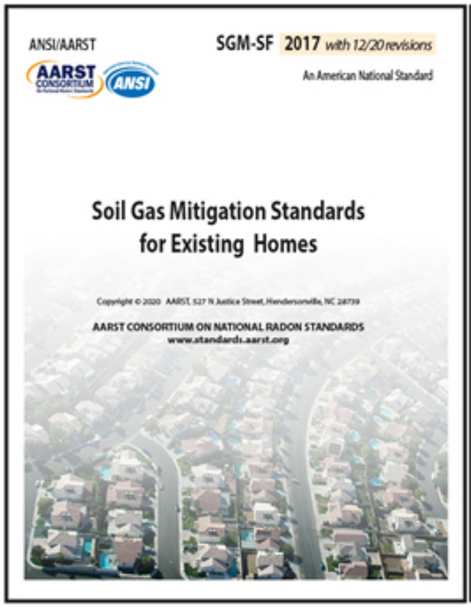
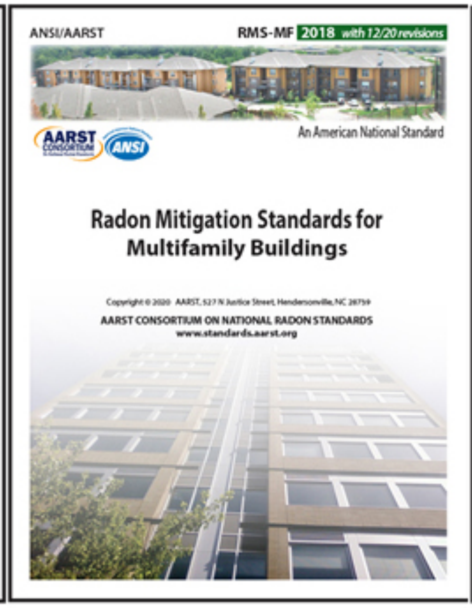
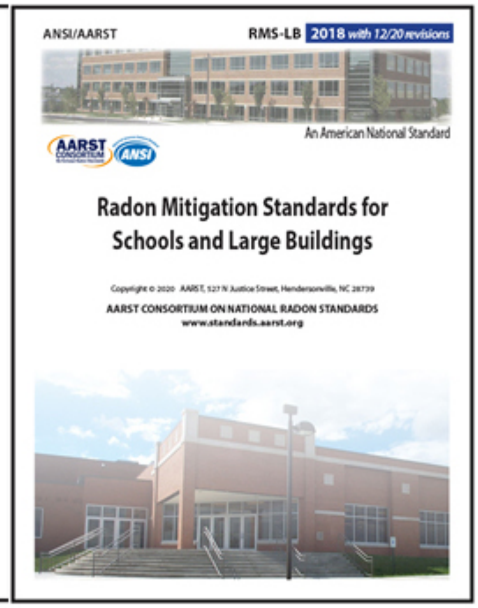
Harmonization effort for

SGM-SF, RMS-MF and RMS-LB Mitigation Standards

*Continuous maintenance efforts to improve these standards are currently ongoing.*




**Read me**

**This proposed revision and replacement for Section 12 is harmonized to include more clarity regarding practices needed for successful mitigation and appropriateness of each non-ASD mitigation method.** The proposed revision is applicable to the following ANSI/AARST publications:

— SGM-SF 2017 rev12/20 — RMS-MF 2018 rev12/20 — RMS-LB 2018 rev12/20

Latest published versions of those standards are available for comparison at www.standards.aarst.org where all ANSI/AARST standards can be found for review at no charge and for purchase.

The current mitigation standards committee roster (consensus body) can be linked to from www.standards.aarst.org/public-review. The current work project includes (1) harmonization, where possible, for all portions of these documents to read the same for the same tasks; (2) update based on new experiences, and (3) renderings that are more conductive to stakeholders who are involved in compliance assessment.

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## Public Review: SF-MF-LB Section 12 Update 3-22

## *COMMENT DEADLINE:* **May 30th, 2022**

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

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

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

Title of Public Review Draft: **SF-MF-LB Section 12 Update *3-22***

• **Name:** Affiliation:

• **Clause or Subclause**:

• **Comment/Recommendation**:

• **Substantiating Statements**:

• [___] Check here if your comment is supportive in nature and does not require substantive changes in the current proposal in order to resolve your comment.

