

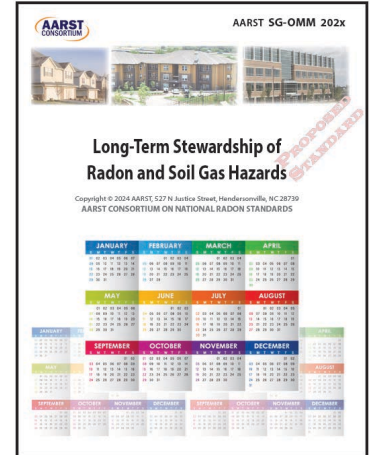
2nd Public Review of SG-OMM 202x

Long-Term Stewardship of Radon and Soil Gas Hazards

This standard of practice provides prescriptive requirements and guidance for long-term management of hazards associated exposure to indoor *radon* gas and chemical vapors, to include:

- a) monitoring *radon* and soil gas *hazards* across time to protect building occupants, and
- b) continued operation and maintenance of systems designed to reduce soil gas hazards.

The requirements in this standard of practice are applicable to all buildings intended for occupancy, except dwellings where the owner is both the occupant and responsible party for maintaining stewardship of radon and soil gas hazards. This standard does not contain requirements for compliance by professional service providers contracted to provide related services.



COMMENT DEADLINE: April 21st, 2025

REQUESTED PROCESS AND FORM FOR FORMAL PUBLIC REVIEW COMMENTS

Submittals (MS Word preferred) may be attached by email to 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.)

REQUESTED FORMAT

Public Reviewed Item and Its Date: SG-OMM 202x

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

Repeat the four bullet items above for each comment.

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SG-OMM 202x

Long-Term Stewardship of Radon and Soil Gas Hazards

Significance of Purpose

This document contains minimum requirements and guidance designed to respond to the health threat of radon gas, chemical vapors, and other hazardous soil gases.

Designation: SG-OMM

As used for catalogue identification, “SG-OMM” stands for Soil Gas-Operation, Maintenance and Monitoring.

Normative References

ANSI/AARST MAH	(Protocol for Conducting Measurements of Radon and Radon Decay Products in Homes)
ANSI/AARST MA-MFLB	(Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily, School, Commercial and Mixed-Use Buildings)
ANSI/AARST MW-RN	(Protocol for the Collection, Transfer and Measurement of Radon in Water)
EPA TO-15:	(EPA/600/4-90/010 1990 Compendium of Methods for the Determination of Air Pollutants in Indoor Air)
EPA TO-17:	(EPA/625/R-96/01b 1999 Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air - Second Edition)

Other ANSI/AARST standards developed to respond to the health threat of radon gas, chemical vapors, and other hazardous soil gases:

ANSI/AARST SGM-SF	(Soil Gas Mitigation Standards for Existing Homes)
ANSI/AARST SGM-MFLB	(Soil Gas Mitigation Standards for Existing Multifamily, School, Commercial and Mixed-Use Buildings)
ANSI/AARST CCAH	(Reducing Radon in New Construction of One- & Two-Family Dwellings and Townhouses)
ANSI/AARST CC-1000	(Soil Gas Control Systems in New Construction of Multifamily, School, Commercial and Mixed-Use Buildings)

Other ANSI/AARST standards developed to respond to the threat of cancer caused by radon:

ANSI/AARST MS-QA	(Radon Measurement Systems Quality Assurance)
ANSI/AARST MS-PC	(Performance Specifications for Instrumentation Systems Designed to Measure Radon Gas in Air)
ANSI/AARST RRNC	(Rough-in of Radon Control Components in New Construction of 1 & 2 Family Dwellings and Townhouses)

AARST Consortium on National Standards

Website: www.standards.aarst.org Email: standards@aarst.org

527 N Justice Street, Hendersonville, NC 28739

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) as they become available (such as templates for field notices, inspection forms, interpretations and approved addenda updates across time).

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SG-OMM

Long-Term Stewardship of Radon and Soil Gas Hazards



SECTION 1

SCOPE

1.1 Scope and Purpose

This standard of practice provides prescriptive requirements and guidance for long-term management of hazards associated with exposure to indoor *radon* gas and chemical vapors, to include:

- a) monitoring *radon* and soil gas *hazards* over time to protect building occupants, and
- b) continued operation and maintenance of systems designed to reduce soil gas hazards.

The requirements in this standard of practice are applicable to all buildings intended for occupancy including the use of buildings or structures, or a portion thereof, for single family, multifamily or congregate residential occupancies and nonresidential occupancies such as educational and commercial occupancies.

Exception: Dwellings where the owner is both the occupant and responsible party for maintaining stewardship of radon and soil gas hazards.

1.2 Applicability

1.2.1 *Responsible parties*

This standard of practice does not contain requirements for compliance by professional service providers contracted to provide any or all services needed to meet the requirements herein. The party responsible for compliance is the property owner or manager responsible for safe conditions in the building(s).

1.2.2 *Stewardship practices*

This standard of practice addresses monitoring to confirm low hazard conditions over time, to include:

- a) Initial assessments and re-assessments to assure low hazard conditions; and
- b) *Operation, maintenance, and monitoring (OM&M) for mitigation systems* based on:
 1. *Active soil depressurization (ASD) methods*; and
 2. *Non-ASD mitigation methods and systems*.

1.2.3 *Applicable provisions*

The terms “shall” and “required” indicate provisions herein that are mandatory for compliance with this standard. The terms “note”, “informative”, “should” and “recommended” indicate provisions considered to be helpful or good practice but that do not contain a mandatory requirement.

1.3 Limitations

1.3.1 *Jurisdictional compliance*

This standard of practice does not contain all code or other jurisdictional requirements where a *mitigation system* is installed. Adherence to this standard does not guarantee or supersede compliance with applicable codes or regulations of any federal, state, or other *authority having jurisdiction (AHJ)*.

1.3.2 *Source materials*

This standard does not address *OM&M* practices associated with hazardous gases or substances in outside air, combustible soil gases, or characterization, possession, handling, containment, generation, or disposal of radioactive or chemically contaminated materials.

1.3.3 *Combustible gases and contaminated source materials*

This standard does not address practices associated with combustible soil gases and removal of contaminated source materials, including:

- a) Capture, containment and disposal of chemically contaminated vapor or condensate; and
- b) Chemical products stored or associated with building materials.

1.3.4 *Safety and regulatory authorities*

This standard of practice is not intended to address all safety concerns associated with its use. The user of this standard is responsible to establish appropriate health and safety practices and for determining the applicability of regulatory limitations prior to using the standard.



SECTION 2

DEFINITION OF TERMS

Terms not defined herein have their ordinary meaning as defined in “Merriam-Webster’s Dictionary.”

- 2.1 action level (radon), n—A threshold that warrants taking action to protect occupants. The radon action level in the U.S. is 4 pCi/L (150 Bq/m³) or greater, as published by the United States Environmental Protection Agency (USEPA).
- 2.2 action level (VI), n—The concentration of any specific *chemical of concern* that warrants taking action to reduce occupant exposure, as published by *authorities having jurisdiction (AHJ)*.
- 2.3 acute hazard, n—Concerns of harmful effects from immediate or short-term exposure (e.g., ≤ 30 days).
- 2.4 active soil depressurization (ASD), n—A fan-driven system to create a vacuum in soils that is greater in strength than the vacuum applied to the soil by air pressures within the building. ASD mitigation systems include, but are not limited to, sub-slab depressurization (SSD), sub-membrane depressurization (SMD), and depressurization of non-habitable airspaces.
- 2.5 attenuation factor, n—Calculations for estimating indoor concentrations of soil gas hazards based on subsurface concentrations of *chemicals of concern*.
- 2.6 authority having jurisdiction (AHJ), n—Federal, state, province, township, or other jurisdictional body having authority over practices or products.
- 2.7 Becquerel per Cubic Meter (Bq/m³), unit of measurement—A unit of radioactivity representing one disintegration per second per cubic meter: 1 Bq/m³ (0.027 pCi/L).
- 2.8 chemical of concern (COC), n—A chemical in vapor, liquid, or soil that has been identified at a site ~~location~~ to potentially pose health and safety hazards.
- 2.9 chemicals of concern (COCs), n—More than one *chemical of concern*.
- 2.10 chronic or continuous hazard, n—Repeated exposure by the oral, dermal, or inhalation route for more than approximately 10% of the life span in humans or repeated exposure events (e.g., ≥ 26 years) to somewhat higher concentrations to result in a similar degree of hazardous exposure.
- 2.11 clearance testing, n—As required within radon measurement protocols in accordance with ANSI/AARST MA-MFLB. The clearance test procedure includes testing all ground-contact dwellings and non-residential rooms that are occupied or intended to be occupied; not less than 10% of dwellings and non-residential rooms on each upper floor; and any mitigated areas on upper floors.
- 2.12 hazardous soil gas, n—Soil gases and vapors regulated by the jurisdiction having authority due to toxic, flammable, or explosive hazards.
- 2.13 Jobsite logs, n—Records of actions taken or verification of compliance with standards or design features that may be recorded by staff, subcontractor staff, supervisors, third-party inspectors, or the *AHJ*.
- 2.14 mitigation, n—Reducing occupant exposure to indoor concentrations of airborne *radon* gas or other hazardous gases or vapors that enter a building with other soil gases or enter a building from water that is exposed to indoor air.
- 2.15 mitigation system, n—Any system designed to reduce indoor air concentrations of *radon* gas, *chemicals of concern* or other soil gas pollutants.

- 2.16 non-ASD, n—Mitigation methods that rely on passive methods, mechanical dilution or pressurization of indoor air, or cleaning of air or water. If used as stand-alone methods, non-ASD methods do not rely on *active soil* depressurization.
- 2.17 operation, maintenance, and monitoring (OM&M), n—The process of surveillance for continued operation and maintenance of installed components and performance measurements to verify continued low hazard conditions.
- 2.18 performance test, n—A test procedure to characterize the general degree of effectiveness for mitigation efforts within a specific area of a building.
- 2.19 picocuries per liter (pCi/L), unit of measurement— A unit of measurement for the amount of radioactivity in a liter of air. CONVERSION: $1.0 \text{ pCi/L} = 37 \text{ Bq/m}^3$.
- 2.20 pressure field extension (PFE): The distance a pressure change, created by drawing soil-gas through a suction point, extends outward across a sub-slab gas permeable layer, under a membrane, behind a solid wall, or within a hollow wall.
- 2.21 radon (Rn), n—A colorless, odorless, naturally occurring, radioactive, inert gaseous element formed by radioactive decay of radium-226 (Ra-226). Its atomic number is 86. Although other isotopes of radon occur in nature, this document refers to radon gas Rn-222. Rn-222 is measured in *picocuries per liter (pCi/L)* or in *Becquerel per cubic meter (Bq/m³)*.
- 2.22 soil gas, n—Air within soil that can contain *radon gas, chemicals of concern*, or other hazardous gases or vapors.
- 2.23 subchronic hazards, n—Repeated exposure by the oral, dermal, or inhalation route for more than 30 days up to approximately 90 days, or more than approximately 10% of the life span in humans.

