Summary of Radon Standards of Practice

Purpose of This Document

This document provides a summary of the dangers of radon gas and its properties, testing for radon in single-family and multifamily homes, and how to mitigate radon using soil gas control systems. For detailed specifications and instructions, consult the referenced American National Standards Institute (ANSI)/American Association of Radon Scientists and Technologists (AARST) Standards, or consult a qualified contractor or soil-gas mitigation professional certified according to requirements from the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB).

This document summarizes guidance from the following ANSI/AARST Standards:

- **ANSI/AARST Standard MAH-2019:** Conducting Tests for Radon and Radon Decay Products in Single-Family Homes (https://standards.aarst.org/MAH-2019/index.html)
- **ANSI/AARST Standard CC-1000 2018:** Soil Gas Control Systems in New Construction Buildings (https://standards.aarst.org/CC-1000-2018/)
- **ANSI/AARST Standard MAMF 2017 with 1/21 Revisions:** Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily Buildings (https://standards.aarst.org/MAMF-2017/)
- **ANSI/AARST Standard RMS-MF 2018:** Radon Mitigation Standards for Multifamily Buildings (https://standards.aarst.org/RMS-MF-2018/index.html)
- **ANSI/AARST Standard CCAH 2020:** Reducing Radon in New Construction Of One & Two Family Dwellings And Townhouses (https://standards.aarst.org/CCAH-2020/index.html)

Background on Radon

- Radon is a colorless, odorless, radioactive gas. It occurs naturally, in very small amounts, in soil and some minerals in the ground.
- Radon is hazardous to human health, even at low levels. Exposure to radon is the second-highest cause of lung cancer in the United States and is the leading cause of lung cancer among non-smokers.
- Long-term exposure to radon is responsible for approximately 21,000 lung cancer deaths per year.
- Radon levels are measured in curies. One curie is the amount of radiation produced when one gram of radon decays. The U.S. Environmental Protection Agency's (EPA) action level for radon–the level at which intervention is suggested–is 4 picocuries per liter (pCi/L), or 4 trillionths of a curie per liter of air.
- The average radon level in outdoor air near the ground is 0.4 pCi/L.
- The Indoor Radon Abatement Act of 1988 authorized the federal government to seek ways to reduce radon exposure. EPA and the Surgeon General recommend all homes be tested for radon.

Testing Protocols

Consider hiring a qualified radon measurement professional to conduct a radon inspection. A qualified professional is certified according to requirements from NRPP or NRSB.

According to AARST, for single-family dwellings, the cost to test for radon ranges from $100 to $275. For multifamily buildings, the range is $50 to $80 per unit.

Test Devices

Use a device approved by NRPP, NRSB, or a local authority. Always follow your test kit's instructions, and make sure your device is appropriate for the conditions. Test kits for residents may be provided by the local health department or state agency at low or no cost.

There are two kinds of radon testing devices:

- **Passive devices** give a time-weighted average reading. These are the most commonly used devices for radon testing, are inexpensive, and work well for an initial test or short-term testing.
- **Active devices** (continuous radon monitors – CRM) collect hourly readings that can indicate whether there was an unusual occurrence during the test that might invalidate the overall measurement. These devices are more costly than passive tests.

Summary of Radon Standards of Practice *(continued)*

When and Where To Test

1. Newly constructed homes should be tested before becoming occupied.
2. The lowest occupied floor (in single-family buildings).
3. Test only during normal weather conditions. Avoid testing during unusual or severe weather.
4. Conduct tests during cold seasons when heating systems operate day and night.
5. Radon tests should be conducted in rooms that are living spaces, like bedrooms, living rooms, or studies. Do not test in closets, kitchens, bathrooms, or garages.
6. Make sure the doors and windows are closed, but normal operation is permitted.