***Repeat the five bullet items above for <u>each</u> comment.***

**Requested registration of your contact information and copyright release.**

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**PLEASE SHIP TO:** *StandardsAssist@gmail.com* Commenters are responsible for informing the standards assistant staff a when changing contact information or other preferences.

**Notice regarding unresolved objections:** While each committee seeks to resolve objections, please notify the committee responsible for an action or inaction if you desire to recirculate any unresolved objections to the committee for further consideration. Notice of right to appeal. (See Bylaws for the AARST Consortium on National Radon Standards - Operating Procedures for Appeals available at www.radonstandards.us, Standards Forum, Bylaws): (2.1) Persons or representatives who have materially affected interests and who have been or will be adversely affected by any substantive or procedural action or inaction by AARST Consortium on National Radon Standards committee(s), committee participant(s), or AARST have the right to appeal; (3.1) Appeals shall first be directed to the committee responsible for the action or inaction.

## AARST Consortium on National Radon Standards

Website: www.standards.aarst.org Email: StandardsAssist@gmail.com

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 Radon 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).

### Notices

Notice of right to appeal: Bylaws for the AARST Consortium on National Radon Standards are available at www.standards.aarst.org/public-review. Section 2.1 of Operating Procedures for Appeals (Appendix B) states, "Persons or representatives who have materially affected interests and who have been or will be adversely affected by any substantive or procedural action or inaction by AARST Consortium on National Radon Standards committee(s), committee participant(s), or AARST have the right to appeal; (3.1) Appeals shall first be directed to the committee responsible for the action or inaction."

Commentary/Rationale: This proposed revision to Section 12 is harmonized to replace Section 12 in AARST SGM-SF 2017 rev. 12/20, AARST RMS-MF 2018 rev. 12/20 and AARST RMS-LB 2018 rev. 12/20. Improvements include more clarity regarding practices needed for successful mitigation and appropriateness of each non-ASD mitigation method. Improvements include additional care to organize content more uniformly.

# 12.0 NON-*ASD* MITIGATION METHODS

## 12.1 General

Note—This standard encourages addressing other indoor air quality concerns[1]. However, most non-*ASD* mitigation methods are more prone to failure compared to *ASD*. Often it is lack of maintenance necessary to sustain *mitigation* design effectiveness. Other times, designs are not adequate to address changing volumes of highly concentrated *radon* or soil gas entering a building. The volumetric rate of entry changes dynamically with short-lived and seasonal changes in building operation response to outdoor conditions.

### 12.1.1 *Design and documentation*

Non-destructive and diagnostic investigations shall be conducted prior to installation, in accordance with Sections 5.2, 5.3 and as required in this Section 12. Each method applied shall conform with all requirements of Section 5.1 *Appropriate Systems,* Section 8 *All Systems* and Section 10 *Documentation*.

### 12.1.2 *Combination of methods/systems*

Where multiple methods are employed or inadvertently result from installation, the *OM&M* manual required in Section 10.5 shall provide a plan for *OM&M* regarding each resulting *mitigation* method.

### 12.1.3 *HVAC repairs or modifications*

Where an incidental failure or condition of an HVAC component is suspected of causing *radon* or *soil gas* entry and it can be repaired in a permanent fashion, *diagnostic performance testing* or indoor *radon* or *soil gas* concentrations after the repair are permitted for verifying of *mitigation* effectiveness. Where *mitigation* resulted from a repair, an OM&M manual in accordance with Section 10.5 is required.

### 12.1.4 *Proposals*

Prior to installation, the client shall be provided an estimate of total ownership costs for: Indoor Air Pressurization (Section 12.3), Indoor Air Dilution (Section 12.5) and Soil Air Dilution (Section 12.6) mitigation systems. Total ownership costs shall include installation costs and the annual operating costs with observance that costs for energy, replacement and repair items, labor, and testing may change in the future.

### 12.1.5 Plans for *OM&M*

Where the mitigation method includes filters, exterior intake and exhaust vents, duct balance, controls, or other items that need to be monitored to maintain mitigation goals, the plan for *OM&M* shall prominently list them and provide instructions for routine inspections and maintenance.

### 12.1.6 *Verifying effectiveness*

Where *mitigation* methods are based on mechanical dilution or pressurization of indoor air, or rely on passive methods, two post-*mitigation clearance tests* are required to verify seasonal effectiveness. Where the option to conduct seasonal testing is beyond the control of the contractor, the plan for *OM&M* shall identify the mitigation method and related requirements that include:

a. One *clearance test* conducted under conditions that are representative of the predominant *normal occupied building operating condition,* such as heating season conditions, and
b. Another *clearance test* conducted under cooling season conditions, or the alternate seasonal condition of longest annual duration.