SECTION 3 MEASURING CONCENTRATIONS AND AIR PRESSURE RELATIONSHIPS.

3.1 Measuring Radon Gas

Radon gas measurement events shall be conducted, as applicable to building type, in accordance with:

- a) ANSI/AARST MAH: *Protocol for Conducting Measurements of Radon and Radon Decay Products in Homes*; or
- b) ANSI/AARST MA-MFLB: *Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily, School, Commercial, and Mixed-Use Buildings*.

3.2 Measuring Chemicals of Concern (COCs)

3.2.1 Measurement methods

Measurement to characterize COC concentrations shall be conducted using one of the following methods:

- a) EPA TO-15: EPA/600/4-90/010 1990 *Compendium of Methods for the Determination of Air Pollutants in Indoor Air*;
- b) EPA TO-17: EPA/625/R-96/01b 1999 *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air - Second Edition*); or
- c) Other existing or new methodology approved by the AHJ.

3.2.2 Indoor air measurement

Indoor measurements to characterize indoor COC concentrations shall be conducted in accordance with methods and procedures required in this [Section 3.2.1](#) and in Normative [Annex A](#).

3.2.3 Soil gas measurements

Measurement events that intend to characterize COC concentrations in soil gas shall be conducted in accordance with standard industry practices deemed acceptable to the AHJ.

3.2.4 Characterization of COCs

Where characterizing health risks from chemical vapor, measurements shall be conducted in accordance with requirements in a), b), c) and d) in this [Section 3.2.4](#).

- a) Measurements that provide a full suite for possible COCs concentrations in soil or groundwater in proximity to the building foundation shall be conducted or available for review.
Exception: Where COCs are known based upon previous sampling or characterizations, a full suite of measurements for possible COCs concentrations is not required.
- b) Where required by the AHJ or by contract, indoor measurements shall be conducted.
- c) Based on measurements that included a full suite of possible COCs present in soil or groundwater, it is permissible to conduct future soil gas and indoor measurements that are limited to COCs identified as the primary or representative concern.
- d) Additional lines of evidence, acceptable to the AHJ, shall be permitted for characterizing health risks. Additional measurements of tracer gases, such as *radon*, are among many examples.

3.3 Test Conditions

Test conditions during indoor air measurements and during air pressure measurements conducted for *performance testing* purposes shall be conducted and recorded in accordance with this [Section 3.3](#).

3.3.1 Test conditions for indoor air sampling of COCs

Indoor air measurements for COCs shall be conducted under conditions required in Normative [Annex A](#).

3.3.2 Test conditions for air pressure measurements

Additional test condition information shall be recorded when conducting air pressure measurements, in accordance with Normative Annex B.

3.3.3 Record seasonal conditions

For radon tests and sampling of indoor air for COCs and air pressure measurement events, Table 3.3.3 specifies information that shall be provided with reports of the event. The information provided shall compare test conditions to annual average conditions, as defined in a), b) and c) of this Section 3.3.3.

Table 3.3.3		Reporting Comparison of Building Operating Conditions		* Required data
Outdoor Temperatures		Prevailing Annually	Prevailing During the Test	
	Average	Average annual outdoor temperature *	Average outdoor temperature during test *	
Operating Condition	Heating Conditions	yearly percentage *	percentage during test *	
	Cooling Conditions	yearly percentage *	percentage during test *	
	Mixed Conditions	yearly percentage *	percentage during test *	
Prevailing Operating Condition				
	Average	prevailing operating condition *	prevailing during test *	
Condition less likely to inhibit characterization of radon or soil gas hazard in indoor air		conditions for clear characterization *	conditions during test *	
Water table elevation (general status)			[] average [] low [] high *	
All exterior windows and doors closed			[] yes [] no *	
Indoor temperatures of between 65° and 80° F (18° - 27° C)			[] yes [] no *	

a) Seasonal Changes in Building Operation (defined)

Outdoor temperature conditions that dictate the building operation condition at any point in time shall be used to estimate the percentage of time that each building operation condition occurs during a test or period of interest. Local conditions shall be estimated and recorded as follows.

1. Heating season conditions shall be based on hourly durations when outdoor temperatures are less than 65°F (18° C).
2. Cooling season conditions shall be based on hourly durations when outdoor temperatures exceed 83° F (28° C).
3. Mixed conditions, where neither heating nor cooling conditions prevail, shall be based on hourly durations when outdoor temperatures are in the range of 65° F - 83° F (18° C - 28° C).
4. Coldest season shall be expressed based on the climate zone, as identified in Exhibit 3.3.

b) Annually Predominant Building Operating Conditions When Occupied (defined)

The annually predominant building operating conditions when occupied shall be determined, in accordance with Exhibit 3.3, as the building operating conditions that prevail during the greatest amount of time each year.

Note—For conditions during the test:

The percentage of heating, cooling and mixed conditions during the test can be derived by matching the average outdoor temperature during the test to other climate zone annual average temperatures, as provided in [Exhibit 3.3](#).

c) Seasonal Changes to Soil Permeability

A general statement shall be recorded on whether the local water table is close to annual average elevations or if it is higher or lower than average. Based on observed current and recent weather events, the characterization shall be rendered as a general observation with consideration that:

1. Across extended periods when spring rainfall is plentiful and accumulated snow starts to melt, the water table commonly rises, and
2. An extended period of dry weather commonly causes the water table to fall.

Note—The [WaterWatch](#) website published by the United States Geological Survey (USGS) can provide current details relative to estimating local or regional water table status.

Exhibit 3.3 Seasonal Building Operating Conditions When Occupied (By Climate Zone)

Informative advisory—While estimates can be made, it is not possible to predict worst case conditions based on a single *diagnostic* event or measurement. To know, one must test under conditions of concern.

		Caribou ME		Portland ME		Boston		New York, NY		Atlanta									
		Quebec		Buffalo NY		Albany NY		Philadelphia		Charlotte, NC									
		Marquette MI		Burlington NH		Pittsburgh PA		Richmond, VA		Birmingham AL									
		Duluth MN		Indianapolis		Cleveland		Baltimore		Jackson, MS									
		Winnipeg		Milwaukee		Chicago		Louisville		Memphis		Melbourne, FL							
		Grand Forks		Minneapolis		Omaha		Nashville		Dallas		Tampa, FL							
		Anchorage		Bismarck ND		Denver		Saint Louis		Austin		New Orleans		Miami, FL					
		Breckenridge		Pierre SD		Albuquerque		Kansas City		Las Vegas		Houston		Puerto Rico					
		Aspen		Cheyenne WY		Salt Lake		Amarillo TX		San Francisco		Brownsville		Virgin Islands		Certain			
		Fairbanks		Billings MT		Reno, NV		Portland, OR		Los Angeles		Phoenix		Honolulu		Asiatic			
				Helena MT		Boise, ID		Seattle		San Diego		Tucson		Guam		Regions			
		Zone 8		Zone 7		Zone 6		Zone 5		Zone 4		Zone 3		Zone 2		Zone 1			
		Subarctic		Very Cold		Cold		Cool		Mixed		Warm		Hot		Very Hot			
		Annual Average Outdoor Temperatures																	
Home & Work*	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	Hm	Wk	
	27 F	32 F	39 F	45 F	45 F	50 F	49 F	54 F	55 F	59 F	62 F	67 F	69 F	73 F	76 F	80 F	83 F	86 F	
	-3	0 C	4 C	7 C	7 C	10 C	9 C	12 C	13 C	15 C	17 C	19 C	21 C	23 C	24 C	27 C	28 C	30 C	
% per year	100		83		75		75		66		58		42		25		100		
	92		75		66		66		58		42		25		25		100		
Heating	8%		16%		25%		25%		16%		16%		16%		42%		50%		
Cooling	< Freezing		25%		16%		16%		25%		33%		42%		75%				
Neither	< Freezing		8%		16%		16%		16%		16%		16%		16%		16%		
Avg. Low Winter Temps	Zone 8		Zone 7		Zone 6		Zone 5		Zone 4		Zone 3		Zone 2		Zone 1		Acute		
	Dec/Jan/Feb		Dec/Jan/Feb		Dec/Jan/Feb		Dec/Jan/Feb		Dec/Jan/Feb		Dec/Jan/Feb		Dec/Jan/Feb		Dec/Jan/Feb		Dec/Jan/Feb		
	-6 F (-21 C)		2 F (-17 C)		9 F (-12 C)		17 F (-8 C)		26 F (-3 C)		35 F (2 C)		45 F (7 C)		61 F (16 C)		76 F (24 C)		

* Home (Hm) is based on 24-hour temperature averages. Work (Wk) is based on average daytime temperatures.

Climate zone temperatures based on 30-year averages published online in 2016 (e.g., the National Centers for Environmental Information-NOAA) for various cities located within each climate zone. Zone classifications reflect ASHRAE standards 90.1 / 90.2 (The American Society of Heating, Refrigerating and Air-Conditioning Engineers) <https://www.ashrae.org>

SECTION 4

INITIAL AND FOLLOW-UP ASSESSMENTS

4.1 Initial Assessment

Though *mitigation* efforts are not prohibited at any time, assessments, testing, and performance testing shall comply with [Section 3](#). Where passive *mitigation* methods are included during construction of a building, measurements of indoor air shall be conducted prior to or within 90 days of occupancy.

4.2 Where Below Action Levels

Where decisions to not mitigate *radon* or vapor concentrations rely on indoor air measurements that have indicated occupant hazards are below the *action level*, testing shall be conducted again:

- a) within 1 year after initial testing or assumption of *OM&M* duties, if tests have not been conducted under conditions that represent the annually predominant building operating condition when occupied, as defined in [Section 3.3.3 b](#); and
- b) no less than every 5 years, or as required by the *AHJ* for vapor intrusion.

4.3 Decisions Based On Fluctuating Data

Where decisions on whether to mitigate relied on the results of indoor air concentration or air pressure testing procedures that evaluated fluctuations in soil gas entry and distribution, an equivalent test procedure shall be repeated, or as determined by the *AHJ* for vapor intrusion, to reconfirm occupant hazards are below the *action level*:

- a) Not less than every five years; and as applicable
- b) Included in initial post-mitigation testing.

4.4 Decisions to Mitigate

Mitigation efforts shall be undertaken where measured concentrations equal or exceed the national *action level* for *radon* or the *action level* established by the *AHJ* for *COCs* until occupant hazard exposure is below the *action level*.

For *COC* vapor intrusion, decisions to mitigate are permitted to be based on any of the following evaluations relative to hazards attributable to soil gas entry:

- a) Measurements of soil gas adjoining a building foundation with consideration for *attenuation factors* acceptable to the *AHJ*;
- b) Measurements of indoor air confirmed to be coming from soil with consideration for action levels established by the *AHJ* and where required by the *AHJ*; or
- c) Lines of evidence indicating that vapor intrusion hazards exceed the *action level* established by the *AHJ*.

4.5 Initial Post-Mitigation (Commissioning) Evaluation

4.5.1 Initial mitigation effectiveness

Mitigation efforts shall not be regarded as complete until an initial verification for *mitigation* effectiveness is achieved. Verification efforts shall meet requirements of a) or b) of this [Section 4.5.1](#).

