This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

ANSI/AARST **RMS-LB** 2014

An American National Standard

Radon Mitigation Standards for Schools and Large Buildings

AARST CONSORTIUM ON NATIONAL RADON STANDARDS
www.radonstandards.us
standards@aarst.org
Copyright © 2015 AARST, P.O. Box 2109, Fletcher, NC 28732

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Scope Summary and Introduction

This standard specifies practices, minimum requirements and general guidance for mitigation of radon in existing schools and large buildings including both low-rise and high-rise schools and large buildings.

The techniques addressed in this standard provide whole-building consideration yet also apply when implemented to portions of a building or individual occupied spaces.

This standard is intended to:

- Provide minimum requirements and uniform standards that emphasize safety, system quality and effectiveness in the design and installation of mitigation systems for existing schools and large buildings.
- Provide a means to evaluate radon mitigation systems in schools and large buildings.

Significance of Purpose

Radon is the leading cause of lung cancer among nonsmokers and the second leading cause of lung cancer in the general population.[1] For most school children and staff, the second largest contributor to their radon exposure is likely to be their school.[2] Thousands of classrooms nationwide have elevated radon levels, needlessly exposing hundreds of thousands of students and staff to this serious health risk.[3] With similar implications, a correlation has been observed between radon levels in homes, and workplaces in the same area.[4]

Radon in U.S. homes causes approximately 21,000 U.S. lung cancer deaths each year.[5] Be it at home, work or school, an individual's exposure to radon gas combines over time to increase the risk of preventable lung cancer. This document contains minimum requirements and guidance designed to respond to the health threat in schools and large buildings.

Significance of Use

This document is intended to assist in the installation and inspection of mitigation systems by citizens, radon mitigation professionals, property owners, residence/facility managers, residents, consultants, regulators, state radiation control programs and anyone concerned with radon mitigation, to reduce indoor radon concentrations in schools and large buildings.

Applicability: The practices in this standard can be adopted as requirements for contractual relationships or adopted as recommendations or requirements of an authority or jurisdiction such as for state and private proficiency programs or a governmental body. AARST recommends that any authority or jurisdiction considering substantial modifications of this document as a condition of its use seek consensus within the consortium process at AARST Consortium on National Radon Standards prior to adopting a modified version. This provides the jurisdiction with a higher degree of expertise and offers the Consortium on National Radon Standards an opportunity to update this document if appropriate.

Historical Perspective

In the 1950s, studies confirmed increased incidence of radon-induced lung cancer for workers in underground mines. In addition, it was found that indoor radon in homes could be a significant radiation exposure.

In the 1980s, studies found that exposure to radon in homes can exceed exposures found in studies of mine workers.

Since 1988, the Indoor Radon Abatement Act has authorized U.S. state and federal activities to reduce citizen risk of lung cancer caused by indoor radon concentrations.

Since the early 1990s, USEPA has advised all U.S. schools to test for radon and to reduce levels to below 4 pCi/L[3].

In 1999, the National Academy of Sciences confirmed that any exposure to radon holds a degree of risk with publication of BEIR VI. [3] In addition, the Academy's BEIR VII committee stated that exposure to radiation, including any concentration of radon, carries risk.

In 2009, the World Health Organization's *WHO Handbook on Indoor Radon* confirmed the association between indoor radon exposure and lung cancer, even at the relatively low radon levels found in residential buildings.[1]

Initiated in 2010, the U.S. *Federal Radon Action Plan* highlights an *ultimate* public health goal for the elimination of preventable radon-induced cancer. This plan is the result of a collaborative effort led by the U.S. Environmental Protection Agency (EPA) with the U.S. Departments of Health and Human Services (HHS), Agriculture (USDA), Defense (DOD), Energy (DOE), Housing and Urban Development (HUD), Interior (DOI), Veterans Affairs (VA) and the General Services Administration (GSA).

Document History

Previous radon mitigation standards were developed primarily for radon mitigation in single-family, detached residential buildings. They were not intended to address the wider scope of challenges associated with schools and large buildings. This standard seeks to harmonize existing practices with inclusion of specific enhancements applicable to most schools and large buildings.

Keywords

Radon, Radon Gas, Radon Mitigation, School, Large Building, Radon Test

Normative References

"Protocol for Conducting Measurements of Radon and Radon Decay Products In Schools and Large Buildings" (ANSI/AARST MALB). See: **http://www.aarst.org**

---

[1] World Health Organization, "WHO Handbook on Indoor Radon: A Public Health Perspective" 2009

[2] USEPA, "Radon Measurement In Schools", July 1993 (EPA-402-R-92-014)

[3] USEPA, "Tools For Schools", June 2010"

[4] Silvia Bucci, Gabriele Pratesi, Maria Letizia Viti, Marta Pantani, Francesco Bochicchio and Gennaro Venoso, "Radon in workplaces: first results of an extensive survey and comparison with radon in homes", 2011

[5] National Academy of Sciences, "Biological Effects of Ionizing Radiation" (BEIR VI Report) 1999

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Metric Conversions

Conversions from English-American measurement units to the International System of Units (SI) are rendered herein with literal conversion. The conversions are not always provided in informational text or tables. It is acknowledged that rounding off to a similar numeric conversion is common (i.e. 4.0 pCi/L rounded to 150 Bq/m^3 rather than literal conversion to 148 Bq/m^3) for locations where SI units of measurement are used in standard practice. Conversions should apply as commonly used in such locations or jurisdictions.

Consensus Process

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

This standard is under continuous maintenance by the AARST Consortium on National Radon Standards for which the Executive Stakeholder Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form and instructions may be obtained in electronic form at **www.radonstandards.us**

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

Contact Information

AARST Consortium on National Radon Standards.
Email: **standards@aarst.org** EFax: 913-780-2090
Website: **www.radonstandards.us**
P.O. Box 2109, Fletcher, North Carolina 28732

Disclaimer: *The AARST Consortium on National Radon Standards strives to provide accurate, complete and useful information. The AARST Consortium on National Radon Standards will make every effort to correct errors brought to its attention. However, neither the AARST Consortium on National Radon Standards, its sponsoring organization the American Association of Radon Scientists and Technologists nor any person contributing to the preparation of this document makes any warranty, express or implied, with respect to the usefulness or effectiveness of any information, method or process disclosed in this material. Nor does AARST or the AARST Consortium on National Radon Standards assume any liability for the use of, or for damages arising from the use of any information, method or process disclosed in this document. It is the sole responsibility of radon practitioners using this standard to stay current with changes to the standard and to comply with local, state and federal codes and laws relating to their practice.*

Table of Contents

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

RMS-LB
Radon Mitigation Standards for Schools and Large Buildings

1.0 SCOPE

1.1 This standard specifies practices, minimum requirements and general guidance for mitigation of radon in existing Schools and Large Buildings.

This standard addresses a wide range of Schools and Large Buildings including, among others, the use of a building or structure, or a portion thereof for: Business occupancies (Group B[6]) 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.

1.2 This standard addresses practices that are applicable to multi-use buildings or structures that are divided into any combination of occupancies including educational, commercial or residential[7] occupancies.

1.3 The scope includes High-rise buildings with an occupied floor located more than 75 feet (22 860 mm) above the lowest level.

1.4 The scope does not intend to exclude: 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 display and sale of merchandise, goods, wares or merchandise incidental to such purposes and accessible to the public.

1.5 This standard addresses practices that are applicable to structures or a portion thereof be they rented, leased or owned including co-op owned buildings.

1.6 The techniques addressed in this standard provide whole building consideration yet also apply when implemented to portions of a building or individual occupied spaces.

1.7 This standard is intended:

1.7.1 To provide minimum requirements and uniform standards that emphasize safety, system quality and effectiveness in the design and installation of mitigation systems for existing Schools and Large Buildings.

1.7.2 To provide a means to evaluate mitigation systems in Schools and Large Buildings.

1.8 **Limitations**

1.8.1 This standard is not intended to be used as a design manual, and compliance with its provisions will not guarantee reduction of indoor radon to any specific concentration.

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

1.8.3 This standard does not contain all code or other requirements of the jurisdictions where the radon mitigation system is being 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, state or local agency with jurisdiction.

1.8.4 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.

2.0 SIGNIFICANCE OF USE

2.1 This document is intended to assist in the installation of mitigation systems by radon mitigation professionals and those trained in radon mitigation practices, and to assist in the inspection of mitigation systems by citizens, radon mitigation professionals, property owners, residence/facility managers, residents, consultants, regulators, state radiation control programs and anyone concerned with radon mitigation, to reduce indoor radon concentrations in schools and large buildings.

2.2 **Conventions:** The term “shall” indicates those provisions herein that are considered mandatory, while terms such as “should” or “recommended” indicate provisions considered helpful or good practice, but which are not mandatory.

2.3 **Applicability**

2.3.1 These standards of practice can be adopted as requirements for contractual relationships or adopted as recommendations or requirements of an authority or jurisdiction.

2.3.2 If the minimum requirements of this document exceed local, state or federal requirements for the locale in which the mitigation is conducted, then this document’s minimum requirements shall be followed.

2.3.3 ***Prior Systems:*** This standard shall not apply to radon mitigation systems installed in schools and large 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

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

[7] For residential dwellings, see ANSI/AARST RMS-MF "Radon Mitigation Standards for Multifamily Buildings".

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

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.

3.0 QUALIFIED CONTRACTORS

3.1 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 schools and large buildings. The Contractor, contracting team or management team shall include individuals who have appropriate technical knowledge, skills and experience required to mitigate schools and large buildings, including at least one "Qualified Mitigation Professional." Persons including radon professionals shall be qualified for their apportioned task.

3.2.1 ***Qualified Mitigation Professional:*** Regardless of team composition, a "Qualified Mitigation Professional" for the purposes of this document is defined as:

"An individual that has demonstrated a minimum degree of appropriate technical knowledge and skills specific to radon mitigation of schools and large buildings:

a) as established in certification requirements of the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB); and
b) as required by statute, state licensure or certification program, where applicable.

Responsibilities for Qualified Mitigation Professionals include compliance with this standard and tasks identified in Section **6** (investigations prior to design) and Section **11** (inspections subsequent to installation). Sections **4** and **12** require that the "Qualified Mitigation Professional" be identified in documentation.

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).

3.2.2 ***Qualified Ventilation Professional:*** For the purposes of this document, a "Qualified Ventilation Professional" is an individual qualified, at a minimum, to conduct and evaluate airflow dynamic measurements as required under Section **10** of this document. The appropriate technical knowledge requires hands-on experience and training that may be obtained by completing trade-specific courses such as for: energy auditing; specific radon training courses; design of heating, ventilation and air conditioning (HVAC); or mechanical engineering.

3.2.3 ***Other Qualified Professionals:*** Other persons working with the Contractor or management team (e.g. design, utilities, engineering and facilities staff) should be 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.

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 Appendix **C**.

4.0 GENERAL PRACTICES

The following general practices include recommendations and certain requirements for all contacts between Contractor(s) and Client(s). (For guidance to aid Clients, see Appendix **A**.)

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 The Contractor shall advise the Client in writing that retesting 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 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:
    i. approved test devices;
    ii. closed-building conditions;
    iii. test locations; or
    iv. test durations.

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 Radon and Radon Decay Product Measurements In Schools and Large Buildings"* (ANSI/AARST MALB).

4.1.1.1 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.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

4.2 **Building Specifications:** The Contractor should request that the Client provide any available information on the building (e.g. construction specifications) that might be of value in determining the mitigation strategy.

4.3 **Known Hazards:** The Contractor shall request that the Client provide information regarding all known safety hazards for the building and adjacent or nearby buildings that might be related to design and installation of the mitigation systems. Information of concern, among others, includes for asbestos, lead paint or other hazards. It is recommended that the Contractor contact the building's safety officer or facility manager, if applicable, to help identify known hazards.

4.4 **Communication Plan – Coordination:**

It is highly recommended to develop a specific and written plan for communicating information throughout the process to all affected parties. The Contractor should coordinate with Client staff members (i.e., senior staff, appropriate communications staff and maintenance staff) to develop the communication plan. This plan should be agreed to and signed by the responsible parties prior to the mitigation.

Recommended components of the communication plan include the following action items:

4.4.1 Develop notices (with instructions, general information and information on whom to contact for inquiries) that may be specific for each affected audience, including:

a. Facilitating staff: Facilitating staff might normally include building managers, maintenance managers, custodial staff, teachers and other supervisors.
b. Workers, students, parents, and other occupants of the building.

(See notice examples in Exhibits **A-2** and **A-3**.)

4.4.2 Develop timetables and means for distribution of notices.

4.4.3 Specify which management staff member is responsible for onsite activities.

4.4.4 Specify the structure of additional communication paths between senior staff, facilitating staff, maintenance staff and the professional radon service provider(s).

4.4.5 Identify and provide contact information for those individuals who are authorized to respond to public inquiries.

4.4.6 Consider meeting with parent or worker associations or management staff representatives, if applicable, to thoroughly discuss test results, planned mitigation, impact on other residents, and who should be responsible for maintenance and payment for the mitigation work.

4.5 **Access Notices Required**

4.5.1 The Contractor shall request that the Client(s) provide notices to occupants a minimum of 24 hours before entering the building and in a manner that meets existing owner agreements and local laws, if applicable. (See Exhibit **A-1** for a sample "Contractor to Client" notice and Exhibits **A-2** and **A-3** for a sample "Client to Staff" and "Client to Occupant" notices.)

4.5.2 The Contractor shall request in writing that notices to occupants include instructions, warnings or guidance for specific disruptive or hazardous situations, including:

4.5.2.1 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

4.5.2.2 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 the following text or equivalent:

"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.*

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. Material Safety Data Sheets (MSDS) 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."*

(See notice examples in Exhibits **A-1** and **A-3**.)

4.5.2.2.1 Notification requests to Clients regarding hazardous materials (as illustrated in Section 4.5.2.2) shall include: a general description of the hazardous materials; symptoms that might indicate sensitivity to the materials; and actions to take if symptoms are observed.

4.5.3 It is recommended that the Contractor post or leave notices for affected occupants when using sealants that include the notice text provided in Section 4.5.2.2. (See example in Exhibit **A-4**.)

4.6 **MSDS***:* The Contractor shall provide Material Safety Data Sheets to the Client upon request.

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**.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

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 for the proposed mitigation design. (See Sections **5.2** and Section **12**);

4.7.2.3 A statement that describes options and costs for initial 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 costs and the annual operating costs with the understanding 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 ***Additional Proposal Content:*** Proposals should also 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) an estimate of time needed to complete the work;
c) a description of the system or fan monitors and list of appropriate actions for Clients to take if a monitoring device indicates system degradation or failure;
d) a statement of planned methodology for egress, soil gas control and sealing when portions of a structure are significantly challenging in terms of access (e.g. crawlspaces);
e) a statement describing any known hazards associated with installation including chemicals used in or as part of the installation; and
f) a statement indicating compliance with and implementation of all relevant standards of certifying agencies having jurisdiction (e.g., code requirements).

4.8 **Jurisdictional Authorities and Codes**

4.8.1 ***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 http://www.epa.gov/iaq/whereyoulive.html

4.8.2 ***Building Codes:*** All components of the mitigation work shall be in compliance with the applicable mechanical, electrical, building, plumbing, energy and fire prevention codes, or any other regulations of the jurisdiction where the work is performed. For localities having no relevant code requirements, the most recent version of nationally published codes should be observed to help assure safety of occupants and building integrity.

4.8.3 ***Licenses and Permits*** required by local ordinances shall be obtained.

5.0 SYSTEMS DESIGN

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 Clients 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 control of indoor pollutant sources becomes more important as buildings become more airtight;
b) system durability;
c) acceptable aesthetics (including system appearance, noise and occupant comfort);
d) ease of service;
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; and,
f) compliance with all applicable building and safety codes.

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 shall also avoid obstructing doorways or windows and accessibility to switches, controls, electrical junction boxes or equipment requiring maintenance.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

5.5 **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**.

5.6 **Permanent Systems Required:** Mitigation systems shall be designed and installed as an integral, permanent addition to the building.

5.6.1 ***Limits on Temporary Solutions:*** When delays in the installation of a permanent mitigation system are unavoidable and a temporary system utilizing any mitigation method is employed, the following actions are required:

5.6.1.1 *Label Temporary Systems:* The Contractor shall place label(s) in a conspicuous location on the system or system components stating the words "Temporary Radon Reduction 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 Section **5.6.1.2**.

The label shall include the Contractor's name, phone number, and applicable certification number and certifying agency. (See label example in Exhibit **B**.)

5.6.1.2 *Time Limits on Use of Temporary Systems:* All Contractor correspondence shall indicate that use of a temporary mitigation system is limited to no longer than 30 days except for the following specific cases:

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

5.6.1.2.2 The use of a temporary system is limited to no longer than 90 days subsequent 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

5.6.1.2.3 The use of a temporary mitigation system shall be extended only to a point that is reasonably appropriate when multiple parties or jurisdictions of authority must individually and collectively approve the installation plan and the logistics of such approval process thereby necessitates a delay in the installation of a permanent mitigation system.

5.6.1.3 *Risk Communication (temporary systems):* The Contractor shall notify the Client of labeling requirements upon implementation of the temporary system. In addition, the Contractor shall provide the Client with risk information relative to concentrations measured in the dwelling(s) as portrayed in EPA's publication "Citizens Guide to Radon" or state publications. 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 greater risk indicated should be included. See example in Exhibit **B**.

5.6.1.3.1 The Contractor should inform the Client that the standard of care requires due diligence for timely completion of a permanent mitigation system and that the Client is responsible for the health and safety of occupants.

5.6.1.4 *Request Notification to Occupants (temporary systems):* The Contractor shall request that the Client assign a responsible party to make all appropriate notifications to occupants and facilitating staff about the temporary nature of the system and related health risk. It is recommended that the Contractor obtain signed acknowledgment from the Client that the request for notification to occupants was received.

6.0 BUILDING INVESTIGATIONS REQUIRED PRIOR TO SYSTEM DESIGN

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.

6.1.1 ***Document Review:*** 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:

6.1.1.1 *Radon Measurements:* Review all available radon measurements in the common building structure(s);

6.1.1.2 *Known Hazards:* Review any information made available by the Client regarding known hazards. See Section **13.2** for further guidance. If other related concerns present themselves, consider outreach to other sources that may include state or local health officials; and

6.1.1.3 *Building Design and Operational Specifications:* Review applicable and current drawings, specifications, photos and other information regarding the existing building such as:

6.1.1.3.1 *Foundation Specifications:* Identify installation specifications for foundation components such as footings, aggregate, drainage systems and utility line locations. Related considerations to review include structural and architectural features both as designed and as built;

6.1.1.3.3 *Mechanical Systems:* Review, as appropriate, the design of other systems or components that might be of value in determining the mitigation strategy. These typically include systems for fire protection, HVAC, electrical service, plumbing and any existing mitigation system for radon or other pollutants; and

6.1.1.3.3 *Renovations:* Request to review any future renovation plans for HVAC or structural design.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

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. The diagram(s) should denote all ground contact rooms and building foundation types such as slab-on-grade, basement and crawl space areas. The diagram(s) should include notations of foundation building materials and design, including suspected aggregate or soil types that may be under each portion of the building.

6.1.2.1 *Radon Measurements:* At least one diagram should be annotated with the location and results of all available radon measurements.

6.1.2.2 *Radon Entry Points:* The diagram(s) should include annotation of suspected soil air entry points of significance and the location of construction features that may impact system performance such as suspected interior foundation footers.

6.1.2.3 *Identify Unique Sectors:*

6.1.2.3.1 Within ground contact areas of the building, identify each addition to the original building and each structurally isolated airspace.

Figure 6.1.2.3.1

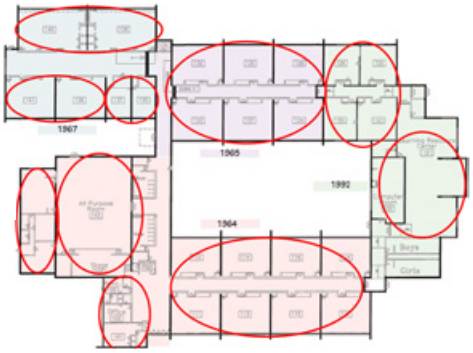
6.1.2.3.2 For ground contact areas, identify the general design and intended purpose of each active component of heating, cooling and ventilation systems (HVAC). (See Table **6.1.2.4**).

6.1.2.3.3 Classify each of the following areas as a "***Unique Sector***":

a) each ground contact area of the building where the multiple rooms are served by individual yet similar heating and cooling technology (as described in Table **6.1.2.4** for Group 1 Basic Heating and Cooling or similar individual room systems); or

b) each ground contact area of the building served by a central HVAC air handling system.

Figure 6.1.2.3.3



6.1.2.4 *Identify Operational Design of HVAC (Heating, Cooling and Ventilation Systems)*

Table 6.1.2.4

Group 1: Basic Heating and Cooling

A dedicated system for each room or unique area that does not supply additional fresh air for 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.
- **Ductless Split Systems:** One system for cooling and one system for heat (i.e. Window AC for cooling and Baseboard heat).

Group 2: Multi-zone Systems

Independent systems and controls for different areas within the same room or unique sector.

Group 3-a: Variable Air Distribution

Systems where the airflow from a single air handler is distributed to multiple rooms or locations with independent controls within each room for duct dampering. Such systems include Variable Air Volume (VAV) systems or systems with fixed volume return vents and controls for dampering supply air.

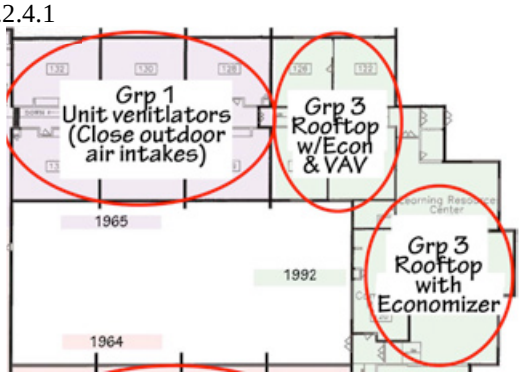
Group 3-b: Variable Outdoor Air Ventilation

- For individual rooms (i.e. Unit Ventilators).
- For multiple rooms (i.e. each system serves an area)
- For a whole building.