For short-term testing, the building should be in normal, "closed building" conditions for 12 hours prior to the test. "Closed door" means the way the building is set up during winter heating and summer air conditioning. It is not necessary to vacate the home. Tests can be conducted while residents conduct their day-to-day lives.

Shared Building Testing

Shared buildings need to meet the "closed-building" conditions described above for a radon test, or the test result may not be accurate. If you do not have access to the other occupied parts of the building, report the conditions and circumstances in writing in all reports.

Procedures for Testing Multifamily Shared Buildings

When conducting large-scale testing of shared family facilities, a measurement professional qualified by NRSB or NRPP should be present and supervising all testing activities. This professional must also prepare a quality assurance plan that includes all apportioned tasks and operations, with all supervised by the qualified measurement professional. Finally, the testing activities must be conducted according to a written work plan prepared by the qualified professional.

Client Communications

The testing plans must include communications with the client regarding the testing procedures, closed-building conditions, HVAC notices, and commitments to follow applicable regulations and air quality control standards. Clients include all property tenants, staff, and management.

Test Locations

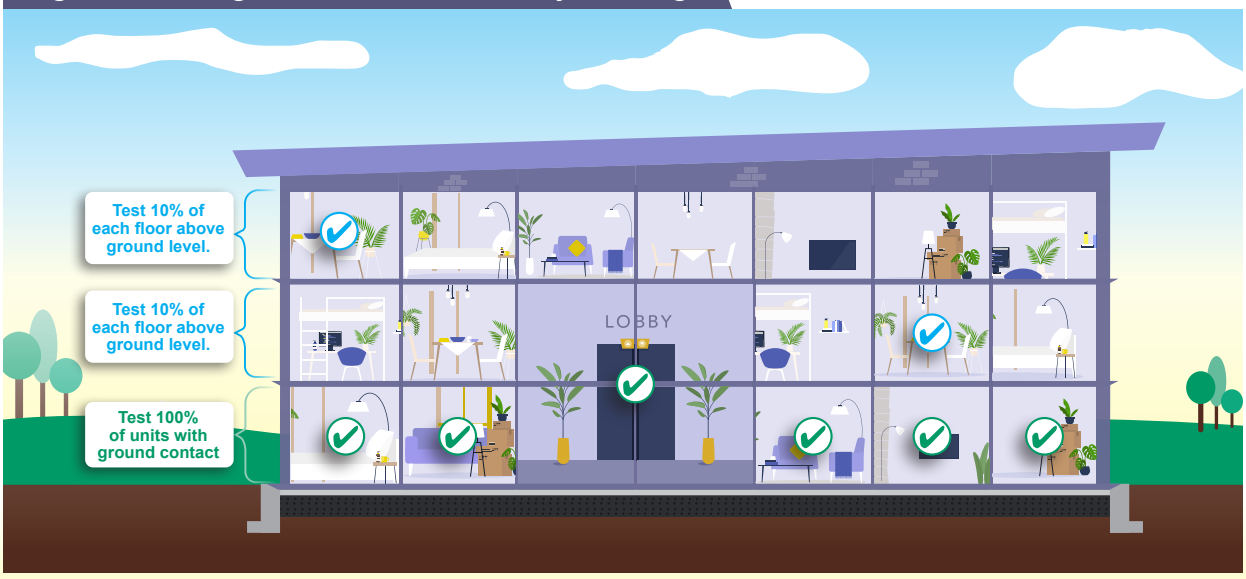
Test All Dwellings With Ground Contact

Testing shall be conducted in all units that are occupied or intended to be occupied, including non-dwelling spaces such as lobbies; that have floors or walls in contact with the ground; or are otherwise the lowest living spaces in a building.

Units Above Ground Floor

For all floors above ground level, 10 percent of the units on each floor should be tested. Round up—at least one unit per floor should be tested even if there are fewer than 10 units.