- a) Radon Gas
Post-*mitigation radon gas* measurements shall be conducted in accordance with the applicable measurement standard listed in [Section 3.1](#) (Measuring Radon Gas).
- b) COC
Post-*mitigation COC* evaluations for *mitigation* effectiveness shall be conducted to include:
 1. Air pressure measurements in soil relative to indoor air where *ASD* systems are employed and, where required by the *AHJ* or client, indoor air measurements;

2. Indoor air measurements where *non-ASD* methods are employed; and
3. Where used to make *mitigation* decisions, other lines of evidence to demonstrate *mitigation* effectiveness.

4.5.2 *Additional mitigation actions*

Whenever *mitigation* systems or methods are found to not reduce hazards to below the action level:

- a) The *mitigation* efforts shall be evaluated by a trained and qualified *mitigation* professional; and
- b) Additional *mitigation* efforts shall be undertaken until occupant exposure to the indoor air hazard is below the action level.

4.6 **OM&M Manuals**

Where buildings are not maintained by the owner/occupant of a home, a plan for *OM&M* embodied in a written *OM&M* manual that complies with Normative **Annex C** shall be created.

4.6.1 *Where below the action level*

Where measurements indicate occupant hazards are below action levels, the *OM&M* plan shall include additional measurements over time in compliance with this standard.

4.6.2 *Mitigation systems*

The *OM&M* plan for mitigation systems shall be approved by a qualified mitigation professional and shall include operation, maintenance and monitoring events that are compliant with this standard.

4.7 **Monitoring Due to Cause**

Regardless of whether mitigation efforts have occurred or the type of mitigation method, procedures that comply with applicable portions of **Section 3** shall be conducted as required in **Table 4.7**.

Table 4.7 Stewardship Monitoring Due to Cause

Procedures to verify continued low hazard conditions shall be conducted in conjunction with any sale of a building and after any of the following events occur:

- ✓ New adjoining additions, structures, or parking lots;
- ✓ Building reconfiguration or rehabilitation; or
- ✓ A ground contact area not previously tested is occupied or a building is newly occupied.

Note—Where the following changes to the structure are observed and substantial, procedures to verify continued low hazard conditions should be conducted:

- ✓ Heating or cooling systems are altered with changes to air distribution or pressure relationships;
- ✓ Ventilation is altered by extensive weatherization efforts;
- ✓ Sizable openings to soil occur due to:
 - groundwater or slab surface water control systems or sewer lines are added or altered (e.g., sumps, drain tiles, shower/tub retrofits, etc.) or
 - natural settlement causing major cracks to develop;
- ✓ Earthquakes, blasting, or formation of sink holes nearby; or
- ✓ An installed *mitigation* system is altered.

SECTION 5

SUBSEQUENT BUILDING CHARACTERIZATIONS

5.1 Seasonal Characterization

Within one year after *mitigation* efforts appear to meet *mitigation* goals, actions required in this **Section 5** shall be taken to ensure *mitigation* effectiveness across seasons. These actions shall be taken by the party assuming stewardship obligations, unless already conducted and included in an OM&M manual.

5.1.1 Characterizing seasonal effects

Steps to characterize building hazards shall be based on expectations resulting from initial testing or assessments. Methods for verifying seasonal effectiveness as required in **Section 5.2** shall include one or more methods identified in a) or b) of this **Section 5.1.1**.

- a) Seasonal testing, as required in **Section 5.2**. Alternatively for radon hazards, testing a full year duration is permissible if previous concentrations measured are less than twice the *action level*.
- b) Seasonal or yearlong air pressure testing of indoor air relative to air within soils.

5.2 Steps for Confirming the Degree of Hazard

Steps for seasonal characterizations shall include compliance with provisions in this **Section 5.2**. Though risk classifications are described herein, classifications of potential hazards, such as *chronic*, *subchronic*, or *acute* risk hazards shall be determined by or meet approval of the *AHJ*.

5.2.1 Class 1 risk—Chronic or continuous risk

Where radon testing has indicated less than 20 pCi/L (740 Bq/m³), or where vapor intrusion assessments have indicated potential harmful effects from continuous exposure to COCs across many years, seasonal building characterizations shall include not less than:


- a. One *performance test* for indoor concentration or *pressure field extension (PFE)* conducted under conditions that are representative of the annually predominant building operating condition when occupied, as indicated in **Exhibit 3.3**, and
- b. Another *performance test* for indoor concentration or *PFE* conducted under the alternate seasonal condition of longest annual duration.

The initial post-*mitigation* testing shall be allowed to qualify for one of the seasonal tests if representing a seasonal test condition required in this **Section 5.2.1**.

5.2.2 Class 2 and 3 risk—Subchronic or acute risk

Where radon testing has indicated 20 pCi/L (740 Bq/m³) or greater, or where vapor intrusion assessments have indicated potential harmful effects from repeated exposure events to COCs for more than 30-days up to approximately 90-days, or across 10% of a life span, seasonal building characterizations shall include testing as required in **Section 5.2.1**, and:

- a. Testing to evaluate the effects of changing water tables and precipitation where they occur for prolonged periods of weeks or months:
 1. When both heating season and lower *water table* elevations occur; and
 2. When both heating season and capped soil, due to snow or ice occurs; and
 3. When high *water tables* occur that have the potential to impede system performance or transport COCs closer to the structure; and
- b. Testing during an intermediate building operating condition under conditions that do not represent the two most predominant building operation conditions, as identified in **Exhibit 3.3**.

Exception: Where local seasonal weather conditions do not include the specific condition otherwise required to be evaluated in this **Section 5.2.2**. Note—See informational **Annex D**. 

SEC SECTION 6: MONITORING TO VERIFY LONG-TERM MITIGATION EFFECTIVENESS

6.1 Passive Mitigation Methods

Note—Closure of air pathways between soil and indoor air is an integral component of most mitigation methods. However, passive *mitigation* efforts without mechanical equipment rely solely on:

- a) Closure of air pathways between soil gas and indoor air; and
- b) Passive soil gas venting, where applicable, that may include efforts to:
 - 1. optimize thermal forces to passively enhance the volume of soil gas exhaust air; or
 - 2. optimize passive dilution of soil gas before soil gas enters a building.

6.1.1 Passive Only

Where efforts to passively mitigate soil gas entry or indoor concentrations without mechanical equipment are implemented, installed, or found in a building, the applicable ongoing monitoring shall comply with **Table 6.1** when testing procedures indicate indoor air concentrations are below action levels.

6.1.1.1 Validation

Validation of initial effectiveness for passive mitigation efforts shall not be complete if no tests have been conducted under conditions that represent the annually predominant building operating condition when occupied, as defined in **Section 3.3.3 b**.

6.1.2 OM&M Manual

Requirements for an OM&M Manual (Annex C) shall apply for situations that include where attempting mitigation by passive means and where passive *mitigation* methods have been included during construction of a new building.

Examples of items to be visually inspected for maintenance are provided in **Annex C, C-4.3, a)**.

Table 6.1 Ongoing Monitoring Methods and Frequency		Radon and Vapor Intrusion
All Buildings		
Passive Methods		
Annual Functionality Inspections	Not less than annually, visual inspections shall verify closure for openings between soil and indoor air and general integrity of any passive vent components that may include soil gas vent piping.	
Indoor Air Measurements	Indoor air testing shall be conducted every 5 years, or as required by the <i>AHJ</i> , to verify continued effectiveness.	
Monitoring Due to Cause	Whenever ownership, occupancy or physical changes to the building occur, as specified in Table 4.7, indoor measurements shall be conducted.	

6.2 ASD Mitigation Systems

Where active soil depressurization (ASD) mitigation systems are installed, ongoing validation of performance shall comply with this **Section 6.2**. Targeted monitoring periods shall include during building operating conditions known to render the system most vulnerable to compromised effectiveness.

Examples of items to inspect for maintenance are provided in **Annex C, C-4.3, a), b) and c)**.

6.2.1 ASD in homes

Where an ASD mitigation system is installed or found in a home, the applicable ongoing monitoring shall comply with **Tables 6.2.1-A and 6.2.1-B**.

Table 6.2.1-A		Ongoing Monitoring Methods and Frequency	Radon
		For Homes	
ASD Systems			
Annual Functionality Inspections	Not less than annually, visual inspections or remote monitoring shall verify ASD fans are operating.		
Mechanical Inspections	Prior to initiating radon testing, inspections shall be conducted to verify the functionality and integrity of system components, including closure for openings between soil and indoor air.		
Biennial Indoor Air Measurements	Radon testing shall be conducted every 2 years to verify continued effectiveness.		
Monitoring Due to Cause	Whenever ownership, occupancy or physical changes to the building occur, as specified in Table 4.7 , indoor radon measurements shall be conducted.		
Monitoring Relative to Risk	Where radon testing has indicated 20 pCi/L (740 Bq/m ³) or greater, radon testing shall be conducted annually.		

Table 6.2.1-B		Ongoing Monitoring Methods and Frequency	Vapor Intrusion Homes
ASD Systems			
Annual Mechanical Inspections	Prior to initiating the <i>PFE</i> or indoor air measurements, inspections shall be conducted to verify the functionality and integrity of system components, including closure for openings between soil and indoor air.		
Annual Air Pressure Measurements	<i>Pressure field extension (PFE) performance testing</i> shall be conducted annually to verify continued effectiveness.		
Indoor Air Measurements	Indoor air measurements shall be conducted as required by the <i>AHJ</i> relative to methods and frequency.		
Monitoring Due to Cause	Whenever ownership, occupancy or physical changes to the building occur, as specified in Table 4.7 , <i>PFE performance testing</i> , and indoor measurements where required by the <i>AHJ</i> , shall be conducted.		
Monitoring Relative to Risk	Where assessments indicate exposure to COCs represents an <i>acute</i> hazard, a method shall be configured to achieve continuous monitoring of system operation.		

6.2.2 ASD in larger buildings

Where an ASD mitigation system is installed or found in a multifamily, school, commercial, or mixed-use building, the applicable ongoing monitoring shall comply with Tables 6.2.2-A and 6.2.2-B.

Table 6.2.2-A Ongoing Monitoring Methods and Frequency		Radon
Multifamily, School, Commercial and Mixed-Use Buildings		
ASD Systems		
Annual Functionality Inspections	Not less than annually, visual inspections or remote monitoring shall verify ASD fans are operating.	
Mechanical Inspections	Prior to initiating radon air testing, inspections shall be conducted to verify the functionality and integrity of components, including closure for openings between soil and indoor air	
Biennial Indoor Air Measurements	After initial <i>post-mitigation clearance testing</i> , testing shall be conducted at approximately 2-year intervals (in between 5-year <i>clearance test</i> events) for all previously tested locations for mitigated areas.	
	<i>Clearance test</i> procedures, in accordance with ANSI/AARST MA-MFLB, shall be conducted at least every 5 years.	
Suspension of Biennial Indoor Air Measurements	While <i>clearance testing</i> must be conducted at least every 5 years, it is permitted to suspend 2-year interval testing for mitigated areas where the required effectiveness of a <i>mitigation</i> system has been verified for at least eight sequential years, and such systems continue to be: <ol style="list-style-type: none"> 1. Visually inspected annually to verify fan operation, and 2. Mechanically inspected at 2-year intervals to verify appropriate functionality and integrity of system components, including closure for openings between soil and indoor air. 	
Monitoring Due to Cause	Whenever ownership, occupancy or physical changes to the building occur, as specified in Table 4.7, indoor air measurements shall be conducted.	
Monitoring Relative to Risk	Where radon testing has indicated 20 pCi/L (740 Bq/m ³) or greater, radon testing shall be conducted annually.	