[1] For further information, see ANSI/ASHRAE Standard 62.1 "Ventilation for Acceptable Indoor Air Quality" for buildings that are more than three stories tall and ANSI/ASHRAE Standard 62.2 "Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings."

## 12.2 Sources for Air Delivered to a Building

When air is actively or passively used to pressurize an airspace or dilute hazardous concentrations within an airspace, the source of air and design configurations shall comply with all requirements of this Section 12.2.

12.2.1 *Capacity (sources of air)*

System installations shall result in a configuration with capacity to continuously provide no less than 10% more than the minimum rate of air volume, measured in *cfm* ($m^3$/min), needed to achieve *mitigation* goals.

12.2.2 *Controls for variable activation*

Controls for mechanical equipment that pressurize or dilute indoor or soil air shall be configured and verified to achieve *mitigation* goals whenever each portion of the building is *occupied*.

12.2.3 *Air intake and distribution vents*

Air intake and distribution vents shall comply with requirements a), b) and c) of this Section 12.2.3.

a) Vent Blockage
Vents shall be in locations unlikely to be inadvertently blocked by stored or standing items and natural obstructions such as snow or foliage.

b) Vent Protection
Vents shall be protected at both internal and external locations with vent covers, wire mesh or screening in order to prevent blockage from debris, entry of animals or injury to occupants.

c) Duct Balance
*Contractors* shall verify that the balance of incoming and outgoing airflow does not increase negative pressure within portions of the building targeted for *mitigation* that are in contact with the soil.

12.2.4 *Adverse effects*

Sources for air delivered to an airspace shall comply with requirements in a) and b) of this Section 12.2.4.

a) For indoor air sources
Intake vent locations within a building shall not result in adversely affecting other building systems and occupant safety, such as the inducement of *flue gas spillage* from atmospherically vented combustion appliances or distribution of known airborne contaminants.

b) For outdoor air sources
System design shall not result in adverse effects on occupant comfort relative to temperature and humidity, and adverse effects on building materials, such as formation of condensation on indoor wall, floor and ceiling surfaces or ice on exterior components. Intake vents shall be in locations where airborne pollutants, such as from vehicle emissions, trash containers and combustion appliances, are distant enough from the intake to not enter the building.

12.2.4.1 Unnecessary Energy Consumption

The volume of outside air delivered into a building shall be compared to current energy codes to evaluate the practicality of the mitigation method.

Note—Current energy codes[2] for new construction seek to limit the air change rate per hour (ACH) to:

a) For residential buildings, ≤ 5 ACH in climate zones 0, 1 and 2, and ≤ 3 ACH in climate zones 3 through 8, as measured at a pressure differential of 0.2 inch water gauge (50 Pa)[3], or 0.30 cfm/$ft^2$ (1.5 L/s $m^2$).

b) For non-residential buildings, 0.40 cfm/$ft^2$ (2.0 L/s $m^2$) of the building thermal envelope area as measured at a pressure differential of 0.3 inch water gauge (75 Pa)[4].

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[2] The International Energy Conservation Code (as published by the International Code Council)

[3] Testing conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827

[4] Testing conducted in accordance with ASTM E2357, ASTM E1677, ASTM D8052 or ASTM E283

### 12.2.5 *Outdoor air ventilation systems*

Systems that introduce outdoor air into a building shall meet requirements in a) and b) of this Section 12.2.5.

> *Informative—Economizer systems, heat recovery ventilators (HRV) and energy recovery ventilators (ERV)*
>
> — Economizer systems typically deliver untempered outside air into a building to reduce the cost of cooling a building. Controls are often set to automatically activate dampers to adjusting incoming volumes of outdoor air when outdoor air is cooler than indoor air.
>
> — HRV units use the heat of indoor air exhausted to consistently preheat incoming outdoor air.
>
> — ERV units, similar to HRV, have sensors and controls to automatically activate dampers.
>
> Note—Any of these systems may require control adjustments or modification to deliver a minimum degree of outside air into a building at all times.

a) Exhaust and Supply Ports

For *heat recovery ventilator (HRV) and energy recovery ventilator (ERV)* installations, distances specified indoor in Table 12.2.5 are required between indoor supply and inlet vents and outdoor exhaust compared to both active intake vents and passive ventilation openings into the building, such as operable windows.

