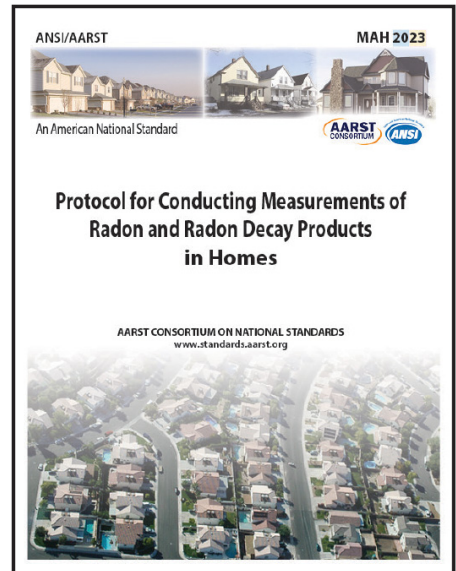


# 2024 Public Review of MAH 2023

Consistent with plans relative to our continuous maintenance program, the latest publication of ANSI/AARST MAH is being published for public review. Processes are still underway for repopulating the standing Radon Measurement committee tasked with review and update of this standard. This public review is intended to garnish comments that will lead to improvements in upcoming publications.

ANSI/AARST standards are available for review and for purchase at [www.standards.aarst.org](http://www.standards.aarst.org). A link to ensure you receive future public review notices can be found at [www.standards.aarst.org/public-review](http://www.standards.aarst.org/public-review).



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## 2024 Public Review: MAH 2023

### **COMMENT DEADLINE: May 20th, 2020**

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#### **REQUESTED PROCESS AND FORM FOR FORMAL PUBLIC REVIEW COMMENTS**

Submittals (MS Word preferred) may be attached by email to [StandardsAssist@gmail.com](mailto:StandardsAssist@gmail.com)

- 1) Do not submit marked-up or highlighted copies of the entire document.
- 2) If a new provision is proposed, text of the proposed provision must be submitted in writing. If modification of a provision is proposed, the proposed text must be submitted utilizing the strikeout/underline format.
- 3) For substantiating statements: Be brief. Provide abstract of lengthy substantiation. (If appropriate, full text may be enclosed for project committee reference.)

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#### **REQUESTED FORMAT**

**Public Reviewed Item and Its Date:** MAH 2023

- **Name:** Affiliation:
- **Clause or Subclause:**
- **Comment/Recommendation:**
- **Substantiating Statements:**

*Repeat the four bullet items above for each comment.*

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### The Consortium Consensus Process

The consensus process developed for the AARST Consortium on National Radon Standards and as accredited to meet essential requirements for American National Standards by the American National Standards Institute (ANSI) has been applied throughout the process of approving this document.

### Continuous Maintenance

This standard is under continuous maintenance by the AARST Consortium on National Standards for which the Executive Stakeholder Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard.

User Tools: User tools are posted online ([www.standards.aarst.org/public-review](http://www.standards.aarst.org/public-review)) as they become available (such as templates for field notices, inspection forms, interpretations and approved addenda updates across time).

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**MAH 2023  
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**MAH**  
**Protocol for Conducting Measurements of  
Radon and Radon Decay Products in Homes**



**1.0 SCOPE AND PURPOSE**

**1.1 Scope**

This standard of practice specifies procedures and minimum requirements when measuring radon concentrations in single-family residences for determining if radon mitigation is necessary to protect current and future occupants. This standard applies to homeowners, professionals and any other party seeking to determine if radon mitigation is necessary for real estate or non-real estate purposes.

**1.2 Limitations**

- 1.2.1 This standard does not address all technical aspects of measurement devices, quality assurance or techniques to specifically identify radon sources such as radon in water supplies, building materials or relative to the possession and handling of radioactive materials.
- 1.2.2 Adherence to this standard does not guarantee or supersede compliance with regulations of any federal, state, or local agency with jurisdiction where testing is performed.

**1.3 Applicability**

- 1.3.1 These standards of practice can be adopted as requirements for contractual relationships or adopted as recommendations or requirements of an authority or jurisdiction such as private proficiency programs, a state radon program or other governmental body.
- 1.3.2 The terms “Note” and “Informative Advisory” indicate provisions that are considered to be helpful or good practice but that do not contain a mandatory requirement.

**Informative Table of Contents for Topics Commonly of Interest**

2.1 Which homes to test	6.0 Conducting the test
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**2.0 INTRODUCTION—BEFORE YOU TEST**

**2.1 Which Homes Should Be Tested?**

*Informative Advisory*—Any home on any parcel of land can have a radon problem. Testing is the only way to know.

Every home should be tested to include new and old homes; tightly sealed and drafty homes; and homes with or without basements or crawl spaces. Radon concentrations cannot be predicted based on state, local or neighborhood radon measurements.

## 2.2 When to Test?

*Informative Advisories:*

### 2.2.1 Test at the earliest opportunity.

Homes can be tested at any time of the year.

### 2.2.2 Test whenever moving to a new residence

To prevent the possibility of long-term exposure to a radon hazard, take the opportunity to test in association with moving into any new or existing home or dwelling.

### 2.2.3 Severe weather

Avoid testing during unusual local severe weather if the test period is less than 72 hours. When severe conditions occur during a test, retesting may be appropriate.

### 2.2.4 Seasonal considerations

While some buildings respond differently to seasonal changes, tests conducted when heating systems operate both day and night are more likely to clearly characterize radon hazards.

## 2.3 Testing Devices

### 2.3.1 Approved test devices required

All test devices used for deciding if mitigation is warranted shall be devices that are listed by one of the following authorities:

- a) As required by local jurisdictions that have a program for evaluating and approving devices; or
- b) A national certification or listing program, such as the National Radon Proficiency Program (NRPP), the National Radon Safety Board (NRSB), or an equivalent program that verifies device compliance with the latest publication of ANSI/AARST MS-PC (Performance Specifications for Instrumentation Systems Designed to Measure Radon Gas in Air).

Note—Identification of two existing bodies that have a program for evaluating and listing devices that meet specified quality requirements is not an endorsement of either program.

### 2.3.2 Test device instructions and appropriateness

Test devices are to be used in compliance with both this standard and instructions provided by the manufacturer that relate to device-specific needs.

Note—It is important to choose devices that are designed for conditions and duration of deployment.

### 2.3.3 Test device types (defined)

As applicable to requirements in this standard, the following definitions shall be used:

- a) "Passive devices" are those that collect a time-weighted average and do not provide hourly readings.
- b) "Continuous monitors" are monitors that can integrate, record, and produce reviewable readings in time increments of 1 hour, and can be recalibrated periodically. If a device is not capable of these functions or is not set to record readings each hour, then it is functioning as a passive device and is not considered a continuous monitor under this protocol.

Note—Section B of the attached MAH Companion Guidance provides descriptions of test devices.

## 2.4 Who Should Conduct the Test?

*Informative Advisory*—Homeowners are encouraged to test with either do-it-yourself home test kits or with a qualified radon measurement professional.

When testing in association with a real estate transaction, it is encouraged that testing be conducted by a qualified radon measurement professional.

## 2.5 Summary of Testing Procedures

Note—Testing begins with Short-Term testing under closed building conditions to quickly identify if a radon hazard is present. No less than two measurement data points are sought for mitigation decisions.

### 2.5.1 Test options

Testing is to be conducted in accordance with procedures required in either:

- a) **Table 5.2**—Time-sensitive testing protocol where a single testing event is used to quickly determine if mitigation is necessary. This protocol is for situations where mitigation decisions are needed relatively quickly, such as within several days or weeks; or
- b) **Table 5.3**—Extended testing protocol where an initial short-term test is followed by confirmatory short-term or long-term testing as needed. This protocol is for situations where an extended period for making a mitigation decision is available, such as several weeks or months, for repeated or longer tests.

Additional requirements and procedures are provided in **Section 5.4** for testing individual dwellings within a shared building and **Section 7.3** for post-mitigation testing.

## 3.0 CHOOSING A TEST LOCATION

### 3.1 Choosing a Floor or Level of a Home

#### 3.1.1 Time-sensitive testing protocol

A test is to be conducted in the lowest level that could be occupied when quick results are needed. If the lowest level is not finished but could serve as a work area, playroom, or additional bedroom at some time in the future, then a test is to be conducted in this level of the home.

#### 3.1.2 Extended testing protocol

When there are no immediate time constraints, a test is to be conducted in the lowest level of the home that is occupied. If the lowest level serves as a work area, playroom or an additional bedroom, a test is to be conducted in this level of the home.

*Informative Advisory*—Tests conducted in areas above a basement can fail to characterize a radon hazard if heating systems are not active during the test. For this situation, it is best to test when the heating systems are active or in the lowest level that could be occupied.

#### 3.1.3 Additional test locations recommended

*Informative Advisory*—Additional test locations are encouraged.

Additional test locations are specifically recommended for:

- a) Each area that exceeds 2,000 square feet (189 m<sup>2</sup>) on the level of the home being tested;
- b) Each area of the home served by a different heating and cooling system; and
- c) Each unique foundation area. This recommendation includes split-level foundations or where slab-on-grade rooms attach to basement or crawl space areas. One test location may not be representative of radon concentrations in other areas of the home.

### 3.2 Choosing a Room

Note—It is best to choose test locations where people are more likely to spend time, such as a finished or occupied room when this choice exists. When this choice does not exist, then preferred choices are areas not currently used or finished but that could serve as a work area, playroom, or an additional bedroom at some time in the future.

### 3.3 Choosing a Location Within a Room

Detectors are to be placed in accordance with [Table 3.3](#).

Note—The intent is to test in the general breathing zone.

Table 3.3 Requirements for Test Locations Within a Room		
<b>Detectors shall be located NOT less than:</b>	<ul style="list-style-type: none"> <li>3 feet (90 cm) from exterior doors and windows or other potential openings to the outdoors.</li> </ul>	<p>No less than 3 Feet (90cm) 3 Feet (90cm) 20 Inches (50cm)</p>
	<ul style="list-style-type: none"> <li>20 inches (50 cm) above the floor.</li> <li>1 foot (30 cm) from the exterior wall of the building.</li> <li>1 foot (30 cm) below the ceiling.</li> <li>4 inches (10 cm) from other test detectors and objects or surfaces that are above or to the side of the detector.</li> </ul> <p>Exception: Less than 4 inches (10 cm) is permitted for detectors that are not affected by nearby proximity to other objects. Confirm manufacturer or laboratory requirements or recommendations prior to exercising this exception.</p>	<p>No less than 1 Foot (30cm) Exterior Walls 4 Inches (10cm)</p>
<b>Side-by-side detectors</b>	<p>Detectors are to be not more than 8 inches (20 cm) from each other when seeking to use the average test result of two side-by-side detectors for QC checks and mitigation decisions.</p>	<p>No more than 8 Inches (20cm)</p>
<b>Place detectors where not easily disturbed</b>	<p>Informative Advisory—Select a position within the room where the detector(s) will not likely be disturbed, moved, or have their performance altered during the measurement period.</p>	
<b>Detectors shall NOT be located:</b>	<ul style="list-style-type: none"> <li>inside closets, cabinets, sumps, crawl spaces or nooks within the building foundation.</li> <li>near heat sources, such as on appliances, radiators, fireplaces or in direct sunlight.</li> <li>near drafts caused by fans or heating and air conditioning vents or in enclosed areas of high air velocity such as mechanical/furnace closets.</li> <li>within enclosed areas of high humidity such as bathrooms, laundry rooms and kitchens that are isolated from large open areas by partitions or other enclosures.</li> </ul> <p>Exception: Such locations should be avoided but are permitted for detector types that are virtually unaffected by high humidity. Confirm manufacturer or laboratory requirements or recommendations prior to exercising this exception.</p> <p>Informative Advisory—Avoid placing detectors on or near objects that may produce radiation such as natural stone (e.g., rock collections, granite counter tops, hearths, or slate pool tables).</p>	

## 4.0 TEST CONDITIONS REQUIRED

### 4.1 Closed-Building Protocol Requirements

Closed-building conditions, as they are for occupied conditions in winter heating seasons or summer cooling seasons, are required when short-term test results are used for mitigation decisions. Closed-building conditions in accordance with **Tables 4-A, 4-B** and **Exhibit 1** are required to be:

- a) initiated 12 hours prior to the test for tests lasting less than 72 hours; and
- b) maintained throughout the test period for tests lasting 2 to 90 days.