Table 6.2.2-B Ongoing Monitoring Methods and Frequency		Vapor Intrusion
For Multifamily, School, Commercial and Mixed-Use Buildings		
ASD Systems		
Annual Mechanical Inspections	Prior to initiating PFE or indoor air testing, inspections shall be conducted to verify the functionality and integrity of system components, including closure for openings between soil and indoor air.	
Annual Air Pressure Measurements	<i>Pressure field extension (PFE) performance testing</i> shall be conducted annually to verify continued system effectiveness.	
Indoor Air Measurements	Indoor air measurements shall be conducted as required by the <i>AHJ</i> relative to methods and frequency.	
Monitoring Due to Cause	Whenever ownership, occupancy or physical changes to the building occur, as specified in Table 4.7 , <i>PFE performance testing</i> procedures, and indoor measurements where required by the <i>AHJ</i> , shall be conducted.	
Monitoring Relative to Risk	Where assessments indicate exposure to COCs represents an <i>acute</i> hazard, a method shall be configured to achieve continuous monitoring of system operation.	

6.3 Non-ASD Mitigation Systems or Methods

Where non-ASD mitigation systems or methods are employed, ongoing validation of performance shall include all applicable provisions required in this **Section 6.3**. Targeted monitoring periods shall include during building operating conditions known to render the system most vulnerable to compromised effectiveness.

Note—*Non-ASD mitigation* methods are those that rely on:

- a) mechanical dilution and/or pressurization of indoor air
- b) mechanical dilution or pressurization of soil gas that adjoins the building foundation, or
- c) cleaning of air or water.

Examples of items to inspect for maintenance are provided in **Annex C, C-4.3, a), b) and d)**.

6.3.1 Non-ASD in homes

Where a *mitigation* design that relies on *non-ASD* methods is implemented, installed, or found in a home, the applicable ongoing monitoring shall comply with **Tables 6.3.1-A and 6.3.1-B**.

Table 6.3.1-A Ongoing Monitoring Methods and Frequency		Radon
Homes		
Non-ASD Methods		
Annual Functionality Inspections	Not less than annually, visual inspections or remote monitoring shall verify system operation, control settings and general integrity of system components.	
Mechanical Inspections	Prior to initiating radon testing, inspections shall be conducted to verify the functionality and integrity of system components, including closure for openings between soil and indoor air.	
Biennial Indoor Air Measurements	Radon testing shall be conducted every 2 years to verify continued system effectiveness.	
Monitoring Due to Cause	Whenever ownership, occupancy or physical changes to the building occur, as specified in Table 4.7 , indoor measurements shall be conducted.	
Monitoring Relative to Risk	Where radon testing has indicated 20 pCi/L (740 Bq/m ³) or greater, radon testing shall be conducted annually.	
Radon In Water	Where <i>mitigation</i> methods include mitigating <i>radon</i> from water supplies, biennial measurements shall include measurements of <i>radon</i> in water*. Where determined to be the only <i>mitigation</i> method needed, indoor air testing is not also required.	

* Measurements of *radon* in water that enters a dwelling through groundwater supplies, such as a well, shall be conducted in compliance with ANSI/AARST MW-RN (*Protocols for the Collection, Transfer and Measurement of Radon in Water*)

Table 6.3.1-B		Ongoing Monitoring Methods and Frequency	Vapor Intrusion Homes
Non-ASD Methods			
Annual Mechanical Inspections	Prior to initiating the indoor air testing, inspections shall be conducted to verify the functionality and integrity of system components, including closure for openings between soil and indoor air.		
Annual Indoor Air Measurements	Indoor air measurements of COCs shall be conducted annually, or as required by the <i>AHJ</i> , to verify continued effectiveness.		
Monitoring Due to Cause	Whenever ownership, occupancy or physical changes to the building occur, as specified in Table 4.7 , indoor measurements shall be conducted.		
Monitoring Relative to Risk	Where assessments indicate exposure to COCs represents an <i>acute</i> hazard, a method shall be configured to achieve continuous monitoring of system operation.		

6.3.2 *Non-ASD in larger buildings*

Where a *mitigation* design that relies on *non-ASD* methods is implemented, installed, or found in a multifamily, school, commercial, or mixed-use building, the applicable ongoing monitoring shall comply with [Tables 6.3.2-A and 6.3.2-B](#).

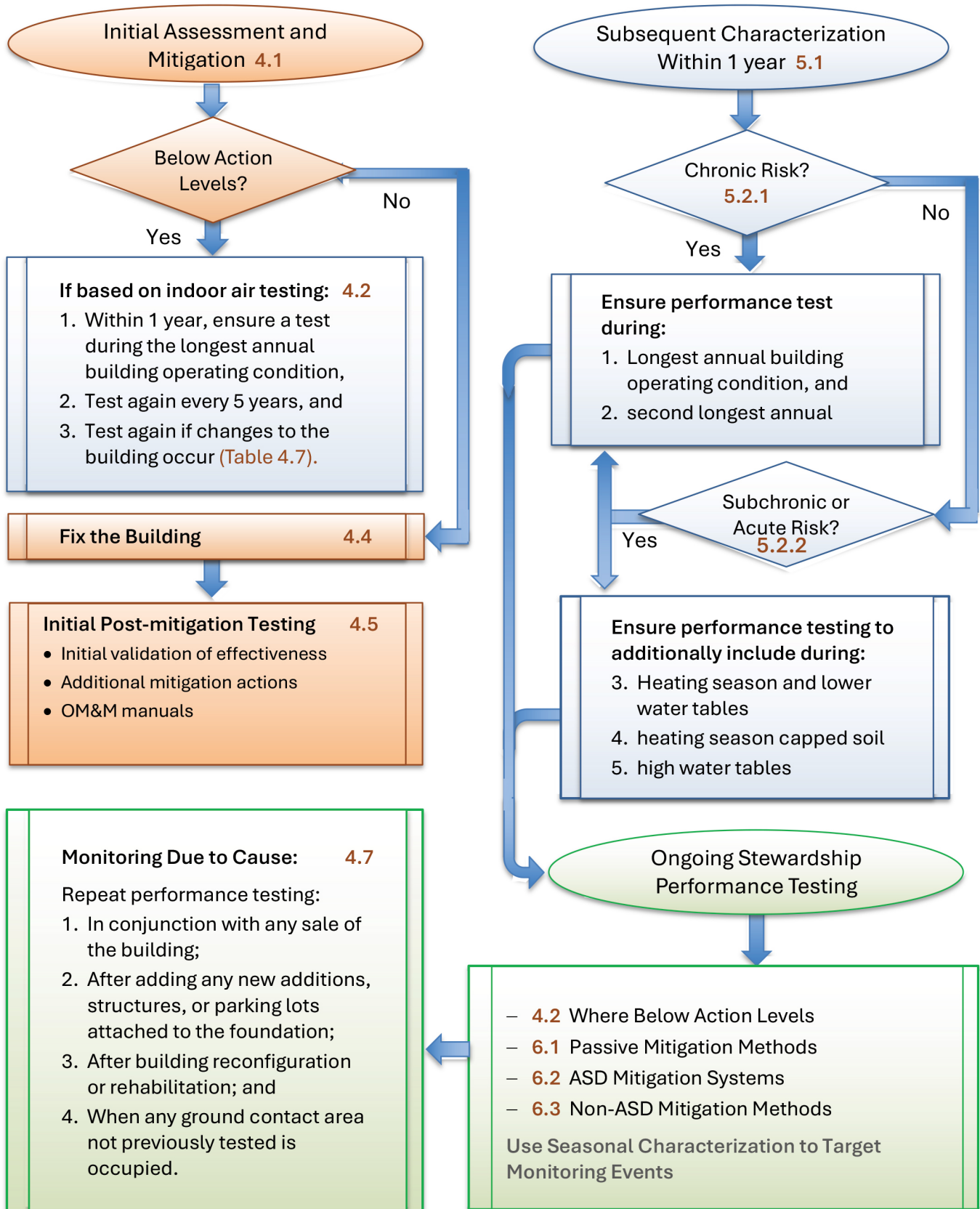
Table 6.3.2-A Ongoing Monitoring Methods and Frequency		Radon
Multifamily, School, Commercial and Mixed-Use Buildings		
Non-ASD Methods		
Annual Functionality Inspections	Not less than annually, visual inspections or remote monitoring shall verify system operation, control settings and general integrity of system components.	
Mechanical Inspections	Prior to initiating radon testing, inspections shall be conducted to verify the functionality and integrity of components, including closure for openings between soil and indoor air.	
Biennial Indoor Air Measurements	After initial <i>post-mitigation clearance testing</i> , testing shall be conducted at approximately 2-year intervals (in between 5-year <i>clearance test</i> events) for all previously tested locations for mitigated areas.	
	<i>Clearance test</i> procedures, in accordance with ANSI/AARST MA-MFLB, shall be conducted at least every 5 years.	
Suspension of Biennial Indoor Air Measurements	While <i>clearance testing</i> must be conducted at least every 5 years, it is permitted to suspend 2-year interval testing for mitigated areas where the required effectiveness of a <i>mitigation</i> system has been verified for at least eight sequential years, and such systems continue to be: <ol style="list-style-type: none"> 1. Visually inspected annually to verify fan operation, and 2. Mechanically inspected at 2-year intervals to verify appropriate functionality and integrity of system components, including closure for openings between soil and indoor air. 	
Monitoring Due to Cause	Whenever ownership, occupancy or physical changes to the building occur, as specified in Table 4.7 , indoor measurements shall be conducted.	
Monitoring Relative to Risk	Where radon testing has indicated 20 pCi/L (740 Bq/m ³) or greater, radon testing shall be conducted annually.	
Radon in Water	Where <i>mitigation</i> methods include mitigating <i>radon</i> from water supplies, biennial measurements shall include measurements of <i>radon</i> in water*. Where determined to be the only <i>mitigation</i> method needed, indoor air testing is not also required.	

