Technical Bulletin

SGM-SF 2023 *Soil Gas Mitigation Standards for Existing Homes*

SGM-MFLB 2023 *Soil Gas Mitigation Standards for Existing Multifamily, School, Commercial, and Mixed-Use Buildings* (RMS-MF and RMS-LB consolidated and updated)

Objective

The purpose of this document is to provide concerned parties with an overview of recent revisions to the ANSI/AARST Standards, *Soil Gas Mitigation Standards for Existing Homes* (SGM-SF 2017), *Radon Mitigation Standards for Multifamily Buildings* (RMS-MF 2018) and *Radon Mitigation Standards for Schools and Large Buildings* (RMS-LB 2018). These standards were recently revised, with RMS-MF and RMS-LB consolidated into a single standard.

Scope

This Technical Bulletin addresses recent revisions of one ANSI/AARST mitigation standard and the revision and consolidation of two mitigation standards. This bulletin is relevant only to these latest revisions. It does not address revisions prior to the 2017-18 updates, nor does it address revisions to any other ANSI/AARST standards that may have been recently updated.

Background

The AARST Consortium "Committee for Radon and Soil Gas Mitigation Standards" is the body responsible for continual review and update of all ANSI/AARST standards. This committee is made up of industry, construction and regulatory professionals, and all proposed revisions are also subject to public review and comment. During the years since the 2018 publication of these standards, the committee has reviewed, revised, consolidated and finalized publication of the standards identified in this document.

Historical Overview

A provisional ANSI/AARST RMS-MF standard was published in 2013, with formal publication in 2014, along with the sibling standard RMS-LB, and was followed by publication of SGM-SF in 2017. The work entailed complete review of previously published mitigation standards (e.g. EPA RMS and ASTM E2121), where content addressed only mitigation in homes. As these new standards addressed both low-rise and high-rise buildings, more complicated enhancement was needed for: communication between all parties; diagnostics prior to design; separation between ASD content and content for sealing between soil and indoor air, because non-ASD methods often considered for large buildings still usually requires sealing. Non-ASD mitigation methods were addressed to provide minimums for diagnostics and design.

Due to the size of many larger buildings, details that can impact public health and the magnitude of cost for larger buildings procedures were elaborated on more explicitly than previously. Because one system can intentionally mitigate multiple dwellings or commercial units, or inadvertently impact such occupied

areas, a variety of related needs were addressed. Similarly, the need for quality control for work conducted and long-term risk management were also addressed.

Work on SGM-SF, RMS-MF and RMS-LB was conducted by different committees (consensus bodies), somewhat simultaneously, where each benefitted from work done on the other. Work began in 2019, with two complicated goals: (1) Harmonize content across the three mitigation standards, and (2) augment sentences to better comply with needs now required when standards are used for compliance assessment. The primary differences resulted in messages and requirements specific to residential versus commercial building needs. Both RMS-MF and RMS-LB standards were updated in 2018, and were the base documents used in the 2023 update and consolidation.

2023 Revisions

SGM-SF 2023 includes the complete harmonization of ANSI/AARST mitigation standards and editorial rendering more compliant with needs for compliance assessment. The focus included Sections 1 through 5 and 9 through 12. Most informational content was relocated to the Companion Guidance. Text relative to doing work on systems installed prior 2023, including when replacing fans, now required non-compliant exhausts and any non-compliant fan location be fixed. Quality control of design and installation practices has been elaborated on to require records of inspections prior to design and after installation along with quality control oversight at the jobsite.

Section 5 (System Design) now provides clearer qualities and details on initial inspections of jobsites. Diagnostics (e.g. PFE analysis) is required prior to all installations, except for radon mitigation in single family dwellings. The conditions of the building operating condition and seasonal conditions are to be documented for any diagnostic or performance check.

Section 7 (ASD System Installation) specifications for membrane materials placed over open soil for radon systems were relaxed to that required by EPA-RMS (i.e. 6 mil poly-membrane).

Section 9 (Post-mitigation Evaluation) now requires at least one PFE performance check measurement upon completion of installations. Additional post-mitigation evaluations for Vapor Intrusion systems were clarified.

Section 10 (Documentation) focuses on owner/occupied documentation with reference to times when a full OM&M manual is required. These situations include non-ASD designs and where maintenance of systems is to be performed by someone other than the owner/occupant.

Section 11 (Health and Safety) was completely rewritten, with focus on a safety management plan that includes safety training.

Section 12 (Non-ASD Systems and Methods) references SGM-MFLB (Soil Gas Mitigation Standards for Existing Multifamily, School, Commercial and Mixed-Use Buildings) for details.

The harmonization project from 2019 to 2023, included content in ANSI/AARST SGM-SF, RMS-MF and RMS-LB. The result revealed two things: (1) Most of the harmonized content was applicable for ANSI/AARST SGM-SF, and (2) Most of the content specific to RMS-MF (multifamily mitigation) was the same for RMS-LB (Schools and Large Buildings). As such, content in SGM-SF is referenced, rather than repeated in SGM-MFLB.

Elaborations retained within SGM-MFLB include pertinent differences in Section 5 (System Design) and Section 8 (All Systems and Methods) relative to collateral mitigation of multiple dwelling or units in a shared building).

Pertinent differences in Section 9 (Post-mitigation evaluations) are provided.

Section 10 (Documentation) focuses more on operation, maintenance and monitoring (OM&M) manuals relative to situations where maintenance of systems is to be done by someone other than an owner/occupant.

Section 12 (Non-ASD Systems and Methods) fully elaborates on Non-ASD system requirements that are more often associated with larger buildings, as an alternative or supplement to ASD mitigation methods.

Summary

Conscientious attention to ensure that mitigation standards reflect the most current methods is imperative in maintaining quality, relevant editions of these standards. This bulletin serves as a ready reference to the most recent updates.

Future Revisions

Future revisions to this standard shall be facilitated per the AARST Consortium “Committee for Radon and Soil Gas Mitigation Standards” normal process, which includes public review. Any such revisions shall be followed by a technical bulletin to address changes.

SGM-MFLB 2023
Soil Gas Mitigation Standards for Existing Multifamily, School, Commercial and Mixed-Use Buildings

Updates Compared To

RMS-MF 2018
Radon Mitigation Standards for Multifamily Buildings

Editor notes

The goals for 2023 publications included:

1. Harmonization of provisions and sentences written by three different committees for RMS-MF, RM-LB and SGM-SF 10 years of time; and
2. Result in standards suitable for compliance assessment where each requirement is clearly stated and informational content removed from most paragraphs within the body of the standard.

The number of pages herein partly explains why a great deal of content is required by reference to SGM-SF. With considerations for users of the standard in the field, there are two other reasons for this choice:

1. Training can be provided with achievable steps that first walk through SGM-SF.
2. Folks don't get confused by wondering if some small detail changed from one standard to the other.

Format herein:

Black text is SGM-MFLB 2013
Though many sentences reworded, **Red** underline text is a substantive change from RMS-MF 2018

Sections with **Blue** Text are required by reference to SGM-SF,
Though many sentences reworded, **Red** underline text is a substantive change from RMS-MF 2018

Both old crossed through headings or content and balloon notes to the side are provided to help understand the source of topic.

SGM-MFLB - 2023

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Soil Gas Mitigation Standards for Existing
Multifamily, School, Commercial and Mixed-Use Buildings

1.0 SCOPE

1.1 This standard of practice specifies minimum requirements for methods that mitigate risks to occupants posed by the presence of radon gas and chemical vapors or gas in existing multifamily, school, commercial and mixed-use buildings. [1]

Commented [GH1]: The scope statements have changed to consolidate practices for both residential, schools, commercial and mixed-use buildings. In addition, the scope includes harmonization with SGM-SF vapor intrusion topics.

1.1.1 *Multifamily*

This standard of practice is applicable to a wide range of multifamily buildings including, among others, buildings or structures, or a portion thereof used as townhouses, apartment houses, convents, dormitories, military congregate residences, fraternities and sororities, and ~~nontransient~~ boarding houses, hotels, live/work units, monasteries, motels, and vacation timeshare properties.

1.1.2 *Schools and office buildings*

Commented [GH2]: Harmonized from RMS-LB

This standard of practice is applicable to a wide range of schools and office buildings including, among others, the use of a building or structure, or a portion thereof for: Business occupancies (Group B) including for offices, educational and training facilities, professional services or service-type transactions; and Educational occupancies (Group E) including for religious and educational purposes through the 12th grade and day care facilities.

~~1.6.3 ***Mixed-use buildings or complicated ventilation***~~

~~When portions of building are used for non-residential purposes and/or contain ventilation systems more elaborate than basic heating and cooling, see ANSI/AARST RMS-LB *Radon Mitigation Standards for Schools and Large Buildings* for appropriate additional practices.~~

1.1.3 Commercial and mixed-use buildings

Commented [GH3]: Harmonized from RMS-LB

The scope of this standard also includes: Assembly occupancies (Group A) including for the gathering of persons for purposes such as civic, social or religious functions; Factory occupancies (Group F) including for fabrication or manufacturing, repair or processing; High-hazard occupancies (Group H); Institutional occupancies (Group I) including for where people are cared for or live in a supervised environment be it under restraint or security, detained in a penal institution, or for medical, surgical, psychiatric, nursing, custodial care or for child care facility purposes; and, Mercantile occupancies (Group M) including for the sale of merchandise, goods, wares or merchandise incidental to such purposes and accessible to the public.

1.2 Limitations

(As replicated in ANSI/AARST SGM-SF)

~~1.6.2 ***Mitigation of other soil gasses (e.g., chemical vapors)***~~

~~When applying radon mitigation techniques herein for other hazardous soil gasses such as for chemical vapor intrusion into buildings, applicable requirements are found in ANSI/AARST **SGM-SF** ***Soil Gas Mitigation for Existing Homes*** with special attention to Section 11 (Additional Requirements), Section 12 (Documentation Required) and Annex B (Health and Safety).~~

~~1.6.5 ***Less common sources of radon gas***~~

~~This standard does not address all mitigation techniques such as may be needed for airborne radon that results from radon in water, building materials or other less common sources of radon gas.~~

1.2.1 *Source materials*

Commented [GH4]: Harmonized from SGM-SF

[1] As point of reference, see the International Building Code (IBC) as published by the International Code Council.

This standard does not address practices associated with characterization, possession, handling, containment, generation, or disposal of radioactive or chemically contaminated materials.

1.2.2 *Mitigation methods*

This standard of practice addresses nearly all methods that reduce occupant exposure to radon or chemical vapors and gas in indoor air. However, it does not specify requirements related to removal or encapsulation of radioactive or chemical sources.

This standard of practice does not specify requirements for practices related to:

a) Removal of radon gas or chemicals from water or outdoor air;

b) Biological or chemical methods that seek to neutralize toxicity of contaminated soil; and

c) Soil Vapor Extraction (SVE), including contaminant capture and disposal methods.

Informative advisory—Active soil gas depressurization (ASD) methods prescribed in this standard mitigate occupant risk by preventing soil gas entry into occupied spaces. These designs need only address soil gas volumes that would otherwise intrude into a building. SVE designs that extract volatile organic compounds (VOC) mass from the soil are not inherently designed to mitigate the current risk to occupants unless also demonstrating functional performance as required in Section 9 Post-*mitigation*.

1.2.3 *Combustible gas*

This standard of practice does not address all practices that may be required for *mitigation* of potentially combustible soil gases.

~~1.6.4 ***Code compliance***~~

1.2.4 *Jurisdictional compliance*

This standard of practice does not contain all code or other requirements of the jurisdictions where the mitigation system is installed. ~~Although the provisions in this standard have been reviewed for potential conflicts with other regulatory requirements,~~ Adherence to this standard does not guarantee or supersede compliance with the applicable codes or regulations of any federal, provincial, state, or local agency with jurisdiction.

1.2.5 *Safety*

This standard of practice is not intended to address all safety concerns associated with its use. It is the responsibility of the user of this standard to establish appropriate health and safety practices, and to determine the applicability of regulatory limitations prior to use of this standard.

~~1.6.1 ***Design and warranties***~~

1.2.6 *Design and warranties*

This standard of practice is not intended to be used as a complete design manual. Compliance with its provisions will not guarantee reduction of indoor *radon* or soil gas to any specific concentration.

2.0 APPLICABILITY *(As replicated in ANSI/AARST SGM-SF)*

~~**2.2 Mandatory Provisions**~~

2.1 Mandatory Conventions

The terms "shall", "required" and "normative" indicate provisions herein that are mandatory. Terms such as "should," or "recommended" and provisions prefaced by the term "Note" or "Informative" indicate provisions that may be helpful or good practice, but which are not mandatory.

2.4 Prior Systems

This standard shall not apply to radon mitigation systems installed in multifamily buildings prior to its effective date, except when a previously installed system is altered. This standard shall apply to only the aspects of the system that are altered, and the Contractor shall recommend to the Client in writing that the noncompliance items be upgraded or altered to meet current standards. A written estimate of the cost for the proposed upgrade(s) should also be provided. For the purposes of this standard, altering a radon mitigation system does not include activities such as replacing worn out equipment while leaving the remainder of the system unchanged.

2.2 Prior Systems

This standard shall not apply to radon or soil gas mitigation systems installed prior to its effective date, except for:

a) Portions of a previously installed system that are altered. For the purposes of this standard, altering a radon or soil gas *mitigation* system does not include incidental repair, such as replacing worn out fans or equipment with equivalent components, while leaving the remainder of the system unchanged; and

b) Portions of a previously installed system that are not compliant with Section 6.4 (ASD Exhaust Discharge) and Section 6.5.2 (Safe fan locations).

Details of incidental repairs and system alterations shall be documented in jobsite logs for each event.

Commented [GH5]: Harmonized from SGM-SF
Adds a new requirement for existing system health/safety.

2.3 Use

Where requirements of this standard exceed local, state, provincial or federal requirements for the locale in which the *mitigation* is conducted, minimum requirements in this document shall be followed.

3.0 QUALIFIED CONTRACTORS

~~**3.1 Trained Professionals**~~

~~The practices outlined in this standard are intended for the use of a contractor or management teams among which at least one individual is specifically trained in the technology of radon reduction~~

~~**3.2 Contractors, Teams and Qualifications**~~

~~Persons qualified in varied disciplines with different skill sets are needed to accomplish radon reductions in many multifamily buildings. The Contractor, contracting team or management team shall include individuals who have appropriate technical knowledge, skills and experience required to mitigate multifamily buildings, including at least one "Qualified Mitigation Professional." Persons, including radon professionals, shall be qualified for their apportioned task.~~

3.1 Contractors, Teams, and Qualifications

The term *"Contractor"* within this standard shall refer to persons, individuals, or firms, regardless of the organizational structure of the entity, which engage in mitigating occupant risk from *radon* gas or chemical vapors and other soil gases that are present in indoor air.

To be considered qualified, the *contractor*, contracting team, or management team shall include at least one "qualified mitigation professional" as defined by:

a) Section 3.2, where mitigating occupant exposure to radon gas; or

b) Section 3.3, where mitigating occupant exposure to chemical vapors or other soil gases.

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~~3.2.1 ***Qualified Mitigation Professional***~~

3.2 Radon Mitigation Professionals *(Advanced Credential)*

A *"qualified radon mitigation professional"* is defined as:

"An individual who has demonstrated a minimum degree of appropriate technical knowledge and skills specific to design and installation of systems that mitigate occupant exposure to radon gas in existing multifamily, school, commercial and mixed-use buildings as established in listing or certification requirements of:

a) a national program that is compliant with requirements in Section 13.1; and

b) as required by local statute, state or provincial licensure or certification programs that evaluate individuals for radon-specific technical knowledge and skills."

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3.2.1 *Responsibilities*

Responsibilities for *qualified* ***radon*** *mitigation professionals* shall include compliance with all provisions in this standard except where identified within a provision as specific to only mitigation of chemical vapors or other soil gases.

3.3 Soil Gas Mitigation Professionals *(Advanced Credential)*

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A *"qualified soil gas mitigation professional"* is defined as:

"An individual who has demonstrated a minimum degree of appropriate technical knowledge and skills specific to design and installation of systems that mitigate occupant exposure to hazardous chemicals vapors and gas in existing multifamily, school, commercial and mixed-use buildings as established in listing or certification requirements of:

a) a national program that is compliant with requirements in Section 13.1; and

b) as required by local statute, state or provincial licensure or certification programs that evaluate individuals for soil-gas-specific technical knowledge and skills."

3.3.1 *Responsibilities*

Responsibilities for *qualified* ***soil-gas*** *mitigation professionals* shall include compliance with all provisions in this standard except where identified within a provision as specific to only mitigation of radon gas.

~~**3.3 Quality Assurance**~~

~~The Contractor, contracting team or management team shall have or establish a Quality Management System that is applied to each project and includes a Quality Assurance Manual and Quality Control procedures documented for each job site. See Companion Guidance Appendix D.~~

3.4 Quality Management

Qualified mitigation professionals shall establish, maintain, and follow a written quality management program that complies with all provisions of Section 3.4 of the most current publication of ANSI/AARST SGM-SF (Soil Gas Mitigation Standards for Existing Homes).

Informative Figure 3.4 Quality Management

Continuous Goals:

a) *The Quality Objectives.* Mitigation designs that reduce concentrations attributable to soil gas hazards to below the target action levels, while aspiring to minimize known soil gas hazards; and

b) *Physical Quality.* Mitigation systems that are compliant with standards, codes, and statutes, while aspiring to achieve customer satisfaction.

Plan
Implement policies and procedures designed to meet quality goals.

Track successes and failures
Input: Identify items to track that will help gauge if you are meeting quality goals.

Take action to improve
Make changes in policies and procedures to better meet quality goals.

Review successes and failures
Output: Review tracked items for causes of failure in meeting quality goals.

3.4.1 *Quality management programs*

Quality management programs shall include:

a) a means to track jobsite details relative to the scope of services the *mitigation contractor* provides, to address important tasks based on commitments to quality goals; and

b) retain records of training and experience for all staff members who participate in physical installation of *mitigation* system(s).

~~3.3.1 ***Oversight required***~~

~~A Qualified Mitigation Professional should be physically present or ensure a responsible person is present during onsite activities and immediately available to direct, instruct and oversee activities of other individuals, mitigation installers and other professionals engaged in installation activities for the mitigation system(s). See related requirements in Section **11.1.3** *Inspection for compliance*.~~

3.4.2 *Quality control oversight*

The quality management program shall identify individuals, as authorized by the *qualified mitigation professional(s)* and as permitted by statute, state licensure or certification program, who are responsible for *mitigation* activities in accordance with requirements in a) and b) of this Section 3.4.2.

a) Quality of *mitigation* design

Program records shall include currently valid certifications/licenses for persons identified as *qualified mitigation professionals*, in accordance Sections 3.2 or 3.3, who are to be responsible for the quality of *mitigation* design and effectiveness.

~~3.2.2 ***Informative – Other qualified professionals***~~

~~Other persons working with the Contractor or management team (e.g. design, utilities, engineering and facilities staff) should be professionally qualified for their discipline. Such persons should maintain applicable licenses or certifications and acquire permits as required by the jurisdiction where the mitigation work is performed.~~

b) Oversight of jobsite activities

For quality management programs that allow subordinate *qualified professionals* or journey level installers to oversee various jobsite activities while working under the responsible charge of a *qualified mitigation professional*, oversight duties shall not be authorized until quality management records include:

1. The identity of the installer and scope of their oversight authority, to include authorization to temporarily stop work if quality or safety is being compromised; and
2. Currently valid certifications/licenses, related experience, and educational benchmarks, as established by authorities identified in Sections 3.2 or 3.3, that demonstrate a minimum degree of technical knowledge and skills specific to the tasks being conducted.

3.4.3 *Jobsite records*

Quality control (QC) records, specific to each individual *mitigation* effort and system design, installation, and modification, shall be retained in jobsite tracking forms, logs, diagrams or photographs that include:

a) details desired by the *contractor* for tracking quality and those otherwise required in this standard;

b) solutions derived during design or installation that are custom to the building and not the same basic design feature for every building;

c) the identity of the *qualified mitigation professional* responsible for design and effectiveness; and

d) the identity of the *qualified mitigation professional* or authorized journey level installer physically present at each jobsite event who is responsible for quality oversight of the event.

Commented [GH9]: Section harmonized and as modified, required by reference to SGM-SF 2023

Commented [GH10]: Section harmonized and as modified, required by reference to SGM-SF 2023

Commented [GH11]: Section harmonized and as modified, required by reference to SGM-SF 2023

3.4.4 *Managing quality*

The quality management program shall include a written commitment to quality goals and identify a *qualified mitigation professional* who, in coordination with management, is responsible to:

a. update ongoing program changes they deem necessary to better meet quality goals, and
b. review QC records and efforts to improve *quality control* at least annually to ensure program changes are updated, effective, documented and disseminated to affected staff members.

Note—See https://www.iso-9001-checklist.co.uk/9.3-management-review.htm

Commented [GH12]: Section harmonized and as modified, required by reference to SGM-SF 2023

4.0 GENERAL PRACTICES

The contractor shall comply with Section 4.0 of ANSI/AARST SGM-SF and as additionally specified herein.

4.1 Assemble Building Information

~~**6.1 Nondestructive Investigation**~~

~~An investigation of the common building structure(s) shall be conducted by a Qualified Mitigation Professional prior to initiating any mitigation work. The investigation is intended to identify any specific building characteristics and configurations that may affect the design, installation and effectiveness of a mitigation system.~~

Prior to providing proposals, the *contractor* shall obtain or attempt to obtain information that includes:

a) The objective of the *mitigation*, be it *radon gas*, *chemicals of concern (COCs)*, flammable gas or proactive *mitigation* efforts due to suspected hazards;
b) The results of any *radon* measurements or measurements of *chemicals of concern* with information relative to action levels, toxicology, site classification and any other concurrent remedial actions. Measurement results and any related information shall be recorded and retained in jobsite records;
c) Building details regarding design and construction practices for each attached foundation area. The approximate age of the building or portion of the building targeted for *mitigation* shall be determined and recorded in jobsite records; and
d) Any *diagnostic* procedures and measurements that have been conducted for each building or the common portion(s) of the building(s) to be mitigated.

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4.1.1 *Insufficient data*

~~**4.1 Existing Radon Measurements**~~

~~The Contractor shall request from the Client all radon measurement reports for the common building structure(s) or portion(s) of the building(s) to be mitigated. Contractor review of all measurements is important when developing an appropriate mitigation strategy.~~

~~4.1.1 ***Insufficient test data***~~

~~The Contractor shall advise the Client in writing that retesting or additional testing is required when existing tests are insufficient to characterize dynamics of radon entry into the building as it relates to diminished capacity for either:~~

~~a) design of appropriate radon mitigation system(s); and/or~~
~~b) protection for all occupants of the building.~~

~~4.1.1.1 Retest criteria~~

~~Conditions that warrant the retest requirement include:~~

~~a) Tested locations were of insufficient quantity;~~
~~b) Time periods do not reflect average conditions for building occupancy;~~
~~c) The latest test data are older than 12 months and thereby comparisons of current and previous operating conditions for the building are not quantifiable; or~~
~~d) Testing practices do not comply with national or state protocols including for lack of appropriate test locations, test durations, closed-building conditions or approved test devices.~~

~~Appropriate testing protocols are those required by the state where the measurements were conducted, or in absence of state requirements specific to multifamily buildings, in accordance with the most current version *of "Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily Buildings"* (ANSI/AARST MAMF).~~

~~4.1.1.2 Exceptions~~

~~The contractor is permitted to proceed with mitigation designs and installations when extenuating circumstances warrant immediate action. Examples of situations that could warrant action, even though existing test surveys are insufficient, include but are not limited to:~~

~~a) protection of occupants in areas that clearly indicate elevated radon concentrations;~~
~~b) time constraints for building use schedules and other client concerns.~~

The *contractor* shall advise the *client* in writing when additional testing or diagnostics are required to characterize dynamics of *radon* or soil gas entry into the building, particularly as it relates to capacity for either:

a) design of appropriate *mitigation* system(s); or
b) protection for all occupants of the building.

When extenuating circumstances warrant immediate action, the *contractor* is permitted however to proceed with *mitigation designs* and installations.

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4.1.2 *Diagnostic proposals*

The *contractor* shall advise the *client* in writing when *diagnostic procedures* are required prior to *mitigation* system installation.