<b>Table 4-A ESSENTIAL CLOSED-BUILDING PROTOCOL REQUIREMENTS</b>	
Windows	Keep closed on all levels of the building including areas not being tested
Exterior doors (except for momentary entry and exit)	
Heating and cooling systems	Set to normal occupied operating conditions with temperature settings between 65° and 80° F (18° - 27° C)
Systems that temporarily ventilate with outdoor air for seasonal comfort or energy savings	Set to the lowest seasonal ventilation
Whole-house fans	Do not operate
Fireplaces (that burn solid, liquid or gas fuels unless a primary/normal source of heat for the building)	
Clothes dryers, range hoods and bathroom fans	Avoid excessive operation
Required building operation also includes components itemized for clarification in Exhibit 1	

Note 1—**Exhibit 1** provides additional clarification on closed-building requirements for specific components

Note 2—**Section C** of the attached MAH Companion Guidance provides descriptions of ventilation systems.

<b>Table 4-B ADDITIONAL REQUIREMENTS FOR NEW CONSTRUCTION, RENOVATIONS AND REPAIRS</b>	
All openings to the exterior (due to incomplete construction, structural defect, or disrepair)	These opening to the exterior shall be closed or sealed at least 12 hours prior to initiating the test
Heating/cooling systems active and set to a normal occupied temperature	
All windows and exterior doors installed with hardware and seals	
All insulation and exterior siding	
All wall and ceiling coverings to be completed including interior drywall or paneling; does not include decorative finishing of walls, floors, or ceilings	
All fireplaces and fireplace dampers installed	
These items shall be completed or installed at least 12 hours prior to initiating the test	



## 5.0 TESTING PROCEDURES AND OPTIONS

### 5.1 Detector Deployment Periods

#### 5.1.1 Test Phase

When testing more than one location, all areas and levels of the home being tested shall be tested such that the testing periods overlap by a minimum of 46 hours.

Note—Be it the initial testing phase, follow-up, or post-mitigation testing, comparing test results taken at the same time in different locations can be critical for confidence in reliable testing.

#### 5.1.2 Short-Term testing

While deployment periods should optimally collect at least 48 hours of valid sampling time, deployment periods are required to be not less than 46 hours. For test durations of 2 to 90 days, testing is to be conducted under closed-building protocol conditions in accordance with [Section 4](#).

Note—If a short-term test is longer than 2 days, it is best to terminate the test at a 24-hour increment from when the test was started to account for day-to-night fluctuations in radon entry.

#### 5.1.3 Long-Term testing

For test durations greater than 90 days, closed-building conditions are not required.

However, if the goal of the long-term testing is to more closely evaluate annual exposures to radon in a home, then the test period duration is to include heating season conditions that are not less than the percentage of the year when heating systems are active.

Note—If the heating season occurs for 50% of the year, then at least half the long-term test would be conducted during the heating season. Test durations that are longer than 7 days, such as 30-day or 60-day tests can serve to reduce the chance that short-lived temporary conditions adversely influence test results. However, seasonal variations in weather and resulting building operation can be significant influence on test results in many climate regions.

### 5.2 The Time-Sensitive Testing Protocol

Note—This protocol builds upon protocols developed by EPA relative to EPA’s “Home Buyer’s and Seller’s Guide to Radon”.

<b>Table 5.2 Time-Sensitive Testing Protocol (Required Procedure and Summary)</b>	
<b>Step 1 Options</b>	<i>Simultaneous Testing</i> Tests are to be conducted using two short-term test devices at the same time in the same location, 4 to 8 inches (10-20 cm) apart.
	<i>Continuous Monitor</i> Tests are to be conducted using a monitor that records retrievable hourly measurements.
<b>Step 2</b>	<b>Decisions to Fix the Building</b>
	Mitigation decisions are to be based on the average result from a continuous monitor or the average of two test results conducted at the same time in the same location. <sup>1</sup>
	<b>Fix the building</b> if test results meet or exceed the action level, e.g., 4 pCi/L. Consider fixing the building if results are greater than half the action level, e.g., between 2 and 4 pCi/L.
<sup>1</sup> Note—If two short-term test results disagree in terms of making a mitigation decision, see <a href="#">Section 7.2</a>	

### 5.3 The Extended Testing Protocol

Note—This protocol builds upon protocols developed by EPA relative to EPA’s “A Citizen’s Guide to Radon.”

<b>Table 5.3 Extended Testing Protocol (Required Procedure and Summary)</b>	
Step 1	<i>Single Short-Term Test</i> Testing is conducted using a short-term detector at each test location.
Step 2	<i>Retest</i> locations where the initial short-term tests meet or exceed the action level, e.g., 4 pCi/L. If the first short-term test is twice the action level or greater, a second short-term test is to be conducted without delay. <sup>1</sup>
	If the first short-term test exceeds the action level but is less than twice the action level, either a second short-term test or a long-term test is to be conducted.
Step 3	<b>Decisions to Fix the Building</b> Mitigation decisions are to be based on the long-term test results or the average of the two short-term test results. <sup>2</sup> <b>Fix the building</b> if test results meet or exceed the action level, e.g., 4 pCi/L. Consider fixing the building if results are greater than half the action level, e.g., between 2 and 4 pCi/L.
<sup>1</sup> Note—While decisions to mitigate at any time are not prohibited, the second test aids confidence that decisions are not being made based on a faulty test device or unexpected conditions	
<sup>2</sup> Note—If two short-term test results disagree in terms of making a mitigation decision, see <a href="#">Section 7.2</a>	

### 5.4 Shared Building Testing

#### 5.4.1 Testing individual dwellings within a shared building

When testing only one or several dwellings that are part of a shared building and there are dwellings or occupied units above or below the dwelling(s) to be tested, closed-building protocol conditions are required for all portions of the building, including dwellings above and below the tested dwelling(s).

**Exception**—Testing is permitted if closed-building conditions in other dwellings are not achieved when it is beyond the control of the person(s) conducting the test. However, this situation requires that the conditions, circumstances, and appropriate recommendations are described in writing for inclusion with reports when distributed.

Note—It is best to choose test periods when closed-building conditions exist for the whole building.

#### 5.4.2 Use the appropriate testing standard

Testing is to be conducted in accordance ANSI/AARST MA-MALB (Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily, School, Commercial and Mixed-Use Buildings) in addition to, or as otherwise required by, local statutes:

- a) Where the purpose of testing is to assess radon hazards for an entire shared building or a sizable portion of a shared building, and
- b) Where heating and cooling systems add outdoor air ventilation to a shared residential building or where a single air handler distributes air to multiple dwellings.

## 6.0 CONDUCTING THE TEST

### 6.1 Verify Compliance with Required Test Conditions

#### 6.1.1 *Where closed-building conditions cannot be maintained during the test*

Short-term tests are not to be conducted if closed building conditions in accordance with **Section 4** cannot be maintained across the test period.

#### 6.1.2 *Where closed-building conditions did not occur prior to the test*

If closed-building conditions were not maintained for 12 hours prior to deployment, the radon test is to be conducted with one of the following options:

- a) The radon test is postponed until at least 12 hours of closed-building conditions have been maintained prior to initiating the test; or
- b) The test period extends not less than 72 hours after closed-building conditions are initiated; or
- c) The test period is extended if testing with a continuous monitor. For this option, device features or other methods are to be employed to obtain an average reading that represents no less than 46 hours of contiguous data collected after 12 hours of closed-building conditions have been maintained.

Informative advisory—When temporary or unexpected conditions are encountered that might adversely influence test results, it is recommended to take action to circumvent adverse influences on the test result. **Section 8.5.5** includes descriptions of such concerns that, if not resolvable when conducting the test, often result in invalidating the test.

#### 6.1.3 *Where closed-building conditions might pose a health hazard to occupants*

If closed conditions are observed to pose a health hazard, occupants shall not be placed in harm's way.

Note—If closed conditions are observed to pose a health hazard, radon testing should not be conducted and should be rescheduled for a time when conditions are safe. For example, hot weather can pose a health hazard for buildings that have no cooling system or have evaporative cooling systems where, to meet protocol, must be deactivated and closed. Test results conducted when safe conditions require ventilation with outdoor air do not provide reliable information for deciding if mitigation is needed.

## 7.0 ACTIONS BASED ON TEST RESULTS

### 7.1 Action Level Guidance

Countries worldwide have adopted Action Levels for radon exposures. Most are similar to the 4 pCi/L (150 Bq/m<sup>3</sup>) action level recommended in the United States. The action level observed should comply with the guidance of the country, state, or other local jurisdiction of authority where the test is being conducted.

U.S. Action Level. The following Action Level descriptions reflect guidance from the United States Environmental Protection Agency (EPA):

- 4 pCi/L or greater ( $\geq 150$  Bq/m<sup>3</sup>)

Fix the home. The higher the radon concentration, the more quickly action should be taken to reduce the concentrations.

- Below 4 pCi/L ( $< 150$  Bq/m<sup>3</sup>)

Consider fixing the building if test results indicate that radon concentrations are greater than half the action level, such as between 2 and 4 pCi/L (75 and 150 Bq/m<sup>3</sup>)

Because the hazards from radon are virtually the same for radon concentrations that are near action level thresholds, the World Health Organization recommends limiting long-term exposures to less than 2.7 pCi/L (100 Bq/m<sup>3</sup>).

When measurements indicate concentrations lower than about 2.0 pCi/L (75 Bq/m<sup>3</sup>), test data should normally be interpreted as being lower than the test device can accurately measure.

### 7.2 When Two Test Results Disagree

#### 7.2.1 Acceptable difference

When two test devices were deployed to test the same testing location, the average of the two test results is to be used for determining needs for mitigation if:

- a) both test results are above the action level, or
- b) both test results are below the action level.

Note—Some variation between detector results is typical. However, if the variation between collocated (side-by-side) detectors is unusually large, it might indicate problems in the measurement system.

#### 7.2.2 Where test results disagree on exceeding the action level

When one test result is above the action level and the other test result is below the action level:

- a) Acceptable Difference

If the higher result is less than twice the lower result, the average of the test results is to be used to determine if this location needs mitigation.

- b) Not Acceptable

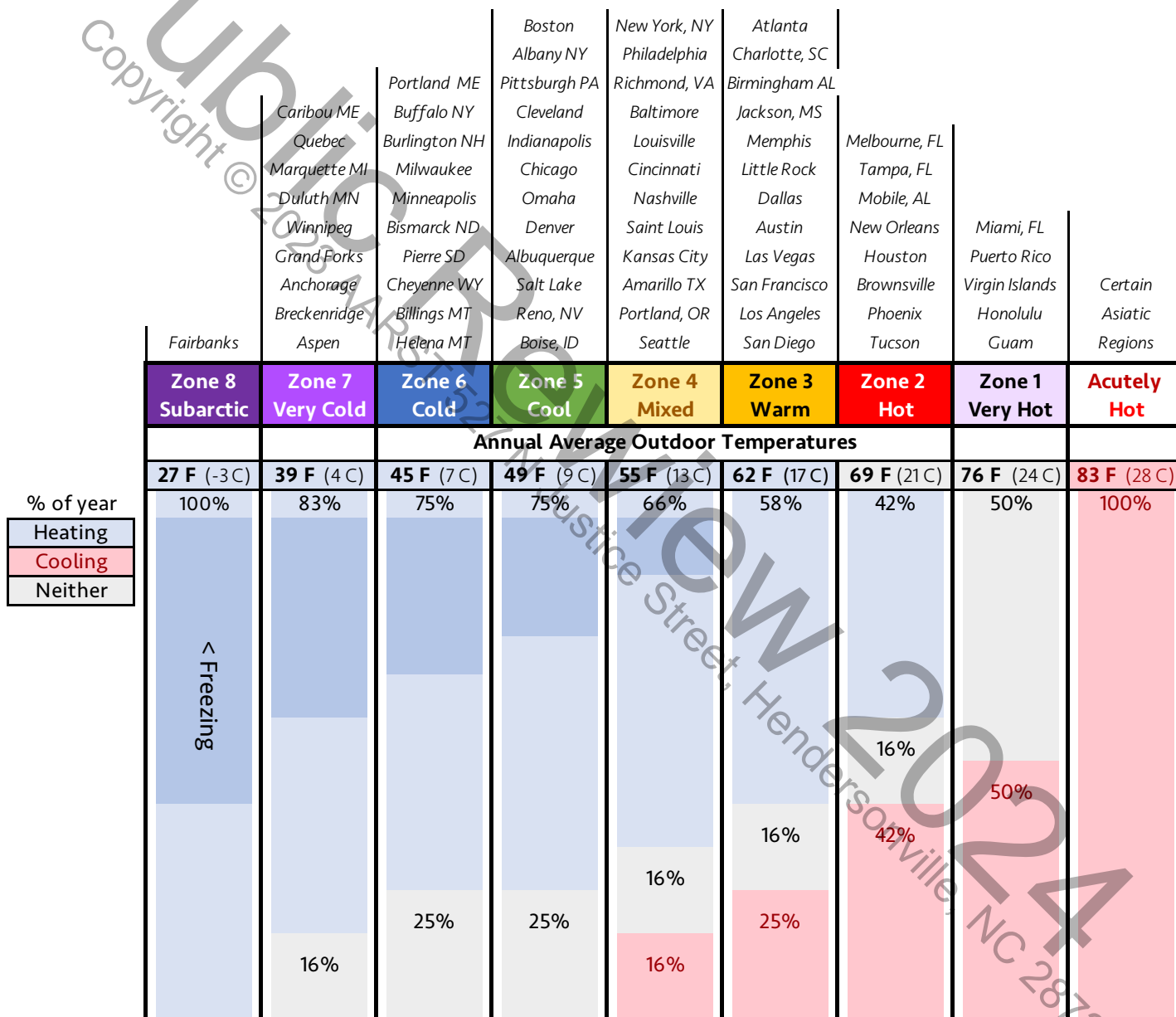
If the higher test result is more than twice the lower test result:

1. For two collocated (side-by-side) tests conducted at the same time, a repeated collocated test for this location is required.
2. For two short-term detectors deployed at different times in the same location, obtaining confirmation on whether mitigation is warranted requires additional testing unless it is decided to proceed with mitigation.