* Measurements of *radon* in water that enters a dwelling through groundwater supplies, such as a well, shall be conducted in compliance with ANSI/AARST MW-RN (*Protocol for the Collection, Transfer and Measurement of Radon in Water*)

Table 6.3.2-B Ongoing Monitoring Methods and Frequency Vapor Intrusion Multifamily, School, Commercial and Mixed-Use Buildings	
Non-ASD Methods	
Annual Mechanical Inspections	Prior to initiating indoor testing, inspections shall be conducted to verify the functionality and integrity of system components, including closure for openings between soil and indoor air.
Annual Indoor Air Measurements	Indoor air measurements of COCs shall be conducted annually, or as required by the AHJ, to verify continued effectiveness.
Monitoring Due to Cause	Whenever ownership, occupancy or physical changes to the building occur, as specified in Table 4.7, indoor measurements shall be conducted.
Monitoring Relative to Risk	Where assessments indicate exposure to COCs represents an acute hazard, a method shall be configured to achieve continuous monitoring of system operation

6.4 Procedural Summary Flowchart (Informative)

Note—This exhibit provides an informational overview for the flow of stewardship procedures.



SECTION 7: DECOMMISSIONING VAPOR INTRUSION MITIGATION AND STEWARDSHIP

Note—In certain instances, the source of hazardous soil gas can be found to have migrated away from a building or concentrations found to be depleted. This can occur either naturally or because of remediation and related efforts. In such circumstances, considerations can include discontinued operation of soil gas *mitigation* systems and ongoing stewardship.

7.1 Decommissioning Systems

Before permanent discontinued operation of soil gas *mitigation systems* and ongoing stewardship, requirements in Sections 7.1.1 through 7.1.4 shall be met.

Exception: These steps are not applicable to soil vapor extraction (SVE) systems unless the SVE system is also designed to function as a soil gas *mitigation system*.

7.1.1 Step 1—Source remediation

With the *mitigation system(s)* still operating, it shall be demonstrated that the applicable groundwater or soil sources have been remediated to the satisfaction of the AHJ.

7.1.2 Step 2—Vapor evaluation

With the *mitigation system(s)* still operating, measurements of the COCs shall be conducted to verify source remediation using procedures approved by the AHJ.

Note—As an example, procedures might entail concentration measurements of vapor within the headspace of sumps that contain groundwater and within ASD exhaust piping.

7.1.3 Step 3—Checks for rebound

Where demonstration of source remediation has been confirmed by measurements of vapor concentrations in adjoining soil and indoors, the system can now be temporarily deactivated for evaluations to demonstrate if vapors rebound to unacceptable concentrations over time. The duration for continued sampling events, that may include accommodating seasonal evaluations, shall meet the approval of the AHJ.

7.1.4 Step 4—Decommissioning

Discontinued operation of the soil gas *mitigation systems* and ongoing stewardship requires approval of the AHJ.

7.2 Property Owner Guidance

The property owner shall be notified in writing that the *mitigation system* is being decommissioned not less than 60 days in advance of permanently deactivating or removal of the *mitigation system* and cessation of OM&M procedures. The notice shall include the following or equivalent message:

“Continued use and maintenance of the *mitigation system(s)* may be valuable for maintaining improved indoor air quality and protection from other soil gas hazards, such as *radon gas*.”

7.2.1 A copy of the OM&M manual shall accompany the notification as updated to include historic data relative to initial purpose and demonstration of evidence used to determine that deactivation is warranted.



Normative Annex A
INDOOR AIR TESTING FOR COCs

A-1 Before Testing

A-1.1 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) and b) of this **Section A-1.1**.

- a) Information about test conditions required in **Section A-4** shall be communicated in writing to the person responsible for the building not less than 24 hours prior to deployment of air sampling devices.
- b) Communications to clients or parties responsible for the property shall include essential elements required for compliance with closed-building protocols.

A-1.2 Adverse VOC influences

To minimize adverse influences on test results due to chemical vapors off-gassing from residual buildup within building materials, furniture, or from stored cleaning fluids or products, notifications and onsite review shall comply with requirements in a) and b) of this **Section A-1.2**.

a) **Stored Chemicals**

Efforts shall be made and documented to reduce off-gassing vapor influences on test results by removing chemicals such as those contained in household cleaning products and other stored chemicals.

b) **After Mitigation or Alteration**

Prior to evaluation of initial effectiveness after activation of a *mitigation system* fan or completion of other *mitigation* efforts, two conditions shall be addressed:

- 1. Valid test periods relative to existing indoor air concentrations begin no sooner than 24 hours after activation or completion of *mitigation* efforts; and
- 2. Valid test periods begin no sooner than 12 hours after initiating closed-building conditions.

Note—In absence of active mechanical air distribution, due to heating, ventilation, and air conditioning (HVAC) design or mild outdoor weather, closed-building conditions that extend to 24 hours or longer prior to sampling events may be advised.

A-2 Ground-Contact COC Test Locations

Indoor air testing procedures for COCs shall include targeting dwellings and nonresidential rooms that are occupied, or intended to be occupied, and that:

- a) have floors or walls in contact with the ground, and
- b) are closest to ground over untested ground-contact locations, to include the lowest level of the building over a crawl space, utility tunnel, parking garage or other non-habitable space that is in contact with ground.

A-2.1 Ground-contact dwellings

For ground-contact dwellings or living units, indoor air testing procedures for COCs shall include targeting the lowest level that serves or could serve as a living area, sleeping quarters, office, playroom or otherwise be occupied for residential use at some time in the future.

A-2.2 Non-residential ground-contact locations

For non-residential ground-contact locations, indoor air testing procedures for COCs shall include targeting ground-contact rooms, offices, classrooms, and other general use areas that are occupied or intended to be occupied.

A-3 Choosing A Location Within a Room

Air sampling devices and detectors for measuring COCs shall be placed in accordance with Table A-3.

Note—As overall guidance, place air sampling devices and detectors in the general breathing zone.

Table A-3 Requirements for Test Locations Within a Room		
<p>Air sample collection devices shall be located NOT less than:</p>	<ul style="list-style-type: none"> 3 feet (90 cm) from exterior doors and windows or other potential openings to the outdoors. 	<p>No less than 3 Feet (90cm) 3 Feet (90cm) 20 Inches (50cm)</p>
	<ul style="list-style-type: none"> 20 inches (50 cm) above the floor. 	
	<ul style="list-style-type: none"> 1 foot (30 cm) from the exterior wall of the building. 1 foot (30 cm) below the ceiling. 	<p>No less than 1 Foot (30cm) Exterior Walls 4 Inches (10cm)</p>
	<ul style="list-style-type: none"> 4 inches (10 cm) from other air sample collection devices and objects or surfaces that are above or to the side of the detector. <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>Side-by-side samples</p>	<p>Sample collection devices are to be not more than 8 inches (20 cm) from each other when seeking to use the average test result of two samples for QC checks and <i>mitigation</i> decisions.</p>	<p>No more than 8 Inches (20cm)</p>
<p>Where not easily disturbed</p>	<p><i>Informative Advisory</i>—Select a position within the room where the devices are unlikely to be disturbed, moved, or have their performance altered during the measurement period.</p>	
<p>Air sample collection devices shall NOT be located:</p>	<ul style="list-style-type: none"> inside closets, cabinets, drawers, sumps, crawl spaces or nooks in the building foundation. near heat sources, such as on appliances, radiators, fireplaces or in direct sunlight. near drafts caused by fans or heating and air conditioning vents or within enclosed areas of high air velocity such as mechanical/furnace closets. within enclosed areas that accumulate high humidity, such as bathrooms, laundry rooms and kitchens that are isolated by partitions and doors from adjoining less humid areas. <p>Exception: Where regularly occupied by workers for essential tasks, such as for cafeteria food preparation. Testing in such locations requires detector types that are virtually unaffected by high humidity which is to be confirmed by the manufacturer or laboratory prior to exercising this exception.</p>	

A-4 Test Conditions—Closed-building protocol

A-4.1 Closed-building conditions, much as they are for occupied conditions in heating seasons or summer cooling seasons, are required. Closed-building conditions compliant with **Tables A-4: A, B, and C**, and **Sections A-4.2 and A-4.3** 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 up to 90 days.

Table A-4: A ESSENTIAL CLOSED-BUILDING PROTOCOL REQUIREMENTS	
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 normal temperatures between 65° and 80° F (18° - 27° C)
Systems that temporarily ventilate with outdoor air for seasonal comfort or energy savings	Set to provide only the volume of outdoor air that is needed at all times of the year
Bathroom fans	Operate normally
Exhausts systems (that temporarily draw air from the building such as from laundries, workshops, community kitchens or for local control of fumes)	Avoid excessive operation
Fireplaces (that burn solid, liquid or gas fuels unless a primary/normal source of heat for the building)	Do not operate

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

Table A-4: C ADDITIONAL CLARIFICATION ON CLOSED BUILDING PROTOCOL REQUIREMENTS FOR SPECIFIC COMPONENTS	
Windows and Doors on all levels of the building including areas not being tested	
Broken windows or doors	Seal closed
Interior partition or stairway doors	Operate normally
Exterior doors into non-residential rooms	Keep closed (except for momentary entry and exit of individuals who customarily enter the building)
Garage doors and doors leading into a garage	Keep closed (except for momentary entry and exit).
Small Appliances	
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
Crawl Spaces	
Passive crawl space vents	Set vents to the condition that prevails during the greatest amount of time each year
Crawl space humidity control systems	Operate normally
Mechanical Systems	
Passive vents for combustion or makeup air	Leave open
Combustion appliance exhaust fans	Operate normally
Fans installed in attics to ventilate only attic air	
Window air conditioners	Operate in recirculation mode only
Evaporative cooling systems	Do not operate and do not cover

A-4.2 HVAC ventilation

A-4.2.1 Outdoor Air for Combustion Appliances

Openings to outside air designed to provide air needed for combustion appliances shall not be closed.

A-4.2.2 Ventilation with Outdoor Air

Where heating, ventilation, and air conditioning (HVAC) operation or design includes temporarily increasing outdoor air ventilation for seasonal comfort or energy savings, outside air inlet dampers shall be configured to provide only the minimum volume of outdoor air that is needed at all times of the year when the building or unique sector is significantly occupied.

Note—Further descriptions are provided in Annex D for Group 3 HVAC systems.

A-4.2.3 Temperature Control Via Air Volume

For variable air volume (VAV) systems that temper room temperatures using thermostats to vary the volume of heated or cooled air coming into rooms, thermostats shall be set to a normal occupied temperature in all portions of the building being tested that are served by the system.

Note—Further descriptions are provided in Annex D for Group 4 HVAC systems.

A-4.3 Individual dwellings or rooms in a shared building

When testing only one or several dwellings or rooms that are part of a shared building, such as an individual apartment, classroom or office, minimum requirements include closed-building conditions in accordance with this **Section A-4** for dwellings and non-residential enclosed rooms:

- a) immediately adjoining above and below the test location(s), and
- b) on all floors directly below test location(s) that are 3 stories or less above grade.

A-5 Minimum Requirements for Efforts to Verify Test Conditions

A-5.1 To fulfill minimum requirements for verifying test conditions, all following steps are **required**:

- a) Inform the person responsible for building operation of the required test conditions.
- b) Post notification of an “Air Test in Progress” in conspicuous locations stating the required conditions of the test.
- c) Request a signature on a noninterference agreement and note in the report if this document was not signed.
- 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:

1. upon placement of air sampling devices to help ensure all closed-building conditions and other protocol requirements are met; and
2. upon retrieval of air sampling devices to help verify that:
 - a. closed-building conditions and other protocol requirements are still being maintained;
 - b. air sampler placement has not changed; and
 - c. tamper seals, if employed, have not been broken.