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~~4.7 Proposals~~

~~4.7.1 ***Initial interactions/proposals***~~

~~Contractors shall provide Clients a statement regarding the extent of building investigations required prior to system design that will satisfy the requirements of Section 6.~~

~~4.7.2 ***Written proposal requirements***~~

~~Contractors shall provide Clients the following written information prior to initiation of the work:~~

~~4.7.2.1 The Qualified Mitigation Professional's:~~
~~a) name, address and phone number;~~
~~b) relevant radon mitigation certification and/or licensing number; and~~
~~c) signature (manual, or electronic in conformance with the Electronic Signatures in Global and National Commerce [E-SIGN] Act);~~

~~4.7.2.2 A description of the proposed mitigation system(s) and a description of the long-term operation, maintenance, and monitoring plan (OM&M) applicable. (See Section 5.2 and Section 12);~~

~~4.7.2.3 A statement that describes options and costs for post-mitigation testing, including the option of third-party testing. Testing to achieve evidence for the initial status of system effectiveness that is satisfactory to the client is required prior to releasing the system to the owner;~~

~~4.7.2.4 The conditions of any warranty or guarantee including whether the Contractor warrants that the proposed system(s) will or will not reduce the radon concentrations below a specified threshold;~~

~~4.7.2.5 An estimate of total ownership costs including installation and annual operating costs while noting that costs for energy, replacement and repair items, labor, and testing may change in the future; and~~

~~4.7.2.6 The Contractor shall clearly state in proposals, and subsequent to installation(s) in accordance with Section 12.1.5, any limitations that the Contractor places on the scope of work and any limitations on professional obligations. For example: Upon completion of an installation and initial retest, it is standard practice that all obligations for implementation of the OM&M plan and any perceived professional obligations for risk management are transferred to the client or property owners in writing. It is also standard practice that any participation in OM&M is stipulated in extensive detail under a separate agreement.~~

~~4.7.3 ***Guidance on additional proposal content***~~

~~Proposals should also include but are not required to include the following content:~~

~~a) a statement that describes the planned scope of the work and a narrative or pictorial description of the mitigation system(s) proposed, including basic operating principles;~~
~~b) a description of design options that might include choices for long-term energy savings, enhanced soil gas control, phased-in strategies, cosmetic enhancement and other amenities;~~
~~c) an estimate of time needed to complete the work;~~
~~d) a description of the system or fan monitors and list of appropriate actions if a monitoring device indicates system degradation or failure;~~

~~e) a statement of planned methodology for egress, soil gas control and sealing when access to portions of a structure is challenging (e.g., crawlspaces);~~
~~f) a statement describing any known hazards associated with installation including chemicals used in or as part of the installation; and~~
~~g) a statement indicating compliance with all relevant standards of certifying agencies having jurisdiction.~~

4.2 Proposals

Contractors shall provide *clients* the following written information prior to initiation of the work:

a) The Qualified Mitigation Professional's name, address and phone number; relevant *radon* or soil gas *mitigation* certification and/or licensing number; and signature (manual or electronic in conformance with the Electronic Signatures in Global and National Commerce [E-SIGN] Act);
b) A description of the proposed *mitigation* system(s) and the elements of the applicable plan for long-term *operation, maintenance, and monitoring (OM&M);*
c) A statement that describes options for initial post-*mitigation* testing, including the option of third-party testing;
d) The conditions of a warranty concerning workmanship and defects in materials;
e) A statement on whether the *contractor* guarantees that the proposed system(s) will or will not reduce *radon* or soil gas concentrations below a specified threshold and conditions or limitations of the guarantee; and
f) Any other limitations that the *contractor* places on the scope of work and any limitations on professional obligations.

Commented [GH16]: Section harmonized and as modified, required by reference to SGM-SF 2023

~~4.7.2.5 An estimate of total ownership costs including installation and annual operating costs while noting that costs for energy, replacement and repair items, labor, and testing may change in the future; and~~

4.2.1 *Non-ASD designs*

As required in Section 12.1.4, *contractors* shall provide *clients* an estimate of total ownership costs including installation and annual operating costs where proposed designs include Indoor Air Pressurization, Indoor Air Dilution and Soil Air Dilution *mitigation* methods.

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4.3 Notification and Hazards

Commented [GH18]: Section harmonized and as modified, required by reference to SGM-SF 2023

4.3.1 *Owner occupied—Ventilation*

The *contractor* shall inform the *client*, prior to starting work, of the need to ventilate work areas during and after the use of sealants, caulks or bonding chemicals containing volatile solvents.

4.3.2 *Not owner occupied*

Where occupants are not the property owner, action is required in accordance with requirements in a) and b) of this Section 4.3.2.

~~4.5.1 ***Prior distribution of notices***~~

a) Access Notices

The *contractor* shall request that the *client(s)* provide notices to occupants no less than 24 hours before entering the building and in a manner that meets local statutes and existing agreements between owner or property managers and occupants.

~~4.5.2 ***Prior advisories for occupants***~~

b) Occupant Advisories

The *contractor* shall request in writing that notices to occupants ~~and other impacted residents~~ include instructions, warnings, or guidance for specific disruptive or hazardous situations, including:

1. Disruptive Activities
   Whenever disruptive procedures are required to complete building investigations, installations or other work that might include entrance to rooms for drilling into concrete floors and other installation or maintenance needs; and
2. Ventilation
   Whenever application of sealants, caulks, or bonding agents that warrant ventilation of work areas is anticipated. For this situation, the contractor shall request that the client(s) provide notices to occupants that include a general description of the hazardous materials; symptoms that might indicate sensitivity to the materials; actions to take if symptoms are observed; and a local or federal reference where further information can be obtained.

Figure 4.3.2 Example Notice to Occupants (See Exhibits A-1, A-2, A-3, and B)

"Occupant Advisory: Common construction sealants used to prevent soil gas entry at foundations and other locations will normally emit vapors that contain modest amounts of certain chemicals generally referred to as volatile organic compounds. The emissions occur mostly during application, but also to a lesser extent as they dry to form an airtight bond. While these chemicals are commonly used, some sensitive individuals may experience discomfort or other health effects when exposed to such chemicals.

Symptoms that may indicate sensitivity to these vapors may include nausea, headaches, dizziness, drowsiness and/or an allergic reaction. Special consideration should be made for the very young or elderly or persons with disabilities who cannot communicate symptoms experienced. Safety Data Sheets (SDS) are available upon request.

If symptoms are observed: Leave the area immediately to breathe fresh air. Avoid further exposure. If symptoms persist, get medical attention. For further information, see: ***https://www.epa.gov/indoor-air-quality-iaq/volatile-organic-compounds-impact-indoor-air-quality"***

4.3.3 *Material safety data sheets (SDS)*
Upon request, the *contractor* shall provide *clients* the published safety data sheets for materials used.

4.4 Jurisdictional Authorities

(As replicated in ANSI/AARST SGM-SF)

4.4.1 *Jurisdictions*
The *contractor* shall comply with all applicable testing, *mitigation* and reporting requirements issued by the federal, provincial, tribal, state, or local jurisdiction that apply to the contract where the *mitigation* is being performed.

~~4.8.2 ***Local jurisdictions*** *(radon)*~~
~~The Contractor shall notify the Client of any reporting requirements published by the state or local jurisdiction where the mitigation is being performed. Information to locate State Radon Offices in the U.S. can be found at~~
~~**www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information#stateradon**.~~

4.4.2 *Local jurisdictions (informative)*
Radon—Information to locate State Radon Offices in the United States can be found at
https://www.epa.gov/radon/epa-map-radon-zones-and-supplemental-information#datainfo

Vapor Intrusion—Information to locate State Offices in the United States can be found at
https://itrcweb.org/membership/state-engagement

4.4.3 *Building codes, licenses, and permits*

All components of the mitigation work shall comply with applicable mechanical, electrical, building, plumbing, energy and fire prevention codes, utility company requirements, and any other regulations of the jurisdiction having authority (JHA) where the work is performed. For localities having no relevant code requirements, the most recent version of nationally published codes shall be observed. Licenses and permits required by the JHA shall be obtained.

5.0 SYSTEM DESIGN

System designs shall meet requirements in Section 5.0 of ANSI/AARST SGM-SF and as additionally specified herein.

5.1 Appropriate Systems

~~**5.1 Health and Safety**~~

~~Mitigation systems shall be designed and installed to avoid the creation of health or safety hazards.~~

~~**5.2 Long-Term Considerations**~~

~~The design and resulting operations, maintenance, and monitoring plan (OM&M) shall, to the extent practicable, include consideration for facilitating and easing the Client's ability to achieve the Client's goal of long-term risk management.~~

~~**5.3 Appropriate Systems**~~

~~Appropriate design features shall be considered, such as:~~

~~a) observance that controlling pollutants at their source rather than after entry to the indoors becomes more important as buildings are designed or retrofitted to be more energy efficient;~~
~~b) system durability;~~
~~c) acceptable aesthetics (including system appearance, noise and occupant comfort);~~
~~d) ease of service; and~~
~~e) long-term operating cost that includes power consumption, conditioned air loss and maintenance and future replacement costs of system components. Design choices should incorporate options that maximize energy conservation.~~

5.1.1 *General principles*

In judging appropriate characteristics of a *mitigation* system or method, considerations such as the following shall be evaluated.

a) Safety
The *mitigation* system shall not create health or safety hazards. The building shall not be altered such that the building becomes less safe than its existing condition, to include, but not limited to, maintaining the existing level of fire protection and level of protection provided by means of egress.

b) Accessibility
Equipment installed that requires routine inspection and maintenance, such as fans, system controls and system monitors, shall be installed in a location *accessible* to individuals responsible for system maintenance without destructive or significant disassembly of building components or finishes.

c) Durability
Materials or methods not specified herein that are used in *mitigation* efforts should be capable of retaining functional integrity for the life of the system. Serviceable mechanical and control equipment should have designed life spans that are comparable to other similar mechanical system equipment.

d) Unnecessary Noise
Choices and actions that minimize objectionable *unnecessary noise* should be part of design and installation for each system. Where noise is both objectionable and unnecessary, actions should be taken to reduce *unnecessary noise* to the extent practicable. *Unnecessary noise* shall be defined as noise generated by system vibration or air rushing sounds at air intakes or exhausts that can be reduced by:

1. Reducing the transfer of vibration from system components that come in contact with building materials; or

Commented [GH19]: Section harmonized and as modified, required by reference to SGM-SF 2023

2. Reducing air velocity at the point of exhaust or at air intakes, such as those within non-habitable spaces or under membranes.

~~**5.4 Other Building Systems**~~

~~The mitigation system shall be designed and installed to avoid compromising the function of any mechanical system or ground water control system and to avoid obstructing doorways, windows and accessibility to switches, controls, electrical boxes or equipment requiring maintenance.~~

5.1.2 *Other building systems*

The *mitigation* system shall not:

a) compromise the functionality of mechanical, groundwater control or drainage systems;

b) compromise the functional integrity of roofs, guttering, siding, or other structural systems;

c) obstruct doorways or operable windows; and

d) obstruct accessibility to switches, controls, electrical service panels or junction boxes and other equipment, such as HVAC components, which require maintenance over time.

5.1.3 *Permanent systems required*

Mitigation systems shall be designed and installed as an integral, permanent addition to the building. Time limits on use of temporary mitigation efforts for optimizing system design or methods, including for uncontrollable logistics or rapid response situations, shall comply with Section 13.2.

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~~**Adjoining Units or Dwellings**~~

~~Considerations during design and installation shall include potential impact on adjoining occupied spaces within a shared building. Where one system might be intended to mitigate several units, dwellings or other areas within a shared building, see requirements for Collateral Mitigation in Section 9.3.5 and disclosures in Section 12.3.~~

5.1.4 *Collateral mitigation*

Where a mitigation system impacts or might impact adjoining dwellings or units in a shared building, *contractors* shall:

a) provide disclosures, in accordance with Section 10.6, where a mitigation system might result in *inadvertent collateral mitigation*; and

b) comply with Section 8.7 when designing *intentional collateral mitigation*.

~~**6.1 Nondestructive Investigation**~~

5.2 Nondestructive Investigation

An investigation of the common building structure(s) shall be conducted ~~by a Qualified Mitigation Professional~~ prior to initiating mitigation work. The investigation shall comply with both requirements in the most current publication of ANSI/AARST SGM-SF, Section 5.2 and those additionally require in this Section 5.2.

The investigation shall include visual inspection of both the exterior and interior of the building(s) in accordance with Section 5.2.2. Jobsite logs shall include the date and identity of the person conducting the inspections and resulting observations noted on diagrams or in jobsite logs.

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~~6.1.2 ***Create diagrams***~~

~~A floor plan diagram shall be developed or procured such as may be complemented with a series of diagrams or with photographic documentation for all ground contact areas of the building to be mitigated.~~

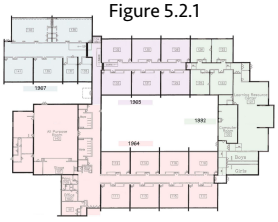
5.2.1 *Diagrams*

Diagrams or sketches shall be created and retained in jobsite logs that meet requirements of a) and b) of this Section 5.2.1.

a) Foundation Types and Sizes
A diagram shall be created that portrays the relative size of each building foundation component of the shared foundation system. The diagram shall identify each attached slab-on-grade, basement, and *crawl space* foundation area, including additions to the original building and attached garages

~~6.1.2.1 *Radon measurements Informative advisory*—At least one diagram should be annotated with the location and results of all available radon measurements.~~

Figure 5.2.1



b) Multiple test locations
Where *radon* or soil gas measurements have been conducted in multiple ground-contact rooms, dwellings or non-residential rooms or units, at least one diagram or sketch shall illustrate available test results and their general location.

5.2.1.1 For large structures, such as a school or large commercial or multifamily building, diagrams and sketches are permitted to be limited to portions of the building to be mitigated.

~~6.1.1 ***Informative guidance—document review***~~
5.2.1.2 Document Review

Informative advisory—The *contractor* should review all available construction drawings, specifications and other information regarding the building that might be of value in determining the *mitigation* strategy. Subject to limitations on what *clients* make available and the extent the *contractor* deems pertinent, the contractor should:

a) Review available radon measurements;
b) Review any information made available by the client regarding known hazards; and
c) Review available specifications, such as:
   1. Foundation specifications;
   2. Heating, cooling and ventilation (HVAC) operational specifications and schedules;
   3. Other mechanical systems such fire protection, electrical service, plumbing and any existing mitigation system for radon or other pollutants; and
   4. Plans, should there be any, for renovations.

~~6.1.3 ***Visually inspect the building***~~
~~A visual inspection shall be conducted to help identify any specific building characteristics, hazards and configurations that may affect the design, installation and effectiveness of a mitigation system. Examples include:~~
~~a. significant slab openings, crawlspaces, adjoining slabs and potential footing locations;~~
~~b. the design nature of HVAC systems that may cause significant building depressurization or have ducting in contact with the soil;~~
~~c. identification of fire-rated assemblies or separation required (including for fire-rated party walls between different occupied spaces and fire-rated floor assemblies); and~~
~~d. identification of general safety concerns that may warrant precautions for worker or occupant health. (See Section 13.)~~
~~6.1.3.1 *Vents*~~
~~An effort shall be made to identify and annotate air intake and passive relief vents that might affect choices in design. Among other purposes, this information can aid in prevention of radon re-entrainment into the building from the discharge of an Active Soil Depressurization (ASD) system.~~

5.2.2 *Visual inspections*

5.2.2.1 Exterior Visual Inspection

An exterior visual inspection shall be conducted that includes all exterior faces of the building, as viewed while standing outside the structure. Jobsite logs shall include:

a) **Foundation Walls.** Notation of foundation wall construction type(s), such as poured concrete, stone, and block (CMU); and

b) **Elevations.** Notation portraying the general height of the building above grade and relative elevation of each attached upper foundation floor compared to the lowest foundation slab or earthen floor.

Where observing air pathways or air handling systems that could hinder or aid effective *mitigation*, as described in **Table 5.2.2.1**, the conditions observed shall be noted in jobsite logs.

Table 5.2.2.1 Examples of air pathways or systems that could hinder or aid effective *mitigation*	
Between indoors and outdoors	Air intakes, exhaust locations and other openings between indoor and outdoor air that, based on their size, could influence a buildings air exchange rate, air pressures or energy consumption.
Between soil and outdoors	Air pathways between soil and outdoor air that, based on their size and location, could represent problems in achieving *ASD* effectiveness
Between soil and indoors	Exterior soil, drain tiles or enclosed spaces over soil that, depending on the total air volume leakage of adjoining interior walls, could need a custom solution

5.2.2.2 Interior Visual Inspection

The interior visual inspection shall be conducted to include all ground-contact rooms. Diagrams, sketches or as otherwise recorded in jobsite logs, shall also include components identified in **Table 5.2.2.2.**

Table 5.2.2.2		Interior Inspection Components
a)	Foundation walls	Notation, where different from exterior inspections, regarding poured concrete, stone, block (CMU) or other wall foundation material(s)
		Load bearing assemblies, such as masonry partitions, and as associated with unique foundation designs
b)	Rooms	A general floor plan layout of room partitions that also denotes finished areas and open earth crawlspaces
c)	Mechanical systems	The location of furnaces, air handlers, boilers and water heaters
		Locations of any ductwork under slabs
d)	Openings to soil	Both observed sizable openings between soil and indoor air and suspected openings, such as under bathrooms or utility access points
e)	Water drainage	Observations regarding water control systems
	1. Sumps	The location and nature of openings to soil within any pits
	2. Surface Water Drainage	Presence or absence of drainage systems for surface water on floors or walls
		Drains or drain systems that drain directly to soil or grey water piping
f)	Safety concerns	Observed conditions that pose safety concerns to workers/occupants
	1. Fire ratings	Observance of fire-rated assemblies or separation required (including for fire-rated walls and fire-rated ceiling and floor assemblies)

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Exception—Jobsite logs shall be updated with pertinent findings during *mitigation* processes where components listed for identification in Tables 5.2.2.1 and 5.2.2.2 were obscured, inaccessible for visual review, or later found to have been inadvertently overlooked during the visual inspection.

5.2.2.3 Chemically Contaminated Water

Where the purpose of the *mitigation* includes chemical vapor intrusion, the *contractor* shall document and provide timely notice to the *client* regarding components identified in Table 5.2.2.3.

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Table 5.2.2.3		Chemically Contaminated Water
a)	Sumps/Pits	Observance of sumps or pits that are open to soil
		If closed and the nature of sump lids or pit covers
		If the pit receives surface water from floors or walls
		The destination of water drained or discharged by pumps
b)	Water Intrusion	Presence of ground water on the surface of floors or walls

~~6.1.4 ***Evaluate design options for viability***.~~

~~6.1.7.1 *Appropriate systems*~~

~~Evaluations for viable design shall account for appropriate system design considerations described in Section 5 and otherwise applicable to the mitigation method.~~

5.2.2.4 Additional Visual Inspections

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The visual inspections of the building, including interior, exterior and roof, shall include review for the design of HVAC and other mechanical systems that may influence mitigation system design. Where conditions in Table 5.2.2.4 are observed, jobsite logs shall include notation of components or description of conditions observed that may influence mitigation system design.

Table 5.2.2.4	Conditions That May Influence Mitigation Design
Exhausts	Exhaust fans capable of causing building depressurization
Ventilation With Outdoor Air	Air intakes vents that may enhance ventilation, or observance of a lack of ventilation
Air Pressure	Unbalanced air pressure relationships across rooms or unique sectors.
Ventilation	Differences in ventilation air across rooms or unique sectors.

5.2.2.5 Unique Sectors

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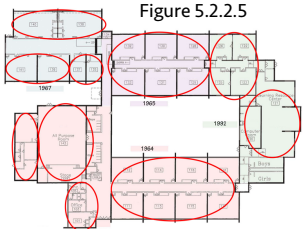
Where a building contains multiple zones of tempered air, such as buildings with multiple dwellings and non-residential spaces, or resulting from room additions, the following procedure is required to evaluate mitigation design needs for each portion of a building:

a) In each ground-contact area, identify the general design of the HVAC system(s) that are present and classify each of the following areas as a "Unique Sector":

1. Each ground-contact area of a shared building where the dwellings, non-residential rooms or mixed-use areas are served by individual "Group 1" Basic Heating and Cooling systems, as defined in Table 5.2.2.5; and

Figure 5.2.2.5



2. Each ground-contact area of a shared building where dwellings, non-residential rooms or mixed-use areas share a central HVAC air handling system. These areas shall be annotated on the diagram(s) or otherwise documented in jobsite logs; and

b) Each unique sector that is served by "Group 3" Variable Outdoor Air Ventilation systems or "Group 4" Variable Air Distribution systems, as defined in **Table 5.2.2.5**, shall be annotated on the diagram(s) or otherwise documented in jobsite logs.

Table 5.2.2.5 **Operational Design of HVAC Systems** (as grouped for the purposes of this standard)
Group 1 Basic Heating and Cooling A dedicated system for each room or unique area that does not provide seasonally variable outdoor air ventilation. • Forced-air heating and air conditioning (HAC) systems, such as normally seen in single-family residences. • Ductless Systems - Non-forced-air hot and cold water circulation (sometimes called radiator systems). - Window AC (w/fresh air closed). - Wall or baseboard heating/cooling. • Split Systems: Individual heating and cooling systems, such as baseboard heat and window AC for cooling.
Group 2 Multi-Zone Systems Independent systems with independent controls for different areas within the same room or unique sector.
Group 3 Variable Outdoor Air Ventilation Systems that seasonally vary outdoor air ventilation for individual rooms, a unique area, or the whole building. Systems include energy economizer systems, heat or energy recovery ventilators and evaporative cooling systems.
Group 4 Variable Air Distribution Systems where airflow from a single air handler is distributed among multiple rooms with independent thermostat controls in each room or unique area that variably open and close dampers to deliver heated or cooled supply air.

Informative advisory—If it is unclear what type of system is present, consider consulting with the building representative, a mechanical engineer, or a heating and air-conditioning contractor.
Note—See Companion Guidance, Section B and G, for more information on *HVAC* systems.

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5.2.3 *Reporting unexpected conditions*

The *contractor* shall provide the *client* timely notice of suspected or unexpected conditions revealed during visual investigations, *diagnostics* or installation that can significantly impact occupant health, budgets, schedules, or other concerns relative to the scope of work. The *contractor* shall document and provide immediate or timely notice to the *client* regarding:

a) hazardous materials or conditions observed but not previously identified by the *client*; and

b) observations of failed or deficient water control systems, to include observance of standing water in a basement or *crawl space*; evidence of groundwater intrusion; and failed pumps or *sump* systems and any pipes that inappropriately discharge or leak contaminants.

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5.2.4 *HVAC usage evaluations (Informative)*

Informative advisory—For more complicated buildings, the *HVAC* design group that serves each unique sector of the building should be documented with either narrative descriptions or annotated on the diagram(s).

5.2.4.1 HVAC Operations

Note— HVAC operational parameters should be documented with either narrative descriptions or annotated on the diagram(s) to include:

a) HVAC setback schedules in terms of hours each day for each operational mode;
b) Ventilation systems that actively bring outdoor air into the building (as described in Table 5.2.2.5, Group 3) and controls activate these systems.
c) Exhaust systems designed to intentionally cause negative pressure in a unique area of the building (i.e., kitchen, shop, or laboratory areas); and
d) Ventilation airflow measurements and pressure measurements obtained from existing records or as determined by conducting diagnostic procedures.

Figure 5.2.4.1 a)

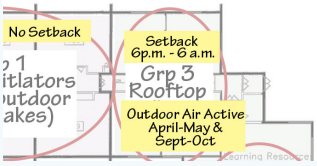
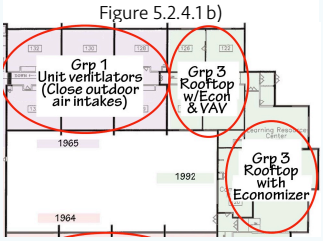


Figure 5.2.4.1 b)



5.2.4.2 Occupancy Use

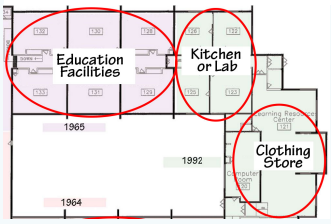
Note—For the purposes of this document:

a) The term "Occupied" is defined as any area of the building that is occupied on a regular basis for more than 4 hours a day;
b) The term "Significantly occupied" is defined as the time period where the building is typically occupied by the majority of the workers or students; and
c) The term "Occupied work or school weeks" are those weeks that do not include vacation days, winter breaks or similar weeks where test conditions do not represent normal occupied conditions.