This degree of uncertainty requires a precautionary stance to include that the higher test result shall be regarded as correct for making mitigation decisions unless further testing indicates otherwise. Test results to be regarded as a more representative reflection of occupant exposure to radon hazards shall be those that most closely align to the predominant normal occupied building operating condition for the location tested, as defined in **Table 7.2.2 b**.

**Table 7.2.2 b Annual Average Building Operating Conditions**

This table provides annual average outdoor temperatures for various climate zones and the building conditions, in terms of heating and cooling system activity, that occur in response to these outdoor temperatures.



Climate zone temperatures based 30-year averages published online (e.g., the National Centers for Environmental Information-NOAA) for a major city located within each climate zone. Zone classifications reflect ASHRAE (The American Society of Heating, Refrigerating and Air-Conditioning Engineers) standards 90.1 / 90.2. For additional information, visit [www.ashrae.org](http://www.ashrae.org).

### 7.3 Post-Mitigation Testing Protocol

The following procedures are required for determining if additional mitigation efforts are warranted.

#### 7.3.1 New construction

Buildings constructed with radon-resistant features that have not been activated with a fan are to be tested in accordance with one of the testing strategies specified in [Section 5](#). Where radon resistant features include a fan activated system, compliance with [Section 7.3.2](#) and [7.3.3](#) is required.

#### 7.3.2 Testing to confirm mitigation effectiveness

One or more short-term test devices are to be deployed to evaluate the initial effectiveness of the mitigation efforts. These short-term measurements are to be conducted no sooner than 24 hours after activation of a mitigation system fan or completion of other mitigation efforts. In addition, closed-building conditions, in accordance with [Section 4](#), are to be maintained 12 hours prior to short-term test periods and throughout the test.

Testing is to be either:

- a) postponed until both conditions are met, or
- b) extended if testing with a continuous monitor where device features or other methods are to be used to obtain an average reading that represents no less than 46 hours of contiguous data collected after both conditions are met.

#### 7.3.3 Where to retest after mitigation

Testing is to be conducted in the same location(s) as the pre-mitigation test(s) or in the lowest level that could be occupied to help ensure the safety of current and future occupants who may use these areas.

In addition, a post-mitigation test is to be conducted in the lowest livable area above any crawl space that is structurally isolated from occupiable or tested rooms.

Informative Advisory—When an ASD system exhausts below the roof, it is recommended to conduct an additional test in the room(s) immediately adjoining the outside exhaust location.

## 8.0 ADDITIONAL PROTOCOLS FOR PROFESSIONAL SERVICES

### 8.1 Qualified Measurement Services

To be considered qualified for conducting measurement services in homes, the person(s) or team, regardless of business organizational structure, shall operate under a quality assurance plan that includes the following requirements for quality of personnel and practices:

- a) Operations shall be conducted under the responsible charge of a qualified measurement professional;
- b) Individuals who place and retrieve radon measurement devices shall be qualified for their apportioned task, as permitted by statute, state licensure or certification program; and
- c) Individuals deemed qualified to place, retrieve, and analyze data obtained from radon measurement devices shall be qualified measurement professionals.

#### 8.1.1 Qualified Measurement Professionals (definition)

A “Qualified Measurement Professional” is defined as: “An individual that has demonstrated a minimum degree of appropriate technical knowledge and skills sufficient to place, retrieve and analyze (as applicable) radon detectors and to implement quality procedures when conducting radon measurements in homes as established by certification requirements of:

- a) a national program that is compliant with requirements in [Appendix A](#); or

- b) as required by statute, state licensure or certification program, where applicable, for licensure or certification programs that evaluate individuals for radon-specific technical knowledge and skills.”

### 8.1.2 QA plans are required

Any person or entity providing radon measurement services shall establish, maintain, and follow a quality assurance program reflective of national requirements such as found in the ANSI/AARST MS-QA (Radon Measurement Systems Quality Assurance). The quality assurance program shall include written procedures and ongoing evidence for meeting quality assurance objectives that, among other things, include a system to record and monitor:

- a) results of quality control check measurements,
- b) training and qualifications of staff, and
- c) protocol compliance and chain of custody.

Note—Section B of the attached MAH Companion Guidance provides descriptions of quality control check measurements.

### 8.2 Measurement Strategy for Home Sales

For tests conducted during a home sale, testing strategies outlined in Section 5.2 for Time-Sensitive Testing are required in addition to, or as required by local statutes where applicable.

### 8.3 Prior Notification

Because failure to comply with required conditions often occurs when residents are not properly informed about the necessary test conditions, procedures for notification shall comply with requirements in a), b) and c) of this Section 8.3.

- a) Responsible notification includes determining whether the building is new, occupied, and who will be responsible for closed-building conditions prior to and during the measurement period;
- b) Information about required test conditions shall be communicated when practicable and documented to the person responsible for the home prior to the 12-hour closed-building requirement; and
- c) Communications to clients or parties responsible for the property shall include essential elements required for compliance with closed-building protocols.

Note—Exhibit 2 provides an example of a written notice that complies with this requirement.

### 8.4 Minimum Requirements for Efforts to Verify Test Conditions

To fulfill minimum requirements for verifying test conditions, all of the following steps are required:

- a) Inform the person responsible for building operation of the required test conditions.
- b) Post notification of a Radon Test in Progress in conspicuous locations stating the required conditions of the test.

Note—Exhibit 4 provides an example door hanger notice that complies with this requirement.

- c) Request a signature on a noninterference agreement and note in the report if this document was not signed.

Note—Exhibit 3 provides an example of a written notice that complies with this requirement.

- d) Conduct visual inspections.

Visual inspections of the dwelling that evaluate observed conditions and document deviations from protocol and temporary conditions that might affect the test result shall be conducted by a qualified measurement professional:

1. upon detector placement to help ensure all closed-building conditions and other protocol requirements are met; and

2. upon detector retrieval of the detector(s) to help verify that:
  - a. closed-building conditions and other protocol requirements are still being maintained;
  - b. detector placement has not changed; and
  - c. tamper seals, if employed, have not been broken.

Note—It is recommended that tests include methods to prevent or attempt to detect interference with testing conditions or the testing detector.

#### 8.4.1 *Surveillance not required*

It is not required to inspect for closed-building conditions during the 12-hour period prior to the test or between placement and retrieval of the detectors.

### 8.5 **Test Reports**

#### 8.5.1 *Essential information*

The following essential information shall be included in reports:

- a) The complete address of the building measured;
- b) Name of the company, contact information, and identification of the measurement professional responsible for adherence to protocols and their current certification numbers or equivalent state certification numbers as applicable; and
- c) Radon Information Sources. The report is to include contact information of the State Radon Office or other local authority for where the test is conducted and information for obtaining federal or state guidance documents.

#### 8.5.2 *Measurement results*

Test reports shall comply with all of the following requirements.

- a) The test report shall contain the result for each measurement location. The report shall also include:
  1. the detector model or type, the detector serial number(s) and the name and identification number of the service or organization used to analyze detectors; and
  2. the beginning and ending dates and times of the exposure period and information on the detector locations such as a diagram, photos, or narrative description.
- b) Radon gas results reported in picocuries per liter (pCi/L) shall be reported to only one digit after the decimal (e.g., 3.2 pCi/L). If the average of two measurements produces a result of  $\geq 3.95$  pCi/L, standard mathematical rules should be followed, and such average shall be reported as 4.0 pCi/L.
- c) The average of collocated measurement detectors shall be reported as well as the individual results.
- d) Measurements made in separate locations shall not be averaged. Detectors located more than 8 inches (20 cm) apart shall be reported individually as separate locations.

#### 8.5.3 *Continuous monitors reports*

Additional requirements for continuous radon monitor test results include:

- a) hourly data shall either be included in the test report or provided to the client upon request;
- b) the calibration date of continuous monitor(s) shall be included on the test report; and
- c) removal of portions of hourly data imbedded within the contiguous sampling period reported (such as to account for weather or other conditions) shall invalidate the measurement.

Exceptions:

1. The first 4 hours of data are to be discarded or incorporated into the result using system correction factors (EPA 402-R-92-004, EPA 1992);



2. The first 12 or more hours are to be discarded in reported results as required for meeting closed-building requirements in **Sections 4, 6.1.2 and 7.3.2 b**; and
3. The first 24 or more hours are to be discarded in reported results as required in **Section 7.3.2 b** after activation of a mitigation system fan or completion of other mitigation efforts, for evaluation of post-mitigation effectiveness.

**8.5.4 Reliability of the measurements**

A specific client advisory and description shall be included in the test report of observed building conditions or other factors that may cause the test to not reflect the client’s risk from radon.

**8.5.5 Quality control of test conditions**

Quality control records when testing homes shall include records of observed test conditions, as specified in **Table 8.5.5**. These test event records shall be either included in the test report or provided to the client upon request.

<b>Table 8.5.5 Quality Control Records / Test Conditions</b>	<i>Example Test Event Log</i>
<b>8.5.5.1 Temporary Conditions</b>	
1. The home was vacant and not operated under occupied operating conditions;	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
2. Systems were temporarily ventilating with outdoor air for seasonal comfort or energy savings during the test period, including:	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
a. Closable passive crawl space vents that were open during the test but would be closed more than 50% of the year for energy savings, comfort or to prevent frozen pipes;	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
b. Window air conditioners did not have closed outside air dampers,	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
c. Evaporative cooling systems were operating or not covered,	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
d. Energy recovery ventilators, heat recovery ventilators or economizer ventilation systems: – the system was not set to the lowest outdoor air ventilation rate that occurs during all seasons. – not all thermostats in areas served by these systems were set to normal occupiable temperatures;	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U  <input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U  <input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
3. Sub-slab return ducts were observed; and	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
4. Weather events occurred that were unusually severe for local weather.	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
<b>8.5.5.2 Deviations from Protocol</b>	
1. Observed noncompliance with required conditions, such as closed-building conditions 12 hours prior to, or during the test period;	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
2. Observed deviation from a normal occupiable indoor temperature; and	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
3. Noninterference controls indicate concerns regarding protocol compliance. Note—Non-interference controls can include signed noninterference agreements, or refusal to sign such agreement, moved devices and observed anomalies in data, such as in hourly CRM data.	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> NA <input type="checkbox"/> U
<b>8.5.5.3 Other:</b>	<i>Specify</i>

*Note—For this example method of logging observed conditions: Y=yes, N=no, NA=not applicable and U=unknown.*

**8.5.6 Report radon mitigation system status (if applicable)**

Where a mitigation system or efforts to mitigate radon are observed, the test report shall include:

- a) a statement that a mitigation system was observed and whether it appeared to be operating.
- b) a statement regarding the condition of any temporary radon mitigation strategies that are not permanent installations, and
- c) a statement on the limits of the inspection. Providing a statement in the report that the test company offers no findings as to the proper installation and operation of the mitigation system is permitted.

Note—Section A of the attached MAH Companion Guidance provides general inspection considerations for radon mitigation systems.

**8.5.7 Opinions and interpretations**

When opinions and interpretations are included, the basis upon which the opinions and interpretations have been made shall be included in test reports. Opinions and interpretations shall be clearly marked as such in a test report. Health and action level guidance provided in equivalent statements or otherwise furnished are to be consistent with federal guidance or as required by the state or other jurisdiction of authority where the test is being conducted.