See Appendix **D** for more information. 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.

6.1.2.4.1 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). (See Section **6.1.2.3** for identifying "Unique Sectors" and Table **6.1.2.4** for HVAC design grouping).

Figure 6.1.2.4.1



This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

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

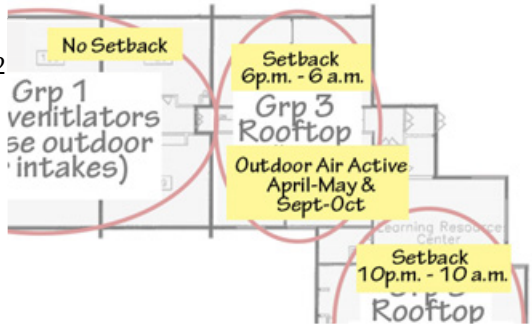
a) HVAC setback schedules in terms of hours each day for each operational mode;
HVAC "setback" is normally the automated or manual operation of system controls to cause different activity for heating, cooling and ventilation systems during occupied periods compared to unoccupied periods;

b) ventilation systems that actively bring outdoor air into the building (see Table **6.1.2.4**, Group 3b) and controls activate these systems.
You should consult with a building representative to better identify operating parameters established for the building(s). See Appendix **E** for typical operating parameters of such 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 conducted in diagnostic procedures (See Section **6.2**.)

Figure 6.1.2.4.2



6.1.2.4.3 Identify occupancy use*:* For the purposes of this document:

a) "*Occupied*" is defined as any area of the building that is occupied on a regular basis for more than 4 hours a day;

b) "*Significantly occupied*" is defined as the time period where the building is typically occupied by the majority of the workers or students; and

c) "*Occupied work or school weeks*" are defined as 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 conditions.

6.1.2.4.3.1 The diagram(s) or documentation should identify the occupancy use for each unique area of the building and the following details:

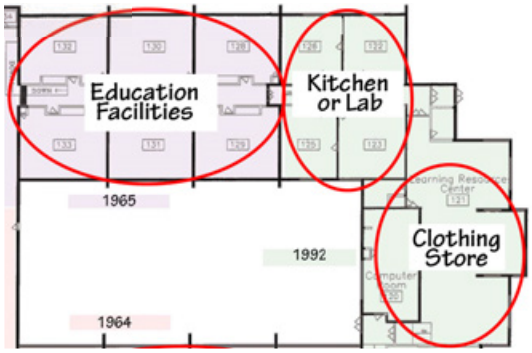
a) the number of months per year that the building or individual portions of the building are significantly occupied;

b) the hours of the day that 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 6.1.2.4.3.1



6.1.2.5 *Evaluate Building Operating Conditions:*

6.1.2.5.1 *Normal Occupied Operating Conditions:* 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.

6.1.2.5.2 C*lear characterization of a radon hazard:* Identify testing periods that reasonably represent when the operating conditions are most likely to emphasize a clear characterization of a radon hazard. This would primarily include time periods when the difference between indoor and outdoor temperatures cause:

a) some degree of regularity in the activity of heating or cooling system blowers. This blower activity can cause negative pressure within the building, unique sector of the building or even an individual room; and/or

b) some degree of regularity for natural negative air pressure inside the building as compared to outside of the building (e.g. stack effect).

Temporary conditions that inhibit clear characterization of a radon hazard include periods when the volume of outdoor air introduced into the building exceeds the minimum amounts required to maintain occupant comfort and health.

6.1.2.5.3 It is recommended to record for proposals, planning and subsequent to testing a written evaluation of testing conditions compared to significantly occupied conditions. 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,

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

The evaluation should include the following components:

Table 6.1.2.5
Evaluation of testing conditions compared to "Normal Occupied Operating Conditions".
(See Appendix E for technical guidance)

Building Operating Conditions To Report:		Report
1.a	Operating conditions that represent the greatest amount of significantly occupied time.	A Technical description
1.b	If the building operating condition represents the greatest amount of significantly occupied time?	"Yes" or "No" description
2.a	Operating conditions that emphasize when clear characterization of radon hazard is most likely.	A Technical description
2.b	If operating conditions emphasize when clear characterization of radon hazard is most likely?	"Yes" or "No" description
3.	Any additional considerations.	Optional
4.	Any descriptions of conditions and possible effects that might warrant repeating the test and recommended timetable for repeating the test.	Conditions and Recommended Retest Timing.

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. identification of fire-rated assemblies or separation required (including for fire-rated party walls between different occupied spaces and fire-rated floor assemblies); and
c. identification of general safety concerns that may warrant precautions for worker or occupant health. (See Section **13**.)

6.1.3.1 An effort shall be made to identify 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.

6.1.3.2 *Mechanical Systems Including HVAC:* The visual inspection shall also include identifying the design nature of HVAC and other mechanical systems that may affect the areas of the building to be mitigated. This includes design nature of HVAC systems that may cause significant building depressurization or have ducting in contact with the soil. If you are unsure as to the type of system that is present, consult with the building representative, a mechanical engineer or a heating and air-conditioning contractor.

6.1.3.3 *Investigative actions:* 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 success of a mitigation system design. Examples include:

a) If extreme pressure differentials exist due to:
   i. tall height or large size of the building;
   ii. large air handlers or multiple midsized air handlers, including conditions of disrepair, that could result in the capacity to induce significant air pressure differentials. Large or multiple exhaust fans can also fall under this consideration as well as large boiler systems or other component capable of generating large volumes of heat.

   Investigative actions can include measurements to identify pressure differences between the inside and outside of the building shell or between rooms.

   Investigative actions might include requesting from the client if any documentation exists regarding pressure and airflow measurements.

b) If ventilation might be significantly inadequate due to:
   i. design, disrepair or operation of outdoor air intake ducts; or
   ii. balance, design, disrepair or operation of internal air ducting and vent systems.

   Investigative actions can include measurements of airflow volume induced by air handlers.

6.1.3.3.1 *Repairs or modifications:* Repairs or modifications to HVAC systems that might be recommended as a result of this investigation shall be conducted in accordance with Section **10.8**.

6.1.4 ***Evaluate Design Options for Viability***.

6.1.4.1 Account for system design considerations described in Section **5** and otherwise applicable to the mitigation method.

6.1.4.2 Design plan(s) of the proposed layout of the mitigation system(s) shall be annotated on a diagram to include mechanical system components of the systems (i.e., ASD fan, piping and suction points).

6.2 Diagnostic Investigation

6.2.1 ***Diagnostic procedures*** shall be performed to enable appropriate and effective system design.

Background: Procedures chosen will depend upon the level of complexity for identifying or characterizing conditions under, beside and within buildings to adequately project the effects of various system designs. Diagnostic investigation can include one or multiple procedures such as: sub-slab pressure field extension (PFE) tests or analysis; visual assessment(s); 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

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

of interest (e.g., common areas, mechanical spaces and spaces not in ground contact).

6.2.2 ***ASD Designs:*** Design of ASD systems in schools and large 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.

6.2.2.1 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).

6.2.2.2 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.

Best practice includes evaluating any differences observed and conducting pressure measurements across the building shells.

6.2.3 ***Characterization of pressure*** differences between indoors and outdoors can be a critical diagnostic tool in high-rise buildings or buildings with large air handlers to help identify the potential challenges related to more extreme building pressures. In such situations, this diagnostic tool is recommended but not required.

6.2.4 ***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.) Diagnostic procedures are needed to:

a. Ensure feasibility of desired radon reductions with such methods; and
b. Aid considerations of unintended consequences regarding energy penalties and health, safety and comfort of dwelling occupants.

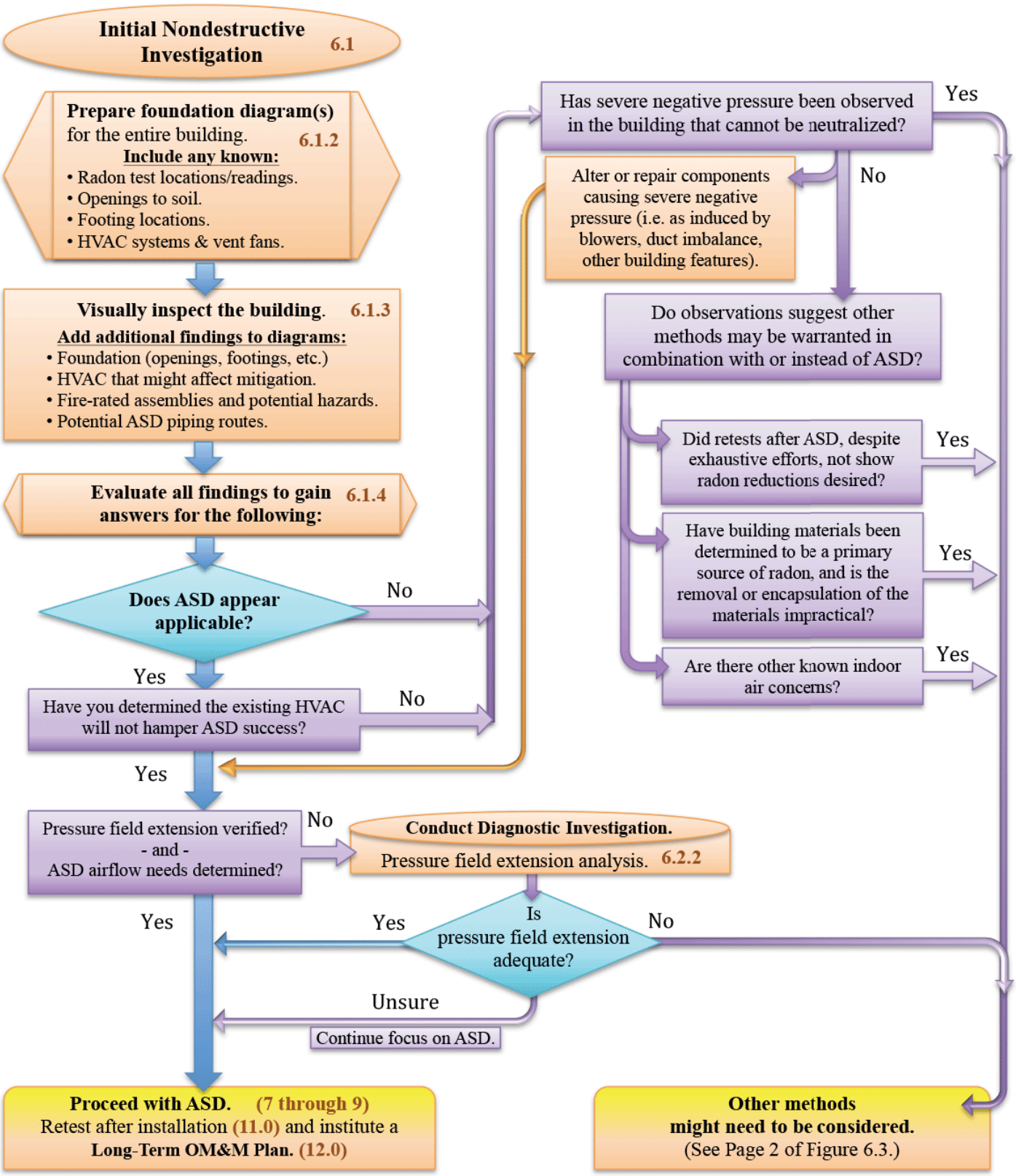
These diagnostics are likely to include other procedures to help project effects of altering building mechanical systems.

6.3 **Design Decisions**

The following flowcharts illustrate example procedures for determining the appropriateness and feasibility of design choices.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

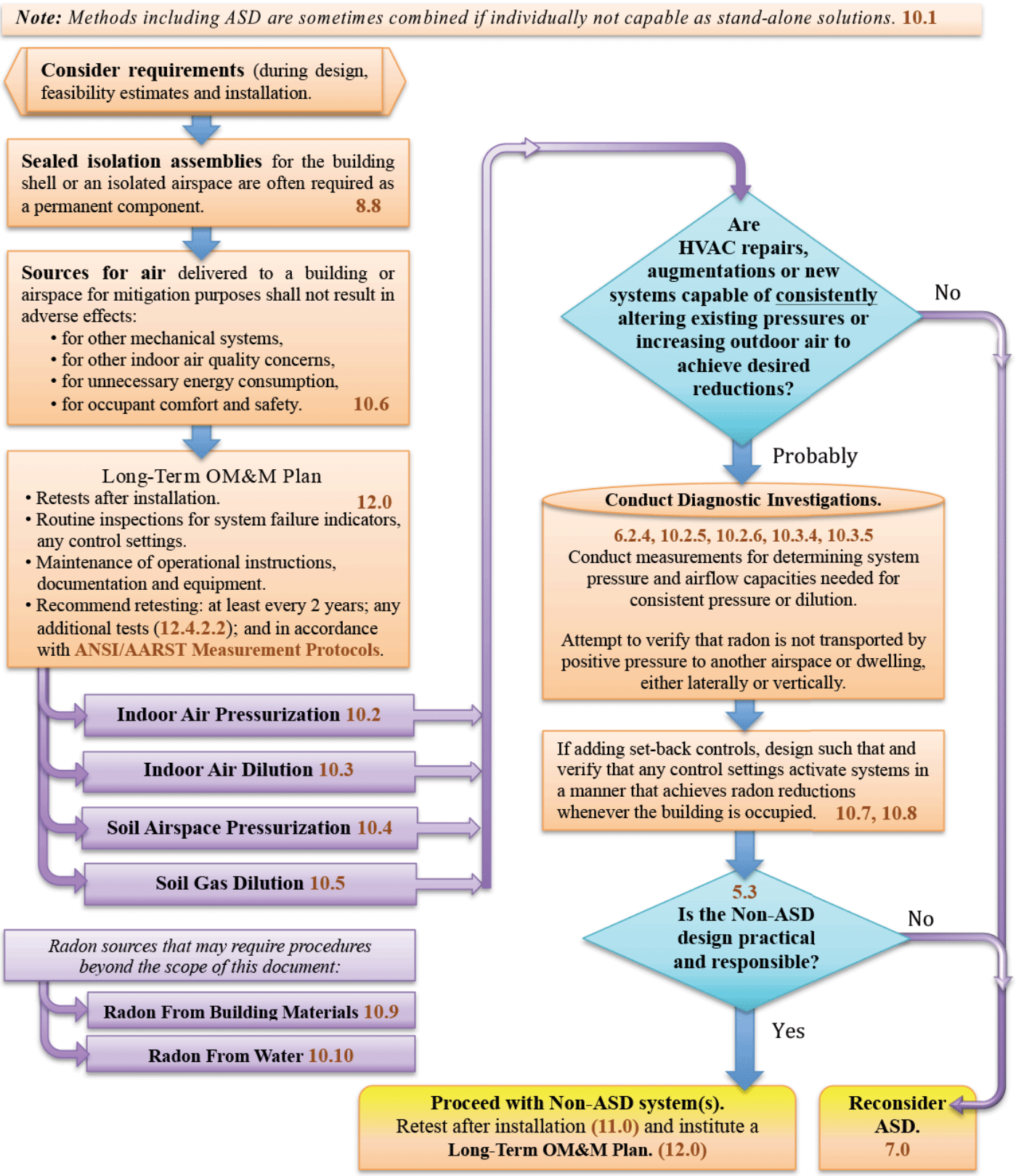
Figure 6.3 (Page 1 of 2) **RMS-LB: Example Design Decision Flowchart**



This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Figure 6.3 (Page 2 of 2) **RMS-LB: Example Design Decision Flowchart**

Non-ASD Methods



This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

7.0 ASD SYSTEM INSTALLATIONS

Active Soil Depressurization (ASD) system installations shall comply with all provisions of this document with the exception of Section **10**, "*Non-ASD Methods and Systems.*"

Background: The preferred applications of ASD entail depressurization of soil air compared to indoor air: under slabs such as with Sub-slab depressurization (SSD); under membranes installed over open soil, a process known as Sub-membrane depressurization (SMD); and behind walls such as with Block-wall depressurization (BWD). Common variations include applications known as Drain-tile depressurization and Sump depressurization. These preferred methods are commonly applied as combined into a single system depending upon the foundation configuration for slabs, walls and crawlspaces.

7.1 ASD Suction Points

7.1.1 ***Suction Pits:*** A cleared void space of at least 0.25 ft^3 or 2.0 gallons (US) (8 L) shall exist or be created below all slab suction points or to the side of all suction points through walls unless excavation is not practicable.

7.1.1.1 Larger pits are recommended, especially where soil or sub-slab material exhibits poor gas-permeability. *Background:* The size of the pit should be determined based upon permeability of the soil or sub-slab material and its relationship to airflow capacity needed to achieve pressure field extension (PFE). Where the combined surface area of pore openings is less than the cross-sectional surface area of the suction pipe opening, a larger pit is likely to enhance PFE.

7.1.1.2 In situations where the suction pit or piping directly access soil air from a drain-tile (Drain-tile depressurization), the configuration shall not result in compromising the capacity of the drainage system.

7.1.1.3 *Seal the Suction Point (slabs/walls):* Openings shall be sealed around ASD suction pipe duct penetrations of foundation slabs or walls in a permanent, airtight manner. When caulking is used:

a) The opening shall be cleaned and sealed with caulk complying with ASTM standard C920 class 25 or greater or equivalent; and
b) Openings greater than 1/2 inch (13 mm) in width they shall be pre-filled as needed with backer rod or comparable material prior to applying caulk.

7.1.2 ***Sumps:*** Sumps that connect to soil air are permissible as a suction point yet should be avoided unless other options are determined to be inadequate for achieving PFE. Concerns include compromised accessibility to sump pumps and observance that some localities disallow use of a sump as the primary suction point.

7.1.2.1 *Seal the Suction Point (sumps):* Openings shall be sealed in an airtight manner at the point at which an ASD suction pipe duct connects to or penetrates a sump lid. Sump lids shall be sealed and otherwise comply with Section **8.5**.

7.1.2.2 *Accessibility to Sumps:* Provisions of Section **8.5** for sealing sumps shall be observed to include a physical access port, or equivalent, and recommended visual access.

Whenever a sump lid is penetrated to accommodate the suction pipe, a flexible coupling disconnect for suction piping shall be provided in accordance with Section **7.2.6.3.** The disconnect should be located as close as practical to the sump lid in a manner to ease removal of the cover.

7.1.3 ***Sub-Membrane Suction Points:*** Suction pipe ducting shall extend to under the soil gas retarder membrane and shall be made open to soil air in a manner that allows PFE under the entire membrane.

7.1.3.1 Consideration should be given to preventing obstruction at the suction pipe by the flexible membrane material or obstruction to PFE such as moist soil adhering over time to the membrane. To achieve unobstructed pressure field extension under the entire membrane, it is recommended to consider attaching suction points under the membrane to perforated pipe not less than 10 feet (3 m) in length and of 4 inch (10 cm) nominal diameter minimum, or other flat engineered soil gas conveyance material with similar airflow capacity. For large membranes or other circumstances, it is recommended to consider longer lengths of perforated pipe or multiple suction points in the membrane(s).

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

7.1.4 ***Non-Habitable Air Spaces:*** These designs entail applying suction point duct piping to an entire airspace such as a crawlspace or a partitioned area that is being used as a soil gas collection plenum. Examples of this ASD design might entail sealed isolation assemblies for raised flooring, partition walls, or entire rooms or crawlspaces.

7.1.4.1 Depressurization of non-habitable airspaces shall not be used as a mitigation system:

a) when combustion appliances are installed within the airspace to be depressurized;
b) when adequate isolation cannot be created between the non-habitable airspace and surrounding airspaces containing one or more combustion appliances. Resulting configurations shall not induce flue gas spillage. (See Section **13.2.2**.); or
c) when design and diagnostic considerations have not accounted for minimizing adverse impacts to building systems, excessive energy penalties or damage to building components as a result of high humidity induced into the depressurized airspace.

7.1.4.2 *Crawl Space Depressurization (CSD)* is one such method that should only be used under specific

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

conditions in which a crawl space cannot be accessed or has insufficient height to work in for applying a membrane over open soil. (See **8.6.9.4**.) However, Sub-membrane depressurization (SMD) is a preferred mitigation method for most open soil areas even if access needs to be created. This preference observes important considerations to minimize energy penalties and damage to building structural components.

7.1.4.3 *Sealing (Non-Habitable Air Space and CSD):* Sealing shall be performed in accordance to Section **8.8** for "*Sealed Isolation Assemblies.*"

7.1.4.4 *Labeling Required (Non-Habitable Air Space and CSD):* See Section **9.4.6.2**.

7.1.5 ***Block Walls:*** The suction pipe locations will be dependent upon the configuration of the hollow void networks within the walls to be depressurized and the ability to close openings in the masonry wall(s) surrounding the void networks.

7.1.5.1 *Sealing (block walls):* Hollow block masonry walls shall be closed at all locations that surround the hollow void network being depressurized in a manner that minimizes migration of air into the void network using materials in accordance with Sections **8.2.1**, **8.2.2** or **8.2.3**. This includes:

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

7.1.5.2 When openings are inaccessible, closure of a lower course of blocks to isolate a smaller void network for depressurization should be considered. To the extent the top or wall surfaces of the hollow void network are not closed, block wall depressurization may not be possible. In addition to poor effectiveness, energy penalties can result when the system(s) induce mostly ventilation, rather than depressurization, of the hollow void network.

7.2 ASD Piping

7.2.1 ***Air and Water Tight:*** All duct piping and fittings moving air, except the intake and exhaust locations, shall result in an air and water tight duct system.

7.2.2 ***Slope Required****:* Above-ground duct piping shall have a continuous downward slope towards the suction point(s) of not less than 1/8 inch (3.2 mm) per foot (30 cm). Configurations that result in obstructed airflow by allowing water to collect within duct piping are prohibited. This requirement is intended to allow rainwater or condensation within the pipes to drain downward into the ground beneath the slab or soil-gas retarder membrane.