Figure 1. Testing Locations in Multifamily Housing



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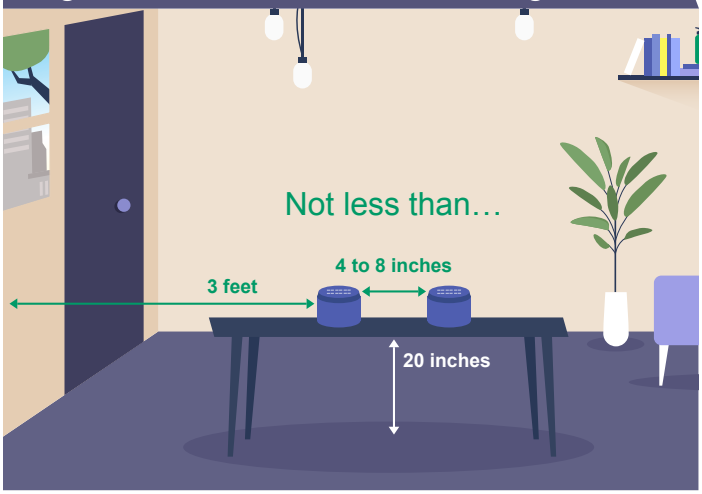
Reporting and Quality Compliance

When conducting a test protocol on a building with multiple dwelling units, it is important to follow strict reporting and quality assurance standards in order to ensure the accuracy of the tests and the safety and privacy of clients. Before beginning such a project, consult AARST/ANSI MAMF 2017: Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily Buildings.

Figure 2. Placement of Passive Testing Devices



Radon test options include short-term tests (2 to 90 days) or long-term tests (greater than 90 days). Short-term tests are most commonly used; however, long-term tests can provide a more accurate indication of average radon levels over time. Long-term tests may be required by some states. Radon professionals generally place two short-term passive devices for a 2- to 5-day test period unless an extended time period for making a mitigation decision or additional review is necessary. In that case, a long-term test may be used.

Time-Sensitive Test Protocol

Short-term tests are commonly used for single-family houses. One reason is the need for quick-turnaround results as part of the sales process.

If the test time is between 2 and 90 days, follow this protocol:

Step 1: Option 1: Simultaneous testing: Use two short-term (passive) test devices at the same time, 4 to 8 inches apart. If the two tests average greater than 4 pCi/L, repeat the tests to confirm the results.

Option 2: Continuous monitor: Use an active monitor that records hourly readings.

Step 2: If necessary, take mitigating action.

If the tests continue to average above 4 pCi/L, contact the building's property manager or owner and consult a certified mitigation professional to develop a mitigation strategy and plan repairs. EPA also recommends considering mitigation if test results are between 2 and 4 pCi/L.

Table 1. Overview of Closed-Building Testing Protocol Requirements for Short-Term Testing

FEATURE	ESSENTIAL REQUIREMENTS	UNDER CONSTRUCTION OR RENOVATION
Windows	Keep closed	Closed and sealed for 12 hours
Exterior doors	Keep closed, except momentary interruptions during entry/exit (normal entry and exit of unit is fine)	Closed and sealed for 12 hours
Heating & cooling systems	Set to normal (65°–80°F)	Installed and set to normal for 12 hours
Systems that ventilate outdoor air	Set to lowest ventilation condition	Installed and set to lowest ventilation condition for 12 hours
Whole-house fans	Do not operate	Do not operate
Fireplaces & dampers	Do not operate	Installed for 12 hours, do not operate
Clothes dryers, range hoods & bathroom fans	Avoid excessive operation	Avoid excessive operation
Insulation & exterior siding	N/A	Completed and installed for 12 hours
Wall & ceiling coverings	N/A	Completed and installed for 12 hours

Extended Test Protocol

Take advantage of "blank" and duplicate tests to set baselines and avoid contaminated tests and false positives. Using blank and duplicate tests is a cost-effective way to confirm the radon level in multifamily housing. For example, if two short-term test results differ, take the average of the two tests. If one result is more than twice the other result, then redo the test.