A-5.2 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.

A-5.3 Quality control of test conditions

Test conditions, as specified in **Table 3.3.3**, shall be recorded, and retained in *OM&M* manual records. Additional quality control steps shall be permitted where deemed warranted by parties responsible for testing quality, such as extended periods between *mitigation* and initial *post-mitigation performance testing* or routine surveillance for compliance with test conditions.

Normative Annex B
AIR PRESSURE TESTING

B-1 PFE / Performance Test Conditions

Pressure measurements of indoor air relative to air within soils or, as applicable, air within adjoining indoor or outdoor air spaces are permitted for *performance testing ASD mitigation systems* and other *mitigation* methods that manipulate air pressure relationships to reduce the volume of soil gas entering a building.

B-1.1 Locations

A minimum of one differential pressure measurement shall be made at a location distant from the ASD suction point(s) with intent to evaluate if depressurization has been achieved or is being maintained within each targeted soil gas collection plenum.

B-2 Non-ASD

Performance testing of *non-ASD mitigation* methods shall include air differential pressure measurements where required by national standards, OM&M plans or *AHJ*, for *mitigation* methods that rely on mechanical systems to manipulate air pressure to achieve *mitigation* goals.

B-3 Jobsite Logs

Jobsite logs for each pressure measurement event shall be retained in OM&M manual records that include:

- a) The status of heating, cooling, or mixed HVAC operating conditions, at the time when conducting *PFE* or other air pressure *performance testing*;

Note—Differing HVAC operating conditions can alter and create false assumptions regarding *PFE* and other air pressure *performance testing* results.

- b) Whether this testing was conducted, as is recommended:
 - 1. with all exterior windows and doors, including garage doors, closed; and
 - 2. with normal occupied indoor temperatures of between 65° and 80° F (18° - 27° C);

- c) The duration prior to this testing that closed-building conditions prevailed.

Note—Closed conditions for one or more hours is recommended prior to air pressure testing; and

- d) Seasonal comparison data, as specified in **Section 3.3**.



Normative Annex C
OM&M MANUALS

C-1 Stewardship Obligations

Ownership and property management shall retain/produce, implement, maintain, and update, as applicable and as determined by the qualified professional, a plan for OM&M and a written OM&M manual in accordance with **Sections C-1** through **C-4.3** of this **Annex C**:

- a) The OM&M plan and manual shall be produced and implemented within 90 days of ownership for radon and within 6 months of ownership for other Soil Gas Hazards;
- b) The OM&M manual and all associated records shall be transferred to the new entity within 30 days whenever the party responsible for system maintenance and monitoring changes to another party who is not the owner/occupant of the property; and

- c) The OM&M manual shall be stored in a format (paper, electronic, other) that the manual and all details and records are readily and equally accessible to property ownership, management, and maintenance personnel.

C-2 Essential Content for All OM&M Manuals

The OM&M manual is to provide stewardship guidance and instruction that include:

- a) Statement of Stewardship Obligations included in C-1 of this Annex C;
- b) A general statement regarding ownership and property management stewardship obligations for assessment, re-assessment, mitigation, and development and implementation of an OM&M Plan and Manual; as well as engagement of a qualified professional regarding these obligations and OM&M content;
- c) A summary of historical testing and mitigation activities. Copies of available previous reports shall be maintained with the OM&M manual;
- d) Instruction to update contact information within the OM&M Manual and on system labels when there is a change in ownership or change in the party/person(s) responsible for maintaining low hazard conditions in the facility;
- e) The OM&M Manual is a living document for the life of the subject facility. Protocols and records are to be updated in the OM&M Manual unless or until the potential indoor environment hazard no-longer exists; as determined by the testing consultant(s), mitigation contractor(s), and/or qualified professional.
- f) Designating a person responsible for OM&M plan implementation and management;
- g) Awareness requirements and procedures for employees, tenants, visitors, and contractors;
- h) Employee training requirements;
- i) One property-specific checklist and schedule of ownership and property management ongoing OM&M Plan action items, as extracted from C-1 through C-4.3 of Annex C;
- j) Record keeping requirements; and
- k) Guidance to the property owner for decommissioning soil gas mitigation system(s). Included shall be a written recommendation: “Prior to decommissioning soil gas mitigation system(s), it is recommended to engage a Certified Radon Professional to evaluate and report on indoor radon conditions and render recommendations regarding decommission (with consideration of occupant exposure to radon). Continued use and maintenance of the mitigation system(s) may be valuable for maintaining improved indoor air and protection from other soil gas hazards, such as radon gas.”

C-3 Essential Testing Content

Where no assessment has been performed or assessment has identified low hazard conditions that do not require mitigation, the OM&M shall contain the following:

- a) Identify soil gas concerns and guidance.
 1. Should no radon testing reports be available for inclusion in historical information, the following or equivalent guidance shall be provided:

“We have no recent test reports or otherwise reliable evidence that radon testing has been conducted. Note—Any building on any parcel of land can have a radon problem. Radon concentrations cannot be predicted based on state, local or neighborhood radon measurements. Testing indoor air for radon is the only way to know.”

2. Should no testing reports relative to COCs be available for inclusion in historical information, the following or equivalent guidance shall be provided:

“We have no recent test reports or otherwise reliable evidence that chemical vapor testing has been conducted. Note—Should there be reason for concern, contact your state health department for further information.”

- b) The dates of initial assessment and re-assessments;
- c) Schedule for on-going re-assessments to assure low hazard conditions;
- d) Required procedures to verify continued low hazard conditions; and
- e) List of conditions/timing/events that necessitate procedures to verify continued low hazard conditions per Section 4.5 and Table 4.5, (Stewardship Monitoring Due to Cause).

Table 4.5 Stewardship Monitoring Due to Cause

Procedures to verify continued low hazard conditions shall be conducted in conjunction with any sale of a building and after any of the following events occur:

- ✓ New adjoining additions, structures, or parking lots;
- ✓ Building reconfiguration or rehabilitation; or
- ✓ A ground contact area not previously tested is occupied or a building is newly occupied.

Note—Where the following changes to the structure are observed and substantial, procedures to verify continued low hazard conditions should be conducted:

- ✓ Heating or cooling systems are altered with changes to air distribution or pressure relationships;
- ✓ Ventilation is altered by extensive weatherization efforts;
- ✓ Sizable openings to soil occur due to:
 - groundwater or slab surface water control systems or sewer lines are added or altered (e.g., sumps, drain tiles, shower/tub retrofits, etc.) or
 - natural settlement causing major cracks to develop;
- ✓ Earthquakes, blasting, or formation of sink holes nearby; or
- ✓ An installed *mitigation* system is altered.

C-4 Essential Mitigation Content

Where assessment has identified the need for mitigation system installation, the OM&M shall contain the following:

- a) The Date of installation;
- b) A list of conditions that indicate component failure or inconsistencies in operating parameters.
- c) Maintenance and monitoring instructions, to include:
 - 1. A description of system monitors and actions to take if system monitors indicate system degradation or failure; and
 - 2. A recommendation to verify continued system effectiveness at regular intervals that comply with this standard;
- d) Records of completed and updated maintenance logs, records of repairs and measurement reports;

- e) Resources for credible health guidance at state, provincial, federal, or other authority; and
- f) Contact information for service inquiries.

C-4.1 *Mitigation System Description*

The OM&M manual is to include information regarding mitigation systems and methods as specified in items a) through e) of this **Section C-4.1**:

- a) System components and sealed components labeled on a floor plan sketch or portrayed in narrative that describes system components and locations.
- b) Basic operating principles;
- c) Fan equipment model(s) and startup parameters, including system monitor pressure gauge readings and any control settings that existed at the time mitigation goals were achieved.
- d) Adverse or extenuating circumstances
A description of important observations that have potential to adversely affect the mitigation system(s) or other building systems; and
- e) Warranty/Guarantees
Information regarding warranties, guarantees and related conditions or limitations.

C-4.2 *Mitigation System Components*

The OM&M manual is to provide detailed operating instructions and information on essentials to maintain *mitigation* equipment and components, to include:

- a) Manufacturer model numbers for fans and essential equipment;
- b) Instructions on equipment and manufacturer instructions where applicable to operation and maintenance;
- c) Precisely described or mapped on a floor plan sketch the locations of components unique to the system, such as suction points, duct pipe routing and exhausts, fans, fan monitors, electronic telemetry/monitoring equipment, electrical disconnects, air flow dampers, and test ports;
- d) Descriptions on how to interpret labels and annotations relative to control settings and other designed operating parameters for the equipment; and
- e) A list of common maintenance and repair tasks associated with the system, such as:
 - 1. Fan and fan monitor replacement or repair;
 - 2. Duct pipe connections; and
 - 3. Sealing and closure of openings between soil and indoor air.

C-4.3 *Maintenance Inspection Checklists*

OM&M manuals are to provide instructions regarding maintenance inspections, in accordance with requirements in a), b), c), and d) of this **Section C-4.3**.

- a) Closure Between Soil Air and Indoor Air
Because it is part of virtually all mitigation methods, the OM&M manual is to define a list of items that are to be visually inspected to verify that openings between soil and indoor air remain closed, to include:
 - 1. Sump pits and similarly large openings to soil, such as for plumbing access;
 - 2. The observance of sizable new cracks or gaps in foundation floors or walls that often occur due to natural settlement of a building; and

3. The integrity of soil gas retarder membranes placed over open soil and below slabs if there evidence of building reconfiguration or rehabilitation that may have damaged soil gas retarder.

b) Visual Operational Inspection Checklist

The OM&M manual is to define a list of items that are to be visually inspected to verify continued operation of fans and other components, such as system monitors, controls, and appropriate labeling.

c) ASD Mechanical Inspection Checklist

The OM&M manual is to define a list of equipment to inspect when conducting mechanical performance inspections on ASD mitigation systems that include:

1. Performance indicators, and any fan controls to verify fan operation;
2. Pipe connections, straps, fasteners, fan boots, and exhaust configuration;
3. Electrical components (including switch, GFCI or disconnect operation);
4. Other related building systems, as applicable, such as sump pumps; and
5. If applicable, any permanent PFE test ports.

d) Non-ASD Mechanical Inspection Checklist

The OM&M manual is to define a list of pertinent items to inspect that are dictated by the nature of the specific Non-ASD system or that often include:

1. HVAC control settings;
2. Cleanliness or functionality of HVAC filters and outdoor air inlets;
3. Verification of designed balance for supply, return and exhaust air in rooms of interest; and
4. If applicable, measurements of airflow in and airflow out for HVAC system(s) and duct balance to ensure that no adverse changes have occurred.

SEASONAL TESTING GUIDANCE

Seasonal confirmation is required within the first year that low hazards are indicated by initial or post-mitigation performance testing. Seasonal conditions are defined in Section 3.4.3.

