Designation: D 6327 – 98

Standard Test Method for Determination of Radon Decay Product Concentration and Working Level in Indoor Atmospheres by Active Sampling on a Filter[1]

This standard is issued under the fixed designation D 6327; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method provides instruction for using the grab sampling filter technique to determine accurate and reproducible measurements of indoor radon decay product (RDP) concentrations and of the working level value corresponding to those concentrations.

1.2 Measurements made in accordance with this test method will produce RDP concentrations representative of closed-building conditions. Results of measurements made under closed-building conditions will have a smaller variability and are more reproducible than measurements obtained when building conditions are not controlled. This test method may be utilized under non-controlled conditions, but a greater degree of variability in the results will occur. Variability in the results may also be an indication of temporal variability present at the sampling site.

1.3 This test method utilizes a short sampling period and the results are indicative of the conditions only at the place and time of sampling. The results obtained by this test method are not necessarily indicative of longer terms of sampling and should not be confused with such results. The averaging of multiple measurements over hours and days can, however, provide useful screening information. Individual measurements are generally obtained for diagnostic purposes.

1.4 The range of the test method may be considered from 0.0005 WL to unlimited working levels (WL), and from 40 Bq/m3 to unlimited for each individual randon decay product.

1.5 This test method provides information on equipment, procedures, and quality control. It provides for measurements within typical residential or building environments and may not necessarily apply to specialized circumstances, for example, clean rooms.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* See Section 9 for additional precautions.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1356 Terminology Relating to Sampling and Analysis of Atmospheres[2]

D 1605 Practices for Sampling Atmospheres for Analysis of Gases and Vapors[3]

D 3631 Test Methods for Measuring Surface Atmospheric Pressure[2]

E 1 Specification for ASTM Thermometers[4]

3. Terminology

3.1 *Definitions*— For definitions of terms used in this test method, refer to Terminology D 1356.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *radon*—the particular isotope Radon-222.

3.2.2 *radon decay products (RDP)*—any or all of the particular isotopes polonium-218, bismuth-214, lead-214, and polonium-214.

3.2.3 *grab sampling*—the act and all procedures involved with obtaining a short term sample through the use of an operating air pump.

3.2.4 *working level*—quantity of short-lived decay products that will result in 1.3×10^6 MeV of potential alpha energy per liter of air. The working level is the common unit for expressing environmental RDP exposure.

4. Summary of Test Method [5]

4.1 Grab sampling measurements of RDP concentrations in air are performed by collecting the RDP from a known volume of air on a filter and subsequently counting the activity on the filter following collection. The counting is performed at specified times for specified periods. The energy from radioactive decay of the particles collected on the filter is converted

[1] This test method is under the jurisdiction of ASTM Committee D22 on Sampling and Analysis of Atmospheres and is the direct responsibility of Subcommittee D22.05 on Indoor Air.

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[2] *Annual Book of ASTM Standards*, Vol 11.03.

[3] *Annual Book of ASTM Standards*, Vol 14.03.

[4] *Annual Book of ASTM Standards*, Vol 14.03.

[5] Thomas, J.W. "Measurement of Radon Daughters in Air," Health Physics, Vol 23, 1972, p. 783.

to light pulses by a zinc sulfide phosphor in contact with the filter. The light pulses are detected and converted to counts. Analysis of the number of counts in each counting interval determines the concentrations of the RDP. The two counting methods which have found the most general use are the Kusnetz and the modified Tsivoglou procedures.[6]

5. Significance and Use

5.1 The test method provides a relatively simple method for determination of the concentration of RDP without the need for specialty equipment built expressly for such purposes.

5.2 Using this test method will afford investigators of radon in dwellings a technique by which the RDP can be determined. The use of the results of this test method are generally for diagnostic purposes and are not necessarily indicative of results that might be obtained by longer term measurement methods.

5.3 An improved understanding of the frequency of elevated radon in buildings and the health effect of exposure has increased the importance of knowledge of actual exposures. The measurement of RDP, which are the direct cause of potential adverse health effects, should be conducted in a manner that is uniform and reproducible; it is to this end that this test method is addressed.

