacturers, and regulators concerned with radon progeny measurements are addressed in this standard.

Keywords: air monitoring, air sampling, ANSI N42.50, radiological characterization, radon progeny

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Introduction

This introduction is not part of ANSI N42.50-2022, American National Standard Performance Specifications for Instrumentation Systems Designed for Measuring Radon Progeny in Air.

This standard is the responsibility of the Accredited American Standards Committee on Radiation Instrumentation, N42. The standard was approved on N42 letter ballot.

This standard encompasses measuring all types of radon progeny in air in the workplace, in effluent, and in the environment. It includes initial design, manufacture, minimum performance, performance testing, calibration, and maintenance requirements. This standard covers both real-time monitors and air samplers. It is intended to provide guidance on industry best practices to obtain continual quality in the life cycle of relevant systems.

Contents

1. Overview	12
1.1 Scope.....	12
1.2 Word usage	13
2. Normative references.....	13
3. Definitions	15
4. Units and conversions.....	17
5. Classification of instrument systems	17
6. Performance and testing	17
6.1 Attached and unattached fraction	17
6.2 Radiation response to radon progeny	18
6.3 Sampling system design.....	19
6.4 Electronic criteria	23
6.5 Interfering responses	26
6.6 Mechanical criteria.....	27
6.7 Environmental criteria.....	28
6.8 Calibration and maintenance.....	29
7. Class-specific performance and testing criteria	32
7.1 Grab sampling instruments.....	32
7.2 Continuously sampling instruments.....	32
7.3 Integrating sampling instruments	34
8. Documentation	34
8.1 Type test report	34
8.2 Certificate.....	34
8.3 Manuals and procedures.....	35
8.4 Records	36
Annex A (informative) Bibliography	37
Annex B (normative) Radon and radon progeny equilibrium	38
Annex C (informative) Aerosol sampling considerations	39
Annex D (informative) Filter Selection.....	40
Annex E (informative) Radar decay chain	41
Annex F (informative) Life-cycle approach to instrument tests and test requirements	43
Annex G (informative) Other considerations of radiation response	46

American National Standard Performance Specifications for Instrumentation Systems Designed for Measuring Radon Progeny in Air

1. Overview

The objectives of this standard are to provide performance and testing criteria for instruments and instrument systems that have application in radiation dose and/or risk assessment from exposure to radon progeny in air. The standard includes performance testing or generic (type) testing of new instrument models. The standard is not intended to force requirements where previously established requirements exist but rather to supplement or provide guidance in those areas to promote good practices.

Hereafter the term *radon* is used to include ^{222}Rn and ^{220}Rn ; the term *radon progeny* is used to include the radioactive decay products of ^{222}Rn and ^{220}Rn (^{219}Rn is not included in this standard) (see Clause 3). Excluded from this standard are instruments and instrumentation systems designed to measure radon gas. A complementary standard ANSI/HPS N42.51-2015 addresses this class of instrumentation.⁶

The instrumentation addressed by this standard covers a broad range of instrument types that vary in their sampling, detection, and analysis methodologies. This results in a wide range of performance characteristics within this instrument population. A classification system is, therefore, used to group instruments that share similar performance characteristics.

If a system can be determined to fall into multiple instrumentation classes, then those aspects that fall into one class would be governed by those portions of this standard that address that same class. Likewise, those aspects of a system that fall into a separate class would be governed by those portions of this standard that address that same separate class.

This standard specifies requirements and test procedures in the following areas: radiation, response, air sampling, electronic, environmental, and mechanical. This standard makes use of three different verbs, *shall*, *should*, and *may*, to indicate the level of rigor with which a particular criterion is applied. For the purposes of this standard, these verbs are defined in 1.2.

1.1 Scope

This standard specifies minimum performance requirements and performance testing requirements for instruments designed to measure radon progeny in air. Radon progeny has historically been characterized in terms of its *potential alpha energy concentration* (PAEC), expressed in either units of *working level* (WL)

⁶ Information on references can be found in Clause 2.

or joules $\times$ m⁻³. As WL is the term that is correlated with dose and therefore risk, it is a target for regulatory control and so is therefore considered in this standard. This standard addresses the needs of users, manufacturers, and regulators concerned with radon progeny measurements.

1.2 Word usage

In this document, the word *shall* is used to indicate a mandatory requirement. The word *should* is used to indicate a recommendation for a best practice. As such, documentation for not implementing a *should* statement shall be maintained to allow later assessment for continued justification or modification of the noncompliance to the associated recommendations. The word *may* is used to indicate a permissible action. The word *can* is used for statements of possibility and capability.