**8.5.8 Report recommended actions**

The test report shall include equivalent statements for each of the guidance advisories shown in the Tables 8-A and 8-B that apply to the test results.

Note—An example of an appropriate equivalent message:

*“The radon measurement indicates that occupants may be exposed to radon concentrations that meet or exceed the EPA action level of 4 pCi/L. It is recommended to fix the building.”*

<b>Table 8-A Reporting Elevated Radon Concentrations</b>	
EQUIVALENT STATEMENTS FOR THESE ADVISORIES SHALL BE INCLUDED IN THE REPORT	
<ul style="list-style-type: none"> <li>• Fix the building. Test results indicate occupants may be exposed to radon concentrations that meet or exceed the action level, e.g., 4 pCi/L or greater.</li> <li>• Efforts to reduce radon concentrations are not complete until retests provide evidence of effectiveness.                             <ul style="list-style-type: none"> <li>— Initiate short-term radon testing no sooner than 24 hours after a mitigation system is operational and within 30 days after installation of the system(s).</li> <li>— Test again at least every 2 years to ensure that the system remains effective.</li> </ul> </li> </ul>	<p style="text-align: center;"><i>If tested with only a single short-term passive detector</i></p> <ul style="list-style-type: none"> <li>• If this test is a first test conducted using a single short-term passive detector, test this location again.                             <ul style="list-style-type: none"> <li>- If the first short-term test is more than twice the action level (e.g., 8 pCi/L or more): conduct a second short-term test immediately. While decisions to mitigate at any time are not prohibited, the second test aids confidence that decisions are not being made based on a faulty test result.</li> <li>- If the first short-term test is less than twice the action level (e.g., 4 to 8 pCi/L) conduct either a short-term or a long-term test.</li> </ul> </li> <li>• If the average of two short-term tests or the average of a long-term test meets or exceeds the action level (e.g., 4 pCi/L or greater), fix the building. *</li> </ul>

Table 8-B	<b>Reporting Low Concentrations</b>
EQUIVALENT STATEMENTS FOR THESE ADVISORIES SHALL BE INCLUDED IN THE REPORT	
<ul style="list-style-type: none"> <li>• Consider fixing the building if test results indicate radon concentrations greater than half the action level, (e.g., between 2 and 4 pCi/L).</li> <li>• Note that tests conducted when heating systems are active both day and night are more likely to provide a clear characterization of potential radon hazards. †</li> </ul>	
<i>Advisories required regarding continued protection against long-term exposure to a radon hazard</i>	
<ul style="list-style-type: none"> <li>• Retest the building at least every 5 years or, to verify continued effectiveness of radon mitigation systems or efforts, at least every 2 years.</li> <li>• Retest in conjunction with any sale of new or existing buildings.</li> <li>• In addition, be certain to test again when any of the following circumstances occur: <ul style="list-style-type: none"> <li>✓ a new addition is constructed or alterations for building reconfiguration or rehabilitation occur;</li> <li>✓ a ground contact area not previously tested is occupied, or a home is newly occupied;</li> <li>✓ heating or cooling systems are significantly altered, resulting in changes to air pressures or pressure relationships;</li> <li>✓ ventilation is significantly altered by extensive weatherization, changes to mechanical systems or comparable procedures;</li> <li>✓ significant openings to soil occur due to: <ul style="list-style-type: none"> <li>– groundwater or slab surface water control systems that are altered or added (e.g., sumps, perimeter drain tile, shower/tub retrofits, etc.) or,</li> <li>– natural settlement causing major cracks to develop;</li> </ul> </li> <li>✓ earthquakes, construction blasting, fracking, or formation of sink holes nearby; or</li> <li>✓ a mitigation system is altered, modified or repaired.</li> </ul> </li> </ul>	

† Note—Where appropriate, recommendations can include retesting within a year during a time that more closely aligns with the predominant normal occupied building operating condition, as described in informational [Table 7.2.2 b](#). Recommendations can further include guidance on test durations for such testing that are longer than 7 days.

#### 8.5.8.1 *Additional report advisories*

Informative Advisory—Additional advisories are recommended when observations suggest the possibility of higher concentrations under different test conditions. Examples include:

- Observance of Non-ASD passive, pressurization, or dilution mitigation methods  
“Within the first year after mitigation efforts, repeat post-mitigation testing procedures to verify that effectiveness is retained for both the heating season and the cooling season.”
- Observance of geologic considerations for the region (e.g., Karst)  
“Confirming low test results by repeating tests during different seasons and weather conditions or with long-term testing can be especially important for certain geological regions.”

### 8.5.9 Statement of Test Limitations

Informative Advisory—The report should describe the general limitations of the test. An example is the following: “There is an uncertainty with any measurement result due to statistical variations and other factors such as daily and seasonal variations in radon concentrations. Variations may be due to changes in the weather, operation of the dwelling, or possible interference with the necessary test conditions.”

### 8.6 Maintaining Records

Measurement reports shall be kept for a minimum of 6 years or as additionally required by the jurisdiction where the test is conducted.

## 9.0 RADON DECAY PRODUCT MEASUREMENTS (RDP)

### 9.1 Professional Training Is Required

The use of RDP measurement devices requires specific training to properly account for a wide variety of site-specific conditions and technology considerations. Individuals placing, retrieving, and analyzing RDP detectors shall have demonstrated a minimum degree of appropriate technical knowledge and skills specific to RDP measurement as established in certification requirements of:

- a) a national program that is compliant with requirements in **Appendix A**; or
- b) as required by statute, state licensure or certification program, where applicable, for licensure or certification programs that evaluate individuals for radon-specific technical knowledge and skills.

### 9.2 Units of Measurement and Action Level

When radon decay products are measured, the unit of measurement provided by devices is to be in Working Level (WL).

Note—Historically the action level has been cited as 0.02 WL. **Section D** of the attached MAH Companion Guidance provides more descriptive information.

### 9.3 Gas Measurement Also Required

When the test is for determining the need for mitigation in homes, RDP measurement devices shall not be used unless accompanied with a simultaneous radon gas measurement.

### 9.4 Reporting Requirements

#### 9.4.1 Conventions

RDP results shall be reported to no more than three figures after the decimal (e.g. 0.012 WL).

#### 9.4.2 Conversions

Conversions shall not be made between measurements of radon gas (pCi/L or Bq/m<sup>3</sup>) and measurements of radon decay products (WL) for determining if mitigation is needed.

#### 9.4.3 Recommended Actions

Both radon gas and RDP measurements shall be reported along with reference to their respective action levels and recommended actions (in accordance with **Section 8.5**) that apply collectively or individually to each measurement.

#### 9.4.4 Report on conditions

In addition to all other requirements in **Section 8.0**, the report shall include a listing of all items from **Exhibit 5** and the condition of each during the test.

#### 9.4.5 Special Situation

If one collocated measurement (either radon gas or RDP) meets or exceeds the action level, and the other does not, the following options are permitted:

## Professional Services

- a) Further interpretation is not required in the report.
- b) Interpretations.

When an interpretation is requested or reported regarding such a discrepancy relative to decisions to mitigate, reports shall include an assessment of test conditions observed in **Exhibit 5**, or as determined by more thorough investigation. The assessment shall evaluate characteristics of the building that can affect RDP concentrations and, at a minimum, identify both:

1. characteristics of the specific building as they might be expected to either increase or decrease suspended RDP concentrations; and
2. the degree to which such characteristics are either temporary in duration or reasonably stable conditions for that building.

Note—**Section D** of the attached MAH Companion Guidance provides a table that discusses activities and conditions that can influence radon decay product test results.

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## 10.0 DEFINITION OF TERMS

10.1	<b>Action Level</b>	A threshold for when mitigation of exposure to harmful elements is recommended or required.
10.2	<b>Becquerel per Cubic Meter (Bq/m<sup>3</sup>)</b>	A unit of radioactivity representing one disintegration per second per cubic meter: 1 Bq/m <sup>3</sup> (0.027 pCi/L).
10.3	<b>Blank Measurements</b>	Blanks are detectors deployed to verify and document the absence of effects on the measurement resulting from sources other than the air being tested. Since blanks are not exposed (i.e., not left open to permit radon to enter the detector), their measurement value should be below the minimum detectable concentration of the measurement system.
10.5	<b>Client</b>	The individual(s) or parties who hire(s) or pay(s) for radon test services.
10.6	<b>Collocated</b>	Two or more simultaneous measurements in the same location, or side-by-side.
10.7	<b>Continuous Radon Monitor (CRM)</b>	A CRM is an electronic device that is capable of automatically recording a retrievable time series of numeric measurements of radon concentration averaged over time intervals of 1 hour or less.
10.8	<b>Crawl Space</b>	An open area beneath part or all of the livable space of a dwelling that typically has either a concrete slab or dirt floor. The dirt floor may be covered with gravel or a membrane. The crawl space can have an open height of a few inches to several feet. The crawl space can be storage space but is not living space.
10.9	<b>Duplicates and Comparison Checks</b>	Duplicates and comparison checks are pairs of detectors or monitors deployed in the same location, side by side for the same measurement period. Their purpose of is to evaluate precision or agreement between detectors.
10.11	<b>Extended Testing</b>	An initial short-term test which, if a radon concentration is found to be elevated, is followed by a short- or long-term test. The decision to mitigate is based on the average of two short-term tests or the result of the long-term test.
10.12	<b>Karst</b>	A landscape that is characterized by numerous caves, sinkholes, fissures, and underground streams. Karst topography usually forms in regions of plentiful rainfall where bedrock consists of carbonate-rich rock, such as limestone, gypsum, or dolomite, that is easily dissolved.
10.13	<b>Mitigation</b>	Efforts to reduce radon concentrations in the indoor air of a building.
10.14	<b>Mitigation System</b>	A system designed to reduce radon concentrations in the indoor air of a building.
10.15	<b>Normal Occupiable Temperatures</b>	Indoor temperatures of between 65° and 80° F (18° - 27° C).
10.16	<b>Passive Device</b>	Radon measurement detectors or systems that collect a time-weighted average and do not provide hourly readings. Passive detectors include electret ion chambers; activated charcoal kits; liquid scintillation vials; alpha-track detectors; and continuous monitoring devices that are not set to or capable of automatically recording a retrievable series of 1-hour measurements.
10.17	<b>Picocurie per Liter (pCi/L)</b>	A unit of concentration of radioactivity corresponding to 0.037 decays per second or 2.22 decays per minute in a liter of air or water. 1 pCi/L = 37 becquerels per cubic meter (Bq/m <sup>3</sup> ).
10.18	<b>Qualified Measurement Professional (Homes)</b>	As defined in Section 8.1.1.

## Definition of Terms

- 10.19 **Quality Assurance (QA)** A complete program designed to produce results that are valid; scientifically defensible; and of known precision, bias, and accuracy, including planning, documentation, and quality control activities.
- 10.20 **Quality Control (QC)** The system of activities to ensure a quality product, including measurements made to ensure and monitor data quality. This includes calibrations and background, duplicate, blank and spiked measurements; inter-laboratory comparisons; audits; and other control activities.
- 10.21 **Radon (Rn)** A colorless, odorless, naturally occurring, radioactive, inert, gaseous element formed by radioactive decay of radium (Ra-226) atoms. The atomic number is 86. Although other isotopes of radon occur in nature, in this document, radon refers to the gas Rn-222.
- 10.22 **Radon Decay Products (RDP)** Often termed "radon progeny," each radon atom after emitting an alpha particle transforms to become different radioactive elements in a series where the short-lived decay products of radon (Po-218 and Po-214) also emit alpha particles as they decay. These decay products are solid elements rather than gaseous and are left suspended in the air we breathe.
- 10.23 **Radon Test Detector** The element of a radon measurement device or system that detects radon. The detector may be a separate component from the analysis equipment such as for many passive radon measurement systems or may be housed within a device that functions as a combined detector and analysis instrument.
- 10.24 **Radon Test Device** A radon measurement system regardless if configured as a combined detector and analysis instrument or as a system where detectors and analysis equipment are separate components.
- 10.25 **Single-Family Dwelling** A residence or home intended to house a single family and requiring discrete testing location(s).
- 10.26 **Spiked Measurements** Spikes are detectors that have been exposed in an approved chamber to a known concentration of radon (i.e., "spiked" with radon). Spikes help evaluate the accuracy of a laboratory analysis and/or how accurately detectors supplied by a laboratory measure radon.
- 10.27 **Standard Operating Procedure** A written document that details an operation, analysis, or action whose mechanisms are prescribed thoroughly, and which is commonly accepted as the method for conducting certain routine or repetitive tasks.
- 10.28 **State Radon Office** An office established by a state government to provide information about radon and in some cases, to regulate radon activities in a manner as required by local statute.
- 10.29 **Test Interference** The altering of test conditions prior to or during a measurement to change the radon or radon decay product concentrations, or the altering of the performance of the measurement equipment.
- 10.30 **Time Sensitive Testing** A measurement strategy that involves a single phase of testing, requiring enhanced quality control measures. Time-sensitive tests include simultaneous and continuous monitor testing.
- 10.31 **Valid Sample Time** The period representing occupied conditions after stabilizing building conditions with initiation of the closed-building protocol. Examples of valid sampling times include: The period beginning 12 hours after closed-building protocols are initiated or 24 hours after activation of a radon mitigation system. Valid sampling time is further defined by all other related requirements within this standard

## Definition of Terms

including but not limited to maintenance of closed-building conditions throughout the test period for short-term testing.