7.2.3 ***Positively-Pressurized ASD Duct Piping*** or other components of an ASD system shall not be installed in, or pass through or pass under the conditioned space of the building. (See Section **7.5.3.1** for additional description.)

7.2.4 ***Labels Required*** *(duct piping):* See Section **9.4.4**.

7.2.5 ***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:

7.2.5.1 *ABS Piping* shall comply with ASTM D2661, F628 or F1488. The pipe wall thickness shall be Schedule 40.

7.2.5.2 *PVC Piping* shall comply with ASTM D2665, F891, or F1488. The pipe wall thickness shall be Schedule 40.

7.2.5.3 *Exception 1:* Alternative materials specified in codes for "Subslab Soil Exhaust Systems"[8] are generally permitted and include various iron, steel, copper or other materials that may eventually achieve code or jurisdictional acceptance.

7.2.5.3.1 All ASD plastic piping shall meet durability specification in ASTM D1785 for Schedule 40 or greater with one exception that is permitted in codes for "Sub-slab Soil Exhaust Systems." Rigid non-perforated PVC pipe meeting ASTM D2949 having a wall thickness less than Schedule 40 is permitted with the following restrictions:

a. The pipe is installed only at interior locations and enclosed within wall cavities. Additional protection should also be considered for locations where damage to the pipe might occur;
b. Conversion to other accepted materials occurs immediately upon exiting the wall cavity and prior to exiting the building; and
c. If allowed by the local jurisdiction and approved by the Client to meet durability needs.

Note: ASTM D2949 is a plastic pipe specification for a specific material that is configured with an outer diameter that is smaller than Schedule 40 products and often cited by codes as acceptable for this use. For pipe installed within common wall cavities, an outer diameter (OD) that is less than 3.5 inches (89 mm) can sometimes reduce unnecessary noise that often results when fan vibration transfers to piping and the affected piping touches a wall enclosure. While the outer diameter for ASTM D2949 pipe material is compatible with materials commonly called Schedule 20 piping, below-grade pipe materials that might be otherwise described as Schedule 20, 30, 35 or other description are, consistent with nationally recognized codes, not permitted for above-grade use by this standard.

7.2.5.4 *Exception 2:* Downspout and other light-duty rigid materials of appropriate durability to the building's original design for the specific application are permitted with the following restrictions:

a. The material is installed only at exterior locations and where air within the duct piping is under positive pressure;
b. Duct size is in accordance with Section **7.3.6**;
c. Materials are, at a minimum, equal to the commercial durability of existing downspout materials used for the building where the system is

[8] As point of reference for alternative piping, see the International Mechanical Code (IMC) Section 512.2 (as published by the International Code Council).

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

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

d. The situation calls for a balance of considerations between acceptable aesthetics compared to long-term durability and use of the specific material is deemed by the Client and jurisdiction to warrant acceptability. The client should also be informed in writing prior to installation and in subsequent documentation (see Section **12.1.4**) that:
   i. Decorative pipe frequently requires more maintenance and is not as durable as welded or solvent-welded pipe; and
   ii. Options for painting or surrounding plastic pipe within other cosmetic enclosures, including downspout materials, might also be considered.

7.2.5.5 *Appropriate Duct Pipe Choices (ASD):* Choice of duct materials should account for durability including for drainage of condensate water that naturally occurs consistently within ASD piping. Considerations should also account for locations of potential high-impact damage and fire ratings appropriate for the situation.

7.2.6 ***ASD Pipe Joint Materials and Connections:*** 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 **7.2.6.3**.

7.2.6.1 *ABS Plastic Pipe Joints.* ABS plastic pipe joints shall be solvent welded in accordance with the pipe manufacturer's instructions with solvent cement conforming to ASTM D 2235.

7.2.6.2 *PVC Plastic Pipe Joints.* The joint surfaces for PVC plastic pipe and fittings to be solvent welded shall be prepared with a primer conforming to ASTM F656. PVC plastic pipe joints shall be solvent welded in accordance with the pipe manufacturer's instructions with solvent cement conforming to ASTM D2564.

7.2.6.3 *Flexible Coupling Disconnects:* Where disassembly may be required in the future for maintenance purposes, the disconnect shall consist of two unconnected portions of the ASD pipe joined with a flexible coupling, that complies with ASTM D5926, ASTM C1173 or an equivalent method. Other permitted uses of a *Flexible Coupling Disconnect* include:

a) when joining duct piping materials that are incompatible for solvent welding;
b) at locations where physical constraints inhibit the ability to join duct pipe materials by means of a solvent weld; and
c) at locations intended to minimize noise by breaking the direct transfer of fan vibration energy to other duct piping.

Other methodologies that allow at least equivalent durability and ease of disconnect are permitted (i.e., threaded pipe or union disconnect).

7.2.6.3.1 *Flexible Couplings Required (ASD fans):* See Section **7.5.6**.

7.2.6.4 *Alternative Pipe Materials* identified in Section **7.2.5.3** (e.g. iron, steel and copper) shall be joined in accordance with the pipe manufacturer's instructions and as required by code.

7.2.6.5 *Downspout* materials if permitted in accordance with Section **7.2.5.4** shall be welded to achieve a watertight seal or sealed and mechanically fastened (i.e. using hardware fasteners that are weather-rated for outdoor use) at each joined connection. When sealed and mechanically fastened:

a) 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 due to forces such as extreme temperatures and ultraviolet light from the sun. Sealants shall be durable and suitable for use on gutter materials; and
b) Where flange connections are used to join sections of duct material, each pre-formed or modified flange connection shall be connected in a manner where the duct material below the junction is flanged to the outside of the junction. The section of duct material above the junction shall be flanged inward and inserted downward into the junction. This configuration helps prevent water from escaping out of the duct that can cause duct degradation due to ice or water damage on other building materials.

7.2.7 ***Secure Duct Piping***

7.2.7.1 Duct piping shall be fastened securely to the structure of the building with hangers, strapping or other supports that will adequately and durably secure the duct material. Mechanical hardware or fasteners that anchor or secure the duct supports to building components shall be durable for the purpose and weather-rated when employed for outdoor use. The anchoring method and fastening materials shall be suitable to secure the anchors in a durable manner to whatever building components are chosen for securing the duct piping. Existing plumbing pipes, ducts or mechanical equipment shall not be used to support or secure duct piping. Fastening systems that extend a component (such as a nail or screw) through the duct piping and into a wall or other supporting surface shall not be used to support or secure duct piping.

7.2.7.2 Supports for ASD plastic piping shall be installed at least every 10 feet (3m) on vertical runs and at least every 6 feet (1.8m) on horizontal runs or as required by code, whichever is more stringent. See Section **4.8**. Support adequate to ensure structural integrity of the piping should also be provided directly below the discharge location and at fan locations. Refer to appropriate codes or manufacturer recommendations

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

for guidance for securing alternate ASD duct materials identified in Section 7.2.5.3 (e.g., iron, steel or copper).[9]

7.2.8 ***Unnecessary Noise:*** Duct piping and fans shall be mounted and secured in a manner that minimizes transfer of vibration to the structural framing of the building. Fastening methods and materials should isolate duct piping in a manner that does not transfer the energy of vibrating ducts to building materials and result in unnecessary noise.

7.2.9 ***Provide Access Clearance***

7.2.9.1 Duct piping shall not block egress from entrances and exits to the building, including those designated for fire and safety.

7.2.9.2 Duct piping shall not block any necessary access to any areas requiring maintenance or inspection such as mechanical equipment or a crawl space.

Exception: Flexible coupling disconnects in accordance with Section 7.2.6.3 are permitted where allowed by code as an alternative to provide access by temporary removal and airtight replacement of ASD pipe sections.

7.2.10 ***Protect Ducts From the Elements*** *(Insulation):* As required by codes or climate conditions, duct piping shall be provided with insulation.

7.2.10.1 Where it is likely on a regular basis (e.g., annually or every few years) that freezing temperatures will result with ice buildup within duct piping that would adversely affect long-term system performance, duct piping and fans shall be provided with insulation that is protected from the elements and has an R-value of no less than 4 or greater depending upon climate extremes.

7.2.10.2 Where it is likely that condensation will occur on the exterior surface of duct piping to the extent damage would occur to adjacent building materials, duct piping shall be provided with insulation having an external vapor barrier and an R-value not less than 1.8.

7.2.11 ***Observe Codes*** [10] *(duct pipe routing):* Codes that impact choices in duct pipe routing include but are not limited to:

a) Codes that are intended to maintain the integrity of a building's structural members. These codes place limits on the extent and location for sawing, notching and boring holes in a building's structural support members; and

b) Fire codes that are intended to inhibit the spread of fire and smoke. These codes normally prohibit materials such as plastic pipe from being routed through HVAC ductwork or a fire-rated assembly unless specific procedures are taken to control the spread of fire and smoke.

[9] As point of reference for securing alternative piping, see the International Mechanical Code (IMC) Section 305 (as published by the International Code Council).

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

7.3 ASD Pipe Sizing:

ASD duct piping shall, at a minimum, 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.

To aid assurance that requirements to ensure capacity to transport an adequate volume of air are met:

7.3.1 ***The Minimum Inside Diameter (ID)*** of 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) inside diameter (ID) pipe or as determined by PFE Analysis. (See Section 6.2 for guidance.)

7.3.2 ***When Larger Air Volume Needs Are Indicated:*** ASD duct piping from the exhaust point to the soil gas collection plenum(s) should be equivalent or greater than the cross-sectional area of a 4-inch (100-mm) ID pipe, or greater as needed, when the necessary airflow for the entire system is determined to be more than 80 cubic feet per minute (CFM) (2.3 m^3/min).

7.3.3 ***When Smaller Air Volume Needs Are Verified:*** If PFE Analysis indicates air flow yield of less than 40 CFM (1.1 m^3/min) is adequate airflow capacity for achieving mitigation goals, 2-inch (50-mm) inside diameter (ID) pipe is allowed.

7.3.3.1 In addition, if airflow yield exceeds 40 CFM (1.1 m^3/min) due to observed needs for fan pressures much stronger than normally employed for ASD (i.e., greater than about 6 inches WC (1500 Pa), 2-inch (50-mm) inside diameter (ID) pipe is allowed so long as:

a) The system still meets the needs for an appropriate design, as described in Section 5.3; and

b) Adequate air volume transport is achieved for establishing a vacuum within each airspace being depressurized.

7.3.4 ***Multiple Suction Points:*** Each duct pipe should individually be provided with capacities described in Sections 7.3.1, 7.3.2 and 7.3.3, and be joined to the system in a manner to maintain those capacities.

7.3.5 ***Maintain whole system air volume capacity:*** All components of the ducting system that reduce capacity for air volume transport shall be accounted for including at the system exhaust where protective components might be employed (e.g. wire mesh or rain caps) and at connections to the soil gas collection plenum (e.g. the circumference or size of slab penetrations).

7.3.6 ***Sizing for Alternative Duct Materials****:* A natural reduction to airflow capacity shall be accounted for when using alternate materials (e.g. gutter downspout in Section 7.2.5.4). Crimped flange connections reduce airflow capacity and the equivalent cross-sectional area of the duct. To achieve equivalent capacity, gutter downspout materials employed shall be:

a) no less than 3 x 4 inch material (75 x 100 mm) to meet capacities stipulated in Section 7.3.1 for 3-inch (75 mm) inside diameter pipe.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

b) no less than 4 x 5 inch material (100 x 127 mm) to meet capacities stipulated in Section **7.3.2** for 4-inch (100 mm) inside diameter pipe. (When even larger air volume needs are indicated, duct size shall increase respectively.)

c) greater than 2 x 3 inch material (50 x 75 mm) unless capacities as stipulated in Section **7.3.3** for 2-inch (50 mm) inside diameter pipe are verified..

7.3.7 ***Maximum Air Velocities:*** Objectionable noise should be accounted for at ASD exhaust locations. Air rushing noise usually reaches an objectionable threshold at air velocities of about 1600 FPM (488 m/min) or lower. Air velocities of 1600 FPM (488 m/min) result when air is driven at:

35 CFM (1.0 m^3/min) through a 2-inch (50-mm) pipe
80 CFM (2.3 m^3/min) through a 3-inch (75-mm) pipe
140 CFM (4.0 m^3/min) through a 4-inch (100-mm) pipe

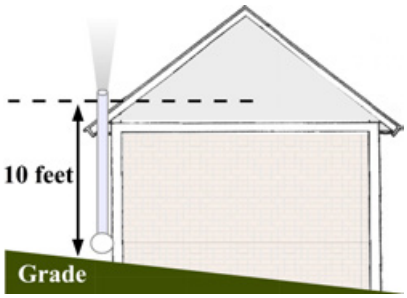
7.4 **ASD Exhaust Discharge – Design and Location:**

All of the following requirements shall be met for design and location of the point of discharge (with distances measured as the shortest distance around intervening obstacles) in order to reduce the potential for: 1) re-entrainment of radon into the structure; 2) exposure of individuals outside the building to radon and other soil gas constituents in the exhaust air; and 3) damage to building components.

7.4.1 ***Outside:*** The point of discharge shall be outside the structure.

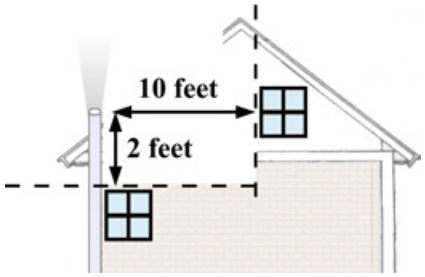
7.4.2 ***Grade:*** Not less than 10 feet (3 m) above grade nearest the point of discharge.

Figure 7.4.2



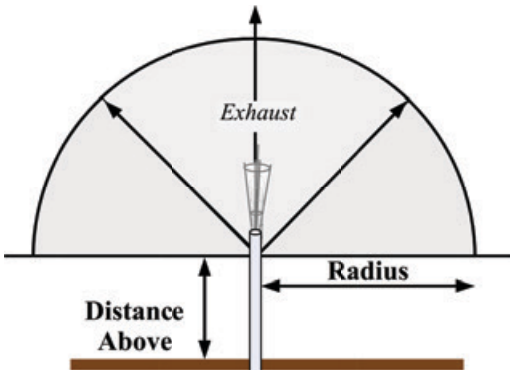
7.4.3 ***Openings In The Building Shell:*** Not less than 2 feet (60 cm) above or not less than 10 feet (3 m) away from operable windows, doors or other passive ventilation openings into the occupiable portion of the structure or an adjacent structure.

Figure 7.4.3



7.4.4 ***Mechanical Air Intakes:*** Not less than 3 feet (90 cm) above or not less than a 30-foot (10-m) radius distance away from mechanical air intake openings that are above or horizontal to the point of discharge. Mechanical air intakes include, among others, any intake openings for make-up air, evaporative coolers or sources of air for systems designed to alter the pressure or dilution characteristics of a structure.

Figure 7.4.4



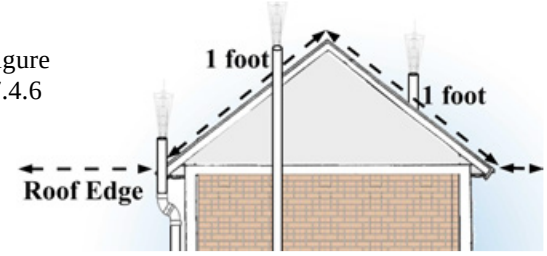
7.4.5 ***Decking, Patios, Sidewalks or Exterior Corridors:*** Not less than 10 feet (3 m) above or not less than a 20-feet (6-m) radius distance away from exterior flooring surfaces where individuals traverse or congregate that are above or horizontal to the point of discharge.

7.4.6 ***Roof:***

7.4.6.1 Not less than 1 foot (30 cm) above the roof at the point ASD piping penetrates a roof.

7.4.6.2 Not less than 1 foot (30 cm) above the edge of the roof when ASD piping is attached to the side of a building unless all requirements of Section **7.4.6.2.1** are met.

Figure 7.4.6



7.4.6.2.1 The point of discharge is permitted to be below the edge of the roof when all of the following requirements are met:

a) The edge of the roof exceeds 30 feet (10 m) above grade nearest the point of discharge, which can exceed Occupational Safety and Health Administration (OSHA) ladder safety limits. If scaffolding or elevated lifts that meet OSHA safety requirements are available and practicable, they may be used as needed to reach greater heights;

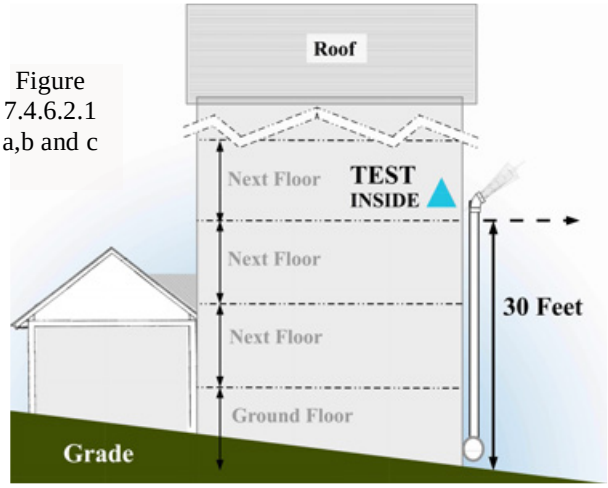
b) The point of discharge is not less than 30 feet (10 m) above grade nearest the point of discharge;

c) Testing is conducted within adjoining occupiable areas to help verify that concentrations are below the action level. This testing is required no later than in conjunction with the initial post-

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

mitigation test and included in all future post-mitigation tests;

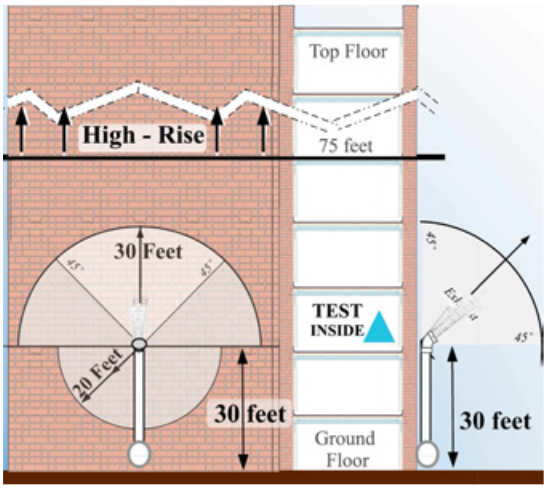
Figure 7.4.6.2.1 a,b and c



d) Openings in the building below the point of discharge are not less than a 20-foot (6-m) radius distance away from the discharge; and

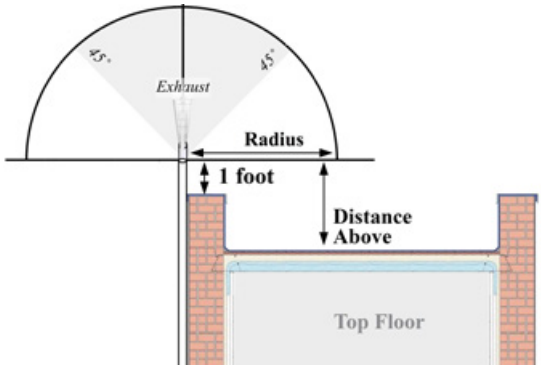
e) Openings in the building above the point of discharge are not less than a 30-foot (10-m) radius distance away from the discharge.

Figure 7.4.6.2.1 d and e



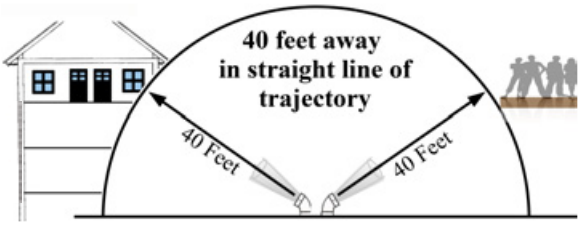
7.4.7 ***Equipment Wells and Parapet Roofs:*** Not less than 1 foot (30 cm) above parapet or enclosing roof components and in accordance with Sections **7.4.5** and **7.4.6**.

Figure 7.4.7



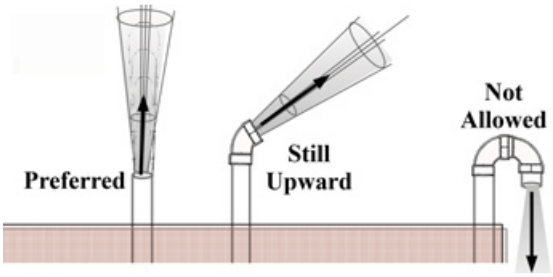
7.4.8 ***Straight line trajectory:*** Not directed in a straight line trajectory toward any location that people are likely to congregate in or any passive or active component of a ventilation system such as a window, door or mechanical intake opening that is less than 40 feet (12 m) away from the point of discharge.

Figure 7.4.8



7.4.9 ***Discharged Air:*** The ASD piping should be configured to discharge air upward without obstruction. The exhaust discharge shall not be installed in a manner that exhausts downward.

Figure 7.4.9



Exception: Downward discharge is permitted in certain situations that can include mitigation systems for radon in water (aeration). Such configurations shall be:

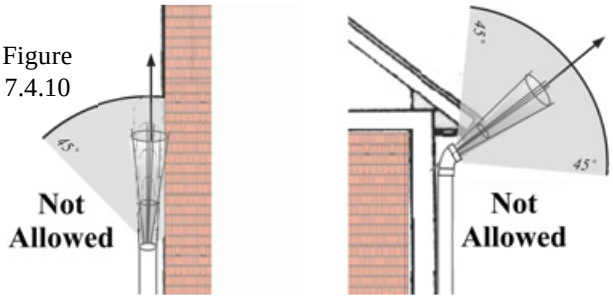
a) not configured to exhaust downward along the side of a building;

b) not configured in a manner where damage to building materials can occur; and

c) not less than a 10-foot (3-m) diameter distance away from all openings into the building for radon in water aeration systems and not less than a 30-foot (10-m) diameter distance away from all openings into the building for all other systems.