**Table 12.2.5** Exhaust and Supply Port Minimum Distances*

| Air volume rate of discharge from indoor supply or outdoor exhaust vents | Directional spread ** distance away from intake | Straight-line trajectory *** distance away from intake | Physical port distance between: 1) indoor supply and inlet vents, and 2) outdoor exhaust compared to inlet vents and other ventilation openings into indoor air |
|---|---|---|---|
| ≤ 150 *cfm* (4 $m^3$/min) | 8 ft (3 m) | 12 ft (3 m) | ≥ 6 ft (3 m)<br>**Exceptions:** Indoor supply and inlet vents are permitted to be closer where, relative to room size(s), dilution goals are met. Exterior exhaust and inlet vents are permitted to be closer where designs preclude cross-contamination of air. |
| ≤ 250 *cfm* (7 $m^3$/min) | 10 ft (3 m) | 15 ft (4.5 m) | |
| ≤ 350 *cfm* (10 $m^3$/min) | 12 ft (3.6 m) | 20 ft (6 m) | |
| ≤ 450 *cfm* (13 $m^3$/min) | 14 ft (4.3 m) | 24 ft (7.6 m) | |
| ≤ 500 *cfm* (24 $m^3$/min) | 14 ft (4.3 m) | 27 ft (8.2 m) | |

* Applicable to ≤ 6 inch (15 cm) diameter duct systems. Larger duct systems require greater distances per ASHRAE 62.1, Appx. B, *Separation of Exhaust Outlets and Outdoor Air Intakes*.

* The *exhaust trajectory* with an *exhaust spread radius* of 45˚as defined in Section 6.4.1.

** The *straight-line exhaust trajectory* with an *exhaust spread radius* of 11˚as defined in Section 6.4.1.

b) Condensate Drainage

A drainage system with capacity to dispose of the condensate water created by the HRV or ERV system shall exist or be provided and be in compliance with Section 7.8 *Drains*.

### 12.2.6 *Passive vent openings*

Where *mitigation* relies on passive vent openings to passively or, as induced by exhausted air, actively provide dilution air to interior or *non-habitable air spaces,* the configuration shall meet requirements in a) and b) of this Section 12.2.6.

a) Vent openings shall be non-closeable when used, installed or altered for *mitigation* purposes to maintain ventilation of an interior space, a crawlspace or other *non-habitable air space*.

b) Protection of building systems shall be provided where passive vents are open to subfreezing conditions, such as insulating, isolating or applying heat-tape to exposed water supply and distribution pipes.

## 12.3 Indoor Air Pressurization

Where the method of mechanically driving air into enclosed portions of a building is used or considered for *mitigating* the volume of *radon* or *soil gas* entering into habitable spaces, the configuration, design process and post-mitigation verification shall comply with all requirements of this Section 12.3.

12.3.1 *Applicability*

Requirements of this Section 12.3 shall apply where the target of indoor air pressurization is *ground-contact* rooms, or as applicable, whole buildings or *non-habitable airspaces*, such as *crawl spaces*, utility tunnels, under raised flooring, behind partitioned walls or in hollow voids within CMU block walls.

12.3.2 *Sources for air*

Sources of air delivered to the airspace being pressurized shall comply with Section 12.2.

12.3.3 *Sealing*

The airspace(s) pressurized shall be augmented, as needed, to resist air movement between the targeted airspace and surrounding indoor and outdoor air, in accordance with Section 7.9 *Sealed isolation assembly.*

12.3.4 *Design capacity*

Mechanical components, newly installed or augmented, shall result in capacity to constantly deliver not less than 10% more than the minimum rate of air volume, measured in *cfm* ($m^3$/min), that is needed to establish positive pressure in the targeted airspace relative to soil that adjoins the foundation.

12.3.4.1 Pressurization Combined with *ASD*

Where applying both *ASD* and increased air pressure within *ground-contact* spaces, the configuration shall result in positive pressure in the targeted airspace relative to soil that adjoins the outer foundation.