- 10.32 **Whole House Fan** A fan that is temporarily activated to enhance occupant comfort by increasing ventilation for the majority of the heated and cooled envelope within a home. Common configurations include attic fans or window fans that exhaust air from the building to enhance the volume of outside air entering the home through open windows.
- 10.33 **Working Level (WL)** A unit of radon decay product concentration. One WL equals any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of  $1.3 \times 10^5$  MeV of potential-alpha energy. It is approximately the alpha-particle energy released from the decay products in equilibrium with 100 pCi of Rn-222.
- 10.34 **Working Level Month (WLM)** A unit of exposure to radon decay products or integrated radon decay product concentration. One WLM is equivalent to an exposure to a radon concentration of 1 WL for a period of 1 working month of 170 hours.



## NORMATIVE APPENDIX A

### National Certification/Listing Programs

For private sector certifications of qualified measurement professionals identified in [Section 8.1.1](#), this standard requires a national program that evaluates and lists qualified individuals, training courses and other products or services, such as laboratory services, integral to achieving public health goals intended by this standard. Programs meeting the purpose, need and requirements of this standard are those with policies as established in a), b) and c) of this [Appendix A](#).

- a) Programs with published policies that:
  1. require persons to undergo education and an impartial examination process prior to granting personal certification or certificates of educational achievement; and
  2. require surveillance of continued competence, not less than as demonstrated by continuing education on standards updates, compliance and other related technical knowledge and skills, prior to granting recertification or renewed certificates or listings; and
  3. require, for the certification of radon measurement laboratories, initial demonstration and scheduled ongoing surveillance of compliance with [ANSI/AARST MS-QA](#) (Radon Measurement Systems Quality Assurance).
- b) Programs that:
  1. have a written policy and means for receiving and adjudicating complaints against individuals or companies who have been granted a credential; and
  2. have publicly published educational and examination requirements for each credential or listing available online where readily accessible for consumers of credentialed services.
- c) Programs that include educational prerequisites as follow:
  1. **Qualified Radon Measurement Professional—Multifamily and Commercial**  
Listing or certification credentials granted that qualify individuals as proficient in placement, retrieval, and analysis (as applicable) of *radon* detectors and to design, plan, and implement quality procedures when conducting *radon* measurements in multifamily, school, commercial and mixed-use buildings are to include:
    - a. current certification as a qualified radon measurement professional in homes; and
    - b. additional education and processes approved by the program relative to tasks required in the most current version of this standard [ANSI/AARST MA-MFLB](#) (Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily, School, Commercial and Multi-Use Buildings) prior to granting this advanced level certification or listing and recertifications or relisting.
  2. **Qualified Radon Measurement Professional—Homes**  
Certifications granted that qualify individuals as proficient in conducting radon measurements in existing homes are to include:
    - a. no less than 16 hours education prior to granting certification that focuses on tasks required in [ANSI/AARST MAH](#) (Protocol for Conducting Measurements of Radon and Radon Decay Products in Homes); and
    - b. biennial recertifications after completing continuing education requirements and any other program surveillance activities.

## Normative Appendix A

Informative Note 1—The National Radon Proficiency Program (NRPP), the National Radon Safety Board (NRSB), or equivalent programs that also meet requirements of a), b) and c) of this normative **Appendix A** meet the requirements of this standard.

Note that identification of existing certification bodies is not an endorsement of their programs.

Informative Note 2—The purpose of requirements in this **Appendix A** is to ensure contractors have an appropriate degree of technical, engineering, and scientific knowledge to protect occupants by providing reliable measurements of *radon gas* present in indoor air.

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**EXHIBIT 1**  
**ADDITIONAL CLARIFICATION ON CLOSED BUILDING PROTOCOL REQUIREMENTS**  
**FOR SPECIFIC COMPONENTS**

<b>Windows and Doors</b>	
Broken windows or doors	Seal closed
Interior partition or stairway doors	No special requirements
Doors leading into a garage	Keep closed (except for momentary entry and exit).
Garage doors	
Pet doors (includes flap openings)	
<b>Small Appliances</b>	
Ceiling fans and portable fans	Do not blow fans directly towards testing devices
Window fans	Remove or seal shut and do not operate
Humidifiers and dehumidifiers	Operate normally
Central vacuum cleaner systems	
<b>Crawl Spaces</b>	
Passive crawl space vents	The condition should reflect average yearlong operation
Crawl space humidity control systems	Operate normally
<b>Mechanical Systems</b>	
Passive vents for combustion air makeup	Leave open
Fireplace dampers	Close dampers or doors if practicable
Combustion appliance fans	Operate normally
Fans installed in attics to ventilate only attic air and not air within the building.	
Return air ducts from forced air heating and/or cooling systems are under concrete floors	Conduct at least one test when air handlers are active
<b>Mechanical Ventilation Systems</b> that can temporarily ventilate with outdoor air for seasonal comfort or energy savings	
Window air conditioners	Operate in recirculation mode only
Evaporative cooling systems (e.g., swamp coolers)	Do not operate and do not cover
Energy recovery or heat recovery ventilators	<p>Operation of permanently installed ventilation systems that bring outdoor air into the home throughout the year is permitted to continue during the test so long as:</p> <ol style="list-style-type: none"> <li>a) the system is set to the lowest ventilation condition that occurs for any season, and</li> <li>b) all thermostats in the building are set to normal occupiable temperatures.</li> </ol>

**EXHIBIT 2 a**  
**SAMPLE FORM: PRIOR NOTICE OF INSPECTION**



Dear \_\_\_\_\_

A radon test is scheduled for the property at \_\_\_\_\_

Tentative test device placement

Day \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_

Tentative test device pick-up

Day \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_

Please inform the occupant. *We will request a signature on our standard form to ensure required conditions for test accuracy. Any test interference that is detected will be documented in the report and may nullify the test results.*

CLOSED-BUILDING PROTOCOL REQUIREMENTS	
For tests of less than 4 days, closed-building conditions are required to begin 12 hours prior to the test. <b>MAINTAIN CLOSED-BUILDING CONDITIONS THROUGHOUT THE TEST PERIOD.</b>	
<b>Windows</b>	<b>Keep closed</b> <i>on all levels of the building including areas not being tested</i>
<b>Exterior doors</b> (except for momentary entry and exit)	
<b>Heating and cooling systems</b>	<b>Set to normal</b> <i>occupied operating conditions with normal temperatures between 65° and 80° F</i>
<b>Systems that temporarily ventilate with outdoor air for seasonal comfort or energy savings</b>	<b>Set to the lowest seasonal ventilation condition</b>
<b>Whole-house fans</b>	<b>Do not operate</b>
<b>Fireplaces</b> including those that burn solid, liquid, or gas fuels unless they are the primary/normal sources of heat for the building	
Clothes dryers, range hoods and bathroom fans	<b>Avoid excessive operation</b>
<b>Do not disturb test devices.</b> The detectors cannot be moved, covered or have their performance altered during the test.	

This radon test can help assure a safe and healthy home. We thank you for your cooperation. For any concerns or questions please contact \_\_\_\_\_ Phone (XXX) XXX-XXX

Sincerely, \_\_\_\_\_

**EXHIBIT 2 b**  
**SPANISH TRANSLATION—GENERAL NOTICE PRIOR TO TESTING**

## Pruebas de Radón Programadas

Estimados Residentes,

Se está tomando un paso importante para ayudar a proteger la salud de todos los ocupantes de este edificio. Las pruebas de radon se están llevando a cabo en partes de este edificio.

El radon es un gas radioactivo natural que a menudo se encuentra en el suelo que puede estar presente en edificios a concentraciones superiores a las recomendadas.

La única manera de saber cuáles son las concentraciones de radon para cualquier edificio es probar.

Día de inicio: \_\_\_\_\_ Fecha \_\_\_\_\_ (Ventanas deben estar cerradas la noche anterior.)

Día de fin: \_\_\_\_\_ Fecha \_\_\_\_\_ Tiempo de finalización: Horas de cierre del negocio

<b>Por favor, ayude a mantener estas condiciones de prueba requeridas en todo el edificio. (12 horas antes de la prueba y durante de la prueba.)</b>	
<b>Ventanas</b>	<b>Mantener cerradas</b>
<b>Puertas exteriores</b> (excepto por la entrada momentánea y la salida)	<i>En todos los niveles del edificio, incluidas las áreas que no se están probando</i>
<b>Sistemas de calefacción y refrigeración</b>	<b>Establecer en normal</b> <i>Condiciones de funcionamiento ocupadas con temperaturas normales entre 65 ° y 85 ° F</i>
<b>Sistemas que ventilan temporalmente con aire exterior para la comodidad estacional o ahorro de energía.</b>	<b>Establecer a la ventilación estacional más baja</b>
<b>Ventiladores de baño</b>	<b>Operar con normalidad</b>
<b>Sistemas de escape</b> (que extraen temporalmente el aire del edificio, como lavanderías, talleres, cocinas comunitarias o para el control local de los humos)	<b>Evitar el funcionamiento excesivo</b>
<b>Chimeneas</b> (que queman combustibles sólidos, líquidos, o gas a menos que sean las fuentes primarias de calor para el edificio)	<b>No operar</b>

**Para información general de salud:**

Copias de la *Manual Informativo Sobre El Radón* de la EPA se puede encontrar en línea en <https://espanol.epa.gov/cai/acerca-del-radon>.

**Para consultas o preocupaciones de informes:**

Persona de Contacto: \_\_\_\_\_ Teléfono: \_\_\_\_\_

Le agradecemos su cooperación para ayudar a garantizar un edificio seguro y saludable.

**EXHIBIT 3**  
**SAMPLE FORM: NONINTERFERENCE AGREEMENT**



Dear Occupant,

This radon test can help ensure healthy conditions in your home. It is important that required closed-building conditions be maintained. Any test interference that is detected will be documented in the report and may nullify the test results

Test device pick-up: Day \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_

<b>CLOSED-BUILDING PROTOCOL REQUIREMENTS</b>	
For tests of less than 4 days, closed-building conditions are required to begin 12 hours prior to the test. <b>MAINTAIN CLOSED-BUILDING CONDITIONS THROUGHOUT THE TEST PERIOD.</b>	
<b>Windows</b>	<b>Keep closed</b> <i>on all levels of the building including areas not being tested</i>
<b>Exterior doors</b> (except for momentary entry and exit)	
<b>Heating and cooling systems</b>	<b>Set to normal</b> <i>occupied operating conditions with normal temperatures between 65° and 80° F</i>
<b>Systems that temporarily ventilate with outdoor air for seasonal comfort or energy savings</b>	<b>Set to the lowest seasonal ventilation condition</b>
<b>Whole-house Fans</b>	<b>Do not operate</b>
<b>Fireplaces</b> including those that burn solid, liquid, or gas fuels unless they are the primary/normal sources of heat for the building	
Clothes dryers, range hoods and bathroom fans	<b>Avoid excessive operation</b>
<b>Do not disturb test devices.</b> The detectors cannot be moved, covered, or have their performance altered during the test.	