Informative advisory—Diagram(s) or documentation should identify the occupancy use for each unique area and the following details:

a) the number of months per year the building or individual portions of the building are significantly occupied;
b) the hours of the day each individual portion of the building is significantly occupied;
c) other areas where occupants or workers may spend more than 4 hours per day; and
d) areas that are not occupied yet can potentially become occupied.

Figure 5.2.4.2



5.2.4.3 Normal Occupied Operating Conditions

Informative advisory—For comparisons required in Section 5.4, for tests and diagnostic testing, see Table 5.2.4.3. Identify testing periods that reasonably represent the normal occupied operating condition for each unique sector of the building. For the purposes of this document, the "Normal Occupied Operating Condition" is defined as: The operational condition for the building or unique sector of the building that exists during the greatest amount of significantly occupied time.

Commented [GH29]: Harmonization with RMS-LB

Table 5.2.4.3 Identifying Your Local Normal Occupied Operating Conditions

Commented [GH30]: Harmonized criteria from MA-MFLB

	Fairbanks	Caribou ME Quebec Marquette MI Duluth MN Winnipeg Grand Forks Anchorage Breckenridge Aspen	Portland ME Buffalo NY Burlington NH Milwaukee Minneapolis Bismarck ND Pierre SD Cheyenne WY Billings MT Helena MT	Boston Albany NY Pittsburgh PA Cleveland Indianapolis Chicago Omaha Denver Albuquerque Salt Lake Reno, NV Boise, ID	New York, NY Philadelphia Richmond, VA Baltimore Louisville Cincinnati Nashville Saint Louis Kansas City Amarillo TX Portland, OR Seattle	Atlanta Charlotte, SC Birmingham AL Jackson, MS Memphis Little Rock Dallas Austin Las Vegas San Francisco Los Angeles San Diego	Melbourne, FL Tampa, FL Mobile, AL New Orleans Houston Brownsville Phoenix Tucson	Miami, FL Puerto Rico Virgin Islands Honolulu Guam	Certain Asiatic Regions
	Zone 8 Subarctic	**Zone 7 Very Cold**	**Zone 6 Cold**	**Zone 5 Cool**	**Zone 4 Mixed**	**Zone 3 Warm**	**Zone 2 Hot**	**Zone 1 Very Hot**	**Acutely 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 % / 92 %	83 % / 75 %	75 % / 66 %	75 % / 66 %	66 % / 58 %	58 % / 42 %	42 % / 25 %	50 % / 25 %	100 % / 100 %
Heating	< Freezing / < Freezing						33 %	75 %	
Cooling						25 %	16 %	50 %	
Neither		16 %	16 %	16 %	16 %	16 %	42 %		
		25 %	25 %	25 %	16 %	25 %	42 %		
			25 %	25 %	25 %	33 %			
			16 %	16 %	25 %				
				16 %	16 %				
	8%								

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)

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

5.2.5 *Evaluation for design capacity*

Note—For estimating mitigation design needs, compare available test data (e.g., indoor air measurements and diagnostic testing) to:

a) the normal occupied operating condition for each unique sector of the building; and
b) the operating conditions that are most likely to emphasize a clear characterization of a radon hazard.

Informative advisory—It is recommended that a written evaluation of testing conditions as compared to significantly occupied conditions be available for proposals, planning, and subsequent to testing. This information will aid evaluation of existing test data relative to capacity needs when designing the mitigation system(s) and for planning post-mitigation testing.

5.2.6 *Investigative actions*

Informative advisory—The contractor should take investigative actions if, in the contractor's judgment, the visual inspection cannot sufficiently gauge the relative magnitude of forces that could enhance or inhibit the success of a mitigation system design, to include:

a) Exceptionally strong negative air pressure indoors relative to adjoining soil air, or
b) Severely inadequate ventilation.

Note—Characterization of pressure differences between indoors and outdoors or across rooms, building air exchange rates and airflow volume and pressures induced by air handlers can provide critical diagnostic information in high-rise buildings or buildings with large air handlers.

5.3 Diagnostic investigation

~~6.2.1 ***Diagnostics are required***~~

~~When mitigating multifamily buildings, diagnostic procedures shall be performed to enable appropriate and effective system design.~~

5.3.1 *All mitigation methods*

Diagnostic analysis shall be conducted prior to final design and installation of *mitigation* systems in multifamily, school, commercial or mixed-use buildings and where the purpose of mitigation includes chemical vapor intrusion.

~~6.2.2.2 *Reliance on experience in like structures*~~

~~When designing for like structures within the same building complex: Information gained at one structure regarding air volume and fan vacuum needs can sometimes be applied to similar structure(s). For this consideration, the minimum requirements of this standard have been met if:~~

~~a) The like structures being compared are located within the same building complex and are of similar size and built with similar construction practices;~~
~~b) At least one PFE measurement is made in each structure that indicates a similar distance for PFE; and~~
~~c) Sufficient additional information is gained from each structure to indicate like conditions exist.~~

Where such *mitigation* projects include multiple homes, buildings or portions of buildings that are like structures, provisions in Section 5.3.1.1 are permitted after completing *diagnostic analysis* for a representative sample of each like structure associated with the project.

5.3.1.1 *Like Structures*

Buildings or portions of a building that resemble each other in size, age, building materials, construction practices, surrounding soils and ventilation system design(s) shall be categorized as like structures. For like structures, information gained at one structure regarding the needed air volume rate, vacuum or pressure strength and other vital operational parameter are permitted to be applied to designs in other like structures.

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Commented [GH32]: Section harmonized and as modified, required by reference to SGM-SF 2023

To exercise this option, requirements in a) and b) of this **Section 5.3.1.1** shall be met prior to release of the mitigation effort for post-mitigation testing of indoor or soil gas concentrations.

a) Jobsite logs shall include information that supports like conditions exist; and

b) Jobsite logs shall include the results of test procedures that validate like conditions exist, to include:

1. For *ASD*, post-mitigation *PFE* performance testing in accordance with **Section 9**; and
2. For non-*ASD* methods, testing procedures required in **Section 12**, as applicable to the *mitigation* method.

5.3.2 *Targeted focus*

The initial target of design and any diagnostic investigations shall prioritize locations that would mitigate occupant exposure to the largest volume of soil gas that is susceptible to migrate into the building.

Exceptions: Where it has been determined that a foundation area is a source of disproportionately more concentrated volumes of radon, chemical vapors, or flammable gas; or where it has been determined that soil gas is not the source of the hazard.

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5.3.2.1 Target Limits

It is not required that diagnostic procedures or *mitigation* methods be applied to all *ground-contact* portions of a building. The percentage of area targeted for *mitigation* compared to size the full building footprint shall be recorded in jobsite logs or identifiable in jobsite diagrams. *Diagnostic* characterizations shall not be reported as being homogenous across any other individual foundation or building area unless verified.

Initial diagnostic steps are often to prove or disprove assumptions regarding how the foundation was constructed and, as applicable, answering any other concerns observed during visual investigations.

Informative advisory—The contractor should take investigative actions if, in the contractor's judgment, the visual inspection cannot sufficiently gauge the relative magnitude of forces that could enhance or inhibit the success of a mitigation system design, to include:

a) Exceptionally strong negative air pressure indoors relative to adjoining soil air, or

b) Severely inadequate ventilation.

Note—Characterization of pressure differences between indoors and outdoors or across rooms, building air exchange rates and airflow volume and pressures induced by air handlers can provide critical diagnostic information in high-rise buildings or buildings with large air handlers.

~~6.2.2.1 *Controlled conditions*~~

~~The PFE analysis shall be conducted under closed-building or normal operating conditions using, among other tools, a differential pressure gauge that is:~~

~~a) calibrated in accordance with national standards or manufacturers' recommendations, and;~~

~~b) capable of reading to 1/1000 inch water column (.25 Pa).~~

5.3.3 *Diagnostic and performance test conditions* *(As replicated in ANSI/AARST SGM-SF)*

Jobsite log records shall include outdoor temperature and the status of heating, cooling, or mixed *HVAC* operating conditions, at the time when conducting diagnostic or performance test measurements. Jobsite logs shall also indicate whether testing was conducted, as is recommended:

a) with all exterior windows and doors, including garage doors, closed; and

b) with normal occupied indoor temperatures of between 65˚and 80˚ F (18˚ - 27˚ C).

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~~6.2.4 ***Non-ASD pressurization or dilution designs***~~

~~Diagnostic procedures shall be performed prior to installation or augmentation of systems when methods that entail building pressurization or building dilution are being considered. (See Section **10** for descriptions of airflow and pressure measurements required.)~~

5.3.4 *Non-ASD methods*

All non-ASD systems, methods and diagnostic procedures shall comply with Section 12.

~~6.2.2 ***ASD designs (diagnostic investigation)***~~

~~Design of ASD systems in multifamily buildings shall include a pressure field extension analysis. PFE Analysis is a set of commonly needed diagnostic techniques to aid design and optimization of soil depressurization systems. Qualitative evidence shall be sought to identify the distance potential of PFE across the Soil Gas Collection Plenum (e.g., airspace under slabs or soil gas retarder). Quantitative measurements shall also be employed for analytical determination of:~~

~~a) air volume capacity needed to overcome leakage from any side of the Soil Gas Collection Plenum such as at the soil or at foundation cracks; and~~

~~b) vacuum strength needed to overcome indoor air pressures and resistance posed by fill materials within the Soil Gas Collection Plenum.~~

5.3.5 *ASD diagnostic PFE analysis* *(As replicated in ANSI/AARST SGM-SF)*

Diagnostic analysis shall include evaluations required in a), b) and c) of this Section 5.3.5.

a. *PFE* Distance (Qualitative)

With vacuum applied at the chosen suction point, evidence shall be sought to characterize the distance PFE can be achieved across the targeted soil gas collection plenum(s). The pilot hole or test port locations shall be at locations that will best characterize:

1. The full expanse of the targeted soil gas collection plenum(s); or
2. As an alternative or supplement, other locations where evidence suggests that large volumes of soil gas are susceptible to being drawn into the building by air pressure differences between soil and indoor air.

Where *PFE* is not demonstrated across most of the targeted soil gas collection plenum(s), further investigation is required.

b. *PFE* Vacuum (Quantitative)

Once goals for PFE distance are met, measurements shall be made to quantify air pressure differences under the slab or membrane relative to indoor air. Jobsite log records shall include the values measured in this effort to characterize vacuum strength needed for ASD design. The measurements shall be made with a micromanometer or equivalent differential pressure gauge that is capable of reading to 1/1000-inch water column (0.25 Pa).

c. Exhaust Air Volume (Quantitative)

Once goals for both PFE distance and vacuum strength are met, the volume of air exhausted to achieve desired PFE, as measured in cfm (m^3/min), shall be recorded in jobsite logs. Fans chosen and duct pipe configurations, in accordance with Section 6.3, shall be capable of transporting this volume of air.

5.3.5.1 Exception

Where *PFE* test locations or test ports cannot be created due to building materials that are virtually irreplaceable, such as for historical preservation properties, or due to denied access to locations of interest, a complete *PFE analysis* is not required. To exercise this exception, jobsite log records shall include the reason why and alternative locations or methods used for verifying design effectiveness.

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5.4 Seasonal Compensation

Jobsite logs shall confirm that a comparison was made between:

a) diagnostic test conditions, as recorded for compliance with Section 5.3.3, and

b) the *normal occupied building operating condition* that prevails during the greatest amount of time each year for local buildings, as illustrated in Table 5.2.4.3 (Identifying Your Local Normal Occupied Operating Conditions).

5.4.1 Vapor intrusion

Because it is not possible to predict worst case conditions based on a single measurement or diagnostic event: Where assessments or indoor measurements indicate chemical vapors or other hazardous gas poses acute or subchronic risks, it shall be recommended to clients that designs address a means consistently monitor if the system is meeting mitigation goals.

5.5 Decisions *(informative)*

The following flowcharts illustrate sample procedures for determining the appropriate design choices.

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Figure 5.5-c Example Design Decision Flowchart— ASD

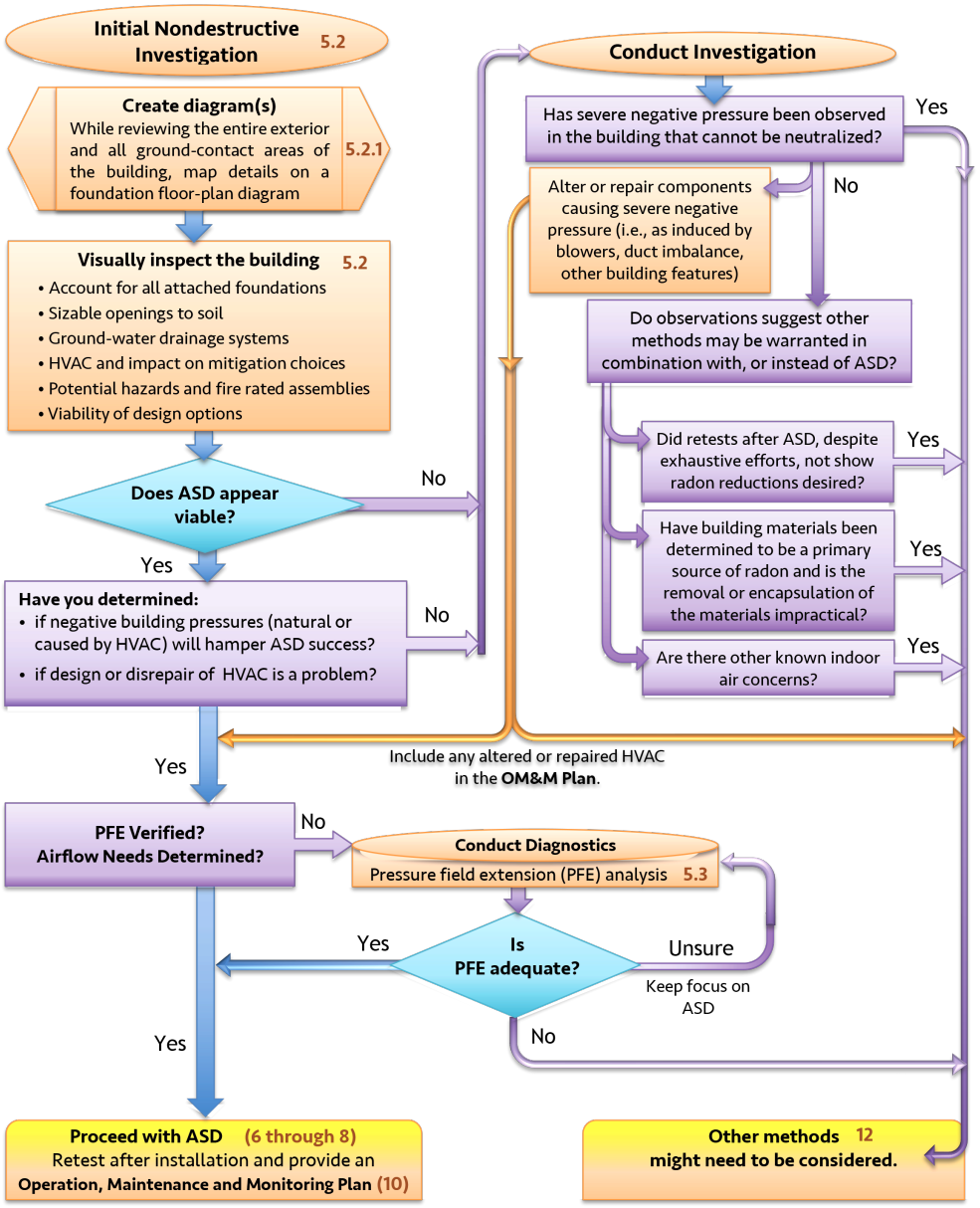
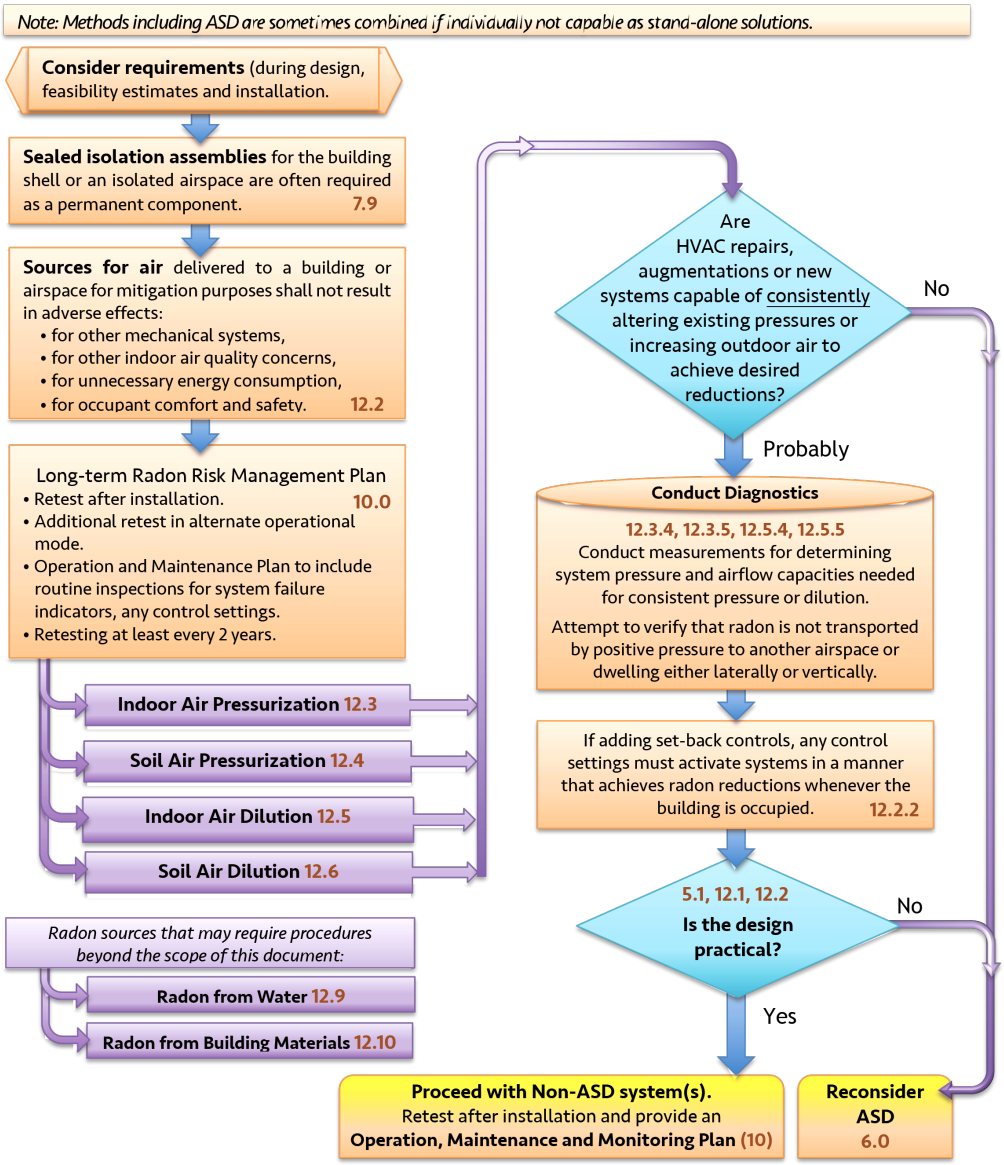


Figure 5.5-d Example Design Decision Flowchart— Non-ASD Methods



6.0 ACTIVE SOIL DEPRESSURIZATION (ASD)

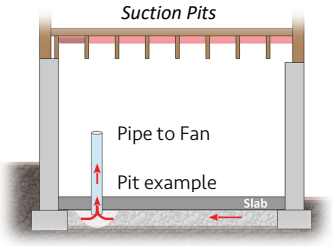
~~7.1 ASD Suction Points~~

6.1 *ASD* Suction Points

6.1.1 *Suction pits*

A cleared void space shall exist or be created below all suction points through slab floors and to the side of all *suction points* through walls unless excavation is not practicable. This cleared void space shall be not less than 0.25 ft^3 (7 dm^3) which equates to 2.0 US gallons (8 L) of excavated sub-slab soil/aggregate.

Exception: Where multiple *suction points* are employed, secondary suction pits designed for condensate drainage or airflow balance are permitted to have a smaller cleared void space.



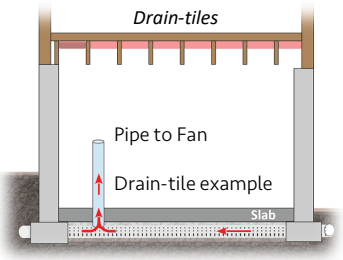
6.1.1.1 Seal the Suction Point

Note

Gaps in concrete surrounding suction pipes shall be sealed in a permanent, airtight manner.

When using caulk, the gap opening shall be cleaned and then sealed with caulk complying with ASTM standard C920 class 25 or greater.

To support caulk while it cures, gap openings greater than 1/2 inch (13 mm) in width shall be pre-filled with foam *backer rod* or comparable material prior to applying caulk.



6.1.1.2 Drain-tile Suction

Where the *suction pit* or suction piping directly accesses soil air from a drain-tile, the configuration shall not result in compromising the capacity of the water drainage system.

~~7.1.2 *Sumps*~~

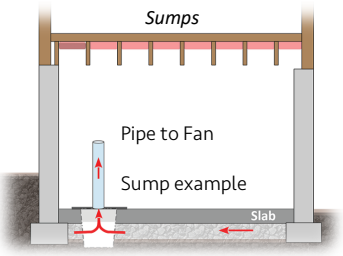
6.1.2 *Sumps*

6.1.2.1 Seal the Suction Point (sumps)

Where *sumps* are used as a *suction point*, *sump* lids shall be sealed in accordance with Section 7.5 in an airtight manner.

6.1.2.2 Accessibility to Sumps

Provisions of Section 7.5 for sealing *sumps* shall be observed to include that a physical access port or equivalent is required. Flexible coupling disconnects for suction piping, as specified in Section 6.2.6, shall be provided to ease *sump* lid removal.



6.1.2.3 Labels Required (sumps)

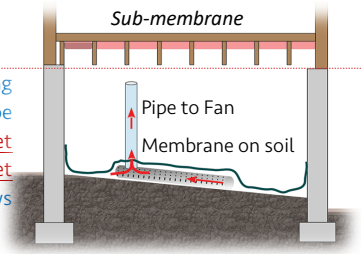
Note

Sump lids shall be labeled in accordance with Section 8.4.6 a.

~~7.1.3 *Sub-Membrane suction points*~~

6.1.3 *Sub-membrane suction points*

For sub-membrane *depressurization* (SMD), suction pipe ducting shall extend under the *soil gas retarder* membrane and shall be installed to prevent obstruction of air volume flow at the air inlet opening(s) of the suction pipe(s). The suction pipe inlet configuration shall be made open to soil air in a manner that allows *PFE* under the entire expanse of the membrane.



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6.1.3.1 Seal the Suction Point (membranes)
The opening around penetrations of a *soil gas retarder* shall be sealed in a permanent, airtight manner. Appropriate sealant materials shall be applied for *ASD* duct piping and other utility pipe penetrations through the membrane such as gasket fittings, pipe clamps, roof flashing or an appropriate sealant.

6.1.3.2 Seal the Membrane(s)
The soil gas retarder installed in accordance with Sections 7.6 and 7.7. The *soil gas retarder*, including seams and edges, shall be sealed to resist air movement between soil and the air above the membrane.

6.1.3.3 Labeling Required (membranes or access ports)
Membranes or *crawl space* access locations shall be labeled in accordance with Section 8.4.6 b.

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~~7.1.4 ***Non-Habitable air spaces***~~

6.1.4 *Non-habitable air spaces*

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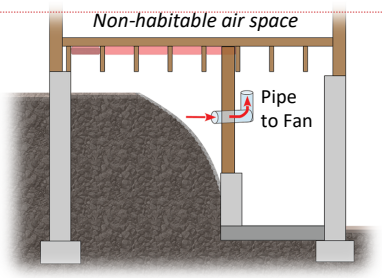
6.1.4.1 Sealing Non-habitable Air Spaces
When depressurizing a non-habitable airspace, all surfaces of the non-habitable airspace that border both indoor and outside air shall be sealed in accordance with Section 7.9 *(Sealed Isolation Assemblies).*



6.1.4.2 Restricted Use
The resulting system shall not cause the structure to become unsafe or adversely affect the performance of the building to include:

a) Adverse impacts to building systems (with the most notable being *flue gas spillage* from atmospherically vented combustion appliances located elsewhere in the building); and
b) Excessive energy penalties and damage to building components (with the most notable being hot, cold and humid outside air drawn into a *non-habitable airspace* by the *mitigation system*).