12.3.5 *Unintended soil gas transport*

For systems that pressurize an airspace, requirements in a) and b) of this Section 12.3.5 shall be met.

a) An evaluation shall be conducted and recorded in jobsite logs for itemizing suspected air pathways where *radon* or *soil gas* could inadvertently be driven laterally under the building or vertically through partitions into another portion of the building.

b) Airspaces adjoining the pressurized airspace laterally and vertically shall be tested for indoor *radon* or *soil gas* concentrations once the system is completed and active.

Exception: Where evaluations do not support the existence of pathways for sizable volumes of soil gas to be inadvertently driven laterally or vertically into other indoor air locations.

12.3.6 *Prior to system installation or augmentation (indoor air pressurization)*

Prior to system installation or augmentation, requirements in a) and b) of this Section 12.3.6 shall be met.

a) Non-destructive investigations shall be conducted in accordance with Section 5.2 and additionally include evaluation of viability for meeting requirements in: Section 7.9 *Sealed isolation assemblies*; Section 12.2 *Sources of air*; and Section 12.3.5 a) *Unintentional soil gas transport.*

b) Diagnostic investigations shall be conducted in accordance with Section 5.3 to evaluate system designs needed to meet requirements in Section 12.3.4 *Design capacity*. Pressure and airflow measurements that coincide with the juncture when the airspace is positively pressured, relative adjoining soils or airspaces containing open soil, shall be recorded in jobsite logs.

12.3.7 *Post-mitigation (indoor air pressurization)*

In addition to updating records as required in Section 9.1.1, functional evaluations after completing the system shall include pressure and airflow measurements to verify that the installed system is compliant with requirements in Section 12.3.3 *Design capacity*. These measurements and visual confirmation of compliance with Section 5.1 *Appropriate systems,* Section 12.2 *Sources for air* and Section 12.3.3 *Sealing* shall be recorded in jobsite logs.

12.3.8 *Documentation (indoor air pressurization)*

An *OM&M* manual that complies with Section 10.5 shall be provided to the client, to additionally include:

a) System operating parameters for the juncture when the airspace is positively pressured, relative adjoining soils or soil airspaces, including:
   1. System totals for both inlet and outlet airflow volumes, as measured in *cfm* ($m^3$/min);
   2. Conditions when these measurements were taken, in accordance with Section 5.3.4; and
   3. Guidance, in accordance with Section 12.1.6, for verifying seasonal effectiveness; and
b) Descriptions of investigations required in Section 12.3.5 regarding the potential for air pressures to result in unacceptable concentrations of *radon* or *soil gas* within other habitable airspaces.

## 12.4 Soil Air Pressurization

Where the method of mechanically increasing air pressure within soil that adjoins the outer foundation is used or considered for *mitigating radon* or *soil gas* entry into habitable spaces, the configuration, design process and post-mitigation verification shall comply with all requirements of this Section 12.4.

12.4.1 *Sources for air*

Sources for air delivered to the airspace being pressurized shall comply with Section 12.2.

12.4.2 *Sealing and ducting*

Soil air *pressurization* systems shall comply with Sections 7 *Sealing* and with Sections 6 *ASD*, with the following exceptions:

a) Section 6.2.3 *Positively pressured pipe;*
b) Section 6.4 *ASD Exhaust Discharge;*
c) Fan location Sections 6.5.2 *Safe locations* and 6.5.3 *Approved locations*; and
d) Section 6.2.5 *Pipe materials* where configured using duct materials.

Requirements in Sections 6.1.1 *Suction pits* and 6.1.2 *Sumps* shall be met even though locations described as suction points will deliver pressured air to the soil rather than negatively pressured air.

12.4.3 *Prior to installation (soil air pressurization)*

Prior to system installation or augmentation, requirements in a) and b) of this Section 12.4.3 shall be met.

a) Non-destructive investigations shall be conducted in accordance with Section 5.2 to additionally include evaluation of viability for complying with Section 12.2 *Sources of air* and Section 12.3.5 a) *Unintentional soil gas transport.*
b) Diagnostic investigations shall be conducted in accordance with Section 5.3 to evaluate PFE for positively pressured soils or airspaces containing open soil, relative to indoor air. Pressure measurements that coincide with the juncture when the targeted adjoining soils or airspaces containing open soil are positively pressured, relative indoor air, shall be recorded in jobsite logs.

12.4.4 *Post mitigation (soil air pressurization)*

In addition to updating records as required in Section 9.1.1, functional evaluations after completing the system shall include pressure and airflow measurements to verify that soil air is positively pressured relative to indoor air. These measurements and visual confirmation of compliance with Section 5.1 *Appropriate systems,* Section 12.2 *Sources for air* and Section 7 *Sealing* shall be recorded in jobsite logs.