Step 1: Conduct a short-term test. One device per location.

Step 2: Retest if the initial short-term test is at or higher than the action level of 4 pCi/L.

- If the first short-term test is twice the action level or greater, a second short term test must be conducted immediately.
- 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 needed. A long term-test involves continuous monitoring of indoor radon levels for more than 90 days.

Actions Based on Test Results

EPA's "action level" for radon exposure is 4 pCi/L.

If the test reads at or above 4pCi/L: Take action to fix the radon issue.

If the test result is between 2 and 4 pCi/L: EPA recommends taking action to fix the property. The World Health Organization (WHO) recommends limiting long-term radon exposure to a maximum of 2.7 pCi/L.

If the test results are below 2 pCi/L: Generally, no mitigation action is required, but it is recommended to retest every 5 years.

Testing After Mitigation

To test whether the mitigation efforts were successful, wait until after all mitigation construction is complete. Tests should be conducted in the same location(s) as before, but additional location testing is recommended, especially in frequently occupied rooms close to ground level. Testing is recommended every 2 years to make sure the mitigation system is working.

Protocols for Professional Services

If a qualified measurement professional is conducting the testing services (this is recommended), the following additional requirements must be followed:

1. Establish, maintain, and follow a quality assurance (QA) plan that reflects national requirements outlined in ANSI/AARST MS-QA Radon Measurement Systems Quality Assurance.
2. Provide timely notification of residents and all other affected parties of the testing requirements and conditions.
3. Verify testing conditions, including:
   a. Inform person(s) responsible of building conditions of the requirements.
   b. Post "Radon Test in Progress" notifications in conspicuous locations.
   c. Prepare a noninterference agreement and request a signature (required).
   d. Conduct visual inspections.
4. Report test results that follow guidelines outlined in ANSI/AARST NAH 2019 Protocol for Conducting Measurements of Radon and Radon Decay Products in Homes, Section 8.5: "Test Reports."
5. Maintain measurement results for 6 years or as additionally required by the local or state jurisdiction.
6. Follow state or local regulations where appropriate.

Mitigating Elevated Radon Levels

If testing reveals radon levels above EPA's action level of 4 pCi/L, contact a qualified professional to discuss your options for making repairs or installing a radon mitigation system. Radon mitigation systems are permanent installations in buildings, and they work to reduce concentrations of radon gas in breathable air and water supply of inhabited spaces. Passive systems do not have fans, while active systems (ASD) include fans.