Depressurization of non-*habitable airspaces* shall not be used where:

a) atmospherically vented combustion appliances are installed within the airspace to be depressurized;
b) isolation cannot be created to resist air movement between the *non-habitable airspace* and surrounding airspaces containing one or more atmospherically vented combustion appliances. Resulting configurations shall not induce *flue gas spillage* described in Section 11.2.2; and
c) the extent of inaccessible openings between the isolated space and both interior and exterior areas surrounding the isolated space has not been evaluated and accounted for in system design and installation.

~~7.1.4.2 *Crawl Space Depressurization (CSD)*~~

Crawl space depressurization is only allowed where an area cannot be safely accessed or has insufficient height to work in.

6.1.4.3 Safety Requirements (non-habitable airspaces)
Where entry into a non-habitable air space being depressurized might occur in the future for maintenance or other reason, precautionary safety features are required to prevent exposures to excessive radon or chemical vapor exposure that can result within the depressurized airspace. Safety features shall include:

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Adds labeling requirement for hatches

a) Access ports to non-habitable air spaces shall be labeled in accordance with Section 8.4.6 c to provide warning and instructions, such as for ventilating the airspace prior entry or as warranted, other precautions and instructions;

b) Doors and access port hatches that can be opened without the use of tools shall be provided hardware to facilitate adding a lock to prevent incidental entry; and

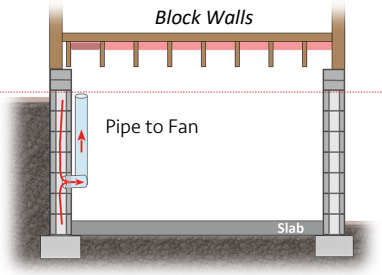
c) Fan monitors required in accordance with Section 8.2 shall be located where they can be accessed without entering the depressurized non-habitable air space.

~~7.1.5 ***Block walls***~~

6.1.5 *Block walls*

6.1.5.1 Suction Pipe Locations

Note—Suction pipe locations for Block Wall *Depressurization* will depend on the configuration of the hollow void network(s) within walls to be depressurized and the ability to close openings that surround the void network(s).



6.1.5.2 Sealing (block walls)

For Block Wall *Depressurization*, all *accessible* openings and gaps in the wall that surround the hollow void network being depressurized shall be closed in accordance with Section 7.4.1 to resist air movement between the depressurized void network and both indoor and outdoor air.

~~**7.2 ASD Piping**~~

6.2 *ASD* Piping

6.2.1 *Air and water-tight*

All duct piping and fittings that transport air shall result in being air- and water-tight.

Exceptions: Soil gas intake locations, exhaust locations, and fan monitor test ports.

6.2.2 *Slope required*

Configurations that result in obstructed airflow as a result of allowing water to collect within duct piping are prohibited. Above-ground duct piping shall have a continuous downward slope toward the *suction point(s)* of not less than 1/8 inch (3.2 mm) per foot (30 cm) to allow condensation or rainwater within the pipes to drain downward into the ground beneath the slab or *soil gas retarder* membrane. When ~~the required slope or~~ drainage cannot be achieved, other methods for draining collected water shall be provided.

6.2.3 *Positively pressurized pipe*

Positively pressurized *ASD* duct piping or other positively pressurized components of an *ASD* system shall not be installed in or pass through or under the conditioned space of the building.

6.2.4 *Labels required (duct piping)*

Duct piping shall be labeled in accordance with Section 8.4.4.

6.2.5 *ASD pipe materials*

All *ASD* duct piping, except piping routed below concrete slabs or under *soil gas retarder* membranes shall be rigid, non-perforated and meet the following requirements:

a) ABS plastic piping shall comply with ASTM D2661, F628 or F1488. Pipe wall thickness shall be Schedule 40 with solid, cellular core or composite wall. ABS pipe joints shall be solvent welded in accordance with the pipe manufacturer's instructions, with solvent cement conforming to ASTM D 2235.

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b) PVC plastic piping shall comply with ASTM D2665, F891 or F1488. Pipe wall thickness shall be Schedule 40 with solid, cellular core or composite wall. PVC pipe joints shall be joined in accordance with the pipe manufacturer's instructions with cement conforming to ASTM D2564. The joint surfaces for PVC plastic pipe and fittings to be solvent welded shall be prepared with:

1. a primer conforming to ASTM F656; or
2. a self-priming product; or
3. as otherwise stipulated in the pipe manufacturer instructions.

c) All *ASD* plastic pipe fittings shall be of the same material as the plastic piping they are joined to, and solvent welded unless joined with flexible couplings in accordance with Section 6.2.6.

~~7.2.6.4 *Alternative pipe materials*~~

Exception 1: Alternative pipe materials

Alternative materials specified in codes for "Above-Ground Drainage and Vent Pipe" [2] are permitted. Alternative pipe materials that include iron, steel and copper piping shall be joined in accordance with the pipe manufacturer's instructions and as required by code.

For buildings classified as single-family structures that contain not more than four attached *dwelling* units on a contiguous foundation, other pipe products are permitted for use where deemed acceptable by:

a) local state licensing/certifying programs that provide written acceptability for the product; or
b) local code authorities for locations that have no state licensing/certifying program.

~~7.2.6.5 *Downspout materials*~~

Exception 2: Downspout material on exteriors

Downspout and other light-duty rigid materials of appropriate durability are permitted for duct piping use if all of the following requirements are met:

a) The material shall be installed only at exterior locations at the pressure side of the *ASD* system;
b) Duct size shall be in accordance with Section 6.3.7;
c) Materials shall be no less than equal to the commercial durability of existing downspout materials used for such buildings where the system is being installed.

   Exception: Where the building is a designated heritage preservation site or operates under similar covenants, the materials used for exterior ducting are permitted to vary according to the historic preservation guidelines or other covenant requirements;

d) Use of the specific material shall be acceptable to the *client* and, if applicable, state licensing or certifying authorities; and
e) Joined connections for downspout materials and joints shall be welded to achieve a watertight seal or sealed and *mechanically fastened* at each joined connection using hardware fasteners that are weather rated for outdoor use. When joined connections are sealed and *mechanically fastened*:
   1. Sealants shall be applied to the inner junction between joined downspout materials in a manner to both establish a complete seal and protect sealants at the bonded location from degradation. Sealants shall be designated by the manufacturer for use on gutter materials; and
   2. Where pre-formed or modified flange connections are used to join sections of duct material, the upper portion of duct material at each connection shall be flanged inward and inserted

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[2] As point of reference for alternative piping, see the International Residential Code (IRC) Table P3002.1 (1).

downward into the lower portion of duct material to allow water and condensate to fully drain downward without collecting water and ice at joint connections.

6.2.5.1 Vapor Intrusion Piping

When *ASD* goals include *mitigation* of chemical vapor intrusion, all duct pipe materials shall meet specifications in ASTM D1785 for Schedule 40. For alternatives to plastic pipe identified in Section 6.2.5:

a) An evaluation shall be made prior to installation for alternative materials such as iron, steel, copper, or other pipe materials, relative to corrosive effects that chemicals may have, and

b) Downspout materials shall not be permitted.

~~7.2.6.3 *Flexible coupling disconnects*~~

6.2.6 *Flexible couplings*

Flexible coupling disconnects that comply with ASTM D5926 or ASTM C1173 are permitted as an alternative for joining two portions of *ASD* duct piping if they establish a secure watertight connection. Equivalent watertight methods are also permitted, such as threaded pipe or union disconnect. Flexible coupling disconnects or equivalent methods are permitted for situations that include:

a) where piping disassembly may be required in the future for maintenance purposes, such as required at sumps and where connecting an *ASD* fan;

b) where joining duct piping materials that are incompatible for solvent welding;

c) where physical constraints inhibit the ability to join duct pipe materials by means of a solvent weld;

d) where intended to minimize noise by breaking the direct transfer of fan vibration to duct piping; and

e) where local codes allow temporary removal and airtight replacement of *ASD* pipe sections to provide access to areas requiring maintenance or inspection of equipment as described in Section 6.2.9.

6.2.7 *Secure duct piping*

~~7.2.7.1 *Fastening supports*~~

6.2.7.1 Duct piping shall be fastened to the structure of the building with hangers, strapping, or other supports that will withstand forces such as wind, ice and other forces or degradation over time. The fastening system shall comply with requirements in a), b), c) and d) of this Section 6.2.7.1.

a) Mechanical hardware or fasteners shall be durable for the purpose and weather-rated when employed outdoors;

b) The anchoring method and fastening materials shall be suitable to secure the anchors in a durable manner to whatever building surface is chosen for securing the duct piping;

c) Existing plumbing pipes, ducts or mechanical equipment shall not be used to support or secure duct piping; and

d) Fastening systems that rely only on extending a nail or screw through the duct piping and into a wall or other supporting surface shall not be used to secure duct piping.

~~7.2.7.2 *Support locations*~~

6.2.7.2 Supports for *ASD* plastic piping shall be installed no less than every 10 feet (3 m) on vertical piping and ~~6 feet (1.8m)~~ 4 feet (1.2 m) on horizontal piping. Alternate *ASD* duct materials identified in Section 6.2.5, such as iron, steel, or copper, shall be secured in a manner that meets codes [3] and manufacturer recommendations.

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[3] As point of reference, the International Mechanical Code (IMC), the International Plumbing Code (IPC) or the International Residential Code (IRC) that are published by the International Code Council.

~~7.2.9 ***Provide access clearance***~~

6.2.8 *Provide access clearance*

Duct pipe routing shall not:

a) block egress from entrances and exits to the building, including those designated for fire and safety;

c) compromise effectiveness of fire suppression systems; or

b) block necessary access to any areas requiring maintenance or inspection such as mechanical equipment or a *crawl space*.

Exception: Flexible coupling disconnects or equivalent methods prescribed in **Section 6.2.6** are permitted where allowed by code to provide access by temporary removal and airtight replacement of *ASD* pipe sections. Such configurations shall be marked or labeled "Removable for temporary access," or equivalent wording.

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~~7.2.10 ***Protect ducts from the elements (Insulation)***~~

6.2.9 *Protect ducts from the elements (insulation)*

Duct piping shall be provided with thermal insulation in accordance with the following two requirements:

a) Where it is likely on a regular basis (e.g., annually or every few years) that freezing temperatures will result in ice buildup within duct piping that would adversely affect system performance, the insulation shall be protected from the elements and have an R-value of not less than 4; and

b) Where it is likely that condensation on exterior surfaces of duct piping would damage building materials, the insulation shall have an external vapor barrier and an R-value of not less than 1.8.

Note—For more extreme climates, greater R-values may be appropriate.

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6.2.10 *Observe codes* [4]

Compliance with codes of the jurisdiction having authority (JHA) and utility company restrictions is required, including those related to maintaining the integrity of a buildings structural members; inhibiting the spread of fire and smoke; and proximity of piping relative to electrical components.

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~~**7.3 ASD Pipe Sizing**~~

6.3 *ASD* Pipe Sizing

ASD duct piping shall be sized and configured to result in adequate capacity to transport the volume of air required for establishing a vacuum under each slab or membrane and within each airspace being depressurized by the *ASD* system.

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6.3.1 *Minimum inside diameter—air volume capacity*

ASD duct piping from the exhaust point to the *soil gas collection plenum(s)* shall be equivalent or greater than the cross-sectional area of a 3-inch (75-mm) inner diameter (ID) pipe or as determined by *PFE* Analysis.

6.3.2 *When larger air volume needs are indicated*

Where *PFE* analysis indicates the necessary airflow for the entire system is more than 80 *cubic feet per minute (cfm)* (2.3 m^3/min), duct piping from the exhaust point to the *soil gas collection plenum(s)* shall be equivalent or greater than the cross-sectional area of a 4-inch (100-mm) ID pipe.

6.3.3 *When smaller air volume needs are verified*

Where *PFE* analysis indicates the necessary airflow for the entire system is equal to or less than 40 cfm (1.1 m^3/min), 2-inch (50-mm) ID duct piping from the exhaust point to the *soil gas collection plenum(s)* is permitted.

[4] As point of reference, see the International Residential Code (IRC) as published by the International Code Council.

6.3.4 *Equivalent cross-sectional area*

Multiple pipes of various sizes that are joined in a parallel manner to result in a combined air volume capacity that is not less than the equivalent cross-sectional area of pipe diameters required in Sections 6.3.1 and 6.3.2 shall be permitted.

The minimum pipe diameter through parallel pipe sections shall be 2-inch (50-mm) ID pipe.

~~7.3.5 ***Maintain whole system air volume capacity:***~~

6.3.5 *Maintain whole-system air volume capacity*

The configuration shall not reduce duct pipe diameters or dimensions in the direction of airflow from the soil gas inlet(s) to the exhaust location such as to result in less whole-system air volume capacity than achieved with pipe sizes specified in Sections 6.3.1, 6.3.2 or 6.3.3. All components of the ducting system that reduce air volume transport capacity shall be accounted for in meeting this requirement, to include any rain caps or other obstructions at exhausts and circumference or size of slab penetration connections to soil gas.

6.3.6 *Multiple suction points*

Each suction pipe shall be sized to provide air volume capacity sufficient to establish a vacuum under each slab or membrane and within each airspace being depressurized by the *ASD* system.

Where air valves, dampers or baffles are used to adjust airflow balance:

a) the location, settings and design shall be included in "as built records" for the system; and

b) they shall be marked or labeled to indicate their purpose, settings and instructions, such as "Radon/Soil Gas System Air Valve. Do Not Alter From Marked Setting," or similar wording.

6.3.6.1 Drainage

When multiple suction points are employed, piping extended to secondary *suction pits* exclusively designed for condensate or rainwater drainage do not require any specific pipe diameter.

~~7.3.6 ***Sizing for alternative duct materials***~~

6.3.7 *Sizing for gutter downspout duct materials*

A natural reduction to airflow capacity shall be accounted for when using gutter downspout in accordance with Section 6.2.5 (Exception 2). Because crimped downspout flange connections reduce airflow capacity, gutter downspout materials employed shall be:

a) no less than 3 x 4 inch downspout material (75 x 100 mm) to meet capacities stipulated in Section 6.3.1 for 3-inch (75-mm) ID pipe; and

b) no less than 4 x 5 inch downspout material (100 x 127 mm) to meet capacities stipulated in Section 6.3.2 for 4-inch (100-mm) ID pipe. When even larger air volume needs are indicated, duct size shall increase respectively.

Gutter downspout material that is less than 3 x 4 inches (75 x 100 mm) shall not be permitted unless, in accordance with Section 6.3.3, *PFE* Analysis indicates that the necessary airflow for the entire system is equal to or less 40 *cfm* (1.1 m^3/min).

6.3.8 *Air velocities (see informative notes)*

6.4 ASD Exhaust Discharge

~~7.4.1 ***General***~~

6.4.1 *General*

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6.4.1.1 Measuring Distances—Stretched String

Distances shall be measured between the closest point of the exhaust opening to the closest point of all location requirements specified in Section 6.4 using the shortest distance, as if a string were stretched between them.

6.4.1.2 Definitions

Definitions a), b), c) and d) of this Section 6.4.1.2 shall apply to exhaust requirements in Section 6.4:

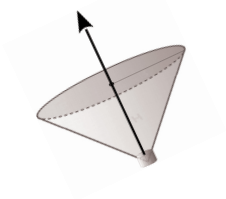
a) *Openings In Structure* The openings created in structural walls or roofs for the purpose of mounting windows, skylights, doors or other assemblies that might open to outdoor air;

b) *Operable Openings* The operable or constantly open portion of windows, skylights, doors and other openings designed to readily operate for increasing ventilation with outdoor air. Portions of a window specifically designed to temporarily open for cleaning are not considered readily operable for increasing ventilation with outdoor air;

c) *Exhaust Trajectory* The angle of the pipe or elbow at the *point of exhaust*.

The angle of the exhaust trajectory from the open end of the pipe or elbow is geometrically defined as the straight- or center-line axis that extends outward from the geometric center of the exhaust opening and is perpendicular to the plane of the exhaust opening; and

d) *Exhaust Spread* The exhaust spread extends outward from the *point of exhaust* in the shape of a circular cone. The tip or apex of the cone is at the geometric center of the exhaust opening and the cone profile grows larger as distance from the *point of exhaust* increases.



The total directional spread of the exhaust or cone is defined in degrees by the offset-axis angle of the cone profile compared to the cone's center-line axis. Expanding outward from the *point of exhaust*:

- An exhaust spread radius of 45˚ equals an exhaust spread diameter of 90˚.
- An exhaust spread radius of 11˚ equals an exhaust spread diameter of 22˚.

~~7.4.2 ***Outdoors***~~

6.4.2 *Outdoors*

The point of exhaust for all soil gas vent systems shall be located outdoors.

6.4.3 *Directional spread (restrictions)*

The *exhaust trajectory* with an *exhaust spread* radius of 45˚ shall not encounter openings in any structures, building materials or the breathing space where individuals congregate or traverse within 10 feet (3 m) from the *point of exhaust*.

Exception: EPDM, composite, or otherwise layered water-tight roofing materials.

6.4.4 *Straight-line trajectory (restrictions)*

The *straight-line exhaust trajectory* with an *exhaust spread* radius of 11˚ shall not encounter openings in any structures, attic ventilation openings, building materials or the breathing space where individuals congregate or traverse within 20 feet (6 m) from the *point of exhaust*.

6.4.5 *Elevation above grade*

The point of exhaust shall be located not less than 10 feet (3 m) above grade nearest to the *point of exhaust* and shall be compliant with Section 6.4.3 (*Directional spread*) and Section 6.4.4 (*Straight-line trajectory*).

6.4.6 *Separation from operable openings in structures*

The point of exhaust shall be compliant with Section 6.4.3 (*Directional spread*) and located:

a) not less than 10 feet (3 m) horizontally to the side operable openings in structures; and
b) not less than 4 feet (120 cm) away from operable openings in structures that are below the point of exhaust.

6.4.7 *Separation from people*

In relationship to exterior flooring surfaces such as decking, patios, sidewalks, and exterior corridors where individuals congregate or traverse, the *point of exhaust* shall be:

a) not less than 10 feet (3 m) above or horizontally to the side of exterior flooring surfaces; and
b) compliant with Section 6.4.3 (*Directional spread*) for an elevation of not less than 10 feet (3 m) above exterior flooring surfaces.

6.4.8 *Equipment wells and parapet roofs*

The point of exhaust relative to open equipment well airspaces or parapet roof construction, where areas are enclosed by more than two walls, shall comply with Section 6.4.3 (*Directional spread*), to include the breathing space where individuals conduct maintenance.

6.4.9 *Angled trajectories*

The point of exhaust shall be directed upward without obstruction at an angle that does not deviate more than 45 degrees from a vertical *exhaust trajectory*. The exhaust discharge shall not exhaust downward.

Exception: 90 degree horizontal exhausts shall comply with requirements in Section 6.4.12.

6.4.10 *Roof*

The *point of exhaust* shall comply with Section 6.4.3 (*Directional spread*) and, unless all requirements of Section 6.4.11 are met, the *point of exhaust* shall be:

a) not less than 1 foot (30 cm) above a pitched roof at the point penetrated;
b) not less than 6 inches (15 cm) above the edge of the roof when *ASD* piping is attached to the side of a building;
c) not less than 18 inches (46 cm) above a flat roof; and
d) not less than 4 feet (120 cm) horizontally away from a vertical wall that extends above the roof edge.

6.4.11 *Below the roof*

The *point of exhaust* shall be permitted to be located below the edge of the roof if the configuration complies with all requirements of Section 6.4 and requirements of a), b), and c) of this Section 6.4.11:

a) The justification for not locating the exhaust above the edge of the roof shall be recorded in the operations and maintenance plan and shall be based upon either:

1. the inability to comply with other requirements of Section 6.4 if the point of exhaust were located above the roof, or
2. the edge of the roof exceeds ~~30~~ 20 feet (6 m) above grade nearest to the point of exhaust;

b) The *point of exhaust* shall be: compliant with Section 6.4.3 (*Directional spread*); not less than ~~30~~ 20 feet (6 m) above grade nearest to the point of exhaust; and not less than 4 feet (120 cm) away from operable openings that are above the point of exhaust; and

c) Testing shall be conducted within the occupiable area that immediately adjoins the 45˚ (*Directional spread*) required in Section 6.4.3. This testing is required no later than in conjunction with the initial post-*mitigation* test and shall be recommended for inclusion in all future post-*mitigation* tests.

6.4.12 *Horizontal trajectory*

While it is best practice to avoid horizontal trajectories, 90-degree horizontal exhaust trajectories are permitted if compliant with all other distances required in Section 6.4 and Section 6.4.12.1 or Section 6.4.12.2.

6.4.12.1 90-Degree Horizontal Discharges

If passing the edge of the roof, the *point of exhaust* for a 90-Degree horizontal discharge shall not be less than 20 feet (7.5 m) above grade nearest to the point of exhaust. The point of exhaust shall comply with Section 6.4.3 (*Directional spread*) including for distances above the breathing space where individuals congregate or traverse as stipulated in Section 6.4.7.

Where "T" style rain caps are configured for 90-Degree horizontal discharge in two directions, both discharge trajectories shall meet these requirements.

6.4.12.2 Diffused Horizontal Discharge/Rain Caps

The *point of exhaust* for diffused horizontal discharges shall not be less than 15 feet (4.6 m) above grade nearest to the *point of exhaust* and not less than 4 feet (120 cm) above or 15 feet (4.6 m) away from *operable openings* into the structures, such as windows, skylights, and doors.

~~7.4.13 ***Increased distances for large capacity systems***~~

6.4.13 *Increased distances for large capacity systems*

When the ASD system is designed for larger airflow capacities with duct piping larger than 4-inch (100-mm), distances shall be increased beyond what is required in Section 6.4 to comply with Table 6.4.13.

Table 6.4.13

Pipe ID *As in Section 6.4* *3"- 4" Pipe (10 cm)*	Distance Away *Directional spread* *As in Section 6.4.3* *10 ft (3 m)*	Distance Away *Straight-line* *As in Section 6.4.4* *20 ft (6 m)*	Distance Above, Below or To Side *Grade, Operable Openings and People* *Sections 6.4.5, 6.4.6 , 6.4.7, 6.4.10, 6.4.11 and 6.12*
For Larger Pipe ID	**Increase to**	**Increase to**	**Increase distances by another:**
6" (15 cm)	12 ft (3.6 m)	25 ft (7.6 m)	2 ft (1.8 m)
8" (20 cm)	18 ft (5.5 m)	30 ft (9 m)	4 ft (2.4 m)
10" (25 cm)	20 ft (6 m)	40 ft (12 m)	6 ft (1.8 m)
For pipe larger than 10" (25 cm)	Shall be increased to meet or exceed ASHRAE 62.1, Appendix B (Separation of Exhaust Outlets and Outdoor Air Intakes)		

6.5 ASD Fan Installation

~~7.5.1 ***ASD fan design***~~

6.5.1 *Fan design*

ASD fans chosen shall be:

a) designed for *continuous duty* operation;

b) designed or otherwise sealed to reduce the potential for leakage of water and soil gas;

c) designed to allow rainwater or condensation from within *ASD* piping to pass through or around the fan when operating; and

d) represented by the manufacturer as both appropriate for the class of contaminants being extracted and manufactured with features that meet minimum safety standards , to include:

1. thermal protection integral to the fan that prevents dangerous overheating of the motor [5];
2. protection against electrical shock for fans mounted both on the interior and exterior of buildings, that may include a fan installed in a weatherproof protective housing that results in a code compliant configuration; and
3. other features that result in a safe fan installation, such as specified by codes[6] where evaluations of chemicals in soil have indicated that gases passing through the fan are corrosive or could result in a fire, explosion, or serious personal injury.

6.5.2 *Safe locations required*

To avoid accidents that can result in systems leaking radon and soil gas into *occupied spaces* due to a failed pipe joint or other sealed connection:

a) *ASD* fans shall not be installed in the conditioned (heated/cooled) or otherwise occupiable space of a building; and

b) *ASD* fans shall not be installed directly beneath conditioned or occupiable spaces of a building, such as a fan installation within a basement, *crawl space*, or enclosed garage beneath occupiable space.

6.5.3 *Approved locations*

In compliance with requirements in Section 6.5.2, *ASD* fans are to be installed in attics, on the exteriors of buildings, or in garages that are not beneath conditioned or otherwise occupiable spaces.

Note—Ventilated attics or the exterior of the building are preferred locations. Considerations also include locations that avoid objectionable noise from fan vibration and exhaust air.