12.4.5 *Documentation (soil air pressurization)*

Plans for *OM&M* shall be provided to the client in either an *information package*, in accordance with Section 10.2 *Owner-Occupied Maintenance,* or an *OM&M* manual, as required in Section 10.4 *Independent Maintenance*. Plans for *OM&M* shall include descriptions of investigations required in Section 12.3.5 regarding the potential for air pressures to result in unacceptable concentrations of *radon* or *soil gas* within other habitable airspaces.

## 12.5 Indoor Air Dilution

Where the method of mechanically driving *dilution* air into portions of a building is used or considered as a method to dilute *radon* or *soil gas* concentrations after soil gas enters the building, the configuration, design process and post-mitigation verification shall comply with all requirements of this Section 12.5.

### 12.5.1 *Applicability*

Requirements of this Section 12.5 shall apply where the target of indoor air dilution is *ground-contact* rooms, or as applicable, whole buildings or *non-habitable airspaces,* such as *crawl spaces*, utility tunnels, under raised flooring, behind partitioned walls or in hollow voids within CMU block walls.

### 12.5.2 *Sources for air*

Sources for outdoor or indoor dilution air delivered to the targeted airspace shall comply with Section 12.2.

### 12.5.3 *Sealing*

Where dilution air is provided, sealing in accordance with Section 7 shall be conducted to result in a continuous air barrier, to the extent practicable, that resists air movement between soil and indoor air.

### 12.5.4 *Design capacity*

Mechanical or passive components that are newly installed or augmented shall result in a configuration with capacity to continually deliver not less than 10% more than the minimum rate of air volume, measured in *cfm* ($m^3$/min), needed to achieve dilution goals.

### 12.5.5 *Prior to installation (indoor air dilution)*

Prior to installation or augmentation of a mechanical ventilation system for *mitigation* purposes, requirements in a), b) and c) of this Section 12.5.5 shall be met.

a) Non-destructive investigations shall be conducted in accordance with Section 5.2 and additionally include evaluation of viability for meeting requirements in Section 12.2 *Sources of air*.

b) One of the following diagnostic investigations shall be conducted in accordance with Section 5.3 to evaluate system capacity needs for meeting dilution goals.

1. Prescriptive option:
   Blower door measurements or other procedures for evaluating the existing natural air exchange rate per hour (ACH) of the targeted airspace are conducted. The calculation for determining the additional rate of air volume, measured in *cfm* ($m^3$/min), needed to meet dilution goals shall be:

   $$\text{Final ACH} = \text{Initial ACH} \times \frac{\text{Initial Concentration}}{\text{Final Desired Concentration}}$$

2. Performance option:
   Relative to the formula provided in the prescriptive option, an estimated rate of air volume, as measured in *cfm* ($m^3$/min), is delivered to targeted airspace(s). For this option, indoor measurements of *radon* or *soil gas* concentrations shall be conducted to diagnostically determine if system capacity requirements in Section 12.5.4 have been met.

The resulting total ACH being considered to achieve *mitigation* goals and a comparison with to energy conservation codes cited in Section 12.2.4.1 shall be recorded in jobsite logs

c) Inadvertent pressurization
   Pressure measurements shall be conducted to determine if the airspace is now inadvertently pressurized relative to adjoining soil. If so, investigations shall be conducted in accordance with Section 12.3.4 *Unintended soil gas transport.*

### 12.5.5 *Post-mitigation (indoor air dilution)*

In addition to updating records as required in Section 9.1.1, functional evaluations after completing the system shall include pressure and airflow measurements to verify that the installed system is compliant with requirements in Section 12.5.4 *Design capacity*. These measurements and visual confirmation of compliance with Section 5.1 *Appropriate systems,* Section 12.2 *Sources for air* and Section 12.3.3 *Sealing* shall be recorded in jobsite logs.

12.5.5.1 Performance evaluations after completing the system shall include a measurement of *radon* or *soil gas* concentrations in habitable airspace(s) to verify *mitigation* effectiveness.