7.4.10 ***Damage To Building Materials:*** The exhaust discharge shall not be installed in a manner that allows exhaust airflow to directly strike building materials such as exterior walls or roof eaves. High moisture content of discharged air can result in ice formation and water damage to building materials.

Figure 7.4.10



This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

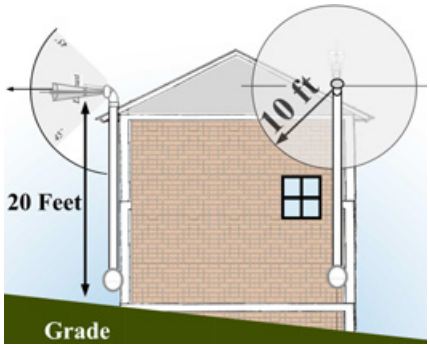
7.4.11 ***Horizontal Trajectory Should Be Avoided*:** For the purposes of this document, 90-degree horizontal discharge configurations are classified as discharging horizontally even though some portion of exhaust air is reflected downward.

Figure 7.4.11

The Contractor should consider the fact that horizontal dispersion and slowed velocity of discharged air reduces the distance that radon, soil air and vapors are carried away from occupants and the building.

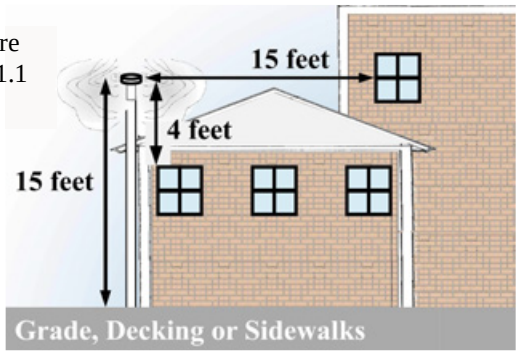
7.4.11.1 *For 90-Degree Horizontal Discharges:* Not less than 20 feet (7.5 m) above grade nearest the point of discharge and not less than a 10-foot (10-m) radius distance away from openings in the building. (See Section **7.4.3**).

Figure 7.4.11.1



7.4.11.2 *For Diffused Horizontal Discharges (e.g., rain caps):* Not less than 15 feet (4.6 m) above grade nearest the point of discharge and 4 feet (120 cm) above, or not less than 15 feet (4.6 m) away from operable windows, doors or other passive ventilation openings into the occupiable portion of the structure or an adjacent structure.

Figure 7.4.11.1



7.4.12 ***Protection From The Elements*** *(discharge)*

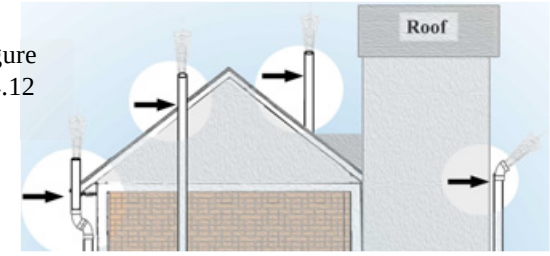
7.4.12.1 Include efforts to:

a) Provide support directly below the discharge location that is adequate to ensure structural integrity of the pipe configuration;

b) Locate or configure the exhaust assembly in a manner that avoids blockage or damage to the exhaust piping as a result of snow, ice curl or other forces; and,

c) Secure and meet code requirements for any piping that extends high enough to require tethering or other means of lateral stability.

Figure 7.4.12



7.4.12.2 *Icing:* The configuration for exhaust airflow should be designed and installed to minimize significant airflow blockages from ice.

7.4.12.3 *Rain Caps (diffused horizontal discharges):* In certain regions or locations where conditions such as pervasive torrential rain, high wind or blockage from debris are likely to be a concern, the use of rain caps can sometimes be warranted. See Section **7.4.11.2** for additional requirements. In addition, consideration for ice accumulation in colder regions is important since ice can obstruct the discharge or damage building components in close proximity. When the concern regards debris or small animals that may enter the piping, see Section **7.4.12.4**.

7.4.12.4 *Wire Mesh or Equivalent:* Rodent/insect screen (mesh not smaller than 1/2 in. [13 mm]) is permitted and recommended where the Contractor or Client is concerned that debris or small animals might enter the point of discharge, or fan blades might cause injury to occupants. However, duct sizes and mesh material commonly chosen can reduce a system's air volume capacity by more than 20%. The resulting configuration shall be in compliance with Section **7.3.5** for retaining air volume capacity required.

7.5 **ASD Fan Installation Requirements**

7.5.1 ***ASD Fan Design:*** ASD fans chosen shall be designed or otherwise sealed to reduce the potential for leakage of water or soil gas from the fan housing. ASD fans mounted on the exterior of buildings shall be rated for outdoor use or installed in a weatherproof protective housing. ASD fans chosen shall be designed to allow rainwater or condensation from within ASD piping to pass through or around the fan when activated. ASD fans chosen shall be designed to accommodate continuous activation over a durable lifespan. ASD fans chosen should be designed to minimize objectionable noise. ASD fans should originate from a manufacturer that lists ASD (radon mitigation) as one of the fan's intended uses.

7.5.2 ***Fan Sizing:*** ASD fans shall be sized to provide the pressure difference and airflow capacity necessary to achieve the mitigation goals. (See Section **6.2** for guidance.)

7.5.3 ***Fan Location:*** ASD fans shall only be installed in attics, on the exteriors of buildings or in garages that are

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

not beneath conditioned or otherwise occupiable spaces. Ventilated attics or the exterior of the building are preferred locations.

7.5.3.1 To circumvent accidents that can result in mitigation systems leaking or fully exhausting concentrated radon 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 in any basement, crawlspace or other interior location directly beneath the conditioned or otherwise occupiable space of a building.

7.5.3.2 ASD fans shall not be installed below ground.

7.5.3.3 ASD fans subject to extreme climate conditions shall be protected from the elements in accordance with Section **7.2.10**.

7.5.3.4 Observe Code[11] and Utility Company Restrictions: Choices for fan and switch/disconnect locations can be subject to requirements of utility companies and fire safety codes that address proximity of ignition sources to flammable materials (e.g., near natural gas meters and Liquid Propane holding tanks).

7.5.4 ***Fan Drainage:*** ASD fans shall be installed in a configuration that avoids condensation buildup in the fan housing. ASD fans shall be installed on vertical runs of ASD piping or in accordance with the manufacturer's installation specifications.

7.5.5 ***Unnecessary Noise:*** Fans and associated duct piping shall be mounted and secured in a manner that minimizes transfer of vibration to the structural framing of the building.

7.5.6 ***Flexible Couplings Required at ASD Fan:*** ASD fans shall be mounted to piping using flexible couplings that comply with ASTM D5926, ASTM C1173 or using an alternative method specified by the manufacturer. This method achieves an airtight connection while facilitating maintenance of the fan.

8.0 SEALING

8.1 **Background and Accessibility**: Sealing is not to be considered a permanent, stand-alone mitigation method.

Background: Sealing openings in the slab, foundation or crawl space membrane is however an important component of most mitigation methods in order to break the connection between soil air and living spaces. For example, sealing is an important component of ASD systems in order to enhance PFE, minimize conditioned air being removed from the building, reduce any depressurization of the building by the ASD system, and allow usage of a more energy efficient and quieter ASD fan.

8.1.1 ***Accessibility to Cracks and Openings:*** For the purpose of this section, the term "accessible" shall mean accessible without destructive or significant disassembly of building components or finishes.

8.1.2 Inaccessible openings or cracks shall be disclosed to the Client and included in the documentation if they may compromise the performance of a mitigation system and are determined to be beyond the ability of the Contractor to seal. (See Section **12.1.4**.)

8.2 **Sealant Materials**

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

8.2.2 When the crack or joint is greater than 1/2 inch (13 mm) in width, a foam backer rod or other comparable filler material shall be inserted into the joint to support the caulk before the application of the sealant.

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

8.2.4 Noncombustible materials shall be used when sealing openings around items such as combustion appliance flues and hydronic heat or steam pipes.

8.2.5 When sealing sump lids, hatchway doors or other items to which access will be needed in the future, sealing shall employ nonpermanent sealant materials such as silicone caulk, gasket materials or other equivalent method.

8.3 **Accessible Slab Cracks:** Accessible openings to soil around the suction piping and utility penetrations and including where the slab meets the foundation wall shall be sealed.

8.3.1 Accessible cracks across a slab that are greater than 1/16 inch (1.6 mm) in width should also be sealed. It is further recommended to seal any accessible expansion or control joints in a slab.

8.3.2 Accessible gaps to soil at perimeter channel drains shall be sealed to the extent practical without compromising water control capability (e.g., perimeter gap or drain that may include interior foundation drainage boards). When sealing perimeter channel drains, methods shall employ materials specified in Section **8.2** or other materials that will achieve closure yet retain flexibility to allow movement of foundation slabs and walls.

8.4 **Other Accessible Openings in Slabs or Foundation Walls:** Other accessible and significant openings in the slab shall be sealed, such as at support posts or openings for plumbing under bathtubs or similar fixtures. On foundation walls, accessible cracks and openings to the soil should be sealed as needed.

8.4.1 ***Block Walls*** *(BWD):* See Section **7.1.5.**

8.4.2 ***Basement De-Watering Systems:*** If an ASD system is installed into a basement de-watering system, exposed openings into the drainage system that can be sealed without compromising the water drainage feature

[11] As required by local statutes or authorities. For further information, contact the local provider for gas or liquid fuel.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

shall be sealed. Any exposed open cores of a block wall foundation that are adjacent to the depressurized de-watering system should be closed and sealed**.**

8.5 **Sumps:** 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. Covers are not required for pits that do not connect to soil air. In addition, the installation of a sump cover or its design shall not be conducted in a manner that compromises other safety concerns (e.g., emergency pressure relief discharge from water boilers or other mechanical systems).

8.5.1 ***Sump Covers:*** Sumps in interior floors that connect to soil air shall have a rigid lid and the lid shall be sealed with a gasket or with nonpermanent caulk such as silicone. The lid shall be mechanically fastened in a manner to facilitate removal for maintenance. Penetrations through the lid such as gaps around electrical wiring, water ejection pipes and ASD piping shall be sealed. The lid shall be made of durable plastic such as polycarbonate plastic or other rot-resistant, rigid material.

8.5.1.1 Sump covers shall include some form of physical access when a sump pump is installed in the pit to allow routine verification that pumps are operational. The sump cover shall include a removable port or section of the lid no less than 4 inches (13 cm) in diameter or equivalent method to satisfy this requirement.

8.5.1.2 Sump covers should allow visual access to permit observations of conditions in the sump by way of a lid window, transparent lid or similar method.

8.5.2 ***Surface Water Relief*** *(slabs):* An alternative drainage system shall be provided and installed in accordance with Section **8.7** when sealing a sump or other slab opening that is the only drain relief for excess water on the slab surface.

8.5.3 ***Sump Pump*** discharge piping shall be equipped with a backflow prevention valve.

8.5.4 ***Labeling Required*** *(sump covers):* Labeling shall be applied in compliance with Section **9.4.6.1**.

8.6 **Membranes and Open Soil**

8.6.1 ***All Mitigation Methods:*** To break the connection between soil gas and the air within the building, soil and other fill material in crawl spaces should be covered with concrete or a soil gas retarder membrane in a manner to minimize air pathways between soil air and the building.

See Section **8.6.9** for additional requirements when employing Sub-membrane Depressurization (SMD).

8.6.2 ***Soil Gas Retarder Material*** *(membranes):* Soil gas retarder membranes shall meet ASTM E1745 class A, B or C. These specifications include water vapor permeance, tensile strength and puncture resistance. Heavier gauge sheeting or a means for protecting the membrane should be employed when crawl spaces are used for storage or frequent entry is required for maintenance of utilities.

8.6.3 ***Seams*** *(membranes):* The seams between adjacent membrane sheets shall be overlapped not less than 12 inches [30 cm]. See Section **8.6.9** for additional requirements when employing SMD.

8.6.4 ***Repairs*** *(membranes):* Tears or punctures in the membrane shall be sealed by one or more of the following methods:

8.6.4.1. A tape recommended by the membrane manufacturer; or

8.6.4.2. An additional sheet of the membrane material that covers and overlaps the tear or puncture not less than 12 inches (30 cm) on all sides and that is sealed with a caulk complying with ASTM C920 class 25 or greater or an equivalent method.

8.6.5 ***Surface Water Relief*** *(membranes):* When there are indications that water is likely to collect on the surface of a membrane, drainage for surface water should be installed in the lowest location and in accordance with Section **8.7**. The Client should be informed about a potential condition and related observations, and any maintenance recommendations should be included in documentation for the long-term operation, maintenance and monitor plan as outlined in Section **12.1.4**.

8.6.6 ***Securing the membrane:*** For crawl spaces or portions of a crawl space that are expected to be regularly accessed for maintenance, storage or other purposes, the membrane should be secured to the walls or other surfaces in a durable manner.

8.6.7 ***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 insect attacks or otherwise protected.

8.6.8 ***Labeling Required*** *(membranes or the crawl space):* See Section **9.4.6.2**.

8.6.9 **Sub-membrane Depressurization (SMD):** In addition to all other provisions in Section **8.6**, the membrane shall be sealed in a manner to result in a closed, soil gas collection plenum under the membrane when SMD is employed.

8.6.9.1 ***Seams*** *(SMD):* The seams between adjacent membrane sheets shall be overlapped not less than 12 inches [30 cm] and shall be sealed with a compatible sealant or a caulk complying with ASTM C920 class 25 or greater, or a method that results in an equivalent durable bond.

8.6.9.2 ***Pipe Penetrations*** *(SMD):* The opening around penetrations of a soil gas retarder shall be in accordance with Section **7.1.3.2**.

8.6.9.3 ***At Walls and Foundation Supports*** *(SMD):* Membranes attached to foundation walls and at penetrations for foundation support components shall be sealed in a manner to minimize air pathways between soil air and the building with the following methods:

a) For flat wall surfaces, the membrane shall be sealed to the foundation walls and supports with

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

a caulk complying with ASTM C920 class 25 or higher or equivalent method.

b) For irregular surfaces, alternative materials and methods are permitted so long as durable closure of the soil gas collection plenum is achieved.

8.6.9.4 ***Inaccessible Areas*** *(SMD):* When portions of the crawlspace cannot be accessed or have insufficient height to work in a safe manner according to safe practices established by OSHA or other authorities, the membrane within inherent boundaries of accessible areas shall be configured to result in a closed, soil gas collection plenum under the membrane.

8.6.9.4.1 ***Inaccessible Areas and Combined Methods:*** In situations where it can be demonstrated to be warranted, a system that inevitably combines SMD, CSD and Soil gas dilution by allowing a portion of the soil gas collection plenum to remain unclosed is preferred as compared to Crawlspace depressurization alone, and thereby permitted By comparison, the membrane component of a properly configured system can provide far superior soil gas control while minimizing adverse effects of energy penalties and moisture within the crawl space.

However, the use of such combination methods shall be disclosed to the Client(s) in accordance with Section **12.1.4** and include justification for the design. In addition, see Sections **7.1.4** (Non-Habitable Air Spaces), **7.1.4.2** (Crawl Space Depressurization) and **10.5** (Soil gas dilution) for additional requirements as a result of allowing a portion of the soil gas collection plenum to remain unclosed.

8.7 **Drains**

8.7.1 A radon-resistant drain or equivalent method with adequate flow capacity should be installed in any drain that discharges directly into the soil beneath the slab, through solid pipe to a dry well, or has other exposure to the soil.

8.7.2 Openings in the slab or at sumps that serve for mechanical system water drainage and are likely to allow blower driven soil air entry into a building shall be modified to minimize this airflow (e.g., drains open to HVAC ducting on the negative pressure side of the HVAC blower). The modification shall be configured in a manner that retains the water drainage capability, such as re-routing the drain line into a condensate pump or a radon-resistant drain, or including a trap in the drain that provides a minimum of 6 inches (15 cm) of standing water.

8.7.3 A one-way flow valve or other mechanical means should be installed when a mitigation system is designed to draw soil gas from drain tiles (internal or external) that discharge water to daylight. This is to prevent outside air from entering the ASD system while allowing an unobstructed flow of drain water to drain out of the water control system. In cold climates, efforts should be made to protect the valve or other mechanical system from freezing.

8.8 **Sealed Isolation Assemblies:** Sealed isolation assemblies are not to be considered a permanent, stand-alone mitigation method.

Background: Sealed isolation assemblies are sometimes employed to help break the connection between soil air and living spaces or to isolate an airspace to facilitate pressurization. A sealed isolation assembly might be the entire building shell or an isolated airspace within a building when pressurization techniques are applied. Sealed isolation assemblies include: sealants or gaskets on hatches or doors; sealed partition walls, floors or ceilings; and other configurations that might resist air migration across a partition or any component of the isolation assembly. Sealed isolation assemblies are sometimes employed to prevent pressure changes induced by a mitigation system from adversely affecting combustion appliances located in an adjoining airspace. Sealed isolation assemblies are critical for effective and appropriate implementation of crawl space depressurization (CSD).

8.8.1 ***Sealing*** *(isolation assemblies):* Any accessible openings between the isolated space and both interior and exterior areas surrounding the isolated space shall be sealed to the extent practicable. Openings to livable areas surrounding the isolated space shall be closed and sealed. Access doors or hatches that are not to be permanently sealed shall be fitted with airtight gaskets and a means of positive closure.

8.8.2 ***Labeling Required*** *(sealed isolation assemblies):* See Section **9.4.6.2**.

9.0 REQUIRED FOR ALL SYSTEMS (ASD and non-ASD)

9.1 A long-term operation, maintenance and monitoring (OM&M) plan in accordance with Section **12**.

9.2 **Fan Monitors**

9.2.1 ***Required:*** All mitigation systems shall include a mechanism to directly indicate if the fan, blowers or other integral mechanical component is operating. (Fan monitors are sometimes referred to as a system failure indicator.) The mechanism shall be simple to interpret and located where it is protected from damage and easily seen or heard by building occupants or maintenance staff.

9.2.1.2 *Routine Inspection Advisory:* The Client shall be advised to conduct routine checks of the fan monitors at least quarterly where fan monitors are only accessible to building staff members and in accordance with Section **12.1.2.** Acceptable options include provisions for offsite electronic monitoring, management and notification.

9.2.1.3 *Powered Monitors:* Visual or audible fan monitors that require electricity for indication of fan failure shall be on non-switched circuits and designed to reset automatically when power is restored after power supply interruptions. Monitors shall not be powered by the same branch circuit as the mitigation system fan(s).

Exception: If telemetric indicators/remote monitors are integrated in the system or if the visual or audible monitor has three alert indicators:

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

a) the system is inside the intended performance range;
b) the system is outside the intended performance range; and
c) the system has no power.

Battery operated monitoring devices shall not be used unless they are equipped with a low-power warning feature.

9.2.1.4 *Monitor Durability:* Fan monitors shall be protected from the elements, including if located outside of a building, and durable for the situation.

9.2.2 ***Collateral Mitigation:*** See Section **9.3.5.3**.

9.2.3 ***Labels Required*** *(monitors, controls and startup):* See Section **9.4.3**.

9.3 **Electrical Requirements** in addition to all other applicable electrical code requirements[12]:

9.3.1 ***Disconnect Required:*** For ASD fans, a means of electrical disconnect shall be provided for in the line of sight and within 6 feet (1.8 m) of the mitigation system fan(s), unless a switch remote from the fan location is employed in a manner to provide a lock-out feature.

9.3.2 ***Labeling Required*** *(disconnects/breakers):* See Section **9.4.5**.

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

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

9.3.5 **Collateral Mitigation:** Collateral mitigation is a situation where a mitigation system may intentionally or inadvertently extend influence to multiple areas within a shared building. When a shared building has commercial units, dwellings, classrooms or other areas that are divided by walls or partitions for separate and distinct occupancy uses, occupants or tenants, the following additional considerations are required:

9.3.5.1 ***Inadvertent Collateral Mitigation:*** See Section **12.3** for required notifications. These are situations where the effects of collateral mitigation are inadvertent and it is beyond the control of the Contractor to coordinate design features and monitor mitigation system effects in adjoining units, dwellings or other potentially affected areas within a shared building.

9.3.5.2 ***Intentional Collateral Mitigation (electrical):*** 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 as a result of Client choices or other conditions, one of the following options is required:

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 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 that is independently electrically metered; or
c) Prior to installation the Contractor shall:
   i. Provide the Client a written communication 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
   ii. Receive written communications to be included with documentation (see Section **12.1.4**) that include:
      1) 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
      2) a statement from the owner of the dwelling(s) or unit(s) that indicates: acknowledgment of the electrical cost information provided by the Contractor; acceptance of obligations for long-term operation and maintenance of the system(s); agreement with the Client's justification; and permission to proceed with the installation.

9.3.5.3 ***Intentional Collateral Mitigation (fan monitors):*** In accordance with Section **9.2** 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

[12] As required by local statutes. For further information, see the National Electric Code® (NEC) as published by NFPA.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

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 **9.2.1.2** and Section **12**; or

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

9.4 Labeling Required:

All labels shall be made of durable materials. 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. All label titles identified in Section **9.4** shall be with lettering of a height of not less than 1/4 inch (6.35 mm). Additional information on the labels shall be with lettering of a height of not less than 1/8 inch (3.18 mm).

9.4.1 ***Label the System(s) – Primary Label:*** A system description label shall be placed on a primary component of each system (e.g. on duct piping near an ASD fan monitor), or within 12 inches (30 cm) of the electric service panel or other prominent location.