6.5.4 *Fan Installation*

Installation of *ASD* fans shall comply with requirements in a), b), c), d) and e) of this Section 6.5.4.

a) *ASD* fans shall be sized to provide the pressure difference and airflow capacity necessary to achieve the *mitigation* goals;

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[5] As a point of reference, products evaluated by an OSHA Nationally Recognized Testing Laboratory for meeting applicable safety standards, such as UL 507 Standard for Safety for Electrical Fans published by Underwriters Laboratories Inc., Northbrook, Illinois. ulstandards.ul.com

[6] As a point of reference, additional information on code compliant fans rated for hazardous applications such as explosion proof fans are provided in the attached Companion Guidance for Vapor Intrusion.

b) *ASD* fans shall be installed in a configuration that avoids condensation buildup in the fan housing. To achieve this requirement, *ASD* fans shall be installed on vertical runs of *ASD* piping or in accordance with the manufacturer's specifications;

c) *ASD* fans shall be mounted to piping using flexible couplings that comply with ASTM D5926 or ASTM C1173 or using an alternative method specified by the manufacturer that achieves a watertight connection; and

d) *ASD* fans subject to extreme climate conditions shall be protected with thermal insulation, as needed, in accordance with Section 6.2.10.

e) *ASD* fans shall not be installed below ground.

Exception: Locations that are created or exist below grade that are not beneath conditioned or otherwise occupiable space of a building, such as outside the building shall be permitted if configured to protect the fan and electrical components from damage and degradation. Such locations or any enclosures created shall include reasonable access for maintenance and adequate groundwater control such as drainage and, as applicable, *sump* pump systems. As applicable, all electrical components, including wiring and service switch configurations, shall be rated for use in wet or damp environments

7.0 SEALING

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Closure between soil air and indoor or outdoor air shall comply with all requirements in Section 7 of ANSI/AARST SGM-SF.

7.1 General

7.1.1 Sealing is not to be regarded as a permanent, stand-alone *mitigation* method.

~~8.1.1 ***Accessibility to cracks and openings***~~ ~~8.1.2 ***Inaccessible openings or cracks***~~

7.1.2 *Accessibility to cracks and openings*

For the purpose of sealing requirements herein, the term "accessible" shall mean *accessible* without destructive or significant disassembly of building components or finishes. If inaccessible openings or cracks may compromise the performance of a *mitigation* system, then they shall be disclosed to the *client* and included in *operation, maintenance, and monitoring (OM&M)* documentation.

~~**8.2 Sealant Materials**~~

7.2 Sealant Materials

7.2.1 *Caulking cracks*

When sealing cracks in slabs or foundation walls, the caulks and sealants shall be durable materials, such as urethane or polyurethane, complying with ASTM standard C920 class 25 or greater or equivalent material. Caulks and sealants shall be applied according to the manufacturer's recommendations.

7.2.2 *For larger gaps*

Where a crack or joint is greater than 1/2 inch (13 mm) in width, foam *backer rod* or other comparable filler material to support wet caulk until it cures shall be inserted into the existing gap prior to applying caulk.

7.2.3 *For larger openings*

When sealing larger openings to soil in slabs and foundation walls, the materials shall be durable, such as: non-shrink cementitious products; expanding foam; plastic; or other comparable materials and methods appropriate for the application.

7.2.4 *For heated pipes and flues*

When sealing openings around combustion appliance flues and hydronic heat or steam pipes, noncombustible materials shall be used.

7.2.5 *For sump lids and hatchway doors*

For *sump* lids, hatchway doors or other items that require access in the future, nonpermanent sealant materials are required, such as silicone caulk, gasket materials or other equivalent method.

7.2.6 *Vapor Intrusion sealants*

When *ASD* goals include *mitigation* of chemical vapor intrusion, the *contractor* shall advise the *client* if any sealant products used are known to have long curing periods or contain constituent chemicals identified in *mitigation* goals.

~~8.3 Accessible Slab Cracks~~

7.3 Accessible Slab Cracks

Accessible openings to soil around suction piping, utility penetrations and where the slab meets the foundation wall shall be closed or sealed to resist air movement between soil and indoor air.

7.3.1 *Perimeter channel drains*

Accessible gaps to soil at perimeter channel drains and foundation drainage boards shall be closed or sealed to the extent practical without compromising water control capability of the perimeter drainage system. Where sealing perimeter channel drain gaps, methods shall employ materials that will achieve closure yet retain flexibility to allow natural movement of foundation slabs and walls.

~~Other Openings in Slabs or Foundation Walls~~

7.4 Other Openings to Soil

Other *accessible* and significant openings to soil in slabs or walls shall be sealed to resist air movement between soil and indoor air, such as: at support posts; electrical conduits that are open to soil; and openings for plumbing fixtures under bathtubs.

7.4.1 *Block walls*

Where Block Wall *Depressurization* is installed, all *accessible* openings and gaps in hollow block masonry walls that surround the hollow void network being depressurized shall be closed to resist air movement between the depressurized void network and both indoor air and outdoor air. Closure shall result in resisting migration of air into the depressurized void network, to include:

a) open blocks at the top course of hollow block masonry walls and open blocks under door or window openings; and
b) cracks or openings in the block walls, both inside and outside of the building.

Materials used to close openings and gaps shall be in accordance with Sections 7.2.3, 7.2.4 or equivalent.

7.4.2 *Basement de-watering systems*

If an *ASD suction point* must be installed into a basement de-watering system, exposed openings into the drainage system that can be sealed without compromising water drainage features shall be sealed, to include as required in Section 7.3.1.

~~8.5 Sumps~~

7.5 Sumps and Pits

Sumps or other *accessible* pit openings in the interior slab(s) that connect to soil air shall be covered and sealed to the extent possible without compromising the water control capability of the *sump*. The manner of closure shall not compromise safety concerns, such as emergency pressure relief discharge from hydronic heating system water boilers. Covers are not required for pits that do not connect to soil air.

7.5.1 *Sump cover specifications*

Sumps in interior floors that connect to soil air shall have a rigid lid made of sturdy and durable plastic such as polycarbonate plastic or other rot-resistant, rigid material sufficient to support anticipated loads in the area of use. The lid shall be *mechanically fastened* in a manner to facilitate removal for maintenance. The lid shall be sealed to resist air movement between soil gas and indoor air with a gasket or with nonpermanent caulk such as silicone. Penetrations through the lid such as gaps around electrical wiring, water ejection pipes and *ASD* piping shall be sealed.

7.5.1.1 Sump Pit Access

Where work includes installing, modifying, or altering a sump cover for a pit that includes a *sump* pump, the sump cover shall include a removable handhole port or section of the lid no less than 4 inches (10 cm) in diameter that allows physical access for routine verification that pumps are operational. The access port shall achieve open access and reclosure without the use of sealants, as can be achieved by way of friction fit or screw-on caps, rubber grommets or equivalent methods. *ASD* suction pipe connections shall not be used for access ports.

7.5.1.2 Labeling Required (sump covers)

Sump lid labels shall be provided in compliance with Section 8.4.6 a.

7.5.3 *Sump pump water discharge*

If flexible rather than rigid water discharge piping is found, the *contractor* shall recommend in writing that rigid pipe for water discharge from permanent *sump* pumps be installed. *Sump* pumps or piping configurations for water discharge from the sump pump shall have a backflow prevention valve as typically provided to protect against pump failures. Should there be a need for the *contractor* to alter the destination of discharged sump water, the destination shall meet requirements of local authorities.

7.5.4 *Chemically contaminated water*

When *mitigation* goals include *mitigation* of *chemical vapor intrusion* and the *sump* needs to be installed or its discharge modified, *sump* water shall be handled and discharged to a destination as specified by a qualified environmental consultant.

7.5.5 *Surface water relief (slabs)*

An alternative drainage system shall be provided and installed in accordance with guidance in Section 7.8.1 when sealing a *sump* or other slab opening that is the only drain relief for excess water on the slab surface.

~~**8.6 Membranes Over Open Soil**~~

7.6 Membranes Over Exposed Soil

~~Soil gas retarders shall meet ASTM E1745 class A, B or C.~~

The membrane material shall be not less than nominally 6-mil (0.006 inch; 0.152 mm) in thickness.

7.6.1 *Durable for application*

Where exposed soil areas are expected to be regularly traversed for storage or other purposes, membranes with tensile strength and puncture resistance to withstand anticipated loads shall be employed. Where a membrane will be exposed to sunlight, such as at window wells in a *crawl space*, the membrane shall be resistant to UV degradation.

Exception: Where running mats or other protective materials are installed to protect the membrane where trafficked; where heavy items are stored; or where exposed to sunlight.

7.6.2 *Vapor intrusion (membranes general)*

The *contractor* shall account for the known *chemical(s) of concern* in relationship to manufacturer guidance on *soil gas retarder* materials to help ensure degradation of the material will not occur over time when in contact with the *chemical of concern*.

7.6.3 *Seams (membranes general)*

Seams where membrane materials are joined shall be sealed in accordance with Section 7.7.1 when sub-membrane *depressurization* (SMD) is employed. Otherwise, seams between adjacent membrane sheets shall be overlapped not less than 12 inches (30 cm).

7.6.4 *Repairs*

Tears or punctures in the membrane shall be sealed by:

a) a tape recommended by the membrane manufacturer; or
b) an additional sheet of the membrane material that covers and overlaps the tear or puncture not less than ~~12~~ 6 inches (15 cm) on all sides and that is sealed with a caulk complying with ASTM C920 class 25 or greater, or an equivalent method.

7.6.5 *Label membranes or access ports*

Membranes or the *crawl space* access port shall be labeled in accordance with Section 8.4.6 b.

7.6.6 ***Surface water relief*** *(See important informational notes)*

~~**8.7 Sub-membrane Depressurization (SMD**~~

7.7 Sub-Membrane Depressurization (SMD)

In addition to all requirements in Section 7.6, *soil gas retarder* membranes associated with SMD shall be sealed and secured in accordance with Section 7.7.1 through Section 7.7.4 to result in a closed *soil gas collection plenum* under the membrane that resists air movement between soil and air above the membrane.

~~8.7.1 ***Seams (SMD)***~~

7.7.1 *SMD—Seams*

The seams between adjacent membrane sheets shall be overlapped ~~not less than 12 inches [30 cm] and~~ sealed with a compatible sealant or a caulk complying with ASTM C920 class 25 or greater. Alternatively, a method such as membrane tape recommended by the manufacturer that results in an equivalent durable bond shall be permitted.

~~8.7.2 ***Pipe penetrations (SMD)***~~

7.7.2 *SMD—Pipe penetrations*

The opening around penetrations of a *soil gas retarder* for *ASD* duct piping and other utility pipe penetrations shall be fully closed using materials and methods that result in permanent closure.

~~8.7.3 ***At walls and foundation supports (SMD)***~~

7.7.3 *SMD—Securing the membrane*

Soil gas retarder membranes shall be *mechanically fastened* to foundation walls or footings and at structural supports. All outer edges of the membrane shall be secured by materials and methods that are capable of withstanding anticipated loads that might pull or tear the membrane away from walls or other surfaces.

~~8.6.6 ***Wood components***~~

Any wood installed as part of a *mitigation* system that directly contacts masonry or soil, such as when employed to secure a membrane, shall be resistant to decay and insects or otherwise protected.

7.7.4 *SMD—Sealing the membrane perimeter*

The entire perimeter of the sub-membrane *soil gas collection plenum* shall be sealed or closed in a manner to resist soil gas movement between the soil and air above the membrane using caulk that complies with ASTM C920 class 25 or higher, or alternative materials or methods that provide similar performance.

~~8.7.4 ***Inaccessible areas (SMD)***~~

When portions of the *crawl space* cannot be accessed or have insufficient height to work in a safe manner, as established by the Occupational Safety and Health Administration (OSHA) or other authorities, the edges of the membrane within the boundaries of *accessible* areas shall be closed.

Exception: Where it can be demonstrated to be warranted, systems are permitted with a portion of the membrane edges unclosed. Such design shall meet any additional requirements in Sections 6.1.4 (*Non-habitable air spaces*) and Section 12.6 (*Soil gas dilution*). Open membrane edges shall be disclosed to the *client(s)* in documentation along with justification for the design.

~~**8.8 Drains**~~

7.8 Drains

~~8.8.1 ***Drains to soil***~~

7.8.1 *Drains to soil (see informative notes)*

7.8.2 *Utility drains to soil*

Openings in the slab or at *sumps* that serve for mechanical system water drainage and are likely to draw soil air into a building shall be modified to stop this airflow. The modification shall retain drainage capability, such as the use of a one-way flow valve, re-routing the drain line into a condensate pump or floor drain, or a trap in the drain that can hold at least 6 inches (15 cm) of water.

~~8.8.3 ***Drains to daylight***~~

7.8.3 *Drains to daylight (see informative notes)*

~~**8.9 Sealed Isolation Assemblies**~~

7.9 Sealed Isolation Assemblies

Sealed isolation assemblies are not to be regarded as a permanent, stand-alone *mitigation* method.

7.9.1 *Sealing (isolation assemblies)*

When applying *depressurization* or *pressurization* to air within a *sealed isolation assembly*, any *accessible* openings between the isolated space and areas surrounding the isolated space shall be sealed to resist air movement between the isolated airspace and both indoor and outdoor air. Access doors or hatches that are not to be permanently sealed shall be fitted with airtight gaskets and a means of positive closure.

7.9.2 *Labeling required (isolation assemblies)*

Access ports into sealed isolation assemblies shall be labeled in accordance with Section 8.4.6 c.

~~**9.0 REQUIRED FOR ALL SYSTEMS AND METHODS (ASD and Non-ASD)**~~

8.0 FOR ALL SYSTEMS AND METHODS

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All systems and methods shall comply with requirements in Section 8 of ANSI/AARST SGM-SF and as additionally specified herein.

8.1 Long-Term Plan for OM&M

A plan for long-term *operation, maintenance, and monitoring (OM&M)* is required for all *mitigation* methods.

~~**9.2 Fan Monitors**~~

8.2 System Monitors

8.2.1 *Viewable operating range monitors*

All *mitigation* systems that incorporate a fan shall include a system monitoring mechanism to directly indicate if the fan, blowers, or other integral mechanical components are operating within

the established operating range. Design and installation of such monitors shall comply with requirements in both a) and b) of this Section 8.2.1.

a) Continuous Display
The monitoring device shall provide continuous display of a measured value within the established operating range. The monitor shall be located where it is easily seen and protected from damage or degradation.

b) Start up values
Monitoring devices that continuously display a viewable operating range shall be clearly marked or labeled to indicate the measured pressure, airflow volume or amperage readings that existed at the time *mitigation* goals were achieved.

Exception: Fan monitors that provide remote electronic monitoring and notification in the event of *ASD* fan or other mechanical failure, such as to accommodate where occupants are not the responsible party for system maintenance.

~~9.2.1.2 *Powered monitors*~~

8.2.2 *Active notification monitors*

All *mitigation* systems that incorporate a fan shall also include a monitoring mechanism that actively alerts occupants or other responsible individuals in the event of fan or other mechanical failure. The alert mechanism shall include one or more of the following warning signals:

a) Audible notification that is clear and distinct; or

b) Visual light notification that is vividly observable; or

c) Notification by telemetric means, such as by email or other electronic communication.

8.2.3 *Required for all system monitors*

Requirements for all mechanisms or systems that monitor fan or airflow functionality include:

a) System monitors shall be *readily accessible* to individuals responsible for system maintenance without destructive or significant disassembly of building components or finishes.

b) System monitors shall be protected from the elements and durable for the ambient environmental conditions;

c) System monitors shall be labeled in accordance with Section 8.4.3;

d) Battery operated components shall not be used unless equipped with a low-power warning feature;

e) Components that require electricity for indication of system failure shall be on non-switched circuits and designed to reset automatically when power is restored after power supply interruptions; and

f) Components that require electricity for indication of system failure shall not be powered by the same branch circuit as the *mitigation* system fan(s).

Exception: Where the monitoring system has an independent means, such as a battery backup system, that actively alerts occupants or other individuals of component failure or branch circuit deactivation.

~~**9.3 Electrical Requirements**~~

8.3 Electrical

The electrical service for *ASD* Fans shall comply with the following provisions in addition to all other electrical code requirements. [7]

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[7] As required by local statutes. For further information, see NFPA 70 The National Electric Code® as published by NFPA.

8.3.1 *Disconnect required*

For *ASD* fans, a means of electrical disconnect shall be provided in the line of sight and within 6 feet (1.8 m) of the *mitigation* system fan(s).

Exception: A switch remote from the fan location shall be permitted when concerns sufficiently warrant preventing inadvertent deactivation of the fan.

8.3.2 *Labels required (disconnects)*

Labeling shall comply with Section 8.4.5.

8.3.3 *Protection from shock*

All outdoor wiring for *ASD* fans shall be protected in conduit, unless otherwise permitted by local code, and shall not be a plug disconnect.

8.3.4 *Not allowed*

Wiring shall not be located in or chased through the *ASD* duct piping.

~~**9.4 Labeling Required**~~

8.4 Labeling

~~9.4.1 ***Label materials and lettering***~~

8.4.1 *Label materials and lettering*

All labels shall be made of durable materials that are capable of withstanding ambient conditions where mounted. All label lettering and other annotation on systems shall be of a color in contrast to the color of the background on which the lettering is applied. The minimum lettering size shall conform to requirements a) and b) of this Section 8.4.1.

a) Label titles shall be with lettering not less than 1/4 inch (6 mm) in height.

b) Additional informational text shall be with lettering not less than 1/8 inch (3 mm) in height.

~~9.4.2 ***Label the system(s) – primary label***~~

8.4.2 *Primary labels*

A system description label shall be placed on a primary component of each system. Approved locations for the system description label include on duct piping near an *ASD* fan monitor, within 12 inches (30 cm) of the electric service panel or other prominent location. System monitor devices shall have a label on or near the mechanism that describes how to interpret the monitor and actions to take if a monitor indicates fan failure or degraded fan performance.

The primary label titles shall describe the system purpose, such as “Radon Reduction System” or "Soil Gas Control System." Information required on or near the label(s) shall include content required in Sections 8.4.2.1 or 8.4.2.2 of this Section 8.4.2.

8.4.2.1 Owner-Occupied Maintenance

For systems installed in individually owned and occupied *dwellings* or units where system maintenance and monitoring for continued effectiveness will be the responsibility of the owner, the primary label shall include:

a) Date of installation;

b) Maintenance and monitoring instructions, to include:

1. A description of the system monitors and actions to take if the system monitors indicate system degradation or failure, and
2. A recommendation to verify continued system effectiveness over time, such as:

— a recommendation to conduct a radon test at least every 2 years, or

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— other monitoring procedures as specified in an *OM&M* plan for radon or chemical vapor intrusion systems;

c) State and federal informational resources, to include websites or phone numbers; and

d) The installer's name, phone number and applicable certification/license identification.

8.4.2.2 Independent Maintenance

Where system maintenance and monitoring are the responsibility of someone other than the occupant:

a) Informational content on a primary label that is observable to building maintenance staff or occupants shall include:

1. A description of system monitor(s) or monitoring systems and, as applicable, actions to take if the system monitor indicates system degradation, and
2. The name and contact information of the party responsible for maintenance and repairs.

~~9.4.4 ***Label fan monitors and startup***~~

8.4.3 *System equipment*

System equipment shall be marked or identified with a label title that portrays the system purpose. The labeling shall also comply with requirements in a), b) and c) of this Section 8.4.3.

a) Mechanical Equipment

ASD fans and other system air handling and mechanical equipment shall be labeled.

b) System Monitors

The system monitoring device(s) shall be provided a label near the mechanism, such as a primary label or other label, that includes:

1. Information on how to interpret the monitor; and
2. What to do if a monitor indicates fan failure or degraded fan performance; and

c) System Controls

Where systems include controls for mechanical equipment, a label shall be provided on or near the control mechanism. System control settings that existed at the time *mitigation* goals were achieved shall be clearly marked on the equipment, a label or provided with equipment instructions. General instructions for operation of each control mechanism shall be provided.

~~9.4.5 ***Label duct piping***~~

8.4.4 *Label duct piping*

Interior duct piping shall be marked with not less than one label at each floor level and within attics, garages and *crawl spaces* that portray the system purpose. Examples include "Radon Reduction System" or "Soil Gas Control System."

~~9.4.6 ***Label electrical disconnects***~~

8.4.5 *Label electrical disconnects*

Disconnects, such as switches or plugged connections, for turning off *mitigation* system fans shall be labeled or marked to indicate their purpose. The label title shall identify that the disconnect as a component of the *mitigation* system. Examples include "Radon Fan – Do Not Turn Off," or "Radon Fan – Do Not Unplug."

~~9.4.7 ***Label sealed components***~~

8.4.6 *Label sealed components*

Certain components that are sealed to resist air movement between soil and indoor air shall be labeled in accordance with requirements in a), b), c) and d) of this Section 8.4.6.

~~9.4.7.1 *Label sump covers*~~

a) Sump Covers

Sump lids shall be labeled to identify the lid as a component of the *mitigation* system.

Note—Instructions are recommended, such as "If opened, take care to reseal this cover."

~~9.4.7.2 *Label crawl spaces or membranes*~~

b) Crawl Spaces or Membranes

Where *soil gas retarder membranes* have been installed, a label or marking shall be located in a conspicuous place or places. Examples include access panels or immediately visible once entering the *crawl space*, such as on membrane material near the access location. The label shall include:

1. A label title that indicates the presence of a *mitigation* system component, and
2. Instructions to help preserve the integrity of the membrane. Examples include, "Do Not Alter. Damage or alteration to plastic membrane sheeting can negatively impact system performance".

~~9.4.7.2 *and Sealed Isolation Assemblies*~~

c) Access Locations

Where *mitigation* methods address air within a *non-habitable airspace* that can be accessed, labels shall be provided in a conspicuous place on the outside of access ports, hatches, and doors into the airspace or immediately visible once entering the airspace. The label shall include:

1. A label title that indicates the presence of a *mitigation* system component;
2. Instructions to help retain system effectiveness. Examples include "Keep closed. Leaving open can negatively impact building safety"; and
3. Instructions essential health and safety guidance where there are known health and safety hazards. Examples include:
   a. "Warning—Entry into this airspace can be hazardous. Precautions to ventilate this area are recommended;" and
   b. Applicable descriptions of recommended personal safety procedures, such as the possible need for protective gloves, clothing, respirators, or other personal safety equipment.

~~11.1.3 *Inspection for compliance*~~

8.5 Inspection for Compliance

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Prior to delivery and release of the completed system(s), a *qualified radon mitigation professional* or qualified *soil gas mitigation professional*, as applicable, shall have verified:

a) compliance with this standard;
b) conformance with the intended design criteria; and
c) compliance with local statutes and codes, including for related work conducted by other qualified professionals, as applicable and to the extent practicable.

Any items found that are not compliant with this standard and local statutes or codes shall be brought into compliance.

Exceptions: Professional obligations to identify and correct items that are noncompliant with this standard of practice or local statutes, or codes shall have limits in accordance with Section 8.5.1.

8.5.1 *Limitations of professional obligations*

Contractor obligations regarding inspection for compliance shall be limited to visual inspection and photographic evidence of *readily accessible* components that do not require disassembly of components or finishings to achieve access. Limits to a *contractor's* obligations include a) and b) of this Section 8.5.1.

a) *Contractors* shall not be obligated to meet a minimum requirement in this standard of practice where the requirement is found to be in violation of local statutes or codes; and

b) *Contractors* shall not be obligated to have identified all items that may be noncompliant with local statutes or codes due to:

1. inherent limits of a visual inspection.
2. existence of conditions of that are outside the scope of work and skill sets normally associated with *mitigation*, such as preexisting conditions of mechanical or electrical systems.
3. reliance on superior capabilities reasonably expected from contracted specialists for knowledge of statute and code compliance; or
4. deviations or interpretations of a local jurisdiction that may subjectively or factually conflict with national or regional trends in code and code interpretation.

8.5.2 ***Review with clients*** *(See important informational notes)*

~~**12.6 Retention of Records**~~

8.6 Retention of Records

Records of all *mitigation* work performed shall be kept for no less than: ~~3~~ 6 years, as required by state regulations, or for any warranty period, whichever is longest. Health and safety records including *mitigation Installer radon* or *soil gas* exposure logs, as applicable, and other appropriate medical monitoring records shall be maintained as required by state or federal statutes.