12.5.6 *Documentation (indoor air dilution)*

An *OM&M* manual that complies with Section 10.5 shall be provided to the client, to additionally include:

a) Measurement results of indoor *radon* or *soil gas* concentrations conducted and system operating parameters for the juncture when those measurements have verified achieving system capacity requirements, including:
   1. The system totals for both inlet and outlet airflow volumes, as measured in *cfm* ($m^3$/min), and
   2. Conditions when these measurements were taken, in accordance with Section 5.3.4; and
b) Descriptions of investigations required in Section 12.3.5 regarding the potential for system air pressures to result in unacceptable concentrations of *radon* or *soil gas* within habitable airspaces.

## 12.6 Soil Air Dilution

Where the *mitigation* method entails passive ventilation or a mechanical system that delivers air or exhausts air to cause the entry of dilution air into soil or *non-habitable* airspaces, the configuration and post-mitigation verification shall comply with all requirements of this Section 12.6.

12.6.1 *Sources for air*

Sources of air induced into the soil or targeted airspace shall comply with Section 12.2, to include vent configurations required in Section 12.2.6.

12.6.2 *Sealing and other specifications*

Openings between indoor air and soil or *non-habitable airspaces* shall be closed, in accordance with Section 7 *Sealing*.

12.6.2 *Design specifications (soil air dilution)*

Mechanical exhaust systems shall comply with Sections 6 *ASD*.

**Exception:** Where mechanical system exhaust configurations comply with distances from passive vent intakes required in Section 12.2.5 *Outdoor air ventilation systems,* Table 12.2.5.

12.6.3 *Design capacity (soil air dilution)*

Where mechanical exhaust systems induce ventilation within *non-habitable air spaces,* the configuration shall result in capacity to continually induce cross-ventilation of the *non-habitable airspace*. Where the mitigation method is passive rather than mechanical ventilation, vent locations shall be configured to result in wind driven cross-ventilation of the *non-habitable airspace*.

12.6.4 *Prior to installation (soil air dilution)*

Investigations in accordance with Section 5.2 shall be conducted and recorded to include evaluation for complying with Section 5.1 *Appropriate Systems,* Section 12.2 *Sources of air* and Section 12.2.6 *Passive vents.* Where mechanical systems are employed, the system airflow volume shall be measured, recorded and compared with energy conservation codes described in Section 12.2.4.1.

12.6.5 Post-mitigation *(soil air dilution)*

In addition to updating records as required in Section 9.1.1, functional evaluations after completing the system shall include visual confirmation, recorded in jobsite logs, of compliance with Section 5.1 *Appropriate systems,* Section 12.2.6 *Passive vents,* Section 12.2 *Sources for air* and Section 12.3.3 *Sealing.*

12.6.5.1 Performance evaluations after completing the system shall include a measurement of *radon* or *soil gas* concentrations in habitable airspace(s) to verify *mitigation* effectiveness.

12.6.6 *Documentation (soil air dilution)*

An *OM&M* manual that complies with Section 10.5 shall be provided to the client that includes system operating parameters that existed at the time when *mitigation* goals were met, to include:

1. The system exhaust airflow volume, as measured in *cfm* ($m^3$/min);
2. Conditions when these measurements were taken, in accordance with Section 5.3.4; and
3. Guidance, in accordance with Section 12.1.6, for verifying seasonal effectiveness.

## 12.7 Passive Methods and Systems

When *passive mitigation systems or methods are* employed, the design and configurations shall comply with all requirements that are applicable in this Section 12.7.

12.7.1 *Verifying effectiveness*

Verification of effective passive *mitigation* requires testing indoor *radon* or soil gas concentrations to include requirements in Section 12.1.6 for verifying seasonal effectiveness.

Note—Under specific circumstances, passive technologies for reducing soil gas entry can be effective to the degree to which the connection between soil air and living spaces can be broken and natural forces that drive soil gas into a building can be minimalized or neutralized. However:

a) Achieving a complete between soil air and indoor air is not truly possible or sustainable; and

a) Passive efforts to counter forces that drive soil gas entry are often unreliable or unsustainable.

12.7.2 *Sealing openings to soil*

Sealing of gaps and openings between soil and indoor air is not to be regarded as a permanent, stand-alone *mitigation* method. Efforts to resist air movement between soil and indoor air, that are required for most *mitigation* methods, shall comply with Section 7 *Sealing*.

Note—While studies have indicated as much as a 50% reduction in indoor concentrations can be witnessed, field experience in the lack of reliable or sustainable effectiveness resulted in the following position statement: "EPA does not recommend the use of sealing alone to reduce radon because, by itself, sealing has not been shown to lower radon levels significantly or consistently." [5]

12.7.3 *Passive Soil Ventilation (RRNC)*

Techniques for passive soil ventilation, typically employed during new construction of buildings, shall comply with standards cited and a) and b) of this Section 12.7.3.