9.4.1.1 The label title shall state, "Radon Reduction System" or similar wording and include:

a) the date of installation;

b) an advisory stating that the building should be tested for radon at least every 2 years or as required or recommended by state or federal agencies;

c) an advisory stating that the system should be evaluated for mechanical performance quarterly or as otherwise stipulated for frequency of inspections in an OM&M plan. (See Table **12.4**);

d) the installer's name, phone number and applicable certification identification;

e) the party responsible for OM&M. The label shall state, "This system is under the care, custody and control of _____." *(Insert name and phone number of the responsible party.)*; and

f) notice of additional state or federal resources for radon information (e.g., www.epa.gov/radon; the radon hotline 1-800-SOS-RADON); and the state or local Radon Office as found in the U.S. at http://www.epa.gov/iaq/whereyoulive.html

9.4.2 ***Observable Notices:*** Best practice when systems are not maintained by an individual owner and occupier of a dwelling is to recommend an observable notice that is permanently installed to disclose the presence of the mitigation system and its purpose for protecting health and safety to staff and current future occupants or tenants. The notice should include the party responsible for OM&M (in accordance with Section **9.4.1.1 e**) and provide the dates of the latest radon test and mechanical inspection.

9.4.3 ***Label Monitors, Controls and Startup***

9.4.3.1 *Fan Monitors*, such as manometer pressure gauges or electrical amperage gauges, shall be clearly marked to indicate the pressure, airflow volume or amperage readings that existed at the time mitigation goals were achieved.

9.4.3.1.1 Fan monitor devices shall have a label on or in close proximity to the mechanism that describes how to interpret the monitor and what to do if a monitor indicates fan failure or degraded fan performance. When the fan monitor is not located in close proximity to the primary label described in **9.4.1**, the label title shall state "Radon Reduction System" or similar wording

9.4.3.2 *System Control Settings* for any mechanical equipment shall be clearly marked to indicate the settings that existed at the time mitigation goals were achieved.

9.4.3.2.1 System controls shall have a label on or in close proximity to the mechanism that describes the purpose of the control and general instructions for operation.

9.4.4 ***Label Duct Piping:*** Interior duct piping shall be marked with not less than one label at each floor level with label titles stating "Radon Reduction System" or similar wording. For ASD systems, such labels should be affixed at intervals not greater than 10 feet (3 m) along the developed length of piping.

9.4.5 ***Label Electrical Disconnects:*** Disconnects such as switches or the receptacles providing power to plugged connections for mitigation system fans shall be marked to indicate their purpose. The label title shall identify that the disconnect is a component of a mitigation system such as with the text "Radon Fan", and can include instructions such as "Caution – Radon Fan", "Radon Fan – Leave Switch On" or "Radon Fan – Leave Plugged In."

9.4.5.1 The circuit breaker(s) protecting the mitigation system fan circuit(s) should also be labeled with the text "Radon" or "Radon Fan."

9.4.6 ***Label Sealed Components***

9.4.6.1 *Label Sump Covers:* Sump covers shall be identified with a label that is titled to state "Radon Reduction System" or similar wording and should include text that reads "Component of a Radon Reduction System. Do not tamper with or disconnect." or equivalent wording.

9.4.6.2 *Label Crawl spaces or Membranes (Section **8.6**) and Sealed Isolation Assemblies (Section **8.8**):* Crawl space areas or the soil gas retarder membranes and sealed isolation assemblies that are not occupiable areas shall be labeled. A label or marking shall be located in a conspicuous place or places (such as at access panels) to identify the nature of components and to indicate these to be components of a mitigation system. The label title shall state "Radon Reduction System" or similar wording and should include additional text such as "Do Not Alter" and other text to indicate that alterations to the assembly or membrane

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

can negatively impact system performance. For Sealed Isolation Assemblies (Section **8.8**) where entering the crawl space may pose hazards to future workers, information should be included to advise ventilation or other safety precautions.

9.4.7 ***Label Mechanical Equipment:*** Any major mechanical system installed, repaired or altered that is intended to reduce radon levels shall be labeled with a label title stating "Radon Reduction System" or similar wording to identify the item as a component of a mitigation system.

10.0 NON-ASD METHODS AND SYSTEMS

For general applicability of these methods and impact on other indoor air quality issues, see *"Indoor Air Quality Guide – Best Practices for Design Construction and Commissioning"* published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHREA). www.ashrae.org

10.1 All Non-ASD Methods

10.1.1 ***Appropriateness of Design:*** All systems and methods shall meet the needs for an appropriate design, in accordance with Section **5.3**.

10.1.2 ***Important Maintenance Inspections:*** A regiment of routine inspection shall be recommended in accordance with Section **12.1.2** or as stipulated in an operation, maintenance, and monitoring (OM&M) plan that is in accordance with Table **12.4** to include, as applicable, all filters, exterior intake and exhaust vents, duct balance, controls and other components.

10.1.3 ***Combination of Methods and/or Systems:*** A variety of the methods described herein including ASD can be applied with intentional application of multiple methods to achieve mitigation goals.

10.1.4 ***Long-Term OM&M Plans Required:*** All ASD and non-ASD methods applied shall be accompanied with an OM&M Plan in accordance with Section **12** that includes all applicable provisions for each method.

10.2 Indoor Air Pressurization

Background: Establishing positive pressure in the airspaces close to soil can, under certain conditions, be effective to stop radon entry. Pressurized buildings or airspaces can in some cases be achieved with permanently installed mechanical systems. An air source from upper floors or the building exterior is ducted into a confined airspace with enough air volume and velocity to result in a positively pressured airspace.

When **Indoor Air Pressurization** is employed:

10.2.1 ***Capacity*** *(pressurization):* Mechanical components, newly installed or augmented, shall result in adequate capacity to constantly deliver the air volume and velocity needed to overcome leakage in the outer shell of the building, airspace or isolated assembly. Systems shall be configured in a manner that can produce consistent positive pressure within the airspace being pressurized.

10.2.2 ***Sources for air*** delivered to the airspace being pressurized shall comply with Section **10.6**.

10.2.3 ***Sealing*** *(pressurization):* The building or airspace(s) being pressurized shall be augmented as needed to result in a permanently sealed isolation assembly in accordance with Section **8.8**.

Exception: Access doorways for the building or airspace being pressurized are not required to be gasketed; however a mechanical means to automatically achieve positive closure of doors subsequent to entry and exit is required.

10.2.4 ***Unintentional Radon Transport:*** For systems applied to portions of the building or an airspace rather than the entire building, considerations shall be made during design with attempts to verify after installation that radon is not transported to another portion of the building by the pressurization system. Considerations are to include the potential for systems to inadvertently drive radon under the building or through partitions into adjoining areas located laterally or vertically from the pressurized airspace. Airspaces or occupiable areas adjoining laterally or vertically to the pressurized area shall be tested for radon during either diagnostic procedures or after installation.

10.2.5 ***Prior To System Installation or Augmentations***

10.2.5.1 A Qualified Ventilation Technician shall employ pressure and airflow measurements as needed to evaluate system capacity requirements for the design stipulated in Section **10.2.1**. Blower door measurements during system design are recommended to quantify the capacity needs of the system;

10.2.5.2 Sources for air to be delivered to the airspace shall be evaluated for viability of meeting requirements in Section **10.6**; and

10.2.5.3 An attempt shall be made to evaluate the potential that pressurization might inadvertently transport radon to other airspaces, in accordance with Section **10.2.4**;

10.2.6 ***After Installation or Augmentations***

10.2.6.1 A Qualified Ventilation Technician shall verify with pressure and airflow measurements that adequate capacity for required operating parameters stipulated in Section **10.2.1** were achieved. These measurements shall be recorded in accordance with Section **12.1.2** and often include the system's: total airflow in and total airflow out temperature in and temperature out, air density, altitude and other operating parameters;

10.2.6.2 Sources for air delivered to the airspace shall be verified for compliance with Section **10.6**;

10.2.6.3 An attempt shall be made to verify if the system is inadvertently transporting radon to other airspaces, in accordance with Section **10.2.4**; and

10.2.7 ***A Long-Term OM&M Plan Is Required*** in accordance with Section **12**.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

10.3 **Indoor Air Dilution**

Background: By way of mechanical or passive ventilation components, the introduction of outdoor air to a building or airspace can, under certain conditions, be effective to dilute radon after entry. There are also times when additional ventilation is desired for other purposes.

Note however: The high volumes of added outdoor air required to dilute radon concentrations adequately will often result in unacceptable energy penalties especially when accounting for occupant comfort.[9] Practicality as a stand-alone method increases for buildings with tight, energy efficient construction.

When **Indoor Air Dilution** is employed:

10.3.1 ***Capacity*** *(dilution):* Mechanical or passive components that are newly installed or augmented shall result in a configuration with adequate capacity to continually provide the required volume of dilution air needed to achieve desired goals for radon reduction.

10.3.2 ***Sources for outdoor air*** delivered to the indoors shall comply with Section **10.6**.

10.3.3 ***Coupled With Pressurization:*** Considerations shall be made during design with attempts to verify after installation the potential for positive pressure to result from the system to an extent that radon is transported to another airspace in accordance with Section **10.2.4**.

10.3.4 ***Prior To System Installation or Augmentations***

10.3.4.1 A Qualified Ventilation Technician shall employ pressure and airflow measurements as needed to evaluate system capacity requirements, energy penalties and feasibility for the design stipulated in Section **10.3.1**. Blower door measurements during system design are recommended to quantify the capacity needs of the system;

10.3.4.2 Sources for air to be delivered to the airspace shall be evaluated for viability of meeting requirements in Section **10.6**; and

10.3.4.3 Measurement procedures shall include an attempt to evaluate the potential for the system to change an airspace or portion of the building from negative to positive pressure. If this is found to occur, the requirements of Section **10.2.4** shall also apply.

10.3.5 ***After Installation or Augmentations***

10.3.5.1 A Qualified Ventilation Technician shall verify with pressure and airflow measurements that adequate capacity for required operating parameters stipulated in Section **10.3.1** were achieved. These measurements shall be recorded in accordance with Section **12.1.2** and often include the system's: total airflow in and total airflow out, temperature in and temperature out, air density, altitude and other operating parameters;

10.3.5.2 Sources for air delivered to the airspace shall be verified for compliance with Section **10.6**;

10.3.5.3 Measurement procedures shall include an attempt to verify if the system has changed an airspace or occupiable portion of the building from negative to positive pressure, whereby the requirements of Section **10.2.4** shall also apply; and

10.3.6 ***A Long-Term OM&M Plan Is Required*** in accordance with Section **12**.

10.4 **Soil Airspace Pressurization**

Background: Establishing positive pressure in the gas permeable layer or airspace between occupiable spaces and the soil can, under certain conditions, be effective to stop radon entry. Active Soil Pressurization can, in some cases, be achieved with permanently installed mechanical systems where an air source from upper floors or outdoors is ducted into the gas permeable layer under the foundation or airspace in contact with soil. Where airflow and velocity needs are similar, Active Soil Pressurization systems might resemble inversely applied ASD systems. The systems have more often been employed for special conditions in which natural sub-slab aggregates are so porous that establishing a vacuum under the foundation with ASD is not possible.

When **Soil Airspace Pressurization** is employed:

10.4.1 ***Sources for air*** delivered to the airspace being pressurized shall comply with Section **10.6**.

10.4.2 ***Sealing*** shall be in compliance with Section **8** in order to help break the connection between soil air and living spaces.

10.4.3 ***Unintentional Radon Transport:*** Considerations shall be made during design with attempts to verify after installation that radon is not transported to another airspace or occupiable portion of the building in accordance with Section **10.2.4.**

10.4.4 ***A Long-Term OM&M Plan Is Required*** in accordance with Section **12**.

10.5 **Soil Gas Dilution**

Background: Inducing outdoor air ventilation in the gas permeable layer or airspace between occupiable spaces and the soil, under certain conditions, can be effective to dilute radon prior to entry.

10.5.1 ***Requirements:*** All designs and installations of mechanical systems that induce soil gas dilution shall comply with all requirements for Section **10.3** (Indoor Air Dilution).

10.6 **Sources For Air Delivered To A Building**

Background: A variety of the options may present themselves for sources of air (or make-up air) when needed for pressurization or dilution systems. Meanwhile, many choices can have profound adverse effects on energy consumption and occupant comfort and safety.

10.6.1 ***Capacity*** *(sources of air):* System design and installation shall result in a configuration with adequate capacity to continually provide the required volume of air needed to achieve mitigation goals.

10.6.2 ***Adverse Effects:*** Sources for air delivered to the airspace being mitigated shall not result in adverse effects on the building including for: other mechanical systems

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

(i.e., back draft of combustion appliances); other indoor air quality concerns[13]; unnecessary energy consumption[14]; and for occupant comfort and safety.

Considerations should also include:

a) review or approvals required relative to fire rated envelopes and exit doors, and;
b) asbestos control plans and potential of pollutant transport within a building such as from laboratories, medical facilities and office copying and print facilities.

10.6.3 ***Air Intake and Distribution Vents****:*

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

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

10.6.3.3 *Intake Vents – Air quality:* Intake vents shall be in locations where airborne pollutants (e.g. vehicle emissions, trash containers and combustion appliance emissions) are distant enough from the intake to not enter the building and adversely affect the comfort and safety of occupants.

10.6.3.4 *Intake Vents – Adverse Effects:* Intake vent locations within a building shall be in locations and installed in a manner to not adversely affect energy consumption, other building systems including combustion appliances, and occupant comfort and safety.

10.6.3.5 *Duct Balance:* Contractors shall verify that the balance of incoming and outgoing airflow does not create a negative pressure within portions of the building in contact with the soil.

10.6.4 ***Economizer Systems, Heat Recovery Ventilators (HRV) and Energy Recovery Ventilators (ERV)***

Background: HRV systems are a commonly preferred tool for providing outdoor air to a building or airspace due to energy saved as compared to energy consumption for delivering untempered outside air into a building.

Warning Note: Economizer systems and ERV are often not originally configured to introduce outdoor air into a building at all times due to energy and comfort considerations.

10.6.4.1 Systems shall be configured to constantly deliver the air volume and velocity needed to achieve mitigation goals whenever any portion of the building is occupied, in accordance with Section **10.7**.

10.6.4.2 For HRV and ERV installations, interior supply and exhaust ports shall be located a minimum of 12 feet (3.8 m) apart. The exterior supply and exhaust ports shall be positioned to avoid blockage by snow or leaves and be a minimum of 10 feet (3 m) apart.

10.6.4.3 Adequate drainage capacity shall be considered in design and provided to accommodate condensate water from systems. Floor drains to the sanitary sewer system or other foundation drain systems are recommended for meeting this need. HRV and ERV systems often condensate a continuous flow of water during certain seasons.

10.6.5 ***Important Maintenance Inspections****:* A regimen of routine inspection shall be recommended in accordance with Section **12.1.2** or as stipulated in an OM&M plan that is in accordance with Table **12.4** to include all filters, exterior intake and exhaust vents, duct balance, controls, and other components.

10.6.6 ***Foundation Vents*** shall be noncloseable when installed specifically to increase the natural ventilation of a crawlspace for mitigation purposes. Therefore in areas subject to subfreezing conditions, the need to insulate, isolate or apply heat-tape to water supply and distribution pipes in the crawl space should be considered when installing foundation vents.

10.7 Controls For Variable Activation

Background: Controls are often installed where is it desired for energy conservation or other consideration to variably cycle system(s) activation or capacity based upon occupancy patterns and seasonal effects on building systems.

10.7.1 ***Configuration:*** Controls for mechanical equipment shall be configured and verified to activate systems in a manner that achieves mitigation goals whenever each portion of the building is occupied. Care should be taken to ensure systems activate in advance of occupied periods in a manner sufficient to achieve radon reductions prior to when the airspace is occupied.

10.7.2 ***Labeling required*** *(controls):* Control settings and fan monitors shall be labeled and annotated in accordance with Section **9.4.3.**

10.8 HVAC Repairs or Modifications

10.8.1 ***Incidental repairs:*** When an incidental failure or condition of a component is suspected of causing radon entry and it can be repaired in a permanent fashion, diagnostic radon tests after completing incidental repairs are an allowed consideration. Should retests indicate mitigation has resulted from an incidental repair: A "Long-Term OM&M Plan" in accordance with Section **12** is required. The inspection regimen stipulated in Table **12.4** should include observance of items or similar components that appear prone to routine failure and any related systems that are volatile to alteration over time.

[13] For further information, see ANSI/ASHRAE Standard 62.1-2013 "Ventilation for Acceptable Indoor Air Quality" for buildings that are more than three stories tall or ANSI/ASHRAE Standard 62.2-2013 "Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings"

[14] For further information, see ANSI/ASHRAE/ USGBC/IES 189.1-2011, "Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings," or ICC 700-2008, "National Green Building Standard for Residential Construction".

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

10.8.2 ***Modifications to HVAC systems and controls:*** The intended non-ASD methodology for mitigation shall be identified within Section **10** and any resulting actions shall be in compliance with the applicable provision(s) of Section **10**. Modifications should be in compliance with ASHREA ventilation standards.[9] Regardless if the choice of mitigation method was influenced by desires to address other indoor air quality concerns, a Long-Term OM&M Plan in accordance with Section **12** is required when augmenting HVAC systems or controls to include all applicable provisions for each method applied. It is highly recommended to ensure that the design capabilities of the system are more than is minimally required so that any degradation to the system's functionality over time can be accommodated as needed.

10.9 **Radon from Building Materials**

Background: Under specific circumstances where it has been determined that building materials are a primary source of elevated radon concentrations, see Section **10.3** (Indoor Air Dilution) if applicable. Other considerations currently beyond the scope of this document include encapsulation, isolation or removal of building materials.

10.10 **Radon from Water**

Background: Under specific circumstances where it can be determined that radon from a water supply is a primary source of elevated radon concentrations in air, aeration and charcoal filtration are common methods employed to achieve radon reductions. Such methods are currently beyond the scope of this document.

10.11 **Air Cleaning**

Background: Radon gas itself cannot be cleaned 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 onto which a portion of these elements have attached are cleaned from the air with filtration or other technologies or activities. However, challenges for the use of air cleaning as a method for radon risk reduction 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 adequately 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.

Currently published and peer reviewed science does not support that the amount of risk reduction sought can be quantified or verified for consistency with current technologies. Consistent with EPA technical guidance publications[15], air cleaning as a means of reducing the risk from radon is not recommended as a mitigation method.

[15] 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).

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

11.0 POST-MITIGATION (ALL SYSTEMS)

11.1 Post-Mitigation Functional Evaluation/Inspection

11.1.1 ***For ASD Systems:*** In conjunction with activating an ASD system, the suction in system piping shall be measured and recorded along with at least one PFE measurement that is conducted under closed-building or normal operating conditions.

It is recommended that both measurements be made under conditions that reflect normal building operation when significantly occupied and include consideration for worst-case conditions.

11.1.1.1 The PFE measurement shall be made and recorded at a point distant from each suction point(s) to verify intended design using a differential pressure gauge capable of reading to 1/1000 inch water column (.25 Pa).

It is recommended that locations where PFE tests are made be recorded and closed in a nonpermanent fashion to facilitate any future needs (e.g. diagnosing a system when radon tests do not indicate success in achieving mitigation goals).

11.1.2 ***For Non-ASD Systems:*** Measurements of airflow volume, pressure and other system parameters that are applicable to the method chosen shall be recorded after installation.

11.1.3 ***Inspection for Compliance:*** Prior to delivery and release of the completed system(s) for use, a Qualified Mitigation Professional shall have verified:

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

Any items found to not be in compliance with any RMS-MF requirements or other local statutes or codes shall be changed to be in compliance.

11.2 Initial Radon Retests After Mitigation

11.2.1 ***Initial Retests After Mitigation:*** To provide an initial measure of system effectiveness, a short-term radon measurement shall be conducted no sooner than 24 hours after a mitigation system is operational and within 30 days after installation of the system(s).

11.2.2 ***Qualified Measurement Professionals*:** For the purpose of this document, a Qualified Measurement Professional is defined as an individual that has demonstrated a minimum degree of appropriate technical knowledge and skills specific to radon measurement in schools and large buildings:

a) as established in certification requirements of the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB); and
b) as required by statute, state licensure or certification program, where applicable.

11.2.3 ***Contractor Obligations*** to ensure post-mitigation testing is conducted have been satisfied once post mitigation test results are accepted by the Client as satisfactory evidence for the initial status of system effectiveness.

11.2.3.1 For the purposes of this initial post-mitigation test, Contractor obligations are satisfied regardless of whether this testing is conducted by:

a. an independent, Qualified Measurement Professional; or
b. the Contractor who installed the mitigation system(s), if also a Qualified Measurement Professional (and if allowed by local statutes or code). To avoid any appearance of conflict of interest, the Contractor shall recommend to the Client that post-mitigation testing be conducted by an independent Qualified Measurement Professional; or
c. individuals specifically cited by local statutes or jurisdictional authorities to be exempt from requirements herein that call for a Qualified Measurement Professional.

11.2.4 ***Test Devices:*** Radon test devices employed shall be listed as approved by either the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB), or as required by the state where the measurement is being performed.

11.2.5 ***Test Protocols:*** All testing shall be conducted in accordance with the most current version of *"Protocol for Conducting Measurements of Radon and Radon Decay Products In Schools and Large Buildings"* ANSI/AARST MALB); in accordance with Section **11.2.3.1**; and, in accordance with any state protocols and requirements, where applicable.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

12.0 DOCUMENTATION AND LONG-TERM OPERATION, MAINTENANCE AND MONITORING PLANS

The potential risk from radon exists as long as a building is occupied. Therefore, mitigation systems represent an essential component for long-term risk management.