Please sign this form and add any comments to help ensure accurate tests:

**To the best of my knowledge, the required conditions were kept prior to & during the test.**

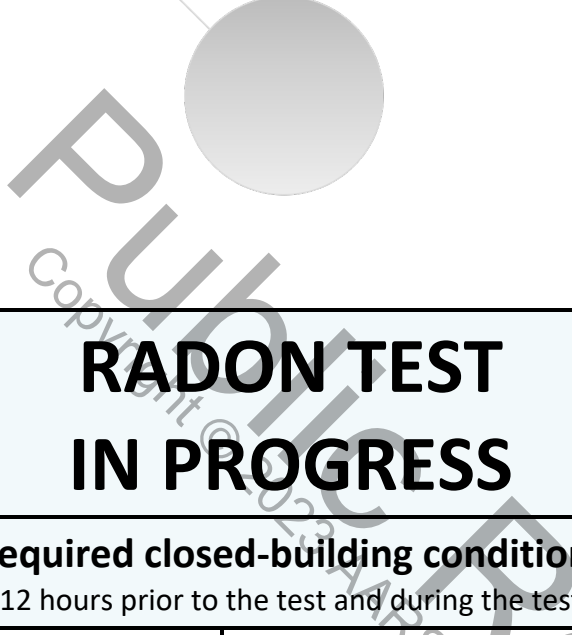

**Signature** \_\_\_\_\_ **Date** \_\_\_\_\_

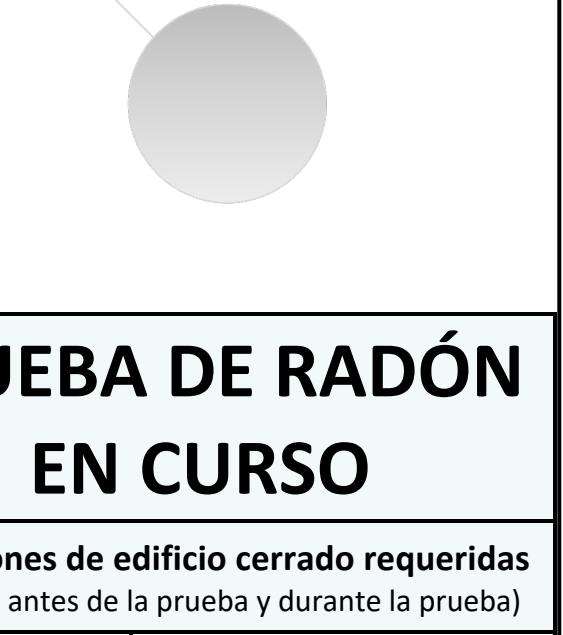

Comments if any: \_\_\_\_\_

We thank you for your cooperation in ensuring that this test contributes to a safe and healthy home.

Sincerely, \_\_\_\_\_ Phone (XXX) XXX-XXX

**EXHIBIT 4  
SAMPLE DOOR HANGER NOTICES**

	
<h2><b>RADON TEST IN PROGRESS</b></h2>	
<p><b>Required closed-building conditions</b> (12 hours prior to the test and during the test)</p>	
<b>Keep closed</b>	<p><b>Windows &amp; Exterior doors</b> <i>(except for momentary use)</i></p>
<b>Set to normal</b>	<p><b>Heating &amp; Cooling systems</b> <i>keep between about 65° - 80° F)</i></p>
<b>Set to lowest outdoor ventilation</b>	<p><b>Systems that temporarily ventilate with outdoor air for seasonal comfort or energy savings</b></p>
<b>Avoid excessive operation</b>	<p><b>Clothes dryers, range hoods and bathroom fans</b></p>
<b>Do not operate</b>	<p><b>Whole-house and window fans</b></p>
	<p><b>Fireplaces that burn solid, liquid or gas fuels, unless they are the primary sources of heat for the building</b></p>
 <p><b>Do not disturb test devices.</b></p>	

	
<h2><b>PRUEBA DE RADÓN EN CURSO</b></h2>	
<p><b>Condiciones de edificio cerrado requeridas</b> (12 horas antes de la prueba y durante la prueba)</p>	
<b>Mantener cerrado</b>	<p><b>Ventanas y Puertas Exteriores</b> <i>(excepto para uso momentáneo)</i></p>
<b>Establecer en normal</b>	<p><b>Sistema de Calefacción y Refrigeración</b> <i>(mantener entre ~65° - 80° F)</i></p>
<b>Establecer en la condición de ventilación más baja</b>	<p><b>Sistemas que ventilan temporalmente con aire exterior para comodidad estacional o ahorro de energía</b></p>
<b>Evitar funcionamiento excesivo</b>	<p><b>Secadoras de ropa, campanas extractoras, y ventiladores de baño</b></p>
<b>No operar</b>	<p><b>Ventiladores para toda la casa y ventiladores de ventanas</b></p>
	<p><b>Chimeneas que queman combustibles sólidos, líquidos, o gas a menos que sean las primarias fuentes de calor del edificio</b></p>
 <p><b>No molestar los dispositivos de prueba.</b></p>	

**EXHIBIT 5**  
**RDP MEASUREMENT—ASSESSMENT OF TEST CONDITIONS**

<b>For Local airspace</b> (The room and any adjoining rooms that are not physically isolated by partitions and closed doors.)		
<b>Item</b>	<b>Action</b>	<b>Reporting Requirements</b>
<input type="checkbox"/> Ceiling fans	<i>Disallow use</i>  <i>Or</i> <i>Choose a different test location</i>	<input type="checkbox"/> List each item on the report  <input type="checkbox"/> Report existence of any items present and any deviations in required action
<input type="checkbox"/> Circulating fans		
<input type="checkbox"/> Filter or electrostatic air cleaners		
<input type="checkbox"/> Unvented fireplaces		
<input type="checkbox"/> Vacuum cleaners		
<input type="checkbox"/> Humidifiers or dehumidifiers		
<input type="checkbox"/> Particulate creation, such as: <ul style="list-style-type: none"> <li><input type="checkbox"/> - smoking,</li> <li><input type="checkbox"/> - cooking</li> <li><input type="checkbox"/> - burning candles/other</li> <li><input type="checkbox"/> - pets</li> </ul>	<i>Recommend that occupants avoid activities of this nature that are more than normal</i>	<input type="checkbox"/> List each item on the report  <input type="checkbox"/> Report the condition
<input type="checkbox"/> Proximity to electrostatic fields such as tube TV or computer screens		
<b>For Whole Building or Zone</b> The entire building or local heating or cooling zone that is served by a single air handler.		
<input type="checkbox"/> HVAC blower activity	<i>Evaluate</i>	<input type="checkbox"/> Report deviations from expected normal use
<input type="checkbox"/> Occupied or unoccupied	<i>Evaluate</i>	<input type="checkbox"/> Report condition
<input type="checkbox"/> HVAC filtration and electrostatic air cleaners	<i>Evaluate</i>	<input type="checkbox"/> Document all systems present  <input type="checkbox"/> Report system conditions
<input type="checkbox"/> HVAC combustion byproducts	<i>Evaluate</i>	
<input type="checkbox"/> HVAC duct cleanliness	<i>Evaluate</i>	
<input type="checkbox"/> Split systems	<i>Evaluate</i>	
<input type="checkbox"/> Humidifiers or dehumidifiers	<i>Evaluate</i>	
<b>Outside the building</b>		
<input type="checkbox"/> Atypical outdoor air pollution	<i>Evaluate</i>	<input type="checkbox"/> Report condition
<input type="checkbox"/> Humidity	<i>Evaluate</i>	<input type="checkbox"/> Report deviations from normal yearly averaged



## Acknowledgments

*Sincere appreciation is both expressed and deserved for contributions of time and wisdom.*

### Radon Measurement Standards—Consensus Body 2017-2023

Non-voting Chair: Shawn Price

Non-voting Assist Team: Gary Hodgden

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National Association of Realtors  
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Spruce Environmental  
Rad Elec, Inc.  
RADON Measurements Lab  
Bowser-Morner

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# MAH Companion Guidance



Advisory—The information contained in this guidance document does not contain requirements necessary for conformance to the MAH standard and is not part of this ANSI/AARST American National Standard (ANS). The information contained in this guidance document has not been processed in accordance with ANSI's requirements for an ANS. As such, this guidance document may contain material that has not been subjected to public review or a consensus process.

- CG Section A      GENERAL INSPECTION OF INSTALLED RADON MITIGATION SYSTEMS**
- CG Section B      UNDERSTANDING DEVICES AND QUALITY CONTROL TERMINOLOGY**
- CG Section C      UNDERSTANDING HVAC SYSTEMS DESCRIBED IN THE STANDARD**
- CG Section D      UNDERSTANDING RADON DECAY PRODUCT MEASUREMENT**

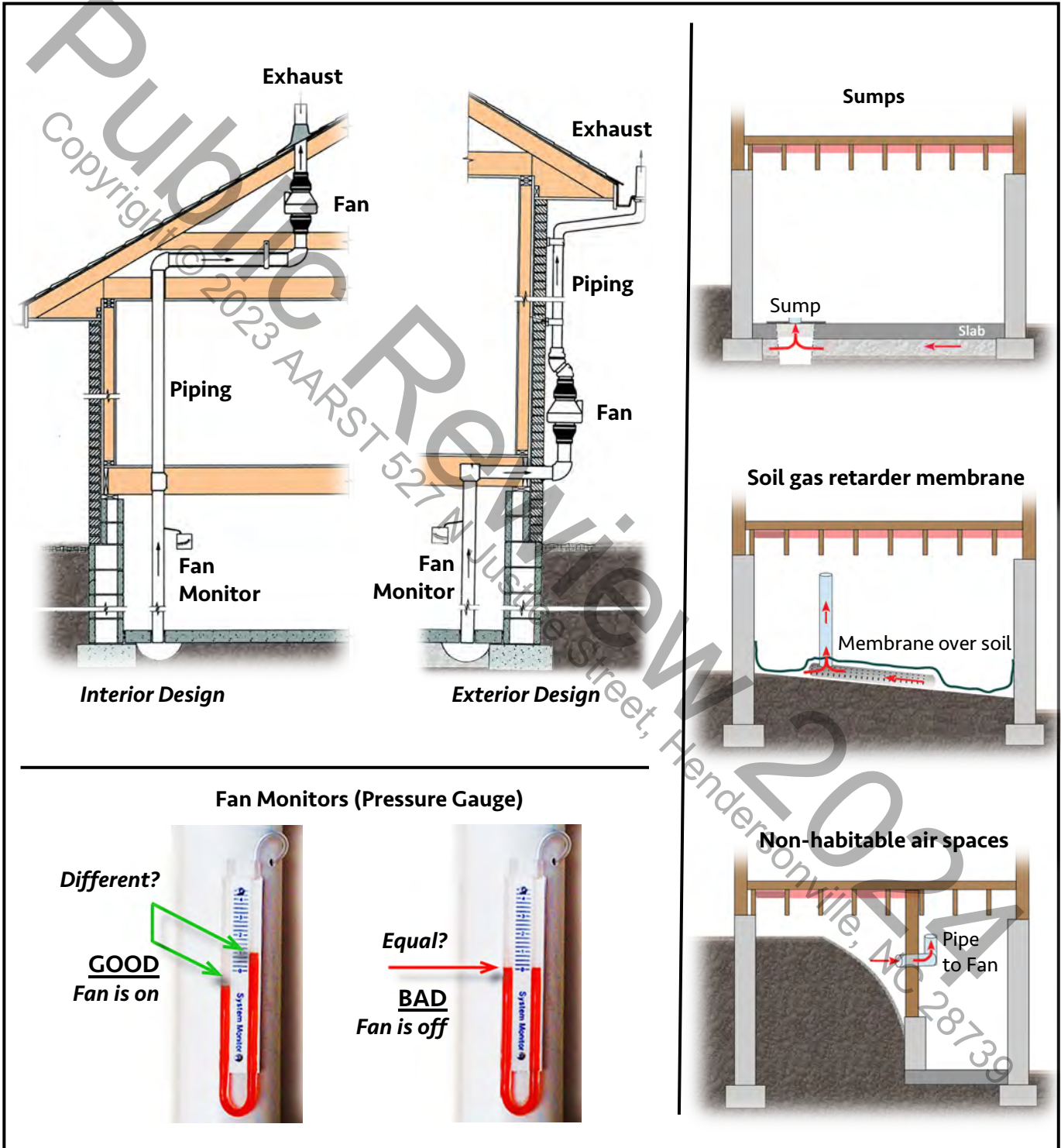


### GENERAL INSPECTION CHECKLIST FOR INSTALLED RADON MITIGATION SYSTEMS

The checklists on the following two pages are provided for evaluating:

- 1) Health and Safety, and
- 2) Functional Integrity of System Components.

*Advisory*—These checklists are NOT for verifying compliance with any published standard or regulation.



# GENERAL INSPECTION — EXISTING RADON MITIGATION SYSTEMS

## SAFETY REVIEW

Advisory—This list is intended for use by homeowners and inspection personnel.  
It is not intended to verify compliance with local regulations or any published radon standard.