For single-family homes, ANSI/AARST CCAH, *"Reducing Radon in New Construction of One & Two Family Dwellings and Townhouses."*

For multifamily, school or other large buildings, ANSI/AARST CC-1000, *"Soil Gas Control Systems in New Construction of Buildings".*

Note—The practices therein are not normally practical after construction.

12.7.4 *Passive vents*

Vent openings shall be non-closeable and comply with Section 12.2.5 when installed or altered to increase ventilation of an interior space, a crawlspace or other *non-habitable air space* for *mitigation* purposes.

12.7.5 *Passively energized mechanical systems*

Note—Such methods have included wind-driven turbines, solar-powered fans and piping configurations that seek to enhance the effect of heat or wind for generating negative pressure within *ASD* piping.

*Informative advisory*—A wide variety of mechanisms or configurations have been tried and studied for countering the natural energy forces that drive soil gas into a building. Such technologies have not yet demonstrated reliability for consistent and sustainable *mitigation*.

[5] The EPA "Consumer's Guide to Radon Reduction" 402-K92-003, August 1992 and 402/K-10/005, December 2016

## 12.8 Air Cleaning

### 12.8.1 *Radon (air cleaning)*

Post-mitigation verification of effectiveness requires testing indoor *radon* decay products, in accordance with procedures required in ANSI/AARST MAH *"Protocol for Conducting Measurements of Radon and Radon Decay Products in Homes,"* to include for requirements in Section 12.1.4 for verifying seasonal effectiveness,

Note—Consistent with EPA technical guidance[6], air cleaning as a means of reducing the risk from *radon* is not recommended as a *mitigation* method. Published peer reviewed science does not support that, with current technologies, the amount of risk reduction sought can be quantified or verified for consistency.

*Radon* gas itself cannot be cleaned or filtered from indoor air. *Radon's* decay products that do represent the substantial risk from *radon* exposure are partially cleaned from the air as solid particles. However, challenges of using air cleaning as a *mitigation* method that are beyond current technology include:

a) The degree to which *radon* decay products and their associated risks can be verified to have been truly removed from the air;

b) System designs to ensure consistency of air cleaning along with mechanisms to warn occupants when filters or systems degrade in performance; and

c) System design specifications and standards that can ensure all *radon* decay products, including those not attached to solid particles and those that constantly form downstream from any air handler system, are removed from the air throughout multiple effected airspaces.

### 12.8.2 *Chemical vapors (air cleaning)*

Note—Filtration systems can be useful for aiding other systems or for temporary risk reduction. However, filtration systems require rigorous maintenance to retain reductions in exposures to occupants. Such methods, including how filtration might apply to vapors exhausted from a mitigation system, are currently beyond the scope of this document.

## 12.9 Water

### 12.9.1 *Radon from water*

Post-mitigation verification of effectiveness requires testing water indoor *radon* decay products, to include requirements in Section 12.1.4 for verifying seasonal effectiveness, in accordance with procedures required in ANSI/AARST MW-RN *"Protocol for the Collection, Transfer and Measurement of Radon in Water."*

Note—Methods for mitigating radon in water are currently beyond the scope of this document. Where it has been determined that *radon* from a water supply is a primary source of elevated *radon* concentrations in air, aeration and activated charcoal filtration are common methods employed to achieve *radon* reductions.

### 12.9.2 *Chemical Vapors from water*

Note— Chemicals in groundwater are a common source for chemical vapors that enter a building. Methods for handling and disposal of contaminated water are currently beyond the scope of this document.

## 12.10 Building Materials

Note—Where it has been determined that building materials are a primary source of elevated *radon* concentrations, *Indoor Air Dilution*, in accordance with Section 12.5, can be considered. Other methods beyond the scope of this document could include encapsulation, isolation or removal of building materials.

## 12.11 Source Removal

Note—Methods and practices for removal of source material are beyond the scope of this document.

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[6] EPA/625/8-87/019 January 1988 "Radon Reduction Techniques for Detached Houses (Second Edition)" (Section seven, third paragraph) and EPA/626/6-88/024 August 1988 "Application of Radon Reduction Methods" (Section 10.6, third paragraph).