NOTE 1—An appropriate qualifying statement may be included in this standard to indicate if conditional exceptions are allowed. As an example, if a specification is stated as being a “should” or a “may” and is later followed by a subsequent “shall” in the same subsection, the “shall” applies only if the “should” or “may” is implemented.⁷

NOTE 2—It is understood that if something this standard states *should* be done *is not* done, the manufacturer or user shall have included, in a technical basis document, the justification for not using the recommendation, to allow changes in future operation, design, application or interpretation to be properly assessed for any warranted updates.

NOTE 3—This document applies to alpha continuous air monitors.

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/AARST MS-PC-2020, Performance Specifications for Instrumentation Systems Designed to Measure Radon Gas in Air (ANSI 42.51).⁸

ANSI N13.1-2011, American National Standard Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities.

ANSI N42.54-2018, American National Standard Instrumentation and Systems for Monitoring Airborne Radioactivity.⁹

ASTM D6327-2010, Standard Test Method for Determination of Radon Decay Product Concentration and Working Level in Indoor Atmospheres by Active Sampling on Filter.¹⁰

Chen, C. J., et al., Discrimination of airborne radioactivity from radon progeny, *Health Physics* 66, pp. 557–564, 1994.

Collé, R., Hutchinson, J. M. R., and Unterweger, M. P., The NIST Primary Radon-222 Measurement System, *J. Res. Natl Inst. Stand. Technol.* 95, 155. 1990.

Gesell, T. F., Background atmospheric ²²²Rn concentrations outdoors and indoors: A review, *Health Physics* 45, pp. 289–302, 1983.

⁷ Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

⁸ ANSI publications are available from the American National Standards Institute (<https://www.ansi.org/>).

⁹ ANSI N42 publications are available from The Institute of Electrical and Electronics Engineers (<http://standards.ieee.org/>).

¹⁰ ASTM publications are available from the American Society for Testing and Materials (<http://www.astm.org/>).

Hoover, M. D., and Newton, G.J., Radioactive Aerosols, Chapter 35 in *Aerosol Measurement—Principles, Techniques and Applications*, Edited by Willeke, K. and Baron, P. A. Van Nostrand Reinhold: New York, 1992.

IEC 60050-395, International Electrotechnical Vocabulary (IEV)—Part 395: Nuclear instrumentation—Physical phenomena, basic concepts, instruments, systems, equipment and detectors.¹¹

IEC 61000-4-4, Ed. 3.0, Electromagnetic compatibility (EMC)—Part 4-4: Testing and measurement techniques—Electrical fast transient/burst immunity test.

IEC 61000-4-11, Ed. 2.0, Electromagnetic compatibility (EMC)—Part 4-11: Testing and measurement techniques—Voltage dips, short interruptions and voltage variations immunity tests.

IEC 61577-1, Ed. 2.0, Radiation Protection Instrumentation—Radon and radon decay product measuring instruments—Part 1: General principles.

IEC 61577-2, Ed. 2.0, Radiation Protection Instrumentation—Radon and radon decay product measuring instruments—Part 2: Specific requirements for ²²²Rn and ²²⁰Rn measuring instruments.

IEC 61577-3, Ed. 2.0, Radiation Protection Instrumentation—Radon and radon decay product measuring instruments—Part 3: Specific requirements for radon decay product measuring instruments.

IEC 61577-4, Ed. 1.0, Radiation Protection Instrumentation—Radon and radon decay product measuring instruments—Part 4: Equipment for the production of reference atmospheres containing radon isotopes and their decay products (STAR).

IEC TR 61577-5, Ed. 1.0, Radiation Protection Instrumentation—Radon and radon decay product measuring instruments—Part 5: General properties of radon and radon decay products and their measurement methods.

IEC 61578, Radiation protection instrumentation—Calibration and verification of the effectiveness of radon compensation for alpha and/or beta measuring instruments—Test methods.

IEC 62302, Radiation protection instrumentation—Equipment for sampling and monitoring radioactive noble gases.

IEC 62303, Radiation protection instrumentation—Equipment for monitoring airborne tritium.

Marley, F., Investigation of the influences of atmospheric conditions on the variability of radon and radon progeny in buildings, *Atmospheric Environment* 35, pp. 5347–5360, 2001.

NCRP Report No. 78, Evaluation of Occupational and Environmental Exposures to Radon and Radon Daughters in the United States.¹²

NCRP Report No. 97 (1988), Measurement of Radon and Radon Daughters in Air.

US EPA AP-42 (1995), Compilation of Air Emissions Factors, US Environmental Protection Agency, Washington, D. C.¹³

¹¹ IEC publications are available from the International Electrotechnical Commission (<https://www.iec.ch>) and the American National Standards Institute (<https://www.ansi.org/>).

¹² NCRP documents are available from the National Council on Radiation Protection and Measurements (<https://www.ncrponline.org/>).

¹³ US EPA documents are available at: <https://www.epa.gov/air-emissions-factors-and-quantification>.