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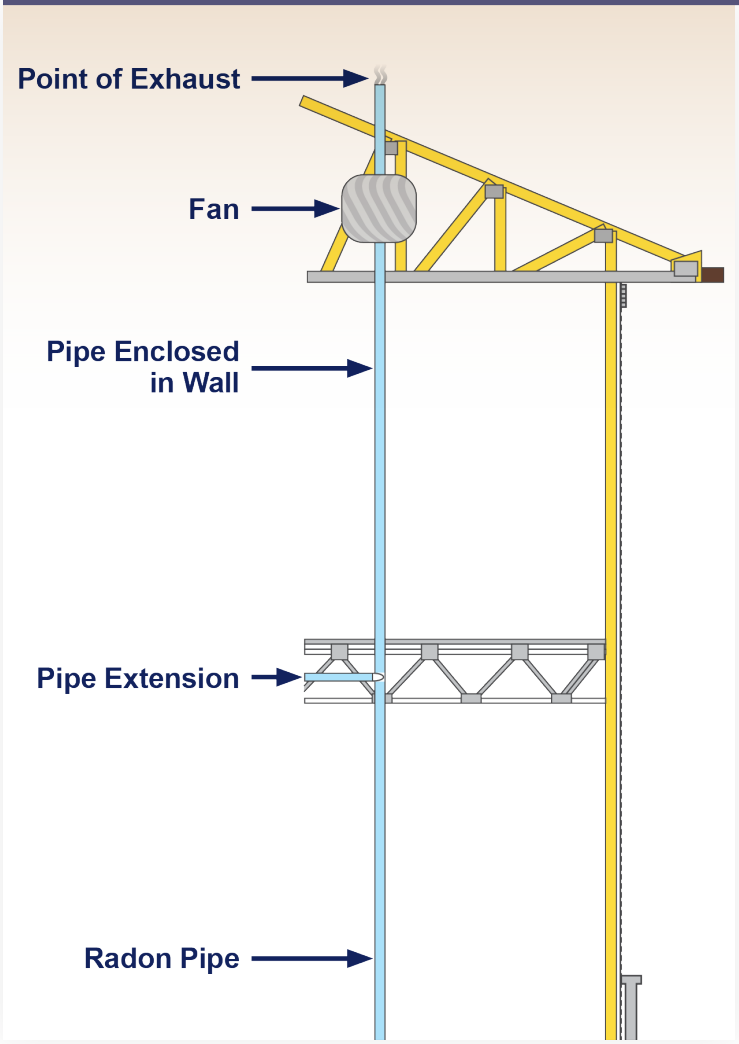
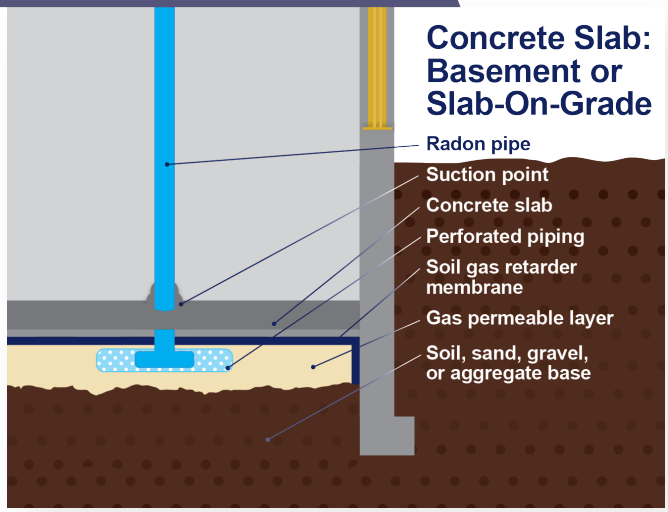
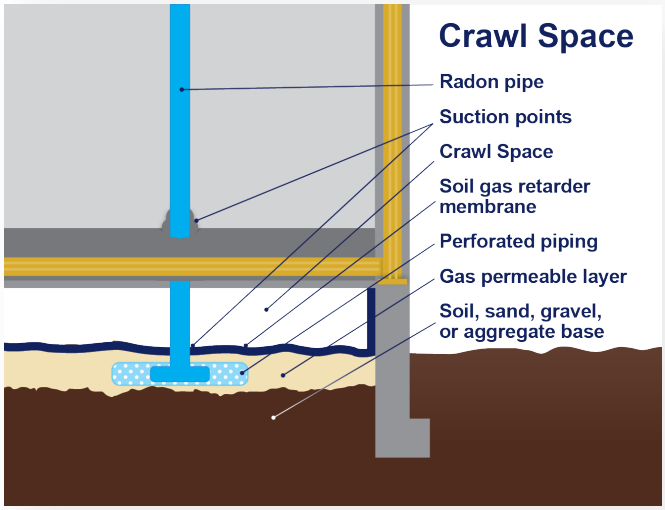
Figure 3. Example of a Typical ASD Installation Using Different Foundations and Grade







Soil Gas Control Systems

Active Soil Depressurization (ASD) Mitigation Systems

There are several different kinds of soil gas and soil chemical mitigation systems. The most common type of system for lowering radon levels in buildings is called **Active Soil Depressurization (ASD).** ASD systems work well for all building sizes, foundation types, and subgrades materials.