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8.7 Intentional Collateral Mitigation

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~~9.3.5.2 *Intentional collateral mitigation (electrical)*~~

8.7.1 ***Electrical (collateral mitigation)***

When a single mitigation system is intentionally designed to satisfy mitigation needs in more than one unit, dwelling or area within a shared building, power provided to the system shall be from a source that is electrically metered independent from individual units unless the meter is common to all units or dwellings.

Exception: In the absence of a common or independently metered power source for the system, requirements within one of the options a), b) or c) of this Section 8.7.1 shall be met.

a) For ASD or non-ASD methods that manipulate air pressures between soil air and ground-contact portions of the building, a stand-alone mitigation system shall be installed in each ground-contact unit or dwelling determined to require mitigation that is independently electrically metered; or

b) For non-ASD methods that are not dependent upon manipulating air pressures between soil air and ground-contact portions of the building, a stand-alone mitigation system shall be installed in each unit or dwelling determined to require mitigation that is independently electrically metered; or

c) Prior to installation the contractor shall:

1. Provide the client a written notice that includes the system's annual electrical costs (specifically calculated for each system based upon current local rates) and the following statement:

> "During future renovations, sales or vacancy of individual dwellings, the health and safety provided to occupants by the mitigation system may cease to exist without the occupant's knowledge. It is incumbent upon the client to inform the building owner(s) of their obligation in this regard for ensuring long-term operation and maintenance for the system and full disclosure of this possibility to future owners."; and

2. Receive written communications to be included with OM&M documentation that includes:

a. A statement from the client that provides the client's justification for why it is truly not viable to achieve independent or common electrical metering or multiple stand-alone systems); and

b. A statement from the owner of the dwelling(s) or unit(s) that indicates:

(1) Acknowledgment of the electrical cost information provided by the contractor;

(2) Acceptance of obligations for long-term operation and maintenance of the system(s);

(3) Agreement with the client's justification; and

(4) Permission to proceed with the installation.

~~9.3.5.3 *Intentional collateral mitigation (fan monitors)*~~

8.7.2 System monitors (collateral mitigation)

In accordance with Section 8.2 for system monitoring, one of the following options is required:

a) Fan monitors are installed in each ground-contact area divided for separate occupancy use that is served by this system for ASD or non-ASD methods that manipulate air pressures between soil air and ground-contact portions of the building; or

b) Fan monitors are installed in each area divided for separate occupancy use that is served by this system for non-ASD methods that are not dependent upon manipulating air pressures between soil air and ground-contact portions of the building; or

c) A program is instituted for routine inspection onsite or by remote telemetric management system regardless of monitor locations and in accordance with Section 10.5 (OM&M Manuals); or

d) A fan monitor is installed in a location that is accessible and visible or audible for occupants of the building.

~~**11.0 POST-MITIGATION (ALL SYSTEMS)**~~

9.0 POST-MITIGATION

Upon completion of the mitigation effort, as installed or augmented, the contractor shall comply with:

a) requirements in Sections 8.5 (Inspection for Compliance), 9.1.1, 9.1.2 and 9.1.3 of ANSI/AARST SGM-SF; and

b) as additionally specified herein.

9.1 Functional Evaluations

Upon completion of the *mitigation* effort, as installed or augmented, actions prior to releasing the work product for post-*mitigation* testing of indoor or soil gas concentrations shall comply with all portions of this Section 9.1 and Section 8.5 (Inspection for Compliance).

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9.1.1 *General*

Jobsite records shall be updated to include:

a. As-installed site plan diagrams or sketches that shall include key components of the *mitigation* system as they exist upon completion of the *mitigation* effort or alteration; and

b. Fan equipment model(s) and any building systems installed or altered to achieve *mitigation* goals.

~~11.1.2 ***For non-ASD systems***~~

9.1.2 Non-*ASD mitigation methods*

Once *mitigation* efforts that include non-*ASD mitigation* systems or methods are complete, evaluations to validate functional performance shall be conducted as required in Section 12 (Non-ASD Methods).

~~11.1.1 ***For ASD systems***~~

9.1.3 *ASD systems*

Once all sealing, piping and other components of the *ASD* system are complete, evidence relative to system performance shall be gathered as required in a), b) and c) of this Section 9.1.3.

a) *Depressurization* Performance

A minimum of one differential pressure measurement shall be made at a location distant from the suction point(s) with intent to evaluate if *depressurization* has been achieved within each targeted soil gas collection plenum. The term soil gas collection plenum shall include where subterranean pathways, such as voids or drain systems, are targeted as a primary source of soil gas entry.

The measurement shall be made using a differential pressure gauge that is capable of reading 1/1000-inch water column (.25 Pa) differences in air pressure. Jobsite log records of the event(s) shall include:

1. The outdoor temperature and building operating conditions, in accordance with requirements in Section 5.3.3; and
2. The measured air pressure within targeted *soil gas collection plenum(s)*, relative to indoor air.

Exception 1: Where, as with stone walls, it is not physically possible to measure *depressurization* with a pressure gauge, evidence obtained and recorded in jobsite logs from smoke testing or other *diagnostic* tools or method is permitted.

Exception 2: Where *PFE* test locations or test ports cannot be created due to building materials that are virtually irreplaceable, such as for historical preservation properties, or due to denied access to locations of interest. To exercise this exception, jobsite logs shall include the reason why and alternative locations or methods used for verifying design effectiveness.

b) Whole System Vacuum

The vacuum within the *main trunk* duct piping on the negatively pressured side of the fan shall be measured and recorded in jobsite logs. If the measurement is outside of the manufacturer recommended operating range, further investigation is required with findings recorded in jobsite logs.

c) Other Pertinent Conditions

A description of other pertinent observations shall be recorded in jobsite logs, to include:

1. A summary of materials and permeable conditions found under targeted slabs and actions taken to comply with requirements for *suction pit* size.
2. Identification of area targeted for *mitigation* compared to size of the full building footprint; and
3. Locations of any sizable, unclosed openings between soil and indoor air that could not be closed to restrict air movement between soil and indoor air.

9.1.4 *Vapor intrusion and ASD*

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9.1.4.1 Vapor Intrusion Test Ports (SGM-MFLB)

For *ASD* systems intended to mitigate chemical vapor intrusion (VI), test ports for future *PFE* and soil gas sampling shall be created and configured to result in permanent test ports that are prominently documented in the *OM&M* manual. The test ports shall comply with a) and b) of this Section 9.1.4.1.

a) Physical properties

The test ports shall be:

1. accessible for future measurements without disassembly of building components or finishes;
2. installed to not present hazards such as tripping hazards to occupants;
3. installed after removing a portion of aggregate, packed fill or expansive soils that can often exist under a test port;
4. installed to retain functionality over time, such as by implementing hardware to allow easy access and closure of the test port in the future; and

5. sealed in a permanent, airtight manner at the opening between test port hardware and penetrations of a slab or soil gas retarder with a configuration that durably secures the test port in place.

b) Test port locations

Strategic locations of test ports shall include the following locations:

1. Test port locations remotely distant from the exhaust vent pipe transition to below the slab or soil gas retarder that are sufficient in number to:
   a. evaluate effectiveness of soil gas transport across the major expanse of the slab or membrane; and
   b. evaluate consistency of soil gas transport across soil gas collection plenums that are joined to a shared exhaust vent pipe.
2. Not less than one test port for each outer quadrant area of the building while also achieving one test port for each *ASD* or soil gas vent system and each soil gas collection plenum joined to a single *ASD* or soil gas vent system; and
3. For larger expanses, not less than one test port for each outer quadrant area of soil gas collection plenums that are 8,000 sq. ft. (744 m^2) or larger while also achieving one test port for each additional 8,000 sq. ft. (744 m^2) area.

Exception: Where there are no openings or utility penetrations through the slab or soil gas retarder, test ports are not required for plenum areas that are less than 64 square feet (6 m^2), or collectively represent less than 10% of any 4,500 square foot (418 m^2) area.

9.2 Radon Test After Mitigation (SGM-MFLB)

For radon mitigation, post-mitigation testing shall comply with requirements in Sections 9.2.1 through 9.2.5 of this Section 9.2.

~~11.2.3 *Contractor obligations*~~

9.2.1 *Contractor obligations*

Where system maintenance and monitoring are the responsibility of someone other than the occupant, the *qualified mitigation professional* cannot be obligated to ensure that post-*mitigation* testing is conducted because the logistics are beyond their control.

~~11.2.5 *Test protocols*~~

9.2.2 *Testing protocol*

All testing shall be conducted in accordance with requirements of the state or equivalent local authority where the measurement is being performed and in accordance with the most current publication of the ANSI/AARST MA-MFLB (Protocol for Conducting Measurements of Radon and Radon Decay Products In Multifamily, School, Commercial and Mixed-Use Buildings).

~~11.2.6 *Additional test locations*~~

9.2.3 *Additional tests*

As applicable when exhausts are located below the roof or when non-*ASD mitigation* methods include mechanically induced pressurization or dilution, testing specific locations for diagnostic purposes or no later than the initial retests after mitigation is required in accordance with:

a) Section 6.4.11 c (*ASD* exhaust—Below the roof), and
b) Section 12.3.5 (Non-*ASD*—Unintentional soil gas transport).

~~11.2.4 *Test devices*~~

9.2.4 *Testing devices*

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Radon test devices employed shall be listed as approved by a national authority, such as the National Radon Proficiency Program (NRPP), the National Radon Safety Board (NRSB) or a program that verifies compliance with the most current version of ANSI/AARST MS-PC; or as required by local statutes for jurisdictions that have a program for evaluating and approving devices.

Note—Identification of two existing certification bodies is not an endorsement of either program.

~~11.2.2 *Qualified Measurement Professionals*~~

9.2.5 *Testing professionals*

Except where testing is conducted by owners of an individually owned and occupied dwelling or unit, testing shall be conducted by a Qualified Measurement Professional—Multifamily and Commercial as identified in Section 13.1.

9.3 Testing for *Chemicals of Concern*

Due to various considerations, *qualified soil gas mitigation professionals* are not required under this standard to ensure post-*mitigation* measurements of hazardous chemical vapors or other substances are conducted.

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~~12.0 DOCUMENTATION~~

10.0 DOCUMENTATION—ALL SYSTEMS AND METHODS

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10.1 Long-Term Plan for OM&M Required

A long-term plan for OM&M is required for all mitigation systems and methods applied. The plan for OM&M shall be provided in an information packet, in accordance with Section 10.2, or in an OM&M manual, in accordance with Sections 10.5.

~~12.2 When Owner/Occupied~~

10.2 Owner-Occupied Maintenance

The contractor shall provide an information package that contains a plan for OM&M that includes essentials for ASD systems installed where the dwelling or unit is both individually owned and occupied by the person(s) responsible for OM&M. The means of providing the information package and its contents shall comply with requirements in Section 10.2 of the most current publication of ANSI/AARST SGM-SF.

~~12.2.1.1 *Non-ASD systems*~~

10.3 Non-ASD Systems

Regardless of whether the owner or an independent party is responsible for maintenance, an *OM&M* manual compliant with Section 10.5 shall be provided where non-*ASD mitigation* designs are employed.

~~12.4 When Not Owner/Occupied~~

10.4 Independent Maintenance

Where maintenance and monitoring of *mitigation* components are the responsibility of someone other than the occupants, the *contractor* shall provide the client a written *OM&M* manual after mitigation that complies with all provisions of Section 10.5.

10.5 OM&M Manuals

OM&M manuals shall include all content required in Section 10.2 of ANSI/AARST SGM-SF for owner-occupied information packages. The OM&M manual shall also comply with all portions of this Section 10.5.

~~12.4.2 *Statement of client obligations*~~

10.5.1 *Stewardship/Monitoring*

OM&M manuals shall recommend post-*mitigation* testing and provide instructions regarding long-term stewardship of *mitigation* systems, to include requirements in a), b), c) and d) of this Section 10.5.1.

a) Stewardship Statement

The *OM&M* manual shall prominently provide the following or equivalent message:

> *"Stewardship Required.*
> *It is incumbent upon property owners and managers to maintain and monitor system effectiveness for the life of the building. Current and future occupants or purchasers of the property should be able to verify by documentation that the minimum requirements of an operation, maintenance, and monitoring plan (OM&M) have been maintained. Essential requirements for long-term risk management are satisfied when building owners and managers comply with this OM&M manual."*

b) Ownership/Management Changes

The *OM&M* manual shall instruct that:

1. Whenever the party responsible for system maintenance and monitoring changes to another party who is not the owner-occupant of the property:
   a. The *OM&M* manual and logs are to be provided to the newly responsible party, and
   b. Newly *responsible parties* are to update contact information on system labels; and
2. Whenever the responsibility for mitigation maintenance and monitoring changes from an independent party to an owner-occupant, the system is to be relabeled to comply with Section 8.4.2.1 and an updated *OM&M* manual is to be provided to the owner(s).

~~12.4.3 ***Summary of ongoing monitoring guidance***~~

c) Radon Measurement/Inspections

Where a *radon mitigation* system is installed or found in a building at the property, *OM&M* procedures provided in the *OM&M* manual shall include all the following:

1. Quarterly inspection to verify operation of fans and other mechanical components;
2. Testing all buildings at the property at least every 5 years. All radon measurements shall be conducted in compliance with ANSI/AARST MA-MFLB. The clearance test procedure required 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.
3. After post-mitigation clearance testing and in between 5-year clearance test events, test all previously tested locations for mitigated areas at nominally 2-year intervals, to ensure continued effectiveness.

   It is permitted to suspend testing at 2-year intervals where the required effectiveness of a mitigation system has consistently demonstrated for a period of not less than eight years, and such systems are:
   a. inspected quarterly to verify fan operation,
   b. inspected biennially for mechanical equipment performance and integrity, and
   c. all buildings at the property and mitigated areas are retested every 5 years.
4. Each of these stewardship testing events to include mechanical inspections conducted by a qualified professional to verify continued performance of equipment.
5. The following or equivalent instructions:

   "Testing to verify continued effectiveness is to 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;

- ✓ A ground contact area not previously tested is occupied or a building is newly occupied;
- ✓ 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, fracking, or formation of sink holes nearby; or
- ✓ An installed mitigation system is altered.

d) Chemical Vapor or Gas Measurements

Where systems are known to mitigate hazardous concentrations of chemical vapor or other hazardous soil gas, the *OM&M* manual shall instruct that stewardship obligations require a routine schedule of ongoing chemical vapor or gas measurements. While guidance is to be provided in the contractor's *OM&M* manual, a client's overseeing team will normally review, amend and integrate opinions of qualified environmental professionals into a final plan for *OM&M*.

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~~12.1.7 ***Historical Information***~~

10.5.2 *Historical information*

The OM&M manual shall include a summary of the pre-and post-mitigation investigation(s) and if available, pre-, and post-mitigation test data.

~~Table 12.4 Operation, Maintenance and Monitoring (OM&M) Plans~~

10.5.3 *System components*

The *OM&M* manual shall provide detailed operating instructions and information on essential *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 Locations of fans, fan monitors, electronic telemetry/monitoring equipment, permanent test ports, electrical disconnects and other components unique to the system;
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.

10.5.4 *Maintenance inspection checklists*

OM&M manuals shall provide instructions regarding maintenance inspections, in accordance with requirements a), b) and c) of this Section 10.5.4.

a) Visual Operational Inspection Checklist

The OM&M manual shall define a list of items that are to be visually inspected on a frequent basis to verify continued operation of fans and other mechanical components, such as system monitors, controls, labels, vents, and filters.

b) Mechanical Inspection Checklist
The *OM&M* manual shall define a list of equipment to inspect when conducting mechanical performance inspections that include:

1. Performance indicators, labels and fan operation;
2. Seals, straps, fasteners, fan boots, pipe connections, and any permanent PFE test ports;
3. Electrical components (including switch, GFCI or disconnect operation); and
4. Other related building systems, as applicable, such as sump pumps and combustion appliances.

c) Vapor Intrusion
Where the mitigation purpose includes mitigation of chemical vapor intrusion, the mechanical inspection shall additionally include recorded measurements of pressure field extension and, as measured within main trunk duct piping, whole system vacuum strength and air volume exhausted.

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10.5.5 *Repairs*
The *OM&M* manual shall include instructions that stewardship obligations require correction and repair of any conditions that are found to indicate component failure or inconsistencies in operating parameters.

10.5.6 *Retention of OM&M records*
The *OM&M* manual shall include instructions that all maintenance logs, records of repairs and measurement reports for radon and soil gas concentrations be retained and assimilated into the OM&M manual.

~~9.3.5.1 *Inadvertent* **collateral mitigation***~~

10.6 Inadvertent Collateral Mitigation

(As replicated in ANSI/AARST SGM-SF)

Where mitigation is not conducted in all attached units or dwellings in a shared building, both the following, or equivalent, statement and example notice in Figure 10.6 shall be prominently included with information packets and *OM&M* manuals to inform the client of inherent obligations to neighboring occupants:

> *"There are inherent obligations to occupants of adjoining dwellings regarding disclosure of elevated radon concentrations found and potential effects on adjoining dwellings as a result of the mitigation system.*
>
> *In accordance with the ANSI/AARST standards, mitigation firms are obligated to advise the client of inherent obligations to neighboring occupants.*
>
> *It is strongly recommended to distribute the following message in writing to occupants of adjoining dwellings and, if applicable, to the homeowner's association or management firm that provides stewardship for neighboring properties."*

Figure 10.6 Example Notice to Neighboring Property Owners and Occupants

From: _____

Elevated radon concentrations were found at (addresses): _____

A mitigation system [ ] has been installed, or [ ] is planned to be installed.

In the interest of health protection, we have been advised to provide you the following messages:

1) Test for radon — it's easy and inexpensive. Any building on any parcel of land can have a radon problem.
2) The radon reduction system installed or planned for installation in our unit can inadvertently move air and extend a vacuum under some adjoining units or dwellings with the intent to stop radon entry into your dwelling. It is recommended that occupants of adjoining units:

a) Seek to maximize radon reductions and energy conservation by closing openings to soil (e.g., closed covers over sumps and large holes).

b) Check for any adverse impacts such as flue gas spillage from combustion appliances.

3) We cannot warrant any degree of radon reductions, nor can we be responsible for maintaining radon reductions, maximizing energy conservation, or checking for unlikely yet possible environmental impacts for adjoining units. For additional guidance, it is recommended to contact the state or local radon office. Sources in the U.S. include the national radon hotline at 1-800-SOS-RADON (1-800-767-7236) and state radon offices that can be found at: https://www.epa.gov/radon/epa-map-radon-zones-and-supplemental-information#datainfo

11.0 HEALTH AND SAFETY

The *contractor* shall establish, maintain, and follow a written safety management program. The program shall comply with requirements in Section 11 of ANSI/AARST SGM-SF.

Advisory Notice

This document cannot address all health and safety concerns associated with *mitigation* installations. Users of this document are responsible for establishing and implementing appropriate safety practices and compliance with applicable federal, state, and local regulations relating to worker health and safety.

~~13.1.4 ***Worker protection plan***~~

11.1 Safety Management Program

The *contractor* shall establish, maintain, and follow a written safety management program. The program shall address health hazards and safety for jobsite workers and others, as it specifically pertains to *mitigation* activities. Where worker safety regulators require review of worker safety programs, the *contractor* shall provide the safety management program and related records as required by federal or local jurisdictional authority.

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11.1.1 *Resources*

The program policies shall address a means for making personal safety equipment available to all jobsite workers, including, but not limited to eye protection, hearing protection, respiratory protection, knee pads, fire extinguishers, hard hats, and steel-toe boots and protective gloves.

11.2 Safety Training

The safety management program shall address a means to inform and educate jobsite workers on safety practices and policies by way of educational courses or staff briefings.

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11.2.1 *Worker training*

Safety precautions reviewed no less than annually with all jobsite workers shall include discussion of:

a) Ventilation of work areas to reduce exposure to radon, radon decay products, hazardous vapors and other airborne hazards;

b) Safe use of all jobsite equipment including safe practices when using ladders or scaffolding, and identifying and avoiding electrical hazards;

c) Safety procedures, that should often include a buddy system, whenever conducting work in *crawl spaces*, confined spaces and where hazards exist from excavation, falling or heat exhaustion. This discussion to include symptoms and appropriate responses to heat exhaustion and Hantavirus;

d) Safety procedures prior to and while drilling through slabs, such as efforts to identify if there are utility lines below slabs or steel tendons within post-tension slabs;

e) Personal safety equipment, to include:

1. Eye protection from flying dust and debris, such as during sawing and drilling;
2. Ear protection from repetitious exposure to loud noise, such as generated by hammer drills;
3. Respiratory tract protection from airborne particulates and biological hazards, such as masks to protect against airborne silica dust, organic vapors, asbestos, glass fibers and communicable diseases; and
4. Protection against bodily harm by way of protective gloves, steel toe boots and hard hats; and

f) Safe driving practices, including parking and backing up at jobsites, and procedures to minimize harm that can result from repetitious muscle strain activity; and

g) Safety considerations relative occupational exposure to radon, chemical and hazardous gases, to include safety data sheets (SDS) and how to access SDS information related with hazardous compounds in products used during construction, such as caulk and glues or bonding products.

11.2.2 *Oversight training*

Person(s) physically onsite who are deemed responsible for overseeing jobsite, educational or briefing events shall additionally include, but not limited to, discussion of:

a) Stopping work until safe conditions can be secured;
b) Posting or providing notice for occupants regarding observed hazards;
c) Hazardous building conditions identified in Section 11.3; and
d) Responses to and reporting work-related accidents or illness.

~~**13.2 Workers and Occupants (General Precautions)**~~

11.3 Hazardous Building Conditions

In any planned work area where it is suspected that contaminants such as asbestos, lead paint, mold or other toxins exist, work shall be conducted in a manner that meets applicable regulations and maintains consideration for the health and safety of both workers and occupants.

~~13.2.3 ***Asbestos***~~

11.3.1 *Asbestos*

In any planned work area where it is known or suspected that asbestos may exist and be disturbed, work shall not be conducted until an accredited asbestos inspector who, where applicable, is licensed by the state or local jurisdiction determines that such work will be undertaken in a manner that complies with applicable asbestos regulations.

Informative advisory—Deteriorating, damaged or disturbed asbestos-containing products can pose a serious health threat to occupants and workers. Asbestos-containing materials can include certain materials for insulation, fireproofing, acoustical materials, floor tiles and adhesives. Care should be taken to recognize that asbestos inspection reports do not always specify the location of asbestos and that previously hidden asbestos-containing materials that can be exposed during construction or renovations.

Note—The *client* should be notified that proper assessment and abatement procedures are to be followed as regulated by NESHAP, OSHA, the LSHR and state and local regulations for the protection of the health and safety of occupants, and *contractors*. For more information, see www.epa.gov/asbestos

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~~13.2.4 ***Lead-based paint***~~

11.3.2 *Lead-based paint*

Informative advisory—Common renovation activities such as sanding and demolition can create hazardous

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lead dust and chips, which can be harmful to adults and children.

Note 1—Any activity that disturbs paint (unless it is known by testing to not be lead-based paint) in pre-1978 target housing is subject to the EPA Lead Renovation, Repair and Painting (RRP) rule (40 CFR 745, Subparts E and Q). EPA has established the Lead-Safe Certification Program for contractors in response to this concern. For more information, see a reference such as www.epa.gov/getleadsafe

Note 2—In addition, all target housing that is federally owned and target housing receiving federal assistance fall under "The Lead Safe Housing Rule" (24 CFR Part 35 Subparts B through R). Please refer to Subpart R—Methods and Standards for Lead-Paint Hazard Evaluation and Hazard Reduction Activities (24 CFR Sections 35.1300 through 35.1355) for HUD specific methods and standards that would be applied for target housing. The Lead Safe Housing Rule and additional HUD information is available at www.hud.gov/healthyhomes .

~~13.2.2 *Flue gas spillage*~~

11.3.3 *Flue gas spillage*

Clients and impacted residents shall be advised of *flue gas spillage* that is encountered during the course of *mitigation* activities. If *flue gas spillage* is observed to result from the *mitigation* system operation, the system shall be deactivated until the condition has been evaluated and corrected. In such event, the *client* or impacted resident shall be advised to contact an HVAC contractor or other qualified person to evaluate and correct *flue gas spillage* condition as well as to verify proper appliance installation and performance.

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~~13.1.2 *Mitigation Installer's exposure to radon*~~

11.4 Radon Mitigation

All jobsite workers physically installing radon *mitigation* systems shall be advised of occupational hazards of exposure to radon and the need to apply protective measures.