12.1 To provide tools essential for Client efforts in long-term risk management, the Contactor shall provide the Client(s) in writing, a final operations, maintenance and monitoring (OM&M) plan for the mitigation system(s) upon completion of the project. OM&M plans shall prominently include the following essential information that any client, property owner, occupant, or designated/responsible person needs to facilitate basic maintenance and risk monitoring that includes:

12.1.1 ***A recommendation to retest*** at least every 2 years and as further stipulated in the most current version of the *"Protocol for Conducting Radon and Radon Decay Product Measurements In Schools and Large Buildings"* ANSI/AARST MALB);

12.1.2 ***Fan Monitors:***

a) ***A description of the fan monitor(s) and a recommendation to check the monitor(s)*** at least quarterly or as otherwise specified in an operational and maintenance plan.

b) Documented startup parameters such as pressure gauge readings that existed at the time successful mitigation was initially achieved.

c) A list of actions for the Client(s) to take if the fan monitor indicates system degradation or failure;

12.1.3 ***A description of the mitigation system(s) as installed to include:***

a) Basic operating principles; and

b) System layout narrative or with system components labeled on a floor plan sketch such as may be complemented with photographic documentation;

12.1.4 ***A description*** of any important observations that might adversely affect the mitigation system(s) or other building systems and any deviations from this standard or state requirements;

12.1.5 ***A statement of limitations*** *the* Contractor places on professional obligations, future maintenance and monitoring of the mitigation system(s) effectiveness; and

12.1.6 ***Contact information*** for service inquiries and identification of the Qualified Mitigation Professional responsible for adherence to protocols to include:

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).

12.1.7 **Historical Information** shall also be provided to the Client either as provided in an information package that contains the OM&M plan or independently distributed, to include:

a) Pre-and post-mitigation test data if available;

b) Pre-and post-mitigation investigation summary;

c) Copies of contracts and warranties;

d) Any building permits required; and

e) An estimate of the annual operating costs.

12.2 For Systems Installed in an Individually Owned and Occupied Unit or Dwelling

12.2.1 The Contractor shall provide an information package labeled "Radon Mitigation Information" or similar wording that includes information and essential components of an OM&M plan in accordance with Section **12.1**. The information package should be securely attached to the system in a visible location or otherwise provided to the Client. If no portion of the system is installed in the livable space, the information package should be installed in an appropriate interior location such as the mechanical room.

12.2.1.1 When a non-ASD system is installed, additional OM&M components applicable to the mitigation method(s) shall be included with the information package in accordance with Section **12.1** and Table **12.4**.

12.3 Statement of Client Obligations Regarding Inadvertent Collateral Mitigation

When mitigation is not conducted in all attached units or dwellings in a shared building, the following statement shall be prominently included with the OM&M plan 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 standard MALB ("Protocol for Conducting Radon and Radon Decay Product Measurements In Schools and Large Buildings"), 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 homeowners association or management firm that provides stewardship for neighboring properties."*

See Figure **12.3** "Notice to Neighboring Property Owners and Occupants"

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Figure 12.3
(Letter or door delivered notice)

***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 your home for radon — it's easy and inexpensive. Testing all homes located below the third floor is recommended. For further guidance see federal publications such as the U.S. EPA's*

   "A Citizen's Guide to Radon"
   http://www.epa.gov/radon/pubs/citguide.html

   "A Radon Guide for Tenants"
   http://www.epa.gov/radon/pubs/tenants.html

2) *The radon reduction system installed or planned for installation in our dwelling can inadvertently move air and extend a vacuum under some adjoining units or dwellings with the intent to stop radon entry into our 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 (767-7236) and state radon offices that can be found at:* http://www.epa.gov/iaq/whereyoulive.html

12.4 **For Buildings in Which Systems Are Not Individually Maintained by the Individual Owner and Occupier of a Unit or Dwelling**

12.4.1 The Contractor shall provide the Client(s) an information package or system operations manual that includes components of the OM&M plan in accordance with Sections **12.1** and **12.3** as applicable, and additional components in accordance with Table **12.4**.

12.4.2 ***Statement of Client Obligations*** *(not owner-occupied):* To inform the Client regarding inherent obligations of the building owner and managers to maintain an OM&M plan, the following statement shall be prominently included with the plan:

"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.* ***The bare minimum requirements for long-term risk management are satisfied when building owners and managers****:*

1) *Perform maintenance inspections as stipulated in the operational and maintenance plan or at least quarterly for fan monitors, system components and any system controls to verify continued operation as designed.*

2) *Maintain equipment, any annotation on equipment and any instructions (including documentation for control settings that existed at the time successful reductions were initially achieved). Engage a qualified professional to inspect the components every 2 years.*

3) *Conduct a retest of mitigated areas at least every 2 years and retest all previously tested locations of the building up to the third floor level at least every 5 years. In addition, retest when any of the following occur:*

   - *A new addition is constructed or significant renovation occurs;*
   - *A ground contact area not previously tested is occupied;*
   - *Heating or cooling systems are significantly altered, resulting in changes to air pressures or distribution;*
   - *Ventilation is significantly altered by extensive weatherization, changes to mechanical systems or comparable procedures;*
   - *Significant openings to soil occur due to:*
     - *ground water or slab surface water control systems (e.g., sumps, perimeter drain tile, shower/tub retrofits, etc.); or*
     - *natural settlement causing major cracks to develop;*
   - *Earthquakes, construction blasting, or formation of sink holes nearby; or*
   - *An installed mitigation system is altered, modified or repaired.*

4) *Disclose the existence of the mitigation system and its purpose for protecting health and safety to current and future occupants or tenants. Best practice includes a publicly observable notice.*

5) *Disclose the OM&M plan and all known relevant history including this statement of inherent obligations to prospective purchasers of the property.*

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

12.4.2.1 *Inadvertent **C**ollateral Mitigation*
When mitigation is not conducted in all attached units or dwellings, a statement in accordance with Section **12.3** shall be prominently included with the OM&M plan.

12.4.2.2 *Pressurization or Dilution Methods*
A notice regarding additional testing is also required when mitigation methods include pressurization or dilution (as in Sections **10.2**, **10.3** and **10.5**). Where these mitigation methods have been employed, the OM&M Plan shall prominently include the following statement:

> *"The mitigation system includes pressurization or dilution of building air and requires additional testing. In locations where elevated radon concentrations were originally found, conduct post-mitigation or diagnostic radon testing during the first year subsequent to installation to verify if system capacity and control settings are effective under stressed or different seasonal conditions. To satisfy this requirement, conduct such testing at least once in the heating season (e.g., November to March) and once in the cooling season (e.g., May to August)."*

12.4.3 ***Record of Submittal:*** The Contractor should request the Client's signature verifying that the OM&M plan has been received and read by the Client. It is further recommended that the Contractor maintain records of such requests and disposition of any Client responses.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Table 12.4 Operation, Maintenance and Monitoring (OM&M)
(These steps can be integrated into an overall indoor air quality plan)

Controls and Mechanical System Monitors	Maintenance Inspections	Frequency of Inspection
12.1.3.1 ***Document Startup Details:*** A description shall be provided for the fan monitors, control settings and other operating parameters that existed at the time successful mitigation was initially achieved. The description should include explicit detail for comparison during inspections and repair, including: a) descriptions of equipment labeling and annotations for fan monitors, control settings and other operating parameters; b) exact locations of fan monitors, electronic telemetry/monitoring equipment for system performance, electrical disconnects and other components; c) instructions for equipment sufficient to interpret labels, annotations and the designed operating parameters for the equipment. When applicable, include manufacturer instructions; d) a list of appropriate actions for the Client(s) to take if fan monitor devices or other inspection procedures indicate the system(s) are not operating as designed; and e) documented measurements for balance of airflow in and airflow out of HVAC system(s) when HVAC is a component of a mitigation system.	The OM&M plan provided shall observe that routine inspections of controls and monitors are a minimum obligation and required component of a long-term risk management plan. The following inspections shall be written into the OM&M plan as required actions: a) inspection of fan monitors, control settings and other operating parameters to ensure the system(s) are operating as designed; b) investigation and correction of any conditions that are found to indicate component failure or inconsistencies with designed operating parameters for the system(s); c) maintenance of records assimilated into the overall building OM&M documentation; and d) The plan shall stipulate that a qualified professional should perform these inspections and if performed by in house maintenance staff, such staff shall be trained in system operations.	The plan shall stipulate recommendations and any requirements for the frequency of inspections, as deemed by the contractor as appropriate to the situation. It is recommended that the plan stipulate inspections be conducted at least quarterly of all fan monitors, controls, and as applicable, filters and vent openings. The plan should also recommend inspections subsequent to: a) system shutdown due to building power failure or emergency; and b) any catastrophic event that could damage system components.
Mechanical Equipment	**Mechanical Equipment Inspections**	**Frequency of Inspection**
12.1.3.2 ***Include Equipment Details and Instructions:*** a) Include manufacturer instructions and instructions specific to design configurations, as appropriate; b) Documentation should include exact locations of fans, electrical disconnects and other components; and c) Include a list of appropriate actions for the Client(s) to take if the fan monitor warning device indicates system degradation or failure. A list of potential repair items for ASD systems should include: i. fan monitor repair or replacement (e.g. reconnect or replace oil in U tube); ii. electrical repair; iii. fan or boot replacement; and iv. sealing of foundation openings to soil or piping connections.	The OM&M plan provided shall observe that mechanical equipment inspections should include all seals, straps, fasteners, electrical system (including switch operation), boots, performance indicators, labels, pipe condition, filters, inlet grills and fan operation. If applicable, airflow in and airflow out of HVAC system(s) and duct balance should be checked to ensure that no significant changes have occurred. Examples of HVAC inspection items: i. functionality of HVAC filters; ii. room differential pressure test; iii. fresh-air damper settings; and iv. verification for supply air into rooms of interest.	The plan shall stipulate that a detailed inspection of all components is to be conducted every 2 years by a qualified professional.

12.1.3.3 **Monitor Radon Concentrations - Retests**	**Frequency of Retests**
Continued follow-up verification for mitigated areas:	*A retest of mitigated areas shall be conducted at least every 2 years*
Continued follow-up verification for the building:	*A retest of the building shall be conducted at least every 5 years*
See ANSI/AARST **MALB** *"Protocol for Conducting Measurements of Radon and Radon Decay Products In Schools and Large Buildings"*	

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

12.5 **Review With Client(s):** After installation(s), Contractors shall offer to provide an educational review of the mitigation system(s) to the Client. The review should include operating principles of the system(s), operation and maintenance of the systems(s) and all other components of the OM&M plan.

12.6 **Retention of Records**

12.6.1 ***Records of all mitigation work*** performed shall be kept for at least 3 years or as long as state regulations require or for the period of any warranty or guarantee, whichever is longer.

12.6.2 ***Other Records*** or bookkeeping required by local, state or federal statutes and regulations shall be maintained for the period(s) prescribed by those requirements.

12.6.3 ***Health and safety records***, including Mitigation Installer radon exposure logs, should be maintained for a minimum of 20 years or as long as state regulations require.

13.0 HEALTH AND SAFETY

Although this document contains specific safety recommendations, it cannot address all of the safety concerns associated with mitigation installations. The user has responsibility for establishing appropriate safety practices.

13.1 **Mitigation Installer Health and Safety:** Federal, state and local standards or regulations relating to Mitigation Installer safety and health, including occupational radon exposure, shall be complied with. References for some applicable publications from OSHA and the National Institute for Occupational Safety and Health (NIOSH) are provided at the close of this document in "Referenced Publications". In addition, the following requirements that are specifically or uniquely applicable for the safety and protection of radon Mitigation Installers shall be met:

13.1.1 ***All Mitigation Installers shall be advised*** of the hazards of exposure to radon and the need to apply protective measures when working in areas of elevated radon concentrations.

13.1.2 ***Each Mitigation Installer's exposure to radon*** or radon decay products at each work site shall be recorded and maintained in a manner as required by jurisdictions of authority. For calculating exposure estimates: Working Level Month (WLM) calculations shall be based upon the Mitigation Installer's exposure hours times radon measurements divided by 200 (or the radon decay product measurements), divided by 170. Calculations for pCi/L/day shall be based on the Mitigation Installer's exposure hours, divided by 24. These calculations shall apply to one of the following radon or radon decay product measurements for the Mitigation Installer's exposure at each work site:

a. The highest pre-mitigation indoor radon measurements or radon decay product measurements.

b. Actual jobsite measurements of radon or radon decay products.

c. The measurements from a radon dosimeter such as an alpha track or comparable device consistently worn at the job site by a Mitigation Installer. The radon dosimeter shall be stored in a low radon environment during nonworking hours, and thereby all exposure to the radon detector is assumed to be the Mitigation Installer's exposure.

13.1.3 ***A Mitigation Installer's Exposure*** shall be limited to less than 5700 pCi/L/days or 4 working level months (WLM) over any 12-month period. An equilibrium ratio of 100 percent shall be used to convert radon levels to radon decay product levels. Practices shall be arranged to keep Mitigation Installers' WLM or pCi/L/day exposure as low as can be reasonably achieved.

13.1.4 ***A Mitigation Installer protection plan*** shall be maintained. Where applicable, the Mitigation Installer protection plan shall be approved by any state or local regulating agencies that require such a plan. The plan shall be available to all Mitigation Installers and be reviewed with each Mitigation Installer at least once a year. Confirmation of a Mitigation Installer's knowledge of the Mitigation Installer protection plan should be recorded with the Mitigation Installer's signature and date. Review of the Mitigation Installer protection plan should include: safe use of all job site equipment including safe practices when using ladders or scaffolding; safe procedures for crawl space work and avoidance of job site hazards; and discussion of hantavirus symptoms. Hazards and protective response by Mitigation Installers should be identified for: hantavirus symptoms; suspected contaminants in soil; or accidents including those that can occur when handling caustic solvents and bonding chemicals.

13.1.4.1 Appropriate safety equipment shall be available on the job site such as hard hats, eye protection, hearing protection, respiratory protection, steel-toe boots and protective gloves during cutting, drilling, grinding, coring or other activities.

13.1.4.2 In any planned work area where it is suspected contaminants such as asbestos, lead paint, mold or other toxins may 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.

13.1.4.3 Each Mitigation Installer shall be provided with the applicable Material Safety Data Sheets (MSDS) for all hazardous materials used and be informed of the safety procedures required for each.

13.1.4.4 Work areas shall be ventilated when practical to reduce a Mitigation Installer's exposure to radon, radon decay products, dust or other airborne pollutants.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

13.2 General Safety Precautions (mitigation installers and other unsuspecting workers and occupants)

13.2.1 ***Job Site Hazards:*** The Contractor should take precautions to protect from jobsite hazards. Where appropriate, the Contractor should post or provide notices, restrict access to job site areas or cease work until safe conditions can be secured. Where appropriate, the Contractor should ventilate areas to reduce exposure to elevated radon concentrations, sealant vapors or other airborne hazards.

13.2.1.1 A review of existing documents and action plans regarding hazardous conditions should be conducted prior to diagnostics or initiation of an installation.

13.2.1.2 Jobsite hazards encountered during the design and mitigation process and appropriate actions can include:

a) Prior to diagnostics or during installation, it is sometimes appropriate that utility line locations be identified in the immediate areas where drilling through slabs will occur. Care should be taken to recognize that design drawings do not always represent actual installations or retrofit installations;
b) When concerns arise for contaminants prior to or during installations such as for chemical or waste pollutants in soil, the Contractor should request confirmation testing or removal of such contaminants; and
c) When confined areas are determined to be hazardous working environments, the contractor should seek safe alternatives. Such alternatives could include altering system(s) design or creating safe means of egress to the confined area.

13.2.2 ***Flue Gas Spillage From Combustion Appliances:*** Altering pressure in the building, directly or indirectly, may cause flue gas spillage. Clients and impacted residents shall be advised of any significant flue gas spillage that is observed. 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 shall be advised to contact an HVAC Contractor or other qualified person to evaluate and correct any significant flue gas spillage condition as well as to verify proper appliance installation and performance. In addition, the Client should be directed to sources of additional information such as those found at:

- **http://www.epa.gov/iaq/homes/hip-combustion.html**
- **Appendix D of the International Fuel and Gas Code** (as published by the International Code Council).

13.2.3 ***Asbestos:*** 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 and floor tiles. In any planned work area where it is suspected that asbestos may exist and be disturbed, work shall not be conducted until a properly certified asbestos inspector determines that such work will be undertaken in a manner that complies with applicable asbestos regulations. For more information, see a reference such as: **http://www.epa.gov/asbestos**

Care should be taken to recognize that asbestos management plans drawings, if even in existence, do not always specify the location of asbestos and previously hidden asbestos-containing materials can be exposed during construction.

13.2.4 ***Lead-Based Paint:*** Common renovation activities such as sanding, cutting and demolition can create hazardous lead dust and chips by disturbing lead-based paint, which can be harmful to adults and children. Any activity that disturbs paint in pre-1978 housing is subject to the Lead Renovation, Repair and Painting (RRP) rule issued by the EPA on April 22, 2008. EPA has established the Lead-Safe Certification Program for contractors in response to this concern. For more information, see a reference such as:
http://www.epa.gov/getleadsafe

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). Information is available at HUD's Office of Healthy Homes and Lead Hazard Control **www.hud.gov**

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

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."

14.1 **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).

14.2 **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.

14.3 **Becquerel per Cubic Meter (Bq/m3):** A unit of measure for the amount of radioactivity in one cubic meter of air. CONVERSION: 1 Bq/m3 equals 0.027 picoCuries per liter (pCi/L).

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

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

14.6 **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.

14.7 **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.

14.8 **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).

14.9 **Depressurization:** A negative pressure induced in one area relative to another.

14.10 **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).

14.11 **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 the "Protocol for Conducting Radon and Radon Decay Product Measurements In Schools and Large Buildings (ANSI/AARST MALB)."

14.12 **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.

14.13 **Feet per Minute (FPM):** A measure of the velocity rate of a fluid, such as air. CONVERSION: 1 fpm = 0.3048 meters per minute (m0.3/min).

14.14 **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.

14.15 **High-Rise Building:** A building that is 75 feet (23 m) or higher.

14.16 **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.

14.17 **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.

14.18 **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.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

14.19 **Intentional Collateral Mitigation**: ASD system(s) intentionally designed to reduce radon concentrations in multiple dwellings that have each been identified by testing to indicate radon concentrations that exceed acceptable limits.

14.20 **Jurisdictional Authorities:** Governing authorities that regulate specific installation requirements or manner of activities will normally include a combination of authoritative bodies as a result 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 statues. In some cases, tribal or international laws or treaties result in an authority that holds jurisdiction over certain activities.

14.21 **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).

14.22 **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.

14.23 **Mitigation System:** Any system or steps designed to reduce radon concentrations or other pollutants in the indoor air of a building.

14.24 **Nontransient:** Occupancy of more than 31 days.

14.25 **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. See "*Significantly occupied*".

14.26 **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*"

14.27 **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*".

14.28 **Picocurie per Liter (pCi/L):** A unit of concentration of radioactivity corresponding to 0.037 decays per second or 2.22 decays per minute in a liter of air or water. 1 pCi/L = 37 becquerels per cubic meter (Bq/m^3).

14.29 **Point of Discharge:** The physical location of piping or duct material at which an ASD system exhausts soil air.

14.30 **Pressure Field Extension:** 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.

14.31 **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.

14.32 **Pressure Field Extension 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 volumes required to achieve a consistent vacuum across the area observed for Pressure Field Extension.

14.33 **Pressurization:** A positive pressure induced in one area relative to another.

14.29 Qualified Mitigation Professional: For the purpose of this document, an individual who has demonstrated a minimum degree of appropriate technical knowledge and skills specific to radon mitigation in schools and large buildings: a) as established in certification requirements of the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB); and, b) as required by statute, state licensure or certification program, where applicable.

14.30 Qualified Measurement Professional: For the purpose of this document, an individual who has demonstrated a minimum degree of appropriate technical knowledge and skills specific to radon measurement of schools and large buildings: a) as established in certification requirements of the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB); and, b) as required by statute, state licensure or certification program, where applicable.

14.34 **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)

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

14.35 **Radon-Resistant Drain:** A mechanism or drain that has a check valve to provide closure by way of gravity or other means of closure in order to minimize air flow if the drain trap dries up, or a trapped drain that has an automatic supply of priming water.

14.36 **Re-Entrainment:** The unintended re-entry into a building of radon that is being exhausted by a radon mitigation system.

14.37 **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 have been sealed. Sealing is conducted in a manner to facilitate reducing the amount of radon entering occupiable spaces, primarily by manipulating air pressure and dilution characteristics within or from outside the sealed isolation assembly. Sealed isolation assemblies are sometimes employed to prevent pressure changes induced by a radon mitigation system from adversely affecting combustion appliances located in an adjoining airspace. Sealed isolation assemblies typically include: sealants or gaskets on hatches or doors; sealed partition walls, floors or ceilings; and other configurations that might resist air migration across a partition or any component of the isolation assembly. **Setback:** See HVAC Setback.

14.38 **Setback:** See HVAC Setback.

14.39 **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*".

14.40 **Soil Gas Collection Plenum:** A 3-dimensional enclosure, in whatever shape it may be, for collecting radon and other soil gases from under slabs, soil gas retarders and from behind walls, that surrounds a void or gas permeable layer. This description of the cavity under a foundation observes that there are at least six sides to this enclosed airspace and that none are perfectly sealed, especially at the side facing soil.

14.41 **Suction Pit:** Space that exists or is created below the suction pipe.

14.42 **Suction Point:** Location at which suction piping is routed through the slab, foundation, membrane, drain tile or sump cover.

14.43 **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.

14.45 **Townhouse:** A single family dwelling unit (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.

14.46 **Unique Sector of a building:** Portions of a common building that are classified by applying both of the following criteria: 1) Identify the original structure from those portions of the building added since original construction, and each structurally isolated airspace within ground contact areas the building, and; 2) Identify for ground contact areas the general design and intended purpose of each active component of heating, cooling and ventilation systems (HVAC).

14.47 **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 or public purposes.

14.48 **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).