Radon Testing	If No, recommended action
<input type="checkbox"/> Was the most recent test within the last 2 years?	<input type="checkbox"/> Test for radon
<input type="checkbox"/> Are recent test reports available?	
<input type="checkbox"/> Is there radon system piping and a radon fan?	<input type="checkbox"/> Test for radon. If readings are low, test again in the heating season
Fan and Exhaust Location	
<input type="checkbox"/> Is the fan outside of occupiable space and not beneath an occupiable space (e.g., not in a basement, crawl space or attached garage that is under occupiable space)?	<input type="checkbox"/> Relocate the fan to meet compliance with current standards
<input type="checkbox"/> Does fan electrical wiring appear safe?	<input type="checkbox"/> Correct unsafe electrical wiring.
<input type="checkbox"/> Is the system exhaust at least 10 feet above grade?	<input type="checkbox"/> Take action to bring the exhaust location into compliance with current standards
<input type="checkbox"/> Is the system exhaust at least 2 feet above or 10 feet to the side of operable openings in all windows, doors or other ventilation openings between outdoor air and indoor air?	
Radon Pipe Routing	
<input type="checkbox"/> Are building exits for fire and safety clear of obstructions?	<input type="checkbox"/> Take action to correct hazards
<input type="checkbox"/> Does pipe routing retain fire protection and safe distances from electrical panels or meters for gas or liquid fuel?	
Radon Fan Monitor	
<input type="checkbox"/> Is there a viewable fan monitor?	<input type="checkbox"/> Install a viewable fan monitor
<input type="checkbox"/> Does the radon fan appear to be running?	<input type="checkbox"/> Activate or replace the fan
Openings to soil	
<input type="checkbox"/> Do all sump pits have rigid sealed lids?	<input type="checkbox"/> Seal or install a durable sump lid
<input type="checkbox"/> Are sump lid materials durable and safe if stepped on?	
<input type="checkbox"/> Are accessible openings to soil closed or sealed except those that might compromise water drainage?	<input type="checkbox"/> As appropriate, seal openings in slabs and <i>crawl space</i> membranes
Non-habitable air spaces	
<input type="checkbox"/> For less common systems that draw air from behind a wall, under a floor or from a <i>crawl space</i> , are openings closed or sealed between the non-habitable air space and both indoor and outdoor air surrounding the non-habitable air space?	<input type="checkbox"/> Take action to establish sufficient closure to prevent energy penalties or flue gas spillage from atmospherically vented combustion appliances
<input type="checkbox"/> If radon testing indicates open foundation or crawl space vents are an important mitigation component, are permanently open vents installed?	<input type="checkbox"/> Take action to install non-closable vents or install a system that is effective during all seasons

# GENERAL INSPECTION — EXISTING RADON MITIGATION SYSTEMS

## FUNCTIONAL INTEGRITY OF COMPONENTS

Advisory—This list is intended for use by homeowners and inspection personnel.  
It is not intended to verify compliance with local regulations or any published radon standard.



TYPE OF MITIGATION SYSTEM(S) INSTALLED	
( ) Sub-slab Depressurization	( ) Sub-membrane Depressurization
( ) Sump Depressurization	( ) Block Wall Depressurization
( ) Drain Tile Depressurization	( ) Depressurization of Non-habitable Airspace
	( ) Soil Vent Piping Without Fan
	( ) Other Method
Radon System Piping	If No, recommended action
<input type="checkbox"/> Is piping watertight or free of visible water leaks?	<input type="checkbox"/> Take action to seal pipe joints
<input type="checkbox"/> Is piping sloped to drain water in the pipe to the soil?	<input type="checkbox"/> Take action to achieve drainage
<input type="checkbox"/> Is piping secured to the building in durable manner?	<input type="checkbox"/> Take action to correct piping deficiencies
<input type="checkbox"/> Is the exhaust air discharging freely without obstructions?	
<input type="checkbox"/> Are building materials safe from exhaust vapor damage?	
<input type="checkbox"/> Is the piping durable and in good repair?	
Fans	
<input type="checkbox"/> Is there a switch, plug or labeled breaker to turn off the fan?	<input type="checkbox"/> Take action to correct the fan installation
<input type="checkbox"/> Do flexible couplings connect the fan to piping?	
<input type="checkbox"/> Is the fan rated for safety and constant activation needed for radon systems and capable of draining water?	
Sump Lids	
<input type="checkbox"/> Are sump lids fastened and sealed in a manner that allows removal for service where closure is achieved with non-permanent materials such as silicone caulk or gaskets?	<input type="checkbox"/> Add features required in national standards that allow reasonable access to conditions inside the pit
<input type="checkbox"/> For suction piping found attached to a sump lid, does the pipe have a flexible coupling disconnect to ease access to the pit?	
Sub-membrane Depressurization	
<input type="checkbox"/> Are air intakes under the membrane free of obstructions?	<input type="checkbox"/> Take action to correct the deficiency
<input type="checkbox"/> Is the top of the membrane free of standing water?	
<input type="checkbox"/> Are all sizable membrane openings to soil closed?	
<input type="checkbox"/> Are the edges of the soil gas retarder closed or sealed?	<input type="checkbox"/> Improvements may be warranted to enhance system effectiveness and long-term integrity of the membrane
<input type="checkbox"/> Is durability of the membrane material adequate?	
<input type="checkbox"/> Is the soil gas retarder is not secured to walls in crawl space areas that are accessible for routine storage or other activity?	
Less Common Radon Mitigation Methods	
<input type="checkbox"/> Does the mitigation method solely consist of system piping, radon fan(s) and closure between soil gas and indoor air?	<input type="checkbox"/> Consult with a radon professional for evaluating Non-ASD systems

## MAH Companion Guidance—Section B

### DESCRIPTIONS OF TEST DEVICES

#### Passive Device Measurement Systems

As used in this standard, “Passive devices” are measurement systems that collect a time-weighted average and do not provide hourly readings.

- **Charcoal adsorption detectors (CAD)**

CAD detectors employ activated charcoal that adsorbs radon from the surrounding air. Exposure durations are typically limited to 2-7 days. After exposure, detectors must be sent to the laboratory without delay. Detectors are configured for either Gamma-ray Spectroscopy or Liquid Scintillation Spectroscopy analysis.

- **Alpha-track detectors (ATD)**

ATD detectors utilize a piece of plastic inside a container. Alpha particles emitted from radon strike the plastic detector and create damaged “tracks” that are visible with a microscope. The track density is determined by the laboratory to achieve an average radon concentration for the time period the detector is exposed.

- **Electret ion chamber detectors (EIC)**

EIC detectors use a chamber made of, or lined with, an electrically conductive material with an electrically charged electret as the detecting mechanism. The decay of radon discharges voltage from the electret. The radon concentration is calculated by comparing the electret voltage measured before and after exposure.

- **Electronic integrating devices (EID)**

An EID is an electronic measuring device similar to a continuous monitor but is not recording a retrievable series of 1 hour measurements. EID devices are categorized as passive devices because such devices do not provide the additional measurement data points needed for making mitigation decisions.

#### Continuous Radon Monitors (CRM)

A CRM is an electronic device that is automatically recording a retrievable time series of numeric measurements of radon concentration averaged over time intervals of 1 hour or less. These additional data points can help to judge whether or not there was an unusual occurrence during the test that might invalidate the overall measurement.

### QUALITY CONTROL (QC)

#### Duplicate or Comparison Check Measurements

Duplicates or comparison check measurements are pairs of detectors or monitors deployed in the same location, side-by-side, approximately every tenth measurement (i.e., 10%). The purpose is to evaluate and track imprecision or agreement between detectors or monitors across time. Using calculations for relative percent difference (RPD):

- In an environment with a radon concentration  $\geq 4$  pCi/L, the goal for agreement is an RPD  $\leq 14\%$ . The warning limit is an RPD  $\geq 28\%$  and the control limit is an RPD  $\geq 36\%$ .
- Between 2 and 4 pCi/L, the goal for agreement is an RPD of  $\leq 25\%$ . The warning limit is an RPD  $\geq 50\%$  and the control limit is an RPD  $\geq 67\%$ .

#### Calibration

Calibration means to adjust or determine or both, the response of an instrument or device relative to a series of conventionally true values. Ongoing annual calibration of each CRM is part of quality assurance efforts.

#### Blank Measurements

Blanks are CAD, ATD or EIC devices deployed for at least 5% of the number of measurements conducted to verify and document the absence of effects on the measurement resulting from sources other than the air being tested. Since blanks are not exposed (i.e., not left open to permit radon to enter the detector), their measurement value should be below the lower limit of detection.

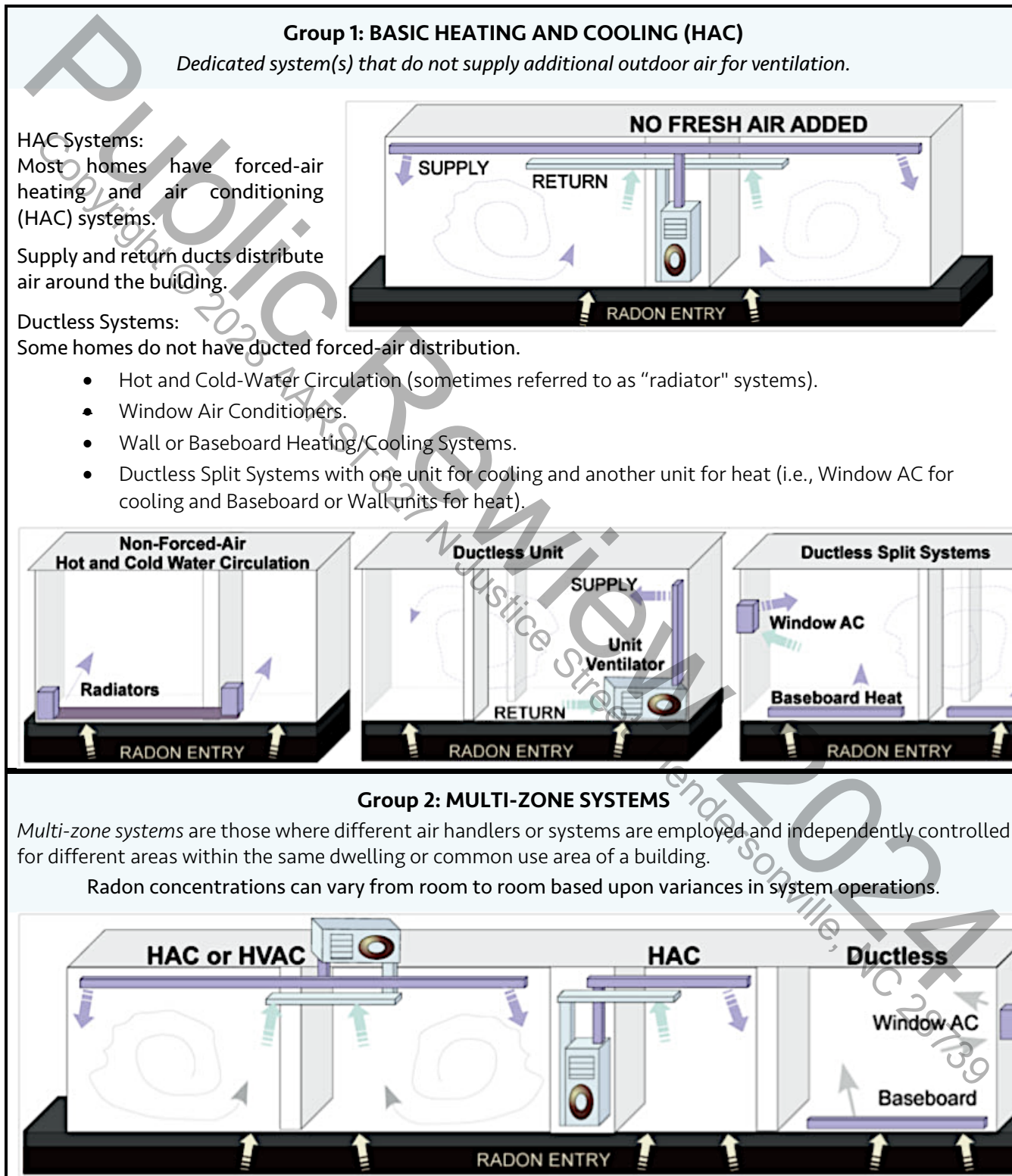
#### Spiked Measurements

Spikes are CAD, ATD or EIC detectors that have been exposed in an approved reference chamber to a known concentration of radon (i.e., “spiked” with radon). Spikes are conducted for at least 3% of the devices deployed for field measurements. Using spiked measurements helps to validate the accuracy of a laboratory analysis and/or detectors supplied by a laboratory.