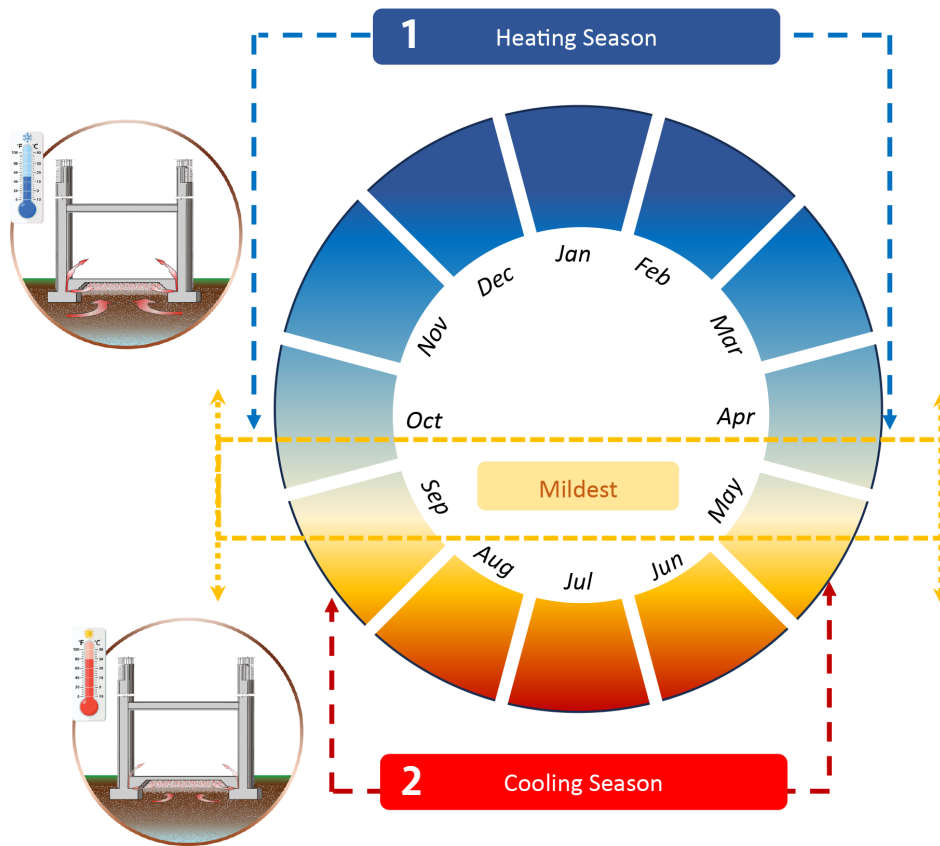
Per Section 4.2 (Where Below Action Levels), additional indoor testing is required if the initial test(s) have not been conducted under conditions that represent the annually predominant building operating condition when occupied, as identified in Exhibit 3.3.

Provision 5.2.1 (Class 1 risk—Chronic or continuous risk) in Section 5 (Subsequent Building Characterization), which is relative to most radon and vapor intrusion concerns, requires:

- a. One performance test for indoor concentration or PFE conducted under conditions that are representative of the annually predominant building operating condition when occupied, as indicated in Exhibit 3.3, and
- b. Another performance test for indoor concentration or PFE conducted under the alternate seasonal condition of longest annual duration.

Initial post-mitigation testing can be counted if representing a seasonal test condition required.

(As illustrated to account for most of the varied climate zones across the Northern Hemisphere)



SEASONAL TESTING GUIDANCE

Additional (Subchronic or Acute Hazards)

Provision 5.2.2 (Class 2 and 3 risk—Subchronic or Acute) in Section 5 (Seasonal Confirmatory Characterization) additionally requires:

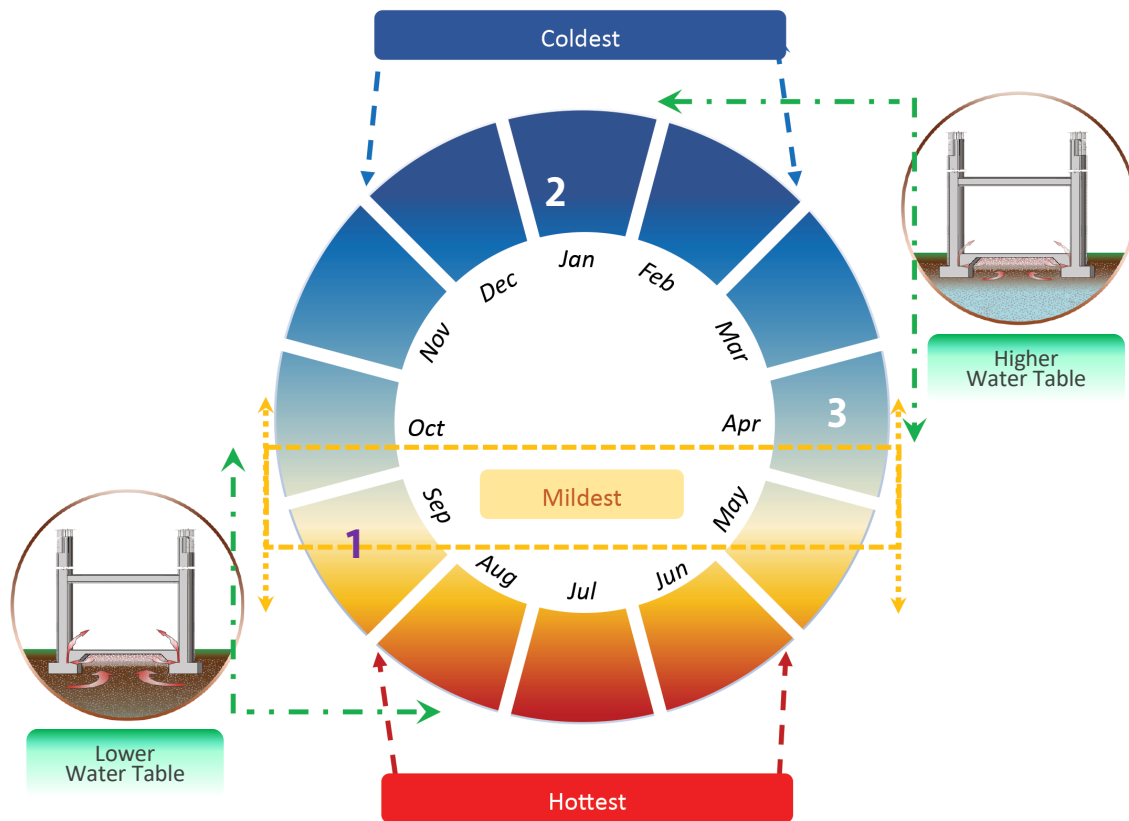
- a. Testing during an intermediate building operating condition under conditions that do not represent the two most predominant building operation conditions, as identified in Exhibit 3.3.
- b. Testing to evaluate the effects of changing water table elevations and precipitation where they occur for prolonged periods of weeks or months:
 - 1. when both heating season and lower *water table* elevations occur;
 - 2. when both heating season and capped soil, due to snow or ice occurs; and
 - 3. when high *water table* elevations occur that have the potential to impede system performance or conversely transport COCs closer to the structure.

Exception: A specific condition where local seasonal weather conditions do not include the specific condition otherwise required to be evaluated in this Section 5.2.3.

Note 1—Additional testing to comply with a is conducted under conditions that do not represent the two most predominant building operation conditions.

Note 2—Tests required for b are illustrated below for approximate times year in most climate zones.

(As illustrated to account for many of the varied climate zones across the Northern Hemisphere)



Definitions of basic and complex HVAC systems as applicable to this standard of practice.

Advisory—If it is unclear what type of system is present, consult with the building representative, a mechanical engineer or a qualified heating and air conditioning contractor.

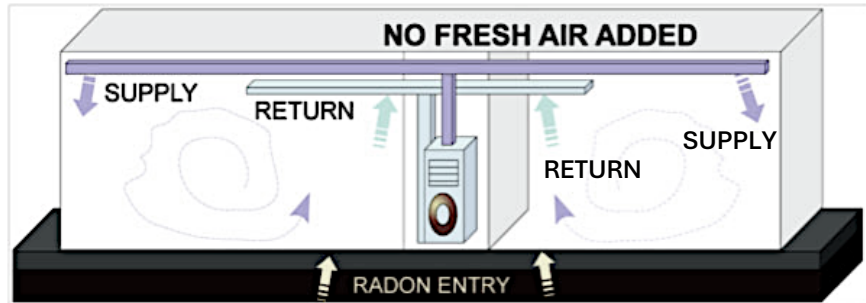
HVAC - DEFINITIONS AND SPECIAL CONSIDERATIONS	
<p>Group 1: Basic Heating and Cooling</p> <p>A dedicated system for each dwelling or unique area that does not provide seasonally variable outdoor air ventilation for added comfort or energy savings.</p> <ul style="list-style-type: none"> • Forced-air heating and air conditioning (HAC) systems such as normally seen in single-family residences. • Ductless Systems <ul style="list-style-type: none"> — Non-Forced-Air Hot and Cold-Water Circulation (sometimes called radiator systems). — Window AC (w/fresh air closed). — Unit Ventilators (w/fresh air closed). — Wall or Baseboard heating/cooling. • Ductless Split Systems: One system for cooling and one for heat (e.g., Window AC for cooling and Baseboard heat). 	<p>No Special Consideration</p>
<p>Group 2: Multi-zone Systems</p> <p>Independent systems and controls for different areas within the same dwelling or unique sector.</p>	<p>Test each unique sector or HVAC zone</p>
<p>Group 3: Variable Outdoor Air Ventilation</p> <p>HVAC systems that temporarily vary outdoor air ventilation for seasonal comfort or energy savings in:</p> <ul style="list-style-type: none"> - individual dwellings; - multiple dwellings; or - the whole building. <p>Such systems include those known as: Energy Economizer systems, Energy Recovery Ventilators (ERV) and Evaporative (swamp) cooling systems.</p>	<p>Set to provide only the volume of outdoor air that is needed at all times of the year</p>
<p>Group 4: Variable Air Volume Distribution</p> <p>HVAC systems where airflow from a single air handler is distributed among multiple dwellings with independent thermostat controls in each dwelling that variably open and close dampers for heated or cooled supply air.</p> <p>Such systems are commonly called Variable Air Volume (VAV) systems.</p>	<p>Set all thermostats and controls to occupied temperature conditions</p>

HVAC GROUP DESCRIPTIONS

Group 1: BASIC HEATING AND COOLING (HAC)

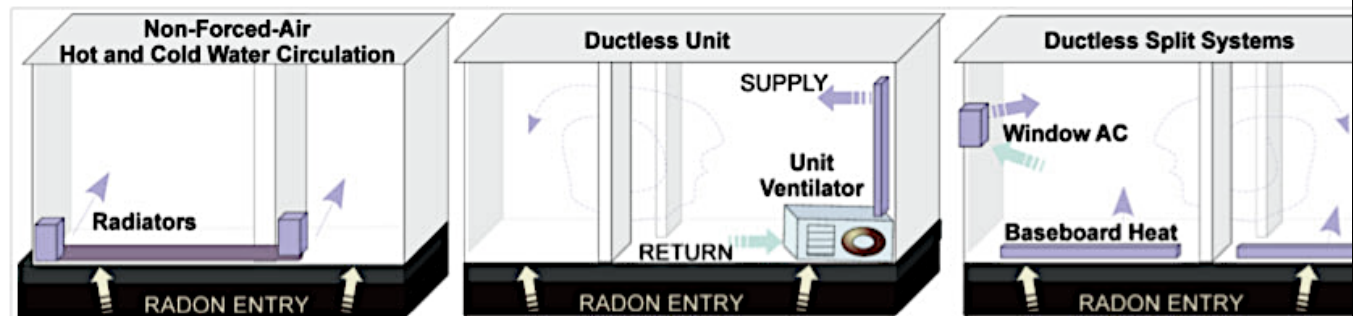
Dedicated system(s) that do not supply additional outdoor air for ventilation.