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Appendix A

Guidance for property owners

Guidance to facilitate Contractor requirements. These steps can often reduce costs while also achieving reliable proposals.	
4.1 **Existing Radon Measurements** 6.1.2 **Create Diagrams**	***Prepare to provide:*** All test reports and at least one floor plan diagram that is annotated with the location and results of all available radon measurements for the common building structure(s) or portion of the building(s) to be mitigated. The floor plan diagram or series of diagrams should illustrate the building foundation including slab-on-grade, basement and crawlspace areas
4.2 **Building Specifications**	***Prepare to provide:*** Any available information on the building (e.g., construction specifications) that might be of value in determining the mitigation strategy
4.3 **Known Hazards**	***Prepare to provide:*** All information regarding known safety hazards for the building and adjacent or nearby buildings that might be related to design and installation of the mitigation systems. Information of concern, among others, includes for programs and regulations related to asbestos, lead paint or other hazards.
6.1 **NONDESTRUCTIVE INVESTIGATION** 6.1.1 **Document Review** 6.1.3 **Visual inspection**	***Prepare to provide:*** Construction drawings, specifications and other information regarding the building that might be of value in determining the mitigation strategy. ***Prepare to provide:*** Access for visual inspections.
6.2 **DIAGNOSTIC INVESTIGATION**	***Prepare to provide:*** Access and funding for diagnostic procedures as appropriate for effective system design. Procedures recommended or chosen will depend upon the level of complexity for identifying or characterizing conditions under, beside and within buildings to adequately project the effects of various system designs.
4.4 **Communication Plan – Coordination** 4.5 **Access Notices Required**	***Prepare to provide:*** Coordination with Contractor and staff members (i.e. senior staff, appropriate communications staff and maintenance staff) to develop the communication plan • Develop notices (with instructions, general information, health advisories and who to contact for inquiries) that may be specific for each affected audience, including facilitating staff such as maintenance managers and supervisors, and occupants. • Develop timetables and means for distribution of notices. • Specify which management staff member is responsible for on-site activities. • Specify the structure of additional communication paths between senior staff, facilitating staff, maintenance staff and the professional radon service provider(s). • Identify who is granted permission to respond to public inquiries and their contact information

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Appendix B

Guidance when considering non-ASD methods:

ASD and Non-ASD methods
When elevated radon concentrations are found, assemble a team of qualified professionals that includes an experienced mitigation professional. (See Section 3.2.1 for a "Qualified Mitigation Professional.") **Keep in mind:** ➢ **Aggressive source control** for contaminants is a critical component in managing indoor air quality as in the examples of hazardous chemicals or microbial and bacterial contamination. ➢ **ASD is a source control method for radon and other soil air contaminants.** Therefore compared to other mitigation methods, ASD will typically demonstrate far greater effectiveness in reducing indoor radon concentrations and of other soil air contaminants. Additionally: ASD provides significant benefits compared to other mitigation methods that include energy conservation and ease of maintenance so critical in maintaining a Long-Term Risk Management Plan. ➢ **Limitations of Non-ASD methods:** Dilution alone is unlikely to be a practical solution if radon concentrations are high. For instance, unless the unit's walls and floors are constructed or rendered to be a complete sealed isolation assembly, other mitigation methods beyond air mixing or additions of outdoor air will most often be needed if initial radon concentrations are above 10 pCi/L. The effects of pressurizing a building or individual airspace can be more pronounced yet each of these methods require rigorous diagnostic evaluations, inspections and maintenance for continued safety of occupants. o See Exhibits **C,** Exhibit Table **C-3** and Exhibit Table **C-4** to gain a sense of complexity associated with HVAC maintenance that needs to be rigorously applied in order to expect long-term success in risk reductions. o Exhibit Table **C-4** also provides a sense of design parameters required for successful mitigation including certain failures in design if not accounted for. o See Section **10** and Section **12** for requirements of Non-ASD methods. These provisions seek to secure the continued safety of occupants.
Radon Mitigation recommendation if radon reductions appear to result from incidental HVAC repairs or augmentation: Apply all requirements in Section **12** for "Long-Term Operation, Maintenance and Monitoring". Such plans help ensure long-term benefits by means of labeling equipment and a routine inspection program. Important overview: Industry experience has been that all benefits are easily defeated when systems and controls, so volatile to unintended alteration, are not inspected regularly.
Overall Indoor Air Quality: The presence of elevated radon gas concentrations can sometimes be an indicator of other indoor air quality concerns. Regardless of radon activities, HVAC systems should be maintained with regular inspections and repairs in a manner to ensure healthy indoor air quality. For further guidance: Information that inherently addresses indoor air quality issues relative to most large buildings can be found at EPA. (See **http://www.epa.gov/iaq/schools.)** EPA's "*Tools For Schools Action Kit*" provides comprehensive tools for evaluation of ventilation systems under the Section for "Ventilation Checklist" and related "*backgrounder*" document. (See **http://www.epa.gov/iaq/schools/actionkit.html**). Occupant symptoms that might guide or trigger an evaluation of indoor air quality and HVAC are described in EPA's "*Problem Solving Tool*". (See **http://www.epa.gov/iaq/schools/problem_solving_tool.html**.) Additional guidance can be found in "***Indoor Air Quality Guide – Best Practices for Design Construction and Commissioning***" published by ASHRAE (**www.ashrae.org**).

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Appendix C

Quality Management Systems for Mitigation Professionals

Background: All radon mitigation professionals should establish, document, implement and maintain a Quality Management System (QMS) and continually improve its effectiveness. Be it a single person company, a large firm or when business relationships exist between multiple entities, quality management can be critical to both the financial bottom line and the health and well-being of the customer. For those with growing companies, the larger the volume of work and the more complex the projects are, the more valuable the QMS becomes.

This document seeks to introduce the fundamentals of a QMS in a manner consistent the ISO 9001 (the international standard for Quality Management Systems).

Portrayed in the most basic and simple terms, a QMS entails:

1) Establishing a Quality Manual (e.g. Quality Assurance Plan).

   a) The plan begins by defining
      i) Minimum quality for the system installation and installation process
      ii) The quality objective (e.g. enhanced safety for the building occupants)

   b) The plan is then rendered to document processes and procedures aimed at meeting those goals

2) Monitoring and managing the results from work performed (e.g. Quality Control).

A QMS consistently compares input information (e.g. the quality policy) to output results (e.g. successes and failures in meeting quality goals).

For systems designs, input information includes a host of details such as standards, codes, customer satisfaction, worker safety and each building's design. Once the installation is complete, comparing the outputs resulting from the system (i.e. retest results, standards compliance and customer satisfaction) is critical for evaluating both success and corrections that are needed.

More specifically:

(From ISO 9001, Section 4.1 "General Requirements" for processes managed by the organization including when an organization chooses to outsource activities)

a) determine the processes needed for the QMS and their application throughout the organization
b) determine the sequence and interaction of these processes,
c) determine criteria and methods needed to ensure that both the operation and control of these processes are effective,
d) ensure the availability of resources and information necessary to support the operation and monitoring of these processes,
e) monitor, measure where applicable, and analyze these processes, and
f) implement actions necessary to achieve planned results and continual improvement of these processes.

Consistency with ISO 9001:2008 ***"Quality management systems"***	**Quality Management Systems (QMS) for Mitigation Professionals**
• 1.0 Scope; 1.1 General; • 4.1 "General Requirements" • 5.0 Top Management; 5.4 Planning; 5.4.1 Quality objectives: "Quality objectives shall be measurable and consistent with the quality policy" (e.g. System Installation Quality).	**A QMS begins with two written policy statements on quality.** *The following statements are examples that are consistent with ISO 9001:* **1) System Installation Quality:** Mitigation systems that are in compliance with standards, codes and statutes while also, to the extent practicable, achieving customer satisfaction. In addition, all related activities are conducted in a safe manner for both workers and occupants. **2) System Quality Objectives:** Mitigation systems that will result, at a minimum, in reducing concentrations to below the target action level and, to the extent practicable, as low as reasonably achievable. In addition, the resulting systems will otherwise not jeopardize the health and safety of occupants or the public.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

4.0 Quality management systems	**Summary Of The Quality Plan & Control**
4.2.1 Documented procedures	• Procedures (each juncture that may warrant written procedures). *Normally each important stage of installation would be broken out with a process or procedure that matched the quality goals.*
	• Interaction between the processes; and • Control of documents and records (to include approvals, reviews, updates, distribution and storage.
	At a minimum, procedures should include recording conditions found and resulting "as installed" condition or configuration for: • Each ASD suction point (See Section **7.1**); • ASD Pipe materials (See Section **7.2**); • ASD Pipe sizing (See Section **7.3**); • ASD Exhaust Discharge (See Section **7.4**); • ASD Fan and model installed (See Section **7.5**); • Sealing (Sections **8.1**-**8.4**), Sump (Section **8.5**), Membranes (Section 8.6), Drains (Section **8.7**), and Sealed Assemblies (Section **8.8**); • Fan Monitors (See Section **9.2**); • Electrical (See Section **9.3**); • Labeling (See Section **9.4**); • Non-ASD Methods - *in detail* (See Section **10.0**); • Post install functional inspection (See Section **11.1**); • Post mitigation retests (See Section **11.2**); • Long-Term OM&M Plans - *in detail* (See Section **12**); • Health and Safety - *in detail* (See Section **13**);
5.0 "Management Responsibility" (Top Management Personnel) *5.1 Management commitment*	Develop and implement a quality management system and continually improving its effectiveness by • communicating to the organization, • conducting reviews, and • ensuring the availability of resources.
5.2 Customer focus	Ensure that customer requirements are determined and are met.
5.3 Quality policy	Ensure that the quality policy is: appropriate; includes commitment to comply and continually improve; and is communicated and understood within the organization.
5.4 Planning	Ensure that the planning of the QMS is carried out and its integrity is maintained.
5.5 Responsibility, authority and communication	Ensure responsibilities and authorities are defined and communicated within the organization. *This effectively requires that all top management personnel and any key personal are identified in the plan.*
5.5 Management review	Review the quality management system, at planned intervals, to ensure its continuing suitability, adequacy and effectiveness.
6.0 Resource management; *6.2 "Human Resources"*	Personnel performing work shall be competent on the basis of appropriate education, training, skills and experience.
6.3 "Infrastructure"	For equipment, materials and support services needed to achieve quality.
7.0, *7.3 1 Design planning:*	The organization shall plan and control the design and development.
7.3.2 Design Input	Standards, codes, customer and site-specific needs.
7.3.3 Verifiable Design Outputs	1) Compliant to standards, codes and consumer satisfaction; 2) Objectives for health protection.
7.3.4 Design review:	Participants to include representatives of functions concerned with the design and development stage(s) being reviewed.
7.3.4 Design validation:	*Compare input needs to expected outputs*. Is the system is capable of meeting the quality objectives?
7.4.3 Verification of installation	Inspection to ensure the installed configuration meets quality requirements.
8.0 Analysis and improvement *8.2.3 Monitoring*	Apply suitable methods for monitoring and, where applicable, measurement of the effectiveness of QMS processes. *Compare plan inputs to the resulting output.*
8.3 Control of failed quality	Take action appropriate to the effects, or potential effects, of the failure.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Appendix D

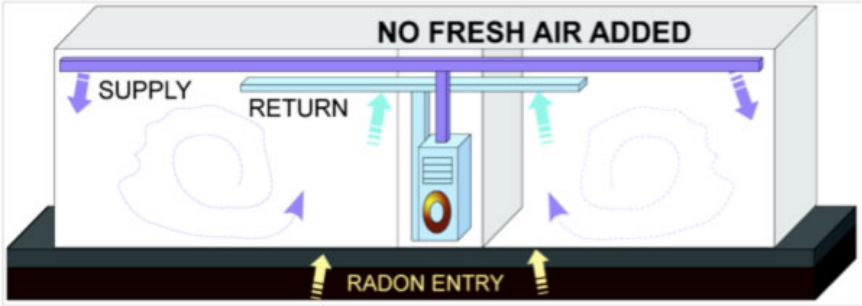
Heating, Cooling and Ventilation Systems

Group 1: Basic Heating and Cooling:

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

HAC Systems:

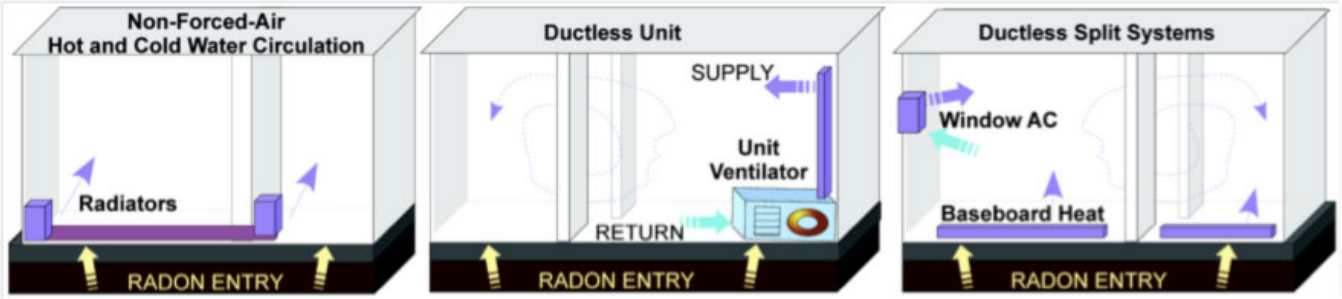
Many schools and large buildings have forced-air heating and air conditioning (HAC) systems for each room or area. These are systems that might be commonly seen in single-family residences that do not supply additional fresh air for ventilation.



Ductless Systems:

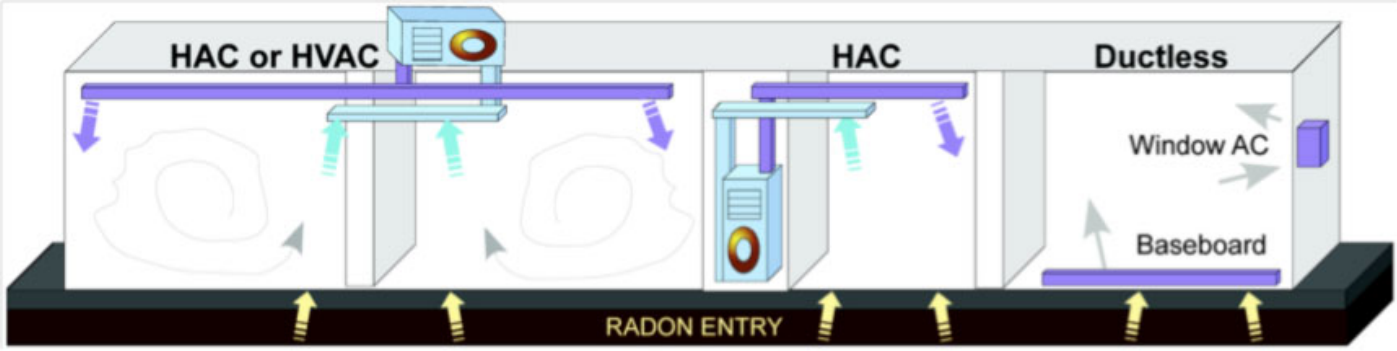
Some schools and large buildings have rooms or areas where systems do not have forced-air ducted distribution.

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



Group 2: Multi-zone systems:

Multi-zone systems are those where different air handlers or systems are employed and independently controlled for different areas within the same room or portions of a building. Such configurations may have been designed originally or added due to modifications of a building or use of an area. Radon concentrations can vary widely room to room based upon variances in system operations.

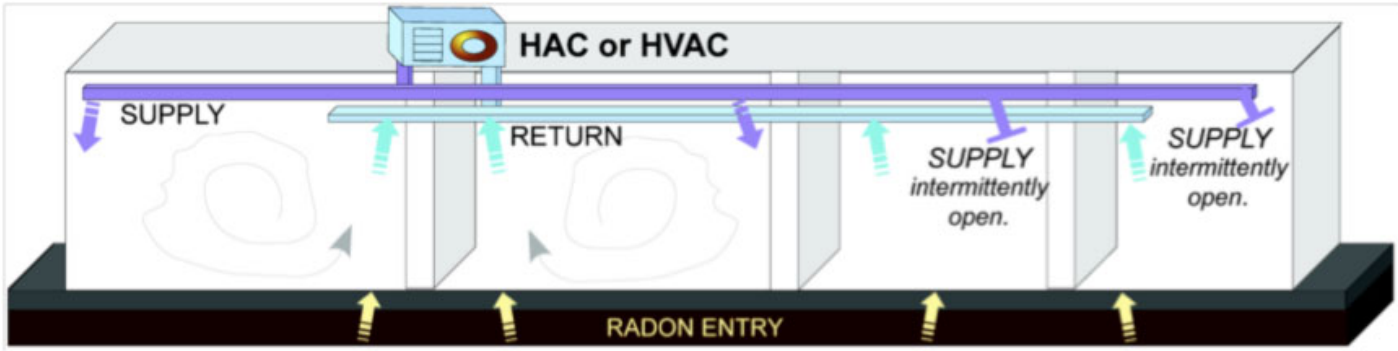


This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Group 3-a: Variable Air Distribution:

The normal operation of these systems can cause changes in distribution of radon or ventilation air and can also affect pressure relationships that can enhance or diminish radon entry. Depending upon the open or closed operating conditions for supply vents and returns vents, radon concentrations can vary widely from test to test (or room to room).

Variable Air Distribution:
Systems where the airflow from a single air handler is distributed to multiple rooms or locations with independent controls within each room for duct dampering. Such systems include Variable Air Volume (VAV) systems or systems with fixed volume return vents in each room and controls for dampering supply air.



Group 3b: Variable Outdoor Air Ventilation:

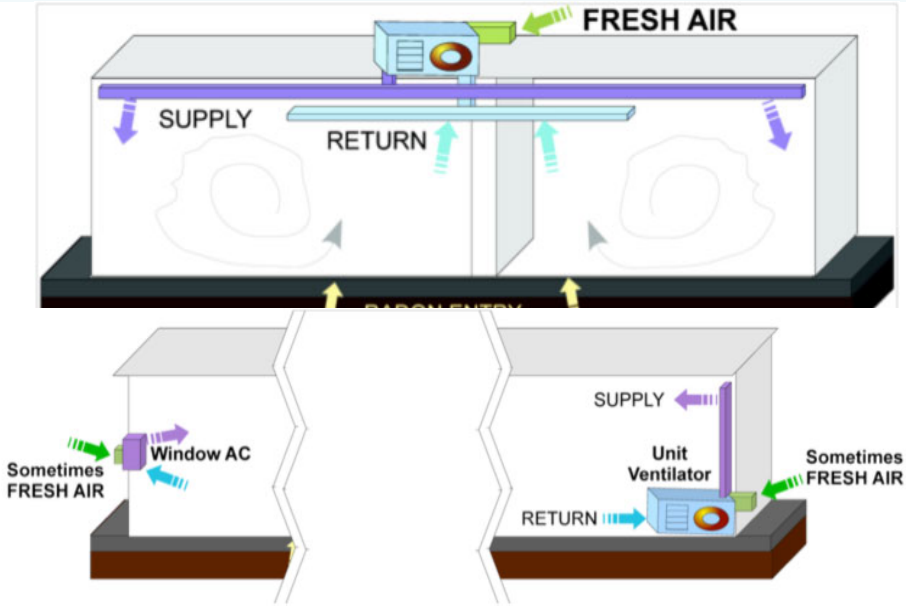
The normal operation of these systems can cause varying changes in fresh air ventilation that can dilute radon concentrations and also affect pressure relationships that can enhance or diminish radon entry. Depending upon the extent of open or closed intake dampers for outdoor air, radon concentrations can vary widely from test to test or room to room.

Outdoor Air Ventilation (HVAC):

Some schools and large buildings have heating, ventilating and air conditioning (HVAC) systems that add fresh air ventilation to the building.

Such systems may exist for service to a whole building, multiple rooms or as single unit ventilators.

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

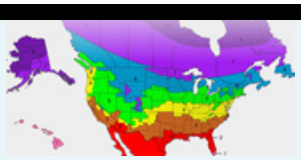


This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

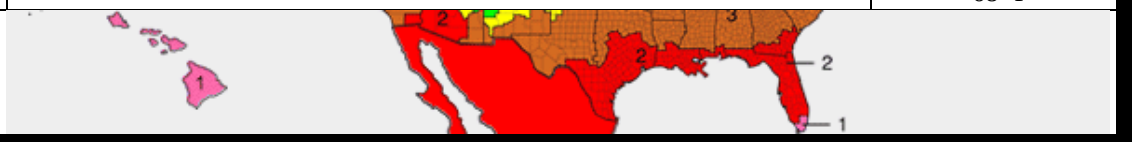
Appendix E

Identifying the normal average operating condition for the building

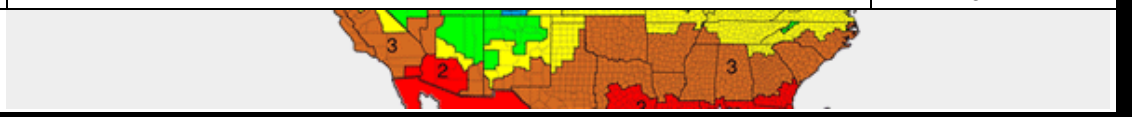
TEMPERATURE ZONES
as designated by ASHREA (The American Society of Heating, Refrigerating and Air-Conditioning Engineers)
https://www.ashrae.org



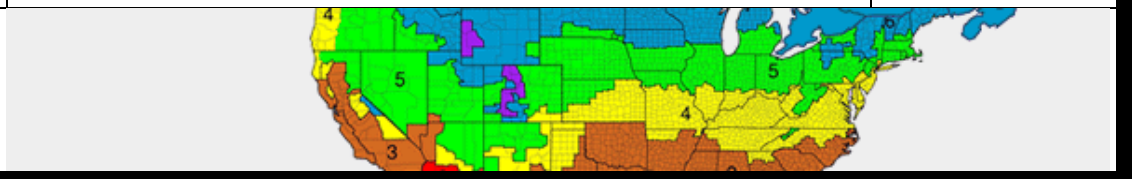
Climate Zone	Example North American States or Cities	Average Annual Temperature
1 Very Hot	Southern Florida and Hawaii	Miami 76˚ F
2 Hot	Florida, New Orleans, Houston, Mexico	New Orleans 68˚ F



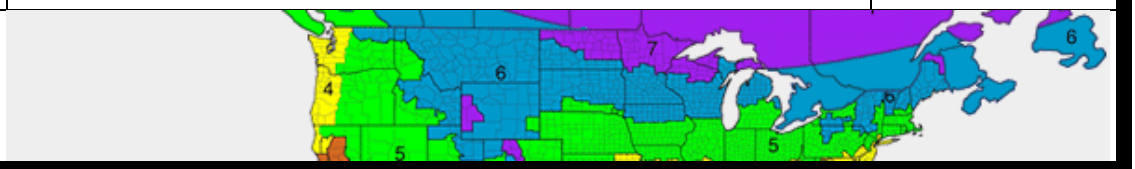
3 Warm	North Carolina to Southern California	Atlanta 61˚ F



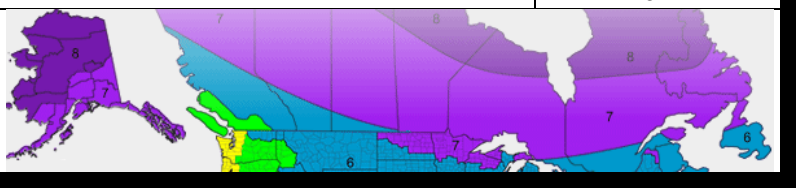
4 Mixed	NYC, NJ, PA, VA, KT, TN KS, MO, Seattle WA, and Portland OR.	Kansas City 54˚
5 Cool	MA, NY, OH, MI, IN, IL, IA, NE, CO, UT and NV.	Chicago 49˚ F



6 Cold	ME, NH, VT, WI, MN, ND, WY, SD and ND.	Montreal 43˚ F



7 Very Cold	Minot, ND; Anchorage, AK; Winnipeg, Canada	Winnipeg 36˚ F
8 Subarctic	Fairbanks Alaska; Cambridge Bay, Canada	Fairbanks 26 ˚ F



Note:

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

The following methodology is intended to be simplistic yet reasonable for use. Other methodologies can include identifying exact control settings for each system or more precise calculations for outdoor temperatures (i.e. extrapolations in terms of degree day calculations). Such methods might provide precision evaluations yet can be overly exhaustive in terms of the needs and purpose.