11.4.1 *Jobsite worker exposure to radon*

Where the purpose of *mitigation* includes *mitigation* of radon gas, the safety management program shall include a means to monitor each worker's exposure to *radon* at each work site based on:

a. The highest pre-*mitigation* indoor radon measurements; or
b. Actual jobsite measurements of radon or radon decay products; or
c. Measurements from a radon dosimeter such as an alpha track or comparable device consistently worn at the job site and stored in a low-radon environment during nonworking hours; or
d. As required by jurisdictions of authority.

11.4.2 *Radon exposure limits*

Jobsite worker exposure shall be limited to 4 working level months (WLM) or 400 pCi/L-Months (pCi/L-M) over any 12-month period in accordance with requirements in a) or b) of this Section 11.4.2.

Note—Less than 1 WLM or 100 pCi/L-M over any 12-month period is a recommended goal that is commonly met for concentrations jobsite workers typically encounter day to day.

a. WLM calculations shall be based upon the jobsite worker's exposure hours times the exposure concentration, as expressed in working level (WL) units of measurement. Working level hours (WLH) shall be derived from WL measurements multiplied times exposure hours. Ongoing totals of WLH shall be divided by 170 workhours/month to achieve working level months (WLM).

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Non-ASD Methods

	Data Entry			Calculations			
0	Date	Hours	pCi/L	WL	WLH	WLM	TOTAL WLM: **0.038 WLM**
1	1/12/2021	8	32	0.32	2.56	0.015	
2	1/13/2021	4	5	0.05	0.20	0.0012	
3	1/13/2021	4	7	0.07	0.28	0.0016	**Total to not exceed 4 WLM in any 12-month period**
4	1/14/2021	8	10	0.10	0.80	0.0047	
5	1/15/2021	8	22	0.22	1.76	0.0104	
6	1/16/2021	4	22	0.22	0.88	0.0052	
				=pCi/L / 100	=WL * Hours	=WLH / 170	=(SUM) WLM
				If calculating 50% ER: =(pCi/L/100) * 0.5			

Table 11.4.2 a Example Spreadsheet Calculations (WLM)

Note—The limits in this standard are based on 100% equilibrium ratio (ER). Where required to report WLM using 50% equilibrium ratio, the WL value or pCi/L-M value would be reduced by 50%.

a. Equivalent pCi/L-M calculations shall be based upon the jobsite worker's exposure hours times the exposure concentration expressed in *pCi/L* units of measurement. pCi/L- hours shall be derived from radon (pCi/L) measurements multiplied times exposure hours. Ongoing totals of pCi/L-hours shall be divided by 170 workhours/month to achieve picocurie months (pCi/L-M).

Table 11.4.2 b Example Spreadsheet Calculations (pCi/L-M)

	A	B	C	E	F	G
	Data Entry			Calculations		
0	Date	Hours	pCi/L	pCi/L-Hours	pCi/L-Months	Total pCi/L-Months: **3.81 pCi/L-M**
1	1/12/2021	8	32	256	1.5	
2	1/13/2021	4	5	20	0.12	
3	1/13/2021	4	7	38	0.16	
4	1/14/2021	8	10	80	0.47	**Total to not exceed 400 pCi/L-Months in any 12-month period**
5	1/15/2021	8	22	176	1.04	
6	1/16/2021	4	22	88	0.52	
				= pCi/L Hours	= pCi/L hours / 170	=(SUM) pCi/L-Months

11.5 Chemical Vapor Mitigation

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11.5.1 *Chemical vapor Intrusion (VI)*

All jobsite workers physically installing systems intended to reduce occupant exposure to hazards from chemical vapors or other soil gas of concern shall be advised of occupational hazards from exposure to such substances and the need to apply protective measures when handling and controlling such hazardous substances. The health and safety program shall include additional educational courses or staff briefings that include review and discussion of a) and b) of this Section 11.5.1:

a) Understanding chemical exposure scenarios.

Note—Three groups of people, or "receptors," can potentially be exposed to chemical contaminants at residential locations where *mitigation* systems are installed;

Informative Table 11.5 Chemical Exposure Scenarios
Summary of various exposure scenarios

Receptor (Persons)	Media to Which Exposed	Routes of Exposure	Common Exposure Durations	Hazards Related to Installations	Hazards Related to Frequency of Exposure
Mitigation Installers	Sub-slab soil	1. Dermal contact 2. Ingestion following hand-to-mouth 3. Inhalation of vapor / particulates 4. Ingestion of particulates	2 hr/event	Varies depending on chemicals present and materials used during system installation	Varies from one-time acute exposure to a series of acute exposures over many years (that can combine to result in a subchronic or chronic risk scenario)
	Indoor air	Inhalation of vapor and, to a lesser extent, particulates	6 hr/event		
Monitoring Events	Indoor air	Inhalation of vapor	1 hr/event		
Residents	Indoor air	Inhalation of vapor	12-24 hours/day	Short-term and dependent upon materials used during system installation	

b) Personal protection regarding contaminated soil, contaminated indoor air and explosive or fire hazard situations.

Note—For guidance, see:

- The NIOSH pocket guide to chemical hazards: **www.cdc.gov/niosh/npg/** ;
- ATSDR (The Agency for Toxic Substances and Disease Registry) list of contaminants commonly encountered: **www.atsdr.cdc.gov/SPL** ; and
- For their minimal risk levels: **www.atsdr.cdc.gov/mrls** .

11.5.3 *Safety oversight*

Where the purpose of *mitigation* includes *mitigation* of chemical vapors or other soil gas of concern, the safety management program shall designate a person to oversee activities who is:

a) trained and qualified in OSHA's HAZWOPER requirements; and
b) authorized to stop work until safe conditions can be secured.

11.5.3.1 Jobsite Hazards

Prior to mitigating any structure for chemical vapor intrusion or explosive gas the *contractor* shall request in writing that the *client* provide a written statement confirming any need, or if there is not a need, for special considerations regarding site conditions and handling or control of hazardous substances, to include:

a) Worker Exposures (relative to maximum concentrations that workers should expect to encounter from inhalation, ingestion and dermal exposures to hazardous substances);
b) Handling of Toxic Soil and Groundwater (including groundwater that might be found in sump wells or intruding above slabs or into *crawl spaces*); and
c) Flammable or Explosive Gases or Vapors.

Informative advisory—The health and safety practices needed can depend on identifying known hazards at the jobsite(s). If the *client* does not furnish appropriate information and guidance related to known chemical or explosive gas hazards, the *contractor*, who is ultimately responsible for jobsite safety, is denied the capacity to institute safe practices.

11.5.3.2 OSHA Requirements

Informative advisory—OSHA mandates special requirements and worker training under certain circumstances. For guidance see:

- The attached Companion Guidance for Vapor Intrusion;
- OSHA HAZWOPER training requirements: **https://www.osha.gov** ; and
- OSHA requirements for "Permit-required confined spaces": OSHA's 29 CFR 1910.146, clause (c)(5)(ii)(C), on test, subclause (1), Oxygen content, (2), Flammable gases and vapors, and (3), Potential toxic air contaminants.

12.0 NON-*ASD* MITIGATION METHODS

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12.1 General

~~10.1.1 *Appropriateness of design*~~

12.1.1 *Design and documentation*

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

~~10.1.2 *Combination of methods and/or systems*~~

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.

Note—Examples include *ASD* plus indoor air dilution or pressurization; or soil gas dilution induced by an *ASD* fan due to sizable crawl space openings to outdoors or sizable unsealed edges of a *SMD* membrane.

~~10.8.1 *Incidental repairs*~~

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 required 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.

~~10.1.5 *Long-term OM&M plans required*~~

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.

~~10.1.4.4 *Notice of additional testing – OM&M*~~

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.

~~**10.6 Sources for Air Delivered to a Building**~~

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.

~~10.6.1 ***Capacity (sources of air)***~~

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.

~~**10.7 Controls For Variable Activation**~~

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.

~~10.6.3 ***Air intake and distribution vents***~~

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 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.

~~10.6.2 ***Adverse effects***~~

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 components, such as formation of condensation on indoor wall, floor and ceiling surfaces or ice on exterior building 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 for new construction[8] 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)[9], 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)[10].

~~10.6.4 ***Economizer systems, heat recovery ventilators (HRV) and energy recovery ventilators (ERV)***~~

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.

Note—Any of these systems may require control adjustments or modification to always deliver a minimum degree of outside air into a building.

- Economizer systems typically deliver untempered outdoor 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.

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) for ≤ 6 inch (15 cm) diameter ducted systems	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)		

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

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

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

* 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.

~~10.6.4.3 *Condensate drainage*~~

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 comply 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.

~~**10.2 Indoor Air Pressurization**~~

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 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).

~~10.2.1 ***Capacity (pressurization)***~~

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.

~~10.1.2 ***Combination of methods and/or systems***~~

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.

~~10.2.4 ***Unintentional radon transport***~~

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 to itemize 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. The evaluation shall be recorded in jobsite logs.

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.

~~10.2.5 *Prior to system installation or augmentations*~~

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 design a system that meets requirements in Section 12.3.4 (Design capacity). The following shall be recorded in jobsite logs: pressure and airflow measurements that coincide with the juncture when the airspace is positively pressured, relative adjoining soils or airspaces containing open soil.

~~10.2.6 *After installation or augmentations*~~

12.3.7 *Post-mitigation (indoor air pressurization)*

Functional evaluations after completing the system shall comply with Section 9.1 and 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 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.

~~*A long-term OM&M plan is required* in accordance with Section 12~~

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.

~~**10.4 Soil Airspace Pressurization**~~

12.4 Soil Air Pressurization

12.4.1 *Applicability*

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.

12.4.2 *Sources for air*

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

12.4.3 *Sealing and ducting*

Soil air pressurization systems shall comply with Section 7 (Sealing) and with Section 6 (ASD), with the following exceptions: Section 6.2.3 (Positively pressured pipe); Section 6.4 (ASD Exhaust Discharge); Fan locations Sections 6.5.2 and 6.5.3; and Section 6.2.5 (Pipe materials) where configured using traditional *HVAC* 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 be used to pressurize rather than depressurize soil air.

12.4.4 ***Prior to installation*** *(soil air pressurization)*

Prior to system installation or augmentation, requirements in a) and b) of this Section 12.4.4 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.

12.4.5 ***Post mitigation*** *(soil air pressurization)*

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.

~~10.4.4 ***A long-term OM&M plan is required*** in accordance with Section 12~~

12.4.6 ***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, or an OM&M manual, as required in Section 10.5. Plans for OM&M shall include descriptions of investigations required in Section 12.3.5 (Unintentional soil gas transport).

~~**10.3 Indoor Air Dilution**~~

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 (Sealing) shall be conducted to result in a continuous air barrier, to the extent practicable, that resists air movement between soil and indoor air.

~~10.3.1 ***Capacity (dilution)***~~

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.

~~10.3.4 ***Prior to system installation or augmentations***~~

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.

~~10.3.3 ***Coupled with pressurization***~~

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.

~~10.3.5 ***After installation or augmentations***~~

12.5.6 *Post-mitigation (indoor air dilution)*

Functional evaluations after completing the system shall include visual confirmation of compliance with Section 5.1 (Appropriate Systems), Section 12.5.1 and 12.5.2 shall be recorded in jobsite logs.

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

~~10.3.6 ***A long-term OM&M plan is required*** in accordance with Section 12~~

12.5.7 *Documentation (indoor air dilution)*

An OM&M manual that complies with Section 10.5 shall be provided to the client. It shall also 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
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 system air pressures to result in unacceptable concentrations of radon or soil gas within habitable airspaces.

~~10.5 Soil Gas Dilution~~

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).

12.6.3 *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.

12.6.4 *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.

12.5.5 *Prior to installation (soil air dilution)*

Non-destructive 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.

12.5.6 *Post-mitigation (soil air dilution)*

Functional evaluations after completing the system shall include visual confirmation of compliance with Section 5.1, Section 12.3.1 and Section 7 shall be recorded in jobsite logs. Performance evaluations after completing the system shall include a measurement of radon or soil gas concentrations in habitable airspace(s) to verify mitigation effectiveness.

12.4.7 *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
> b) efforts to counter natural forces that drive soil gas entry using passive means 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, which 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." [11]

12.7.3 *Passive Soil Ventilation*

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.

a) For single-family homes, ANSI/AARST CCAH (Reducing Radon in New Construction of One & Two Family Dwellings and Townhouses).
b) For multifamily, school or other large buildings, ANSI/AARST CC-1000 (Soil Gas Control Systems in New Construction of Multifamily, School, Commercial and Mixed-Use Buildings).

~~10.6.6 ***Foundation vents***~~

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.

[11] 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[12], 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.

12.8.1 *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

~~10.10 Radon From 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] 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).

~~10.9 Radon From Building Materials~~

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.

13.0 NORMATIVE APPENDICES AND REFERENCES

13.1 National Certification/Listing Programs

For private sector certifications and listings, this standard requires a national program that evaluates and lists qualified individuals, training courses and other products or services, such as laboratory services, integral to achieving public health goals intended by this standard. Programs meeting the purpose, need and requirements of this standard are those with policies as established in a), b) and c) of this Section 13.1.

a) Programs with published policies that:

1. require persons to undergo education and an impartial examination process prior to granting personal certification or certificates of educational achievement; and
2. require surveillance of continued competence, not less than as demonstrated by continuing education on standards updates, compliance and other related technical knowledge and skills, prior to granting recertification or renewed certificates or listings; and
3. require, for the certification of radon measurement laboratories, initial demonstration and scheduled ongoing surveillance of compliance with ANSI/AARST MS-QA (Radon Measurement Systems Quality Assurance).

b) Programs that:

1. have a written policy and means for receiving and adjudicating complaints against individuals or companies who have been granted a credential; and
2. have publicly published educational and examination requirements for each credential or listing available online where readily accessible for consumers of credentialed services.

c) Programs that include educational prerequisites as follow:

1. Qualified Mitigation Professionals—Multifamily and Commercial
   Listing or certification credentials granted that qualify individuals as proficient in designing radon or soil gas mitigation systems in existing multifamily, school, commercial and mixed-use buildings are to include:
   a. current certification as a qualified radon or soil gas mitigation professional in homes; and
   b. additional education and processes approved by the program relative to tasks required in the most current version of this standard, ANSI/AARST SGM-MFLB (Soil Gas Mitigation Standards for Existing Multifamily, School, Commercial and Mixed-Use Buildings) prior to granting this advanced level certification or listing and recertifications or relisting.
2. Qualified Radon Measurement Professional—Multifamily and Commercial
   Listing or certification credentials granted that qualify individuals as proficient in placement, retrieval, and analysis (as applicable) of *radon* detectors and to design, plan, and implement quality procedures when conducting *radon* measurements in multifamily, school, commercial and mixed-use buildings are to include:
   a. current certification as a qualified radon measurement professional in homes; and
   b. additional education and processes approved by the program relative to tasks required in the most current version of ANSI/AARST MA-MFLB (Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily, School, Commercial and Multi-Use Buildings) prior to granting this advanced level certification or listing and recertifications or relisting.

Commented [GH78]: Added relative to ANSI's recent requirements for citing Qualified Mitigation and Measurement Professionals.

3. Qualified Mitigation Professionals—Homes
   Certifications granted that qualify individuals as proficient in designing radon or soil gas *mitigation* systems in existing homes are to include:
   a. no less than 32 hours education prior to granting certification that focuses on tasks required in this standard, ANSI/AARST SGM-SF (Soil Gas Mitigation Standards for Existing Homes); and
   b. biennial recertifications after completing continuing education requirements and any other program surveillance activities.
4. Qualified Radon Measurement Professional—Homes
   Certifications granted that qualify individuals as proficient in conducting radon measurements in existing homes are to include:
   a. no less than 16 hours education prior to granting certification that focuses on tasks required in ANSI/AARST MAH (Protocol for Conducting Measurements of Radon and Radon Decay Products in Homes); and
   b. biennial recertifications after completing continuing education requirements and any other program surveillance activities.

Informative Note 1—The National Radon Proficiency Program (NRPP), the National Radon Safety Board (NRSB), or equivalent programs that also meet requirements of a), b) and c) of this Section 13.1 meet the requirements of this standard.

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

Informative Note 2—The purpose of requirements in this Section 13.1 is to ensure contractors have an appropriate degree of technical, engineering, and scientific knowledge to protect occupants by successfully reducing hazards associated with *radon gas*, chemical vapors or other soil gases that are present in indoor air.

~~5.6.1 *Limits on temporary solutions*~~

13.2 Temporary Systems/ Rapid Response

Commented [GH79]: Previously published and no harmonized with SGM-SF

13.2.1 *Temporary systems limits*

All contractor correspondence shall indicate that use of a mitigation system that is not fully installed or not designed as an integral, permanent addition to the building is limited to no longer than 30 days for occupied buildings except with the following requirements for specific cases:

a) The use of such temporary system is limited to no longer than 90 days when diagnostics for optimizing final design can be justified to necessitate delay in the installation of a permanent system; or

b) The use of such temporary system is limited to no longer than 90 days after to completion of major renovation, change in building use, or building permit requirements that necessitate delay in the installation of a permanent mitigation system; or

c) The use of such temporary mitigation system shall be extended only to a point that is necessary to allow multiple parties or jurisdictions of authority to individually and collectively design, fund and approve the installation plan and the logistics of such approval process thereby necessitates a delay in the installation of a permanent mitigation system.

Where the purpose of mitigation is chemical vapor intrusion, non-ASD mitigation methods that are not integral, permanent additions to the building but are maintained by an independent party under a plan for OM&M are considered permanent up until OM&M monitoring ends.

13.2.2 *Label Temporary Systems*

The contractor shall place label(s) in a conspicuous location on the system or system components stating the words "Temporary Soil Gas Mitigation System" and the date of implementation. The label(s) shall also include a description of the temporary system and an estimated date for completion of a permanent system that shall not exceed the time limits in this Section 13.2.1. The label, such as provided for example in Exhibit D, shall include the responsible party or representative, phone number, and applicable certification number and certifying agency.

13.2.3 *Risk Communication (Temporary Systems)*

The contractor shall notify the client in writing of labeling requirements and its content upon implementation of the temporary system.

13.2.3.1 Radon

When the purpose of the mitigation includes radon, the contractor shall provide the client in writing with risk information relative to concentrations measured in the dwelling(s), such as portrayed in EPA's publication "Citizens Guide to Radon" or similar current literature published by the federal, provincial, tribal, or state authority.

> Note—The contractor should inform the client in writing that the standard of care requires action for timely completion of a permanent mitigation system and that the client is responsible for the health and safety of occupants. Where measured concentrations exceed those rendered in EPA's "Citizens Guide to Radon" (e.g., > 20 pCi/L [740 Bq/m^3]), an extrapolation of the risk indicated, as provided in Exhibit C, should be included.

13.2.4 *Request Notification to Occupants*

The contractor shall request in writing that the client assign a designated party to make all appropriate notifications to occupants and facilitating staff about the temporary nature of the system and related health risk.

Note—It is recommended that the contractor obtain signed acknowledgment from the client that the request for notification to occupants was received.

13.2.5 *Rapid response (informative)*

For the purposes of this document, "Rapid Response" denotes situations where action is required quickly or immediately due to hazards present. Subchronic or acute risk exposures to chemical vapors are examples of situations where excessively hazardous conditions can warrant immediate action. Options that may be considered can include:

a) Vacating the Property
Where acute safety concerns are present and cannot be immediately mitigated, occupants and workers should be evacuated from the building until safe conditions can be established;

b) Enhanced Ventilation
Ventilation with outside air is normally the first consideration as a temporary means to enhance safety. However, care must be exercised for any temporary effort. The amount of ventilation immediately achieved may not be adequate to achieve safe conditions. In addition, ventilation with outside air is seldom viable as a permanent solution;

c) Mechanical Solutions
A variety of mechanical systems can often be temporarily augmented or installed to enhance safety. Care must be exercised for all temporary efforts since the amount of reduced hazard achieved may not be adequate for achieving safety. Rapid response options include:

1. A temporary ASD system not necessarily conforming with all requirements of Section 6; or
2. Enhanced Mechanical Ventilation: The addition of temporary blowers and/or manipulation of HVAC air handler controls; or

d) Other methods might be applicable such as carbon filtration of indoor air or methods with less certainty of protection, such as sealing large openings to soil.

13.3 Normative References

Published by the AARST Consortium on National Standards
For the latest versions of AARST/ANSI documents, see: www.standards.aarst.org

ANSI/AARST SGM-SF (Soil Gas Mitigation Standards for Existing Homes)

ANSI/AARST MA-MFLB (Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily, School, Commercial and Mixed-Use Buildings)
Note—Previously published as ANSI/AARST MAMF and MALB and now harmonized and consolidated into a single standard.

Published by the ASHREA
For the latest versions of ASHRAE documents see: www.ashrae.org

- 62.1 Ventilation for Acceptable Indoor Air Quality for buildings that are more than three stories tall (Appendix B—Separation of Exhaust Outlets and Outdoor Air Intakes)

Published by ASTM International
For the latest versions of ASTM documents see: www.astm.org

- C33 Standard Specification for Concrete Aggregates
- C920 Elastomeric Joint Sealants
- C1173 Flexible Transition Couplings for Underground Piping Systems
- D1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- D2564 Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
- D2665 Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
- D5926 Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems
- E1745 Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- F656 Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- F891 Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core
- F1488 Coextruded Composite Pipe
- D2787 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Commented [GH80]: Not used in this standard

Published by the International Code Council, Inc.
For the latest versions of ICC documents see: www.iccsafe.org

- The International Residential Code® (IRC)
- The International Building Code® (IBC)
- The International Mechanical Code® (IMC)
- The International Plumbing Code® (IPC)
- The International Energy Conservation Code (IECC)

14.0 DESCRIPTION OF TERMS

Terms not defined herein have their ordinary meaning within the context of their use as defined in "Webster's Collegiate Dictionary."

Accessible: Capable of being reached for operation, repair, and inspection.

Accessible, Readily (Readily Accessible): Capable of being reached quickly for operation, repair, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth.

Active soil depressurization (ASD): A family of radon mitigation systems involving mechanically driven soil depressurization, including sub-slab depressurization (SSD), sub-membrane depressurization (SMD), block wall depressurization (BWD) and *crawl space* depressurization (CSD).

Backer rod: A semi-rigid closed-cell foam material resembling a rope (available in various diameters) that is used to fill around pipes, large cracks, etc. to assist in making a sealed penetration.

Becquerel per cubic meter (Bq/m³): A unit of measure for radioactivity in one cubic meter of air. CONVERSION: 1 Bq/m^3 equals 0.027 picocuries per liter (*pCi/L*).

Chemicals of Concern (COC): Chemicals in vapor, liquids or soil that have been identified at a site location to potentially pose health and safety hazards.

Client: The person(s), or company that contracts with a *contractor* to install a mitigation system in a building.

Collateral mitigation: The ability to mitigate more than one occupied *dwelling* or unit with a single mitigation system.

Continuous Duty: A motor may be rated as either continuous duty or intermittent duty. Continuous duty rated motors are rated to be run continuously without any damage or reduction in life of the motor while intermittent duty motors must be allowed to stop and cool before restarting.

Contractor: Any person(s) or contracting firm regardless of organizational structure who installs a mitigation system. See Section 3 for descriptions of Qualified Mitigation Professionals.

Crawl space: A foundation type with an open area beneath the livable space of a *dwelling* that typically has either a concrete slab or earthen floor.

Cubic feet per minute (cfm): A measure of the flow rate of a fluid, such as air. CONVERSION: 1 cfm = 1.699 cubic meters/hour (m^3/hr).

Depressurization: A negative pressure induced in one area relative to another.

Diagnostic procedures: One or multiple procedures for identifying or characterizing conditions under, beside and within buildings to project the effects of various system designs. Diagnostic procedures can include sub-slab pressure field extension tests or analysis; visual observations; characterization of pressure or air exchange rates between indoors and outdoors and also between floors or adjoining air spaces; and *diagnostic radon measurements* at locations of interest (e.g., common areas, mechanical spaces and spaces not in ground contact).

Diagnostic radon measurements: Diagnostic Radon Measurements are intended to confirm specific conditions or effects of mitigation activities. Test locations are identified by their relationship to the specific information being sought. Diagnostic Radon Measurements are not a substitute for testing in accordance with ANSI/AARST measurement protocols.

Dwelling: A building or portion of a building that is used, intended, or designed to be built, used, rented, leased, let or hired out to be occupied or that are occupied for living purposes.

Feet per minute (fpm): A measure of the velocity rate of a fluid, such as air. CONVERSION: 1 fpm = 0.3048 meters per minute (0.3m/min).