**Advisory**—For more details, see [ANSI/AARST MS-QA \(Radon Measurement Systems Quality Assurance\)](#).

## UNDERSTANDING HVAC SYSTEM DESIGNS AND INFLUENCE ON TEST RESULTS

For comfort, indoor temperatures are kept between 65° and 80° F (18° - 27° C). When outdoor temperatures go below about 65° (18° C), buoyant indoor air rises upward to drive radon entry from soil. As outdoor air grows colder, heating systems activate to result in consistent upward stack effect that drives radon entry. Whenever and wherever air handlers are active, radon is distributed around the building.



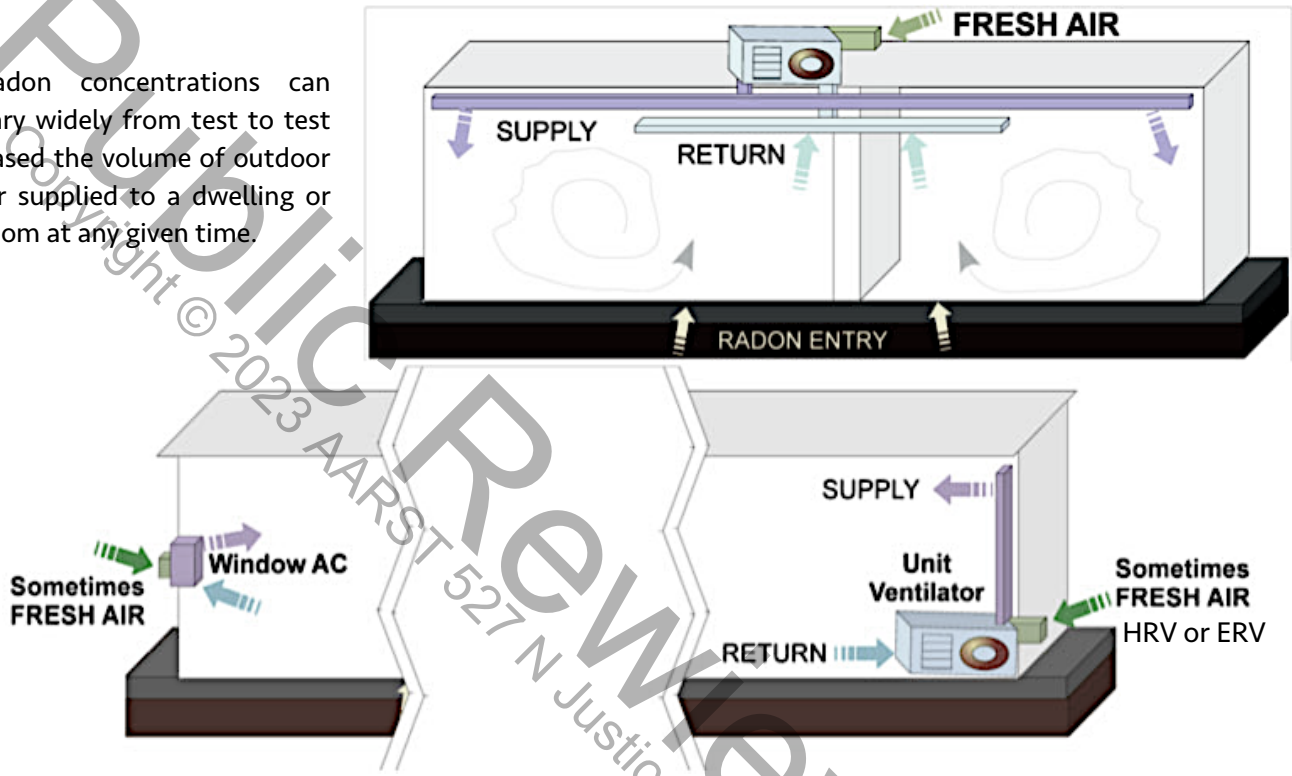


Note—Systems that bring outdoor air into a building for seasonal comfort are common in some regions. Evaporative (swamp) cooling systems have long been a common cooling system in dry climates. Heat recovery ventilators (HRV) and energy recovery ventilators (ERV) are becoming more popular across the country.

**Group 3: VARIABLE OUTDOOR AIR VENTILATION**

Variable Outdoor Air Ventilation (HVAC) systems are those that add outdoor air ventilation for seasonal comfort or energy savings. Such systems may service a whole building, multiple dwellings or a single dwelling or unit ventilator.

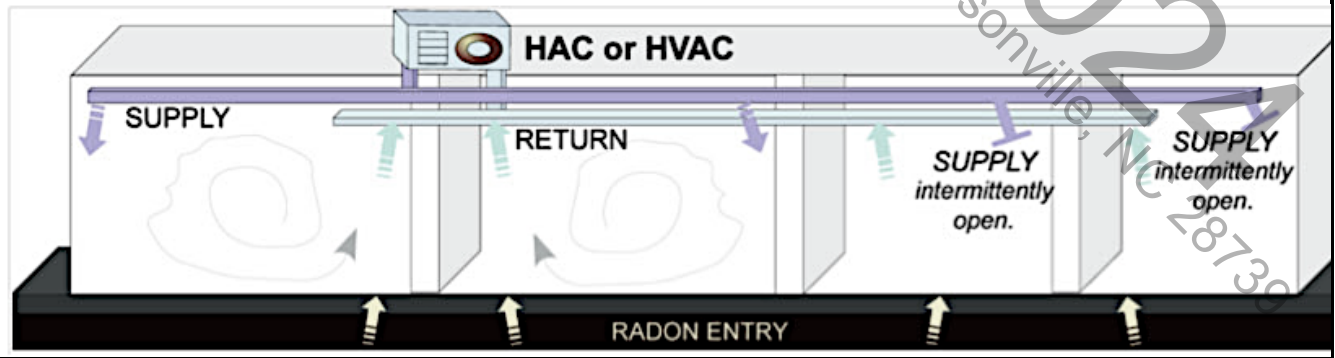
Radon concentrations can vary widely from test to test based the volume of outdoor air supplied to a dwelling or room at any given time.



(Very uncommon for single family residences)

**Group 4: VARIABLE AIR DISTRIBUTION**

Variable Air Distribution systems are those where airflow from a single air handler is distributed to multiple dwellings, rooms or common use areas with independent controls within each area that open and close duct dampers. The normal operation of these systems can cause changes in distribution of radon or ventilation air and can also affect pressure relationships that can enhance or diminish radon entry.



### UNDERSTANDING RADON DECAY PRODUCT MEASUREMENT

#### Introduction

The unit of measurement provided by devices that measure radon decay products is Working Level (WL). The devices measure the activities of short-lived radioactive elements that result from the radioactive decay of radon gas. Often termed “radon progeny,” these decay product atoms are solid elements rather than gaseous and are left suspended in the air we breathe as radon gas decays.

It is the total Alpha energy from the short-lived decay products of radon (Po-218 and Po-214) that is measured when conducting radon decay product measurements.

Historically, action levels have been cited at 0.020 WL in the U.S. The 0.020 WL is mathematically determined based upon an assumption that, when considering a national residential average, about 50% of the radon decay products remain suspended in the air and available for inhalation. More recently, some publications<sup>3</sup> and authorities have indicated that 40% may be a more correct assumption.

#### Measurements

While these assumed equilibrium factors of 50% or 40% may be reasonable for national risk calculations, the normal operating conditions for each home, building or room are affected by a wide range of parameters that can cause significant deviations compared to any assumed equilibrium factor. It is important for the measurement professional to understand and identify the presence of those parameters that can either increase or decrease the suspended radon decay products to determine if those effects are temporary or long-term—either of which can affect an interpretation of the results.

- One benefit of obtaining a radon decay product measurement is to identify situations where ventilation or other conditions have resulted in higher percentages of radon decay products suspended in the air compared to traditional assumptions. This situation would result in greater risk than indicated by a radon gas measurement.
- Another benefit of obtaining a radon decay product measurement is to identify situations where conditions cause lower percentages of radon decay products suspended in the air compared to traditional assumptions. If it can be verified that conditions that cause equilibrium factors to be lower than traditionally assumed are reliably stable, the risk may be lower than indicated by a radon gas measurement.

Regardless, the radon decay product measurement alone cannot pinpoint the equilibrium factor that existed during a test. Therefore, it alone cannot corroborate observations related to building systems or environmental conditions that may or may not be the normal, reliably stable condition. However, by simultaneously conducting a measurement of both radon gas and radon decay products, the measurement professional can better gauge the stability of conditions that may affect an occupant’s risk.

#### Factors Influencing Equilibrium Factors

The following table provides examples of operating parameters that can increase or decrease the equilibrium factor (EF). This list is not comprehensive, and the radon professional conducting radon decay product measurements should view any situation with the following two rules of thumb:

1. Any situation where air circulation is high, more decay products will attach to physical surfaces rather than remain suspended in the air and, hence, the EF will decrease. Conversely low air circulation will cause an increase in EF.
2. Anything that will serve to increase other indoor particles to which RDPs can attach before they contact physical surfaces will increase the suspended RDPs and, hence, the equilibrium factor. Conversely, where the air is very clean, fewer RDPs will attach to suspended particles (with more plating out on physical surfaces) causing the suspended RDPs and the EF to decrease.

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<sup>3</sup> US EPA, EPA Assessment of Risks From Radon in Homes, page 3, June 2003

## RADON DECAY PRODUCT MEASUREMENTS—INFLUENCES ON THE EQUILIBRIUM FACTOR (EF)

The listing below is illustrative of the effects various activities and conditions can have on the RDP measurement test result. The radon professional should review the circumstances in each house that may be increasing or decreasing suspended radon decay products to determine if those variables are long-term or intermittent in making recommendations to the client.

Item	Effect on EF	Discussion
Intermittent Fan Activity such as Ceiling Fans	<i>Decrease</i>	Low EF as a result of ceiling fan or other intermittently active fans will not likely be representative of other rooms without fans and not likely representative of EF during months without fan activity.
Window Air Conditioner	<i>Decrease</i>	Although window A/C should be in total recycle mode for any test, the air movement when operating can increase plate-out on physical surfaces.
Wall mounted split air conditioner or heat pump with blower	<i>Decrease</i>	Recirculated air from a wall unit can increase plate-out of RDPs to physical surfaces for the room in which it is located. A test in such a room may not be representative of other rooms, unless wall units are located in all occupied rooms.
Portable Circulating Fan	<i>Decrease</i>	The operation of a portable fan in a given room can increase plate-out within that room which would not be representative of other rooms in the building.
Forced Air Unit (Auto)	<i>Decreases when blower is ON</i>	Blowers of FAUs cause more plate-out when system is calling for heating or cooling. The amount of reduction is dependent upon frequency of use.
Forced Air (Constant ON)	<i>Decrease</i>	Increased air circulation will cause more RDPs to attach to physical surfaces.
Modular air cleaners (Stand-alone)	<i>Decreases in room it is located within</i>	Air cleaners can significantly reduce EF due to: 1.) increased air movement, and 2.) removal of other suspended particles to which RDPs are attached. Low EFs in a room with an air cleaner will not be representative of other rooms in building.
Whole House Air Cleaners	<i>Decrease</i>	Whole house air cleaners can be stand-alone with their own ductwork system or incorporated into a forced air heating/cooling system with the blower running constantly at a low speed for air borne particulate and allergen removal.
Vacant Building	<i>Variable</i>	The absence of furniture in a building can decrease surfaces to which RDPs can attach. Conversely the absence of occupants can reduce use of air handling equipment.
Non-Forced-Air heating system	<i>Increase</i>	Buildings with radiant style heating systems have lower air movement and hence lower attachment of RDPs to physical surfaces.
Intermittent Particulate Releases	<i>Increases</i>	Activities that release particles into the air can increase EF during periods of release. Examples: <ul style="list-style-type: none"> <li>• smoking,</li> <li>• vacuuming,</li> <li>• burning candles, and</li> <li>• use of fireplace or unvented combustion appliances</li> </ul>
Longer-Term Particulates	<i>Increase</i>	High particulate levels in outdoor air can increase indoor particulate levels. Examples: <ul style="list-style-type: none"> <li>• smoke from fires in the area, and</li> <li>• buildings located in regions of high smog and elevated PM-2.5 plus levels.</li> </ul>
Clean outdoor air	<i>Decrease</i>	Areas where smog and outdoor particulate levels are very low, such as non-industrialized coastal areas can have low EF.
High Humidity	<i>Increase</i>	High humidity can provide airborne water droplets to which radon decay products can attach (similar to dust particles). Attachment to water vapor can also neutralize charge of RDPs causing them to be less likely to plate out on physical surfaces.
Test device near charged surfaces	<i>Decrease</i>	Charged surfaces such as CRT monitors and TV screens that create localized static charges can attract RDPs near them.



# Protocol for Conducting Measurements of Radon and Radon Decay Products in Homes