6. Interferences

6.1 Interferences may be caused by any alpha-emitting particle capable of inducing a light pulse in the phosphor screen used for alpha-counting. In general, the only significant interference source is that of the decay products of radon-220, thoron, which may be considerable in certain geographical regions. The direction of the interference is always positive. The extent to which thoron decay products interfere can be estimated or measured through alpha-spectroscopy or serial type measurements.[7]

6.2 Some depth penetration to the filter may occur. The extent of the penetration may be estimated using membrane filter types not suggested within this test method. The direction of interferences is always negative.

7. Apparatus

7.1 *Collection Apparatus*:

7.1.1 Air pump capable of 10 to 12 L/min flow rate.

7.1.2 Bubble tube airflow calibration cell, 1 L or larger.

7.1.3 Calibrated dry gas meter.

7.1.4 Flow meter (optional).

7.1.5 Open-faced filter holder, 25 or 47-mm diameter.

7.1.6 Membrane filters, mixed cellulose ester, 25 or 47-mm diameter, 0.8-µm pore size.

7.1.7 Sharpened forceps, for removal of sample filters.

7.1.8 Stopwatch, accurate to 1 s.

7.2 *Decay Counting Apparatus*:

7.2.1 Zinc sulfide phosphor discs, 51-mm diameter.

7.2.2 *Scintillation Counter*, scaler and photomultiplier tube.

7.2.3 High voltage power supply.

7.3 Thermometer, (See Specification E 1).

7.4 Barometer, (See Test Methods D 3631).

8. Reagents and Materials

8.1 National Institute of Standards and Technology (NIST) traceable alpha calibration source, typically americium-241, to determine counter efficiency.[8,9]

9. Hazards

9.1 Since radioactive material is being utilized, both in the form of calibration standards and particles collected on sample filters, wear disposable gloves during handling of these items.

9.2 If the atmospheres being measured are known to contain high concentrations of RDP, wear an HEPA half-mask respirator during sampling.

9.3 The calibration source from NIST must be shielded when not being used for calibration. Shield the source by returning the source to the original NIST storage container and placing the source in the original storage geometry within the container.[8]

10. Preparation of Apparatus

10.1 Verify proper operation of the equipment prior to collection of the sample. Refer to equipment manuals for information.

10.1.1 Operate each counting system at the high-voltage (HV) and threshold settings that combines maximum stability, good counting efficiency, and low background counts. Each manufacturer's counting systems have different set-up requirements and optimization procedures. A general similar procedure is available.[10]

10.2 Determine the counter efficiency and background for the sampling filter and phosphor screen pair prior to collection of the sample (see Section 11).

10.3 The air pump, filter assembly, and connecting tubing shall not leak.

10.4 A volume meter is needed for measuring total sample flow. A calibrated dry gas test meter is the most satisfactory total volume meter available for source test work. Calibrate the meter in the laboratory prior to use with a positive displacement liquid meter or a cylinder and piston flow calibrator, and determine a meter correction factor, C_M, as necessary.

10.5 Locate the scintillation counter to provide rapid access from the sampling site when the modified Tsivoglou counting procedure is utilized. This process is necessary due to the short time period between sampling and the start of counting.

11. Procedure

11.1 *Calibration of Scintillation Counter*:

[6] Indoor Radon and Randon Decay Product Measurement Protocols, EPA 402–R–92–004, July 1992, United States Environmental Agency, Washington D.C.

[7] Measurement of Radon and Radon Decay Products in Air, NCRP Report No. 97, National Council on Radiation Protection and Measurements, Bethesda, MD 20814, Nov. 15, 1988.

[8] Interlaboratory Radon-Daughter Measurement Comparison Workshop: 9-12 September 1985, GJ/TMC-25 UC-70A, United States Department of Energy, Washington D.C. [Available through: NIST, National Technical Information Service, United States Department of Commerce, Springfield, VA 22161].

[9] Available from: NIST Standard Reference Materials Catalog, NIST Special Publication 260, U.S. Department of Commerce, Nation Institute of Standards and Technology 1990-1991, Issued January 1990, as Catalog SRM No. 4904NG.

[10] Standard Test Method for Radon Grab Sampling, Revision 02, March 31, 1992; GJ/TMC Technical Procedure RN-GRAB-U, United States Department of Energy, Washington D.C.