ASD systems are relatively low cost. In general, ASD systems involve sealing all interfaces between a building and the ground and use a fan-driven ventilation system to direct radon-contaminated air away from living spaces. The following components are required for all ASD systems, but specifications vary from building to building.

Soil Gas Collection Plenums

Soil gas collection plenums function to redirect radon that may gather below grade. They are required in certain building types and allow radon gas to be vented to the exterior of the building.

A plenum is a three-dimensional enclosure constructed for collecting radon from under slabs and from behind walls that surround a void or gas-permeable layer. When "roughing in" a mitigation system, or installing the system during construction of the building, the plenum(s) is constructed as part of the building's foundation.

Buildings must be constructed with a soil gas collection plenum with surrounding surfaces that sustainably restrict airflow between the gas-permeable layer and spaces outside the enclosing surfaces of the soil gas collection plenum.

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Figure 4: Soil Gas Collection Plenum

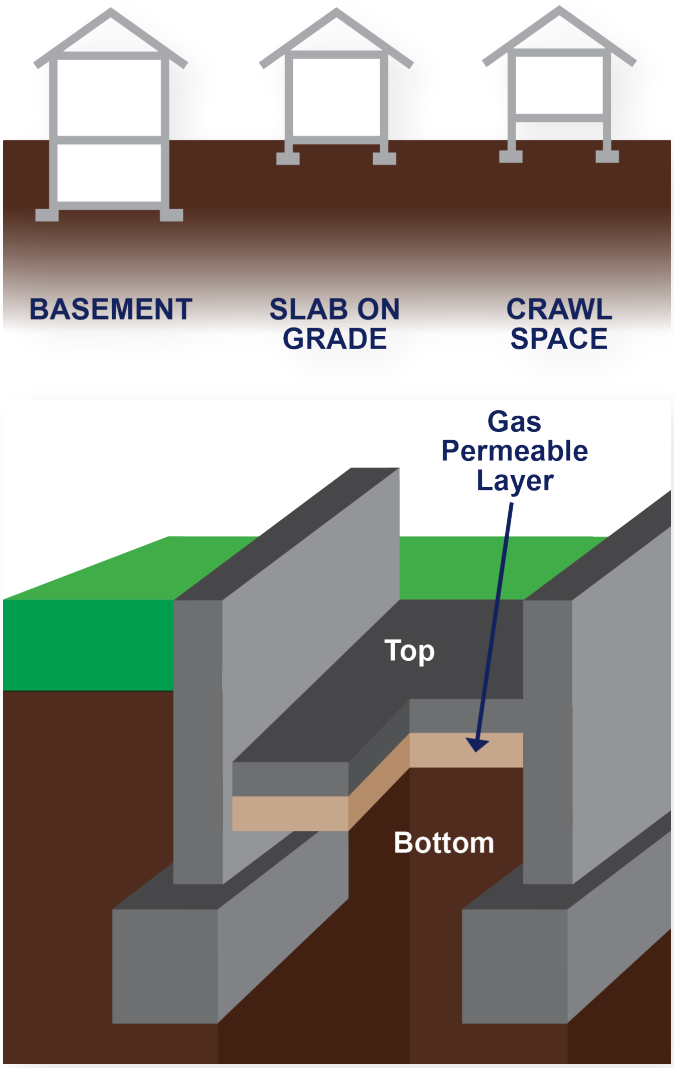
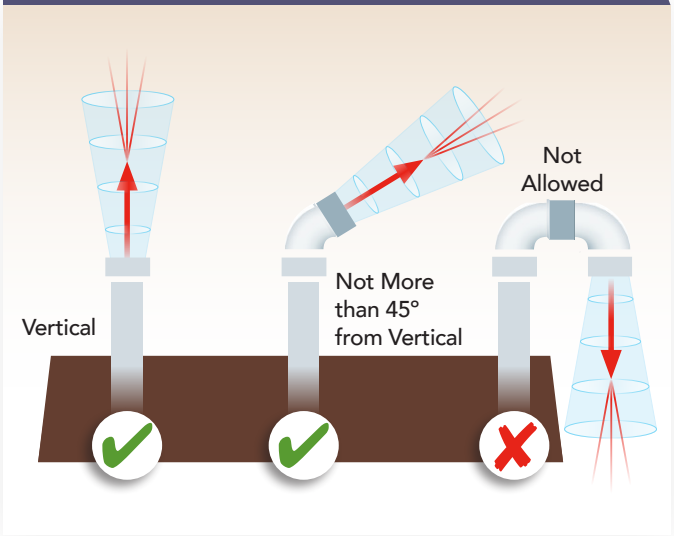