HAC Systems:
 Many buildings have forced-air heating and air conditioning (HAC) systems.
 Supply and return ducts distribute air around the building.



Ductless Systems:
 Some rooms or dwellings do not have ducted forced-air distribution.

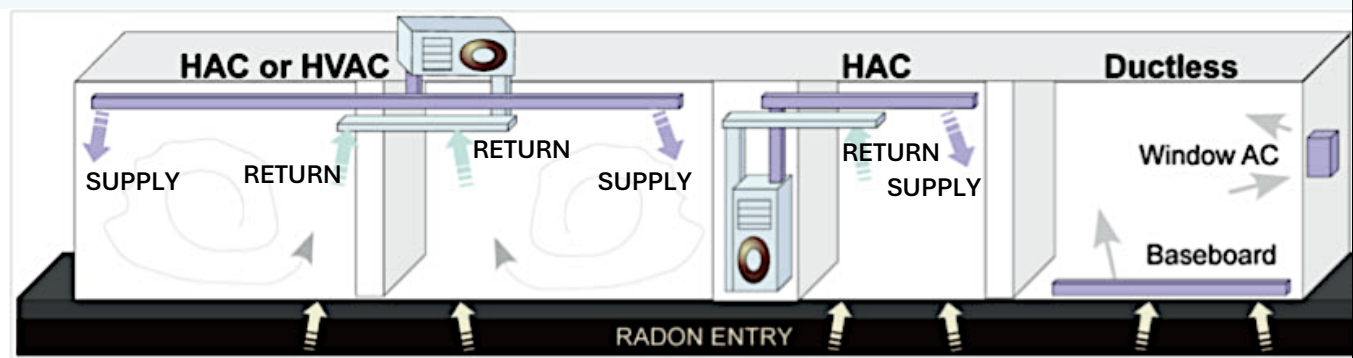
- Hot and Cold-Water Circulation (sometimes referred to as “radiator” systems).
- Window Air Conditioners.
- Wall or Baseboard Heating/Cooling Systems.
- Ductless Split Systems with one unit for cooling and another unit for heat (i.e., Window AC for cooling and Baseboard or Wall units for heat).



Group 2: MULTI-ZONE SYSTEMS

Multi-zone systems are those where different air handlers or systems are employed and independently controlled for different areas within the same dwelling or common use area of a building.

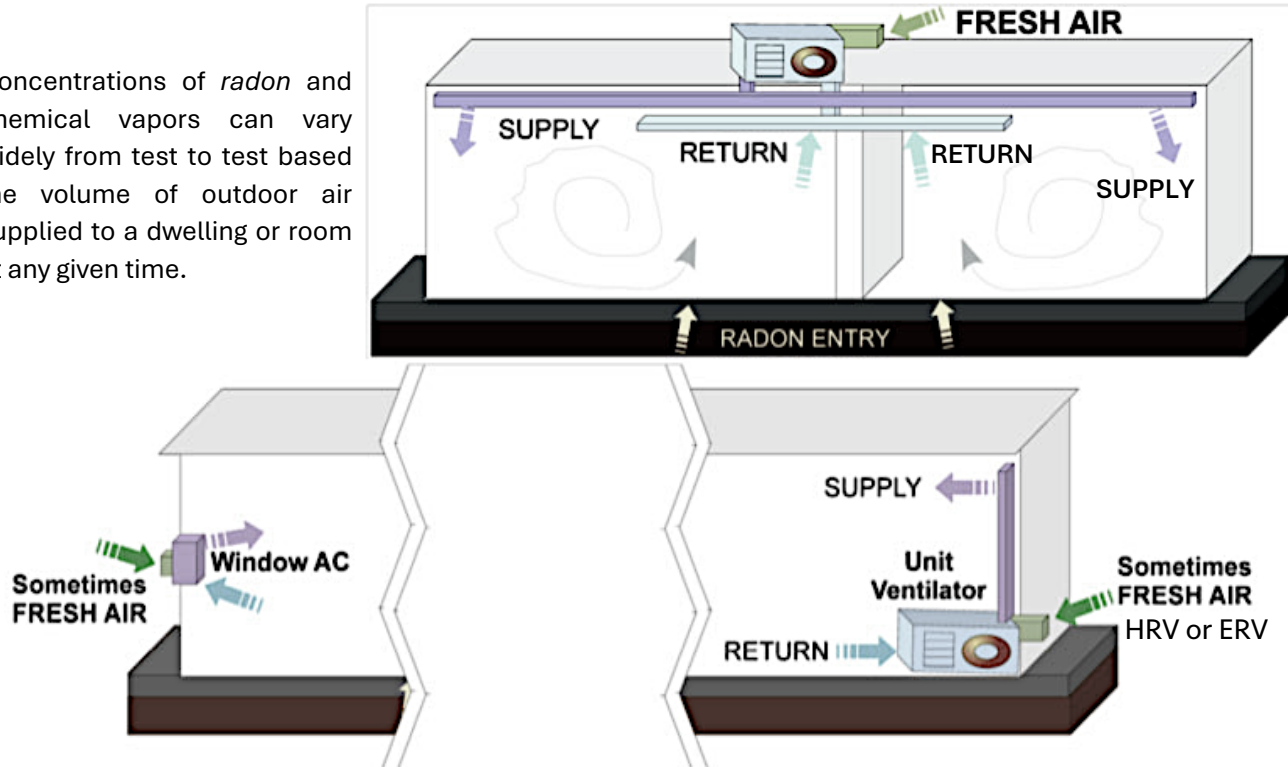
Radon and vapor concentrations can vary from room to room based upon variances in system operations.



Group 3: VARIABLE OUTDOOR AIR VENTILATION

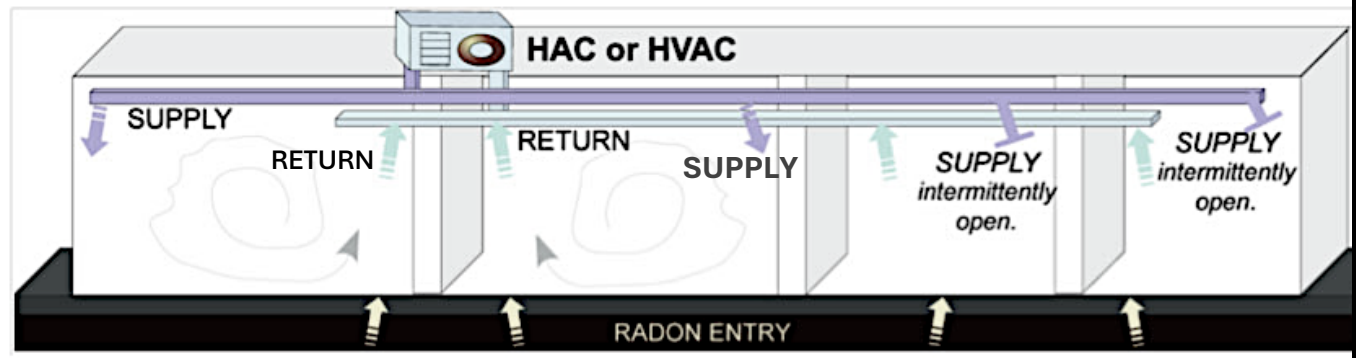
Variable Outdoor Air Ventilation systems are those that add outdoor air ventilation for seasonal comfort or energy savings. Such systems may service a whole building, multiple dwellings or a single dwelling or unit ventilator.

Concentrations of *radon* and chemical vapors can vary widely from test to test based on the volume of outdoor air supplied to a dwelling or room at any given time.



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* and vapor or ventilation air and can also affect pressure relationships that can enhance or diminish the volumetric entry of soil gas containing *radon* and chemical vapors.



Acknowledgments – Committee Participants

Deep appreciation is expressed for contributions of time and wisdom provided by the following experts.

Non-voting Chair and Assistance Team: Gary Hodgden (KS)

<u>Stakeholder Group</u>	<u>Delegate</u>	<u>Affiliation</u>
(Educators)	Brian Hanson (KS)	Midwest University Radon Consortium (MURC)
(Non-Regulated States)	Les Smith (MI)	Michigan Department of Environment
(Regulated States)	Stacy Sowers (PA)	Pennsylvania Department of Environmental Protection
(Regulated States VI)	Susan McKinley (IN)	Indiana Department of Environmental Management
(Federal EPA)	Tommy Bowles (DC)	U.S. Environmental Protection Agency
(Federal HUD)	John Anderskow (DC)	U.S. Department of Housing and Urban Development
(Public Health NGO)	Jill Heins-Nesvold (AL)	American Lung Association
(Rn Measurement Professionals)	Ken Deemer (PA)	Professional Service Provider
(Rn Measurement Prof. <i>alternate</i>)	Jessica Karnes (OH)	Professional Service Provider
(VI Measurement Professionals)	Megan Hamilton (IN)	Professional Service Provider
(Rn Mitigation Professionals)	David Wilson (TN)	Professional Service Provider
(Rn Mitigation Prof. <i>alternate</i>)	Dawn Oggier (FL)	Professional Service Provider
(VI Mitigation Professionals)	Rachel Saari (MI)	Professional Service Provider
(VI Mitigation Prof. <i>alternate</i>)	Tom Hatton (NJ)	Professional Service Provider
(Building Inspection)	Mike Walther (MA)	Professional Service Provider
(Building Scientist)	Isaac Anderson (MA)	Professional Service Provider
(Manufacturers)	Rick Saulen (MA)	Spruce Environmental
(Manufacturers <i>alternate</i>)	Chris Ferguson (IN)	Protect Environmental
<u>Participants Prior to 2024</u>		
(Consumer Advocate and Chair)	David Gillay (OH)	Barnes & Thornburg LLP’s Environmental Department
(Proficiency Program)	Shawn Price (NH)	National Radon Proficiency Program (NRPP)
(Proficiency Prog. <i>alternate</i>)	Kyle Hoyleman (KY)	National Radon Proficiency Program (NRPP)
(VI Measurement Prof. <i>alternate</i>)	Chris Bonniwell (WI)	Professional Service Provider

Assist Team: Kirsten LeBaron, Joanna Mandrecki, Nanci Hermberger, Lindsey Beal, Wensday Worth and Esha Gupta.

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