Flue gas spillage: A condition in which the normal movement of combustion products up a flue (due to the buoyancy of the hot flue gases) is reversed, resulting in the combustion products entering the building. Flue gas spillage of combustion appliances (such as fireplaces and furnaces) can occur when *depressurization* in the house overwhelms the buoyant force of the hot gases. Flue gas spillage can also be caused by a blockage in the chimney or flue termination.

High-rise building: A building that is 75 feet (23 m) or higher.

HAC system: Heating and cooling (air conditioning) systems that are not designed to also supply outdoor air ventilation. HAC systems are common to single-family residences.

HVAC setback: HVAC "setback" is normally the automated or manual operation of system controls to cause different activity for heating, cooling and ventilation systems during occupied periods compared to unoccupied periods.

HVAC system: Heating and cooling (air conditioning) systems that are additionally capable of supplying outdoor air ventilation. If they do not supply outdoor air ventilation, they are more technically referred to as HAC systems.

Informative: Informational content or guidance that is not considered mandatory by this document.

Intentional collateral mitigation: *ASD* system(s) intentionally designed to reduce radon/soil gas concentrations in multiple *dwellings* that have each been identified by testing to indicate radon/soil gas concentrations that exceed acceptable limits.

Jurisdictional authorities: Governing authorities that regulate specific installation requirements or manner of activities will normally include a combination of authoritative bodies because of laws or other requirements adopted at a local municipality, county, province, or state. In addition, national jurisdiction will apply for a variety of activities that are regulated as a result of federal statutes. In some cases, tribal or international laws or treaties result in an authority that holds jurisdiction over certain activities.

Mechanically fastened: A means of connection such as for duct joints or electrical connections that entails more than a pressure fit, glued or twist connection (i.e., mechanical screws employed to secure connection of wiring or ducting).

Mitigation: System or steps to reduce radon concentrations or other pollutants in the indoor air of a building.

Mitigation Installer: A staff member or sub-contractor who participates in installation of the mitigation system(s) and therefore, regardless of qualifications or other obligations herein, is included in considerations for worker health and safety.

Nontransient: Occupancy of more than 31 days.

Normal occupied operating conditions: The operational condition for the building or unique sector of the building that exists during the greatest amount of significantly occupied time.

Normative: Provisions or referenced documents that state practices considered mandatory and required by this document.

Occupied: Any area of the building that is occupied on a regular basis for more than 4 hours a day. See "Significantly occupied" and "Occupied work or school weeks"

Occupied work or school weeks: Those weeks that do not include vacation days such as national or religious holidays, winter breaks or similar weeks where test conditions do not represent normal occupied operating conditions for the building. See "Normal Occupied Operating Condition", "Occupied" and "Significantly occupied".

Operation, Maintenance and Monitoring plan (OM&M): A document that includes information on the operation and maintenance of installed system(s) and guidance for monitoring the effectiveness of the system in the future.

Operations Manual: A document that is normally compiled by the mitigator to provide requirements and guidance for operation and maintenance of the mitigation system(s). This manual is a component of an Operation, Maintenance and Monitoring Plan (*OM&M*) that additionally includes information on monitoring effectiveness of the system.

Overseeing Professional: An individual or firm that aids to assemble and coordinate a qualified team of professionals of diverse skill sets.

Overseeing Team: Those individuals associate with project commissioning for vapor intrusion projects that normally include: Responsible Parties; Regulatory Authorities when compliance with local, state or federal regulatory standards is required; and An Overseeing Professional to assemble and coordinate a qualified team of professionals of diverse skill sets.

Picocurie per liter (pCi/L): A unit of concentration radioactivity corresponding to 0.037 decays per second or 2.22 decays per minute in a liter of air or water. 1 pCi/L = 37 becquerels per cubic meter (Bq/m^3).

Pressure field Extension (PFE): The distance that a pressure change, created by drawing soil-gas through a suction point, extends outward in a sub-slab gas permeable layer, under a membrane, behind a solid wall or in a hollow wall.

Pressure field Extension Test: A *diagnostic* procedure to evaluate the potential effectiveness of an ASD system by using a shop vacuum or other fan or vacuum device to draw air from the space below a slab or from the cavities inside a block wall.

Measuring the change in pressure at various small test holes through the slab or the block wall using a micro-manometer or heatless smoke can provide evidence of the potential effectiveness of an *ASD* system.

Pressure Field Extension (PFE) Analysis: For *ASD* design and optimization, an analysis of 1) qualitative evidence for the distance potential of Pressure Field Extension, and 2) quantitative measurements employed for determining vacuum pressure and air flow volume rates required to achieve a consistent vacuum across the area observed.

Pressurization: A positive pressure induced in one area relative to another.

Quality Control: For mitigation professionals, actions to retain evidence of actual operational and installation quality that is compared to intended goals for quality. The comparison is systematically used to control quality with corrective actions as needed on a jobsite or for improvements to operational procedures.

Quality Management System (QMS): A documented plan of action, often described as a QA plan, which includes Quality Control Procedures for tracking the difference between planned actions and the actual resulting installation or product with systematic review for managing and improving quality.

Radon (Rn): A colorless, odorless, naturally occurring, radioactive, inert gaseous element formed by radioactive decay of radium-226 (Ra-226) atoms. The atomic number is 86. Although other isotopes of radon occur in nature, in this document, radon refers to the gas Rn-222. Rn-222 is measured in picocuries per liter (*pCi/L*) or in becquerels per cubic meter (Bq/m^3).

Re-entrainment: The unintended re-entry into a building of radon or soil gas that is being exhausted by a mitigation system.

Responsible Party (RP): Can be the property owner(s) or extend to include private businesses and/or governmental agencies

Sealed isolation assemblies: The surrounding physical components to an airspace that might include the entire building shell or an isolated airspace within a building that has been sealed to resist air movement between the isolated airspace and both indoor air and outdoor air.

Setback: See HVAC Setback.

Significantly occupied: The time period when the building is typically occupied by the majority of the workers or students. See "Normal Occupied Operating Condition", "Occupied", "Significantly occupied" and "Occupied work or school weeks".

Soil gas collection plenum: A 3-dimensional enclosure for collecting radon and other soil gases from under slabs, soil gas retarders or from behind walls that surrounds a void or gas permeable layer. There are at least six sides to this enclosed airspace, and none are perfectly sealed, especially at the side facing soil.

Suction pit: Space that exists or is created below the suction pipe.

Suction point: Location at which suction piping is routed through the slab, foundation, membrane, drain tile or sump cover.

Sump (Sump pit): A pit below the subsurface grade of a building, which is commonly intended as a component of a ground water control system. Sump pumps and drainage piping are often additional components of such ground water control systems.

Townhouse: A single family *dwelling* (also referred to as a townhome) that is constructed in a group of three or more attached units where each unit extends from the foundation to the roof and has a yard or public way on at least two sides.

Unique sector of a building: Portions of a common building that are individually classified by the general design and the intended design of each active heating, cooling, and ventilation system (HVAC).

Unit: A building or portion of a building that is used, intended, or designed to be built, used, rented, leased, let, or hired out to be occupied or that is occupied for commercial, residential or public purposes.

Working level (WL): Any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3 x 105 MeV of potential alpha energy. This number was chosen because it is approximately the alpha energy released from the decay products in equilibrium with 100 pCi of Ra-222. Exposures are measured in working level months (WLM).

Working Level Month (WLM): A unit of concentration radioactivity corresponding to 1 working level (WL) for 170 hours per month. Although this unit of measurement came from assuming 40-hour work week exposures, it is commonly used to set limits for annual exposure to radon decay product alpha energy.

Exhibit A-1
Sample Notice: "CONTRACTOR TO CLIENT"
Intention to Enter Dwellings

To: Property Management, Corp.
2013 Industrial University Avenue
Anytown, USA

Radon Company
Anytown, USA 800-000-0000

Dear Management and Supervising Staff,
We request that notice of the intention to enter the building be provided to occupant(s) and other impacted residents a minimum of 24 hours before we enter the building area(s) designated below and in a manner that meets any applicable laws.

In addition, we request that notices be provided to occupants and other impacted residents that include instructions, warnings, or guidance for specific disruptive or hazardous situations that may include noise, sealant vapors or other disruptions.

Access is required to for: [ ] Building Investigation [ ] System Installation [ ] Maintenance

Building Address: _____

Building Area(s): _____

Scheduled Date_____ Day _____ Time_____
_____

Procedures are expected to include:
[ ] _____
_____

[ ] **Drilling into concrete floors**

[ ] **Application of sealants.** Occupant Advisory: Common construction sealants used to prevent radon entry at foundations and other locations will normally emit vapors that contain modest amounts of certain chemicals generally referred to as volatile organic compounds. The emissions occur mostly during application, but also to a lesser extent as they dry to form an airtight bond. While these chemicals are commonly used, some sensitive individuals may experience discomfort or other health effects when exposed to such chemicals. *Material Safety Data Sheets (MSDS) are available upon request.*

Symptoms that may indicate sensitivity to these vapors may include nausea, headaches, dizziness, drowsiness and/or an allergic reaction. Special consideration should be made for the very young or elderly who cannot communicate symptoms experienced.

If symptoms are observed: Leave the area immediately to breathe fresh air. Avoid further exposure. If symptoms persist, get medical attention.

We thank you for your cooperation in helping to ensure safe and healthy homes.

Sincerely,
Radon Company, Anytown, USA

Exhibit A-2
Sample Notice : "MANAGEMENT TO FACILITATING STAFF"
Intention to Enter Dwellings

Property Management Company
Anytown, USA 800-000-0000

Dear Custodial, Maintenance and Educational Staff,

Important steps are being taken to lower the risk to occupants in this building from soil gas pollutants. In particular, radon gas is the second leading cause of lung cancer and the leading cause of lung cancer in nonsmokers in the U.S.

Your staff member contacts:

Staff authorized for responding to public inquiries: _____ Phn#_____

For logistics of onsite activities, contact: _____ Phn#_____

Access is needed and scheduled for:

Building: _____

Building Area(s): _____

Scheduled Date_____ **Day** _____ **Time**_____

Access is required to for: [ ] Building Investigations [ ] System Installation [ ] Maintenance

Procedures are expected to entail:

[ ] _____

_____

[ ] **Drilling into concrete floors**

[ ] **Application of sealants.** Occupant Advisory: Common construction sealants used to prevent radon entry at foundations and other locations will normally emit vapors that contain modest amounts of certain chemicals generally referred to as volatile organic compounds. The emissions occur mostly during application, but also to a lesser extent as they dry to form an airtight bond. While these chemicals are commonly used, some sensitive individuals may experience discomfort or other health effects when exposed to such chemicals. *Material Safety Data Sheets (MSDS) are available upon request.*

Symptoms that may indicate sensitivity to these vapors may include: nausea, headaches, dizziness, drowsiness and/or an allergic reaction. Special consideration should be made for the very young or elderly who cannot communicate symptoms experienced.

If symptoms are observed: Leave the area immediately to breathe fresh air. Avoid further exposure. If symptoms persist, get medical attention.

We thank you for your cooperation in helping to ensure safe and healthy homes.

Sincerely,

Management or Radon Company, Anytown, USA

Exhibit A-3
Sample Notice: "MANAGEMENT TO OCCUPANTS"
Intention to Enter Dwellings

Property Management Company
Anytown, USA 800-000-0000

Dear Building Occupants,

Important steps are being taken to lower the risk to residents in this building from soil gas pollutants. In particular, radon gas is the second leading cause of lung cancer and the leading cause of lung cancer in nonsmokers in the U.S. Radon is a naturally-occurring radioactive gas that can be present in some buildings at concentrations that are dangerous to you, your family and pets. Copies of EPA's *A Citizen's Guide to Radon* are available upon request or you can contact your State Radon Office (**http://www.epa.gov/radon/whereyoulive.html**) or EPA regional office for additional information on radon.

Staff authorized for responding to public inquiries: _____ Phn#_____
For logistics of onsite activities, contact: _____ Phn#_____

Access is needed and scheduled for:

Building: _____

Building Area(s): _____

Scheduled Date_____ **Day** _____ **Time**_____

Access is required to for: [ ] Building Investigations [ ] System Installation [ ] Maintenance

Procedures are expected to entail:

[ ] _____
_____

[ ] **Drilling into concrete floors**

[ ] **Application of sealants.** Occupant Advisory: Common construction sealants used to prevent radon entry at foundations and other locations will normally emit vapors that contain modest amounts of certain chemicals generally referred to as volatile organic compounds. The emissions occur mostly during application, but also to a lesser extent as they dry to form an airtight bond. While these chemicals are commonly used, some sensitive individuals may experience discomfort or other health effects when exposed to such chemicals. *Material Safety Data Sheets (MSDS) are available upon request.*

Symptoms that may indicate sensitivity to these vapors may include: nausea, headaches, dizziness, drowsiness and/or an allergic reaction. Special consideration should be made for the very young or elderly who cannot communicate symptoms experienced.

If symptoms are observed: Leave the area immediately to breathe fresh air. Avoid further exposure. If symptoms persist, get medical attention.

We thank you for your cooperation in helping to ensure safe and healthy homes.
Sincerely,
Management or Radon Company, Anytown, USA

Exhibit B
Sample Posted Notice: "CONTRACTOR TO OCCUPANTS"
Sealant Warning

Radon Company
Anytown, USA 800-000-0000

Dear Building Occupants,
Important steps are being taken to lower the risk to residents in this building.

The work has required **application of sealants.**

[✓] **Wet Caulk/Sealants**. Take care to not step in or touch sealants until they are dry.

[✓] **Vapor from sealants:** Common construction sealants used to prevent radon entry at foundations and other locations will normally emit vapors that contain modest amounts of certain chemicals generally referred to as volatile organic compounds. The emissions occur mostly during application, but also to a lesser extent as they dry to form an air-tight bond. While these chemicals are commonly used, some sensitive individuals may experience discomfort or other health effects when exposed to such chemicals.

Symptoms that may indicate sensitivity to these vapors may include nausea, headaches, dizziness, drowsiness and/or an allergic reaction. Special consideration should be made for the very young or elderly who cannot communicate symptoms experienced. **If symptoms are observed:** Leave the area immediately to breathe fresh air. Avoid further exposure. If symptoms persist, get medical attention.

We thank you for your cooperation in helping to ensure safe and healthy homes.

Sincerely,
Mitigation Company, Anytown, USA

Informative advisory—For all jobsites, including owner-occupied properties, it is recommended that the *contractor* post or leave similar notices for affected occupants when using sealants.

EXHIBIT C

TEMPORARY SYSTEMS

Figure C-1:
SAMPLE LABEL
WHEN INSTALLING
TEMPORARY SYSTEMS

Temporary Radon Reduction System	
Date Installed:	
Description of system:	
Estimated date for completion of a permanent system:	[ ] Within 30 days.
	[ ] Within 90 days due to ongoing diagnostics.
	[ ] Within 90 days after renovations.
	[ ] Subject to the approval processes
John Smith Radon Reductions, 866-041-0412, Anywhere America, Cert# 109492 State Proficiency Board	

Figure C-2:
SAMPLE RISK TABLE
FOR RADON
CONCENTRATIONS THAT
ARE HIGHER THAN 20 PCI/L

RADON RISK IF YOU HAVE NEVER SMOKED		
Radon Level	***If 1,000 people who never smoked were exposed to this level over a lifetime ****	
150 pCi/L	***About 270 people could get lung cancer***	***Estimated** for concentrations higher than provided in EPA's Citizen Guide to Radon*
100 pCi/L	***About 180 people could get lung cancer***	
50 pCi/L	***About 90 people could get lung cancer***	
20 pCi/L	*About 36 people could get lung cancer*	*As shown in EPA's Citizen Guide to Radon*
10 pCi/L	*About 18 people could get lung cancer*	
8 pCi/L	*About 15 people could get lung cancer*	
4 pCi/L	*About 7 people could get lung cancer*	
2 pCi/L	*About 4 people could get lung cancer*	
1.3 pCi/L	*About 2 people could get lung cancer*	
* Lifetime risk of lung cancer deaths from EPA's *Assessment of Risks from Radon in Homes* (EPA 402-R-03-003)		

CONSENSUS BODY MEMBERS

Sincere appreciation is both expressed and deserved for years of contributions in time and wisdom provided by all the following consensus body members and staff.

Mitigation Standards—Consensus Body 2019-2022

Chair: Steve Tucker (OR) Assistance Team: Gary Hodgden (KS)

Stakeholder Group	Delegate	Affiliation
(Educators Rn)	Bill Angell (MN)	University of Minnesota
	Chad Robinson (KS) *Alternate*	Midwest University Radon Consortium (MURC)
(Regulated States Rn)	Josh Kerber (MN)	Minnesota Department of Health
	Patrick Daniels (IL) *Alternate*	Illinois Emergency Mgmt. Radon Program
(Federal EPA Rn)	Tommy Bowles (DC)	U.S. Environmental Protection Agency (EPA)
(Federal OHH)	Warren Friedman (DC)	HUD Office of Healthy Homes
(Proficiency Program)	Bruce Snead (KS)	AARST-NRPP (Policy Advisory Board)
	Kyle Hoylman (KY) *Alternate*	AARST-NRPP (Credentialing Committee)
(Measurement Prof. Rn)	Nate Burden (PA)	Professional Measurement Service Provider
	James Fraley (GA) *Alternate*	Professional Measurement Service Provider
(Home Mitigation Prof.)	Bill Brodhead (PA)	Professional Service Provider
	Aaron Fisher (PA) *Alternate*	Professional Service Provider
(Large Bldg. Mitigation)	Tony McDonald (OH)	Professional Service Provider
	Fred Elrott (CA) *Alternate*	Professional Service Provider
(VI Mitigation Prof.)	Tom Hatton (NJ)	Professional Service Provider
	Rachel Saari (MI) *Alternate*	Professional Service Provider
(Building Scientist)	Todd McAlary (CN)	Professional Service Provider
	Chris Ferguson (IN*) Alternate*	Professional Service Provider
(Site Assessment VI)	Chris Lutes (NC)	Professional Measurement Service Provider
	Chris Bonniwell (WI) *Alternate*	Professional Measurement Service Provider
(VI Stewardship VI)	David Gillay (IN)	Professional Legal Services
(Fan Manufacturers)	Dave Hill (MA)	Spruce
	Paul Owen (MA) *Alternate*	*Spruce*
(Ventilation Manufacturers)	Hamid Massali (KS)	Fantech
	Michelle Festa (PA) *Alternate*	Festa

Assist Team: Joanna Mandecki, Nanci Hermberger, Lindsey Beal, Denise Bleiler, Wensday Worth and Marilyn Patrick

SGM-SF Consensus Body 2014-2017

Chair: Dave Kapturowski (MA) Assistance Team: Gary Hodgden (KS)

Stakeholder Group	Delegate	Affiliation
(Educators)	Bill Angell (MN)	Midwest University Radon Consortium (MURC)
(Regulated States Rn)	Josh Kerber (MN)	Minnesota Department of Health
(Federal EPA Rn)	Jani Palmer (DC)	U.S. Environmental Protection Agency (EPA)
(Federal HUD)	Hilary Atkin (DC)	HUD Office of Housing
(Proficiency Program)	Kyle Hoylman (KY)	AARST-NRPP (Credentialing Committee)
(Proficiency Program)	Bruce Snead (KS) *Alternate*	AARST-NRPP (Policy Advisory Board)
(Mitigation Prof. Rn)	David Grammer (NJ)	Professional Service Provider
	Keith Volsted (IL) *Alternate*	Professional Service Provider
(Measurement Prof. Rn)	David Wilson (TN)	Oak Ridge National Laboratory
(Building Inspectors)	Nate Burden (PA)	Professional Service Provider
(Federal OHH)	Warren Friedman (DC)	HUD Office of Healthy Homes

	Eugene Pinzer (DC) *Alternate*	HUD Office of Healthy Homes
(Regional HUD)	Paul Mohr (MO)	HUD Field Representatives
	Sam Gieryn (MO) *Alternate*	HUD Field Representatives
(Federal HUD)	Nelson Rivera (DC)	HUD Community Planning and Development
	Danielle Schopp (DC) *Alternate*	HUD Community Planning and Development
(Manufacturers)	Paul Owen (MA)	Spruce Environmental
(Educators VI)	Kelly Pennell (KY)	University of Kentucky Dept. of Civil Engineering
(Regulated States VI)	David Swim (WI)	Wisconsin Department of Natural Resources
	Pat Troth (IN) *Alternate*	Indiana Dept. of Environmental Management
(Federal EPA VI)	Henry Schuver (DC)	EPA Office of Emergency Response (OSWER)
	Rich Kapuscinski (DC) *Alternate*	EPA Office of Emergency Response (OSWER)
(Mitigation Prof. VI)	Tony McDonald (OH)	Professional Service Provider
	Tom Hatton (NJ) *Alternate*	Professional Service Provider
(Building Scientist VI)	Rachel Saari (MI)	Professional Service Provider
	Robert Truesdale (NC*) Alternate*	RTI (Research Triangle Institute)
(Site Assessment VI)	Chris Lutes (NC)	Professional Service Provider
	Eric Lovenduski (NY) *Alternate*	Professional Service Provider
(Stewardship VI)	David Gillay (IN)	Professional Service Provider
	Chris Bonniwell (WI) *Alternate*	Professional Service Provider
(Regional EPA)	Michael Murphy (IL)	USEPA Region 5 (North-Central Region)
	Alana Lee (CA) *Alternate*	*USEPA Region 9 (Pacific-Southwest Region)*
(Public Health NGO VI)	Lenny Siegel (CA)	Center for Public Environmental Oversight

RMS-MF Subcommittee 2012-2015

Chair: John Mallon (PA) Assistance Team: Gary Hodgden (KS)

Stakeholder Group	**Delegate**	**Affiliation**
(Educators)	Bill Angell (MN)	Midwest University Radon Consortium (MURC)
(Regulated States)	Patrick Daniels (IL)	Illinois Radon Program Manager (IEMA)
(Proficiency Program)	David Wilson (TN)	Technical and Science Committee (AARST-NRPP)
(Proficiency Program)	Shawn Price (NC) *Alternate*	National Radon Proficiency Program (NRPP)
(Realtors)	Russell Riggs (DC)	National Association of Realtors (NAR)
(Consumer Advocacy)	Dave Jacobs (DC)	National Center for Healthy Housing (NCHH)
(Mitigation)	Thomas Hatton (NJ)	Professional Service Provider
(Measurement)	Tony Davenport (FL)	Professional Service Provider
(Measurement)	David Grammer (NJ) *Alternate*	Professional Service Provider
(Home Inspectors)	Bruce Thomas (PA)	Professional Service Provider
(Home Inspectors)	Nate Burden (PA) *Alternate*	Professional Service Provider
(Federal EPA)	Jani Palmer (DC)	U.S. Environmental Protection Agency (EPA)
(Federal HUD)	Warren Friedman (DC)	Office of Lead Hazard Control and Healthy Homes
(Federal HUD)	Hilary Atkin (DC) *Alternate*	Housing and Urban Development (HUD)
	Previous committee members deserving appreciation	
(Non-regulated States)	Joshua Miller (MN)	Minnesota Department of Health - Indoor Air Unit
(Public Health NGO)	Eileen Lowery (RHA) (IL)	Respiratory Health Association (NHA)
(Consumer Advocacy)	Jane Malone (DC)	National Center for Healthy Housing (NCHH)
(Federal HUD)	Chris B. Trent (DC)	Housing and Urban Development (HUD)

Concurrent RMS-LB Consensus Body 2012-2015

Acting Chair: Gary Hodgden (KS)

Stakeholder Group	**Delegate**	**Affiliation**

(Educators)	Bill Angell (MN)	Midwest University Radon Consortium (MURC)
Proficiency Program)	David Wilson (TN)	Technical and Science Committee (AARST-NRPP)
(Federal EPA)	Jani Palmer (DC)	U.S. Environmental Protection Agency (EPA)
(Mitigation prof.)	John Mallon (PA)	Professional Service Provider
(Home Inspectors)	Nate Burden (PA)	Professional Services
(Home Builders)	Steve Tucker (OR)	Specialty Services
(Vapor Intrusion)	Thomas Hatton (NJ)	Specialty Services
(Manufacturers)	Dave Hill (MA)	Manufacturer (Spruce)

Previous committee members deserving appreciation

(Non-regulated States)	Joshua Miller (MN)	Minnesota Department of Health - Indoor Air Unit
(Regulated States)	Matt Shields (PA)	Pennsylvania Department of Environmental Health
(Mitigation prof.)	David Grammer (NJ)	Professional Service Provider
(Measurement prof.)	Charlie Lamb (NY)	Professional Service Provider