Figure 5. ASD Exhaust Discharge & ASD Fan



Plenum Construction

Plenums must be constructed so that the bottom and sides are closed before installing the gas permeable materials. Gas permeable materials include: sand, silt, and gravel. The permeable materials should be installed under the top of the plenum. It should be connected to an exterior foundation drain system, if applicable. Design the plenum so that poured concrete and water don't obstruct openings and ducts. Consult the ANSI/AARST CC-1000 2018 standard, "Soil Gas Control Systems in New Construction of Buildings" for the specific pipe sizes that are required. Use rigid, non-perforated piping to transition from the piping to the plenum. Install test ports prior to closing the plenum. Before closing the plenum, use the appropriate material to cover the area of installation—it will differ depending on the location (concrete floor, crawl space, or other enclosed space). Do a final inspection prior to completing indoor finishes. (See "Soil Gas Control Systems in New Construction of Buildings" for more details.)

Pressure Field Extension Evaluation

Evaluate newly constructed plenums by connecting a fan to the primary trunk of the exhaust vent pipe and measuring the resulting vacuum. Test the pressure for measurements of poor effectiveness and inconsistencies.

ASD Fan

Place the ASD fan inside the vertical piping near the exhaust location. ASD fans are designed to be in operation at all times and should be air- and water-sealed to protect it from damage, and to ensure an effective vacuum. The ASD fan should be inside the building in an uninhabited space such as an attic.

Exhaust Locations

Install the exhaust at or near the top of a building. The direction of the exhaust flow must be not more than 45 degrees from vertical. Exhaust locations should be located at least 15 feet from any building openings and frequently occupied spaces such as playgrounds, patios, or sidewalks.

Summary of Radon Standards of Practice *(continued)*

Complete Systems

To complete an ASD system, the following steps must be taken for effective operation and maintenance:

- **Label systems** – Label all major components of the system, including pipes, fans, and suction points.
- **Evaluate and test** – Have an HVAC specialist evaluate the system and conduct a short-term radon test 24 hours after turning the system on. If the test reveals elevated radon levels (4 pCi/L or greater), continue to retest every 2 years. If the test reveals less than 4 pCi/L, retest every 5 years.
- **Operate and maintain** – The contractor or soil gas mitigation specialist in charge of installing the system must prepare a written, working operation and maintenance plan that property owners and managers can use and implement.

Rough-in Systems

Some jurisdictions, located within regions that consistently result in elevated radon levels in the air, require a minimum of a passive radon mitigation system to be installed in all newly constructed homes. A "rough-in" mitigation system is a system that is installed during or immediately after construction of the building and before it is occupied. When such systems are installed, it is important to test for elevated radon levels prior to occupation, and activation of the system (fan installation) should occur if testing reveals elevated radon.

More Information

Call the National Radon Hotline to easily obtain approved radon test kits: 1 (800) 767-7236.

Visit the Radon Hotline website for more resources: www.epa.gov/radon/what-radon-hotline.

AARST/ANSI Standards: Visit https://www.epa.gov/radon/radon-standards-practice to read all of the AARST/ANSI Standards of Practice for radon and soil gas testing and mitigation.