Steps to identify the normal average operating condition for the building for initial or follow-up radon tests; diagnostic tests; and post-mitigation tests.

1)	**Know The Average Occupied Indoor Temperature:** 74˚ F (23˚ C). Due to required comfort for occupants, the average indoor temperature is usually maintained with stability between 68˚ to 82˚ F (20˚ to 28˚ C). Use an average of about 74˚ F (23˚ C) during estimations unless known to be specifically different. HVAC systems are set to respond to needs for maintaining this comfort range during significantly occupied periods.
2)	**Identify The Average Local Outdoor Temperatures During Significantly Occupied Months.** HVAC systems respond to changes in outdoor temperatures by activating heating, cooling and ventilation air handlers including certain designs that introduce outdoor air ventilation into a building.
3)	**Identify Periods When Heating and Cooling Systems Activate.**

Heating Systems:	In response to needs for indoor comfort: Heating systems will often activate when outdoor temperatures drop to below about 65° F (18˚ C).
Cooling Systems:	In response to needs for indoor comfort: Cooling systems will normally be active when outdoor temperatures exceed about 75° F (28˚ C).

Examples of Heating and Cooling Activity

24 Hour Averages

> 75˚F Cooling
66˚ - 75˚ F Intermittent
< 65˚F Heat

24 Hour Temp Averages

ZONE		Annual Avg	9 mo School Avg	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1 Very Hot	Miami, FL	76	74	82	79	74	69	68	69	72	75	79	82	83	83
2 Hot	New Orleans, LA	69	64	79	70	61	55	52	55	62	69	76	81	82	82
3 Warm	Atlanta, GA	62	56	73	63	53	45	43	46	53	62	70	77	79	79
4 Mixed	Phillidelpia, PA	55	48	68	57	47	36	32	34	42	53	63	72	77	76
5 Cool	Chicago, IL	49	42	65	53	40	27	22	26	37	49	59	69	74	72
6 Cold	Minneapolis, MN	45	37	61	50	33	19	13	18	31	46	59	68	73	71
7-Very cold	Minot, ND	39	30	56	45	26	14	6	11	21	41	53	61	68	67
8 SubArctic	Fairbanks, AK	27	17	45	25	4	-6	-8	-2	11	31	49	60	62	57
8 SubArctic	Cambridge Bay	6	-6	32	11	-9	-21	-27	-27	-22	-7	15	36	47	44

Daytime Only Averages

Daytime Temp Averages

ZONE		Annual Avg	9 mo School Avg	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1 Very Hot	Miami, FL	80	78	85	82	77	73	72	73	76	79	83	85	86	87
2 Hot	New Orleans, LA	73	69	83	75	66	60	57	60	67	74	80	85	87	86
3 Warm	Atlanta, GA	67	61	78	68	58	50	48	51	59	68	75	82	84	84
4 Mixed	Phillidelpia, PA	59	52	73	62	51	40	36	38	47	58	68	77	82	81
5 Cool	Chicago, IL	54	46	70	58	44	31	26	30	41	54	65	75	79	77
6 Cold	Minneapolis, MN	50	41	66	55	37	23	17	23	35	51	64	73	78	76
7-Very cold	Minot, ND	45	36	63	51	31	19	11	16	26	47	59	67	75	74
8 SubArctic	Fairbanks, AK	32	21	50	29	8	-3	-4	3	18	37	55	65	67	62
8 SubArctic	Cambridge Bay	9	-3	33	14	-6	-18	-24	-24	-18	-2	19	39	51	46

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

4) Identify When Outdoor Air Ventilation Systems Activate.

HVAC Economizer Systems are often designed to provide outdoor air to a building or airspace for both health benefits and to economize on energy expenses. Economizer systems vary the amounts of cool outdoor air supplied to the building to assist with the cooling load of the room or rooms. Some systems are set to introduce a minimum volume of outdoor air during virtually all occupied periods.

Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV) provide health benefits of introducing outdoor air to a building while saving energy as compared to energy consumption for delivering untempered outside air into a building.

Low outdoor temperature limits:	**35˚to 42˚ F (1.6 to 5.5 C)** Dampers that allow outdoor air to be brought into a building will, depending upon the system's design, completely close or activate to minimum open damper setting when outdoor temperatures fall below about 35˚-42˚ F (1.6 to 5.5 C). This feature is often required to protect water coils, filters and other components within HVAC units from the cold.
High outdoor temperature limits:	**65° F (18˚ C)** Dampers also often close or return to a minimum open damper setting when outdoor temperatures reach about 65° F (18˚ C) and no longer provide energy savings and comfort benefits.
High outdoor humidity limits:	**Comfort Limits** Some systems will also close dampers or return to a minimum open damper setting when outdoor humidity brought into a building causes discomfort.

Exhaust Systems are sometimes configured to induce cross ventilation with outside air during warm conditions. These systems can be designed to address a large portion of a building, an attic, or a specific area.

Examples of Outdoor Air System Activity

24 Hour Averages

> 75˚F Cooling
66˚ - 75˚ F Intermittent
< 65˚F Outdoor Air or Heat
< 42˚F only Heat

24 Hour Temp Averages

ZONE		Annual Avg	9 mo School Avg	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1 Very Hot	Miami, FL	76	74	82	79	74	69	68	69	72	75	79	82	83	83
2 Hot	New Orleans, LA	69	64	79	70	61	55	52	55	62	69	76	81	82	82
3 Warm	Atlanta, GA	62	56	73	63	53	45	43	46	53	62	70	77	79	79
4 Mixed	Phillidelpia, PA	55	48	68	57	47	36	32	34	42	53	63	72	77	76
5 Cool	Chicago, IL	49	42	65	53	40	27	22	26	37	49	59	69	74	72
6 Cold	Minneapolis, MN	45	37	61	50	33	19	13	18	31	46	59	68	73	71
7-Very cold	Minot, ND	39	30	56	45	26	14	6	11	21	41	53	61	68	67
8 SubArctic	Fairbanks, AK	27	17	45	25	4	-6	-8	-2	11	31	49	60	62	57
8 SubArctic	Cambridge Bay	6	-6	32	11	-9	-21	-27	-27	-22	-7	15	36	47	44

Daytime Only Averages

Daytime Temp Averages

ZONE		Annual Avg	9 mo School Avg	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1 Very Hot	Miami, FL	80	78	85	82	77	73	72	73	76	79	83	85	86	87
2 Hot	New Orleans, LA	73	69	83	75	66	60	57	60	67	74	80	85	87	86
3 Warm	Atlanta, GA	67	61	78	68	58	50	48	51	59	68	75	82	84	84
4 Mixed	Phillidelpia, PA	59	52	73	62	51	40	36	38	47	58	68	77	82	81
5 Cool	Chicago, IL	54	46	70	58	44	31	26	30	41	54	65	75	79	77
6 Cold	Minneapolis, MN	50	41	66	55	37	23	17	23	35	51	64	73	78	76
7-Very cold	Minot, ND	45	36	63	51	31	19	11	16	26	47	59	67	75	74
8 SubArctic	Fairbanks, AK	32	21	50	29	8	-3	-4	3	18	37	55	65	67	62
8 SubArctic	Cambridge Bay	9	-3	33	14	-6	-18	-24	-24	-18	-2	19	39	51	46

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

5) Evaluate And Document Appropriate Test Conditions

A. Identify The Normal Occupied Operating Condition:
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 represents the greatest amount of significantly occupancy time.

B. Identify the operating conditions most likely to emphasize a clear characterization of a radon hazard.
This would primarily include time periods when the difference between indoor and outdoor temperatures cause:

a) Some degree of regularity for natural negative air pressure inside the building as compared to outside of the building (e.g. stack effect), and;
b) Some degree of regularity in the activity of heating or cooling system blowers. This blower activity can cause negative pressure within the building, unique sector of the building or even an individual room.

This would not include time periods when the volume of outdoor air introduced into the building exceeds the minimum amounts required to maintain occupant health.

Examples

Daytime Averages

> 75˚F Cooling
66˚ - 75˚ F Intermittent
< 65˚F Outdoor Air or Heat
< 42˚F only Heat

Daytime Temp Averages

ZONE		Annual Avg	9 mo School Avg	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1 Very Hot	Miami, FL	80	78	85	82	77	73	72	73	76	79	83	85	86	87
2 Hot	New Orleans, LA	73	69	83	75	66	60	57	60	67	74	80	85	87	86
3 Warm	Atlanta, GA	67	61	78	68	58	50	48	51	59	68	75	82	84	84
4 Mixed	Phillidelpia, PA	59	52	73	62	51	40	36	38	47	58	68	77	82	81
5 Cool	Chicago, IL	54	46	70	58	44	31	26	30	41	54	65	75	79	77
6 Cold	Minneapolis, MN	50	41	66	55	37	23	17	23	35	51	64	73	78	76
7-Very cold	Minot, ND	45	36	63	51	31	19	11	16	26	47	59	67	75	74
8 SubArctic	Fairbanks, AK	32	21	50	29	8	-3	-4	3	18	37	55	65	67	62
8 SubArctic	Cambridge Bay	9	-3	33	14	-6	-18	-24	-24	-18	-2	19	39	51	46

Daytime with Outdoor Air Systems

Daytime Temp Averages

ZONE		Annual Avg	9 mo School Avg	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1 Very Hot	Miami, FL	80	78	85	82	77	73	72	73	76	79	83	85	86	87
2 Hot	New Orleans, LA	73	69	83	75	66	60	57	60	67	74	80	85	87	86
3 Warm	Atlanta, GA	67	61	78	68	58	50	48	51	59	68	75	82	84	84
4 Mixed	Phillidelpia, PA	59	52	73	62	51	40	36	38	47	58	68	77	82	81
5 Cool	Chicago, IL	54	46	70	58	44	31	26	30	41	54	65	75	79	77
6 Cold	Minneapolis, MN	50	41	66	55	37	23	17	23	35	51	64	73	78	76
7-Very cold	Minot, ND	45	36	63	51	31	19	11	16	26	47	59	67	75	74
8 SubArctic	Fairbanks, AK	32	21	50	29	8	-3	-4	3	18	37	55	65	67	62
8 SubArctic	Cambridge Bay	9	-3	33	14	-6	-18	-24	-24	-18	-2	19	39	51	46

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Exhibit A-1

Sample Notice: "CONTRACTOR TO CLIENT"

Intention to Enter School or Large Building

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 the custodial, maintenance and educational staff members and to impacted occupants such as workers, students and parents 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 staff and impacted occupants 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

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Exhibit A-2

Sample Notice : "MANAGEMENT TO FACILITATING STAFF"

Intention to Enter School or Large Building

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

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Exhibit A-3

Sample Notice: "MANAGEMENT TO OCCUPANTS"

Intention to Enter School or Large Building

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

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

EXHIBIT A-4

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,
Radon Company, Anytown, USA

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

EXHIBIT B

TEMPORARY SYSTEMS

Figure B-1:
SAMPLE LABEL

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 process of** _____
John Smith Radon Reductions, 866-041-0412, *Anywhere America,* *Cert# 109492 State Proficiency Board*	

Figure B-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)		

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Exhibit C-1

Example ASD: Operational and Maintenance Schedule/Log

ASD: Original Startup System Components and Settings

Friendship School and Office Park, 26000 Main, Anywhere, US

System	#1	#2	#3	#4	#5	#6
System Fan Monitor Location	Bldg #1 Rm. 110	Bldg #4 Laundry	Bldg #5 E Corridor	Bldg #5 W. Hall	Bldg #7 Rm 732	Bldg #9 Office
Fan Model	A21C	A21C	A63B	A21C	A21C	A21C
Fan Location	Attic	East side	Rear	Attic	Attic	Attic
Fan Monitors Type	U-Tube	U-Tube	U-Tube	U-Tube	U-Tube	U-Tube
Items to inspect with sealed items to remain sealed						
Fan Monitor (Startup Differential)	1.7"	1.5"	2.0"/	1.5"	3.5"	1.0"
Sumps	Sealed	N/A	Sealed	Sealed	N/A	(2)Sealed
Crawl membrane	N/A	East wing	N/A	N/A	N/A	N/A
Isolation Assembly	N/A	N/A	N/A	N/A	Crawlspace	N/A

Location of Detailed Information:

See all manufacturer, warranty and instructional information in the systems manual located at:

Main Shop Office

ASD Inspection / Maintenance Log

Year 2014		Qtr 1 Jan 15 .	Qtr 2 Apr 10 .	Qtr 3 July 15	Qtr 4
Sys. # 1 Bldg #1	Fan Monitors	[X] Wally M	[X] WM	[X] John B	[ ]
	Sealed Items	[X]sump sealed	[X] WM	[X] JB	[ ]
	Piping/Labels	[X] WM	[X] WM	[X] JB	[ ]
	Noted concerns:				
	Last Radon Test (at least every 2 years)	[ ]	[ ]	[X]July 10	[ ]
Sys. # 2 Bldg #4	Fan Monitors	[X] WM	[X] WM	[X] New Fan	[ ]
	Sealed Items	[X] WM	[X] WM	[X] JB	[ ]
	Piping/Labels	[X] WM	[X] WM	[X] JB	[ ]
	Noted concerns: 1/15/14 Occupants observed fan noise.				
	Last Radon Test (at least every 2 years)	[ ]	[ ]	[X] July 10	[ ]
Sys. # 3 Bldg #5	Fan Monitors	[X] WM	[X] WM	[X] JB	[ ]
	Sealed Items	[X] WM	[X] WM	[X] JB	[ ]
	Piping/Labels	[X] WM	[X] WM	[X] JB	[ ]
	Noted concerns:				
	Last Radon Test (at least every 2 years)	[ ]	[ ]	[X] July 10	[ ]

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Exhibit C-2

Example Non-ASD: HVAC Operational and Maintenance Schedule/Log

Non-ASD: Original Startup System Components and Settings

Friendship High School, 26000 Main, Anywhere, US

System	#7	#8
System Fan Monitor Location	Bldg #6 Rm. 615	Bldg #8 Shop
Fan (Air Handler) Model	Z2946-12	Z2946-12
Location	Basement	Basement
Fan Monitors Type	U-Tube	U-Tube
Fan Monitor (Startup Differential)	12 "	14"
Sumps	Sealed	N/A
Crawl membrane	N/A	N/A
Isolation Assembly	N/A	All First floor (Windows and Doors)

Location of Detailed Information:

See all manufacturer, warranty and instructional information in the systems manual located at:

Main Shop Office

Non-ASD Mitigation: HVAC Inspection / Maintenance Log

Year 2014		Qtr 1 Jan 15	Qtr 2 Apr 10	Qtr 3 July 15	Qtr 4
Sys. # 7 26101 Main, Building 10	Fan Monitors	[X] John Brown	[X] Bill B.	[X] JB	[ ]
	HVAC components *(See attached checklist)*	[X] JB	[X]Controls had been altered.	[X] JB	[ ]
	Sealed items	[X] JB	[X] BB	[X] JB	[ ]
	Piping/Labels	[X] JB	[X] BB	[X] JB	[ ]
	Noted concerns: 4/10/14 installed lock-out box for local control settings (w/ radon label).				
	Last Radon Test (at least every 2 years)	[ ]	[ ]	[X] July 10	[ ]
Sys. # 8 26111 Main, Building 11	Fan Monitors	[X] Door closer adjusted .	[X] BB	[X] JB	[ ]
	HVAC components *(See attached checklist)*	[X] JB	[X] BB	[X] JB	[ ]
	Sealed items	[X] JB	[X] BB	[X] JB	[ ]
	Piping/Labels	[X] JB	[X] BB	[X] JB	[ ]
	Noted concerns:				
	Last Radon Test (at least every 2 years)	[ ]	[ ]	[X] July 10	[ ]

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Exhibit Table C-3

Example Non-ASD: HVAC Operational Checklist

Inspected items that might reveal a need for system repair.

Non-ASD Mitigation: HVAC Inspection Checklist

Routine Operation and Maintenance

Note: The information in this table is significantly drawn from EPA's "Tools For Schools Action Kit" that inherently addresses indoor air quality issues that relate to many large buildings.

Address: 26201 Main, Building 10 **System:** #7 **Date:** Apr 10, 2014		**Notes**	**Staff:**
Inspection: *Air Handling Unit*	Is the airflow from vents sufficiently meeting mitigation system design specifications?[1 2]	1200 CFM	JB
	Are the filters clean and properly installed?	Replaced	JB
	Are dampers operating correctly	X	JB
Inspection: *Controls, Temperature and Humidity*	Are the control settings and thermostat set to properly meet mitigation system design specifications?	X	JB
	Observations that may warrant further investigation/remediation: • Is air flowing from the vent too cool or too warm? • Does condensation frequently form on windows or cold surfaces? • Is there an objectionable odor? • Are areas in the building overly dusty?	none	JB
Inspection: *Outdoor Air Supply*	Is the ventilation system including related fans on?	X	JB
	Are outdoor intakes, vents or ducts blocked?	X	JB
	Is the airflow from vents sufficiently meeting mitigation system design specifications?[1 2]	1200 CFM	JB
	Is the airflow through outdoor intakes sufficiently meeting mitigation system design specifications?[1 2]	250 CFM	JB
	Observations that may warrant further investigation/remediation: • Are there reports from occupants regarding drowsiness or discomfort or other observations that suggest outdoor air supply is inadequate (i.e. < 15 cfm per person)? • Are combustion appliances in rooms without adequate ventilation?	none	JB

[1] **Airflow**: To detect airflow, use special chemical smoke or a piece of tissue. Release puffs of smoke near openings between the complaint area and adjacent areas (openings include cracks, ducts, wiring and plumbing passageways, and leaky or open doors and windows). Release smoke near vents and grilles to determine airflow direction, if any. Do not breathe on or move quickly near puffs of smoke.

[2] **Air Volume:** Flowhoods are designed to measure airflow at grilles and diffusers. Pitot tubes are designed to measure air velocity in ducts; air velocity is then used to calculate airflow. While flowhoods are more expensive to purchase than pilot tubes, they are easier to use and can be used to measure airflow in ducts by summing the airflows from all vents connected to a given duct.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

Exhibit Table C-4

EXAMPLE Non-ASD: HVAC DIAGNOSTIC/REPAIR CHECKLIST

Comprehensive HVAC System Diagnostic/Repair Checklist This table may be helpful during pre-mitigation evaluations or post mitigation inspections associated with a "Long-Term Operation, Maintenance and Monitoring Plan".
1. OUTDOOR AIR INTAKES
OBSTRUCTIONS: Ensure outdoor air intakes are clear of obstructions, debris, clogs, or covers.
POLLUTANT SOURCES: Resolve any problems with pollutant sources located near outdoor intakes.
AIRFLOW: Confirm that outdoor air is entering the intake appropriately.
2. SYSTEM CLEANLINESS
AIR FILTERS: Replace filters per maintenance schedule.
3. CONTROLS FOR OUTDOOR AIR SUPPLY
Ensure that air dampers are at least partially open (minimum position). Ensure that minimum position provides adequate outdoor air for occupants.
CONTROLS INFORMATION Obtain and review all design inside/outside temperature and humidity requirements, controls specifications, as-built mechanical drawings, and controls operations manuals (often uniquely designed).
CLOCKS, TIMERS, SWITCHES Ensure summer-winter switches are set the correct position with time clocks set appropriately. Ensure that settings fit the actual schedule of building use (including night/weekend use).
CONTROL COMPONENTS Ensure all controls and sensors are functional at both the occupied (day) and the unoccupied (night) settings. This includes checking line pressure for pneumatic controls under both conditions.
OUTDOOR AIR DAMPERS: Ensure the outdoor air damper fully closes within a few minutes of shutting off the air handler and opens (at least partially with no delay) when the air handler is turned on. • In heating mode, the outdoor air damper should go to its minimum position (without completely closing) when the room thermostat is set to 85°F. • In cooling mode, the outdoor air damper should go to its minimum position (without completely closing) when the room thermostat is set to 60°F and mixed air thermostat is set to 45°F.
FREEZE STATS: ***A RADON MITIGATION CONCERN:*** *Freeze-stats close the outdoor air damper and disconnect the supply of outdoor air when tripped. They trip intentionally when the outdoor temperature range is 35°F to 42°F to protect water coils within HVAC units from the cold. As a result, mitigation systems based upon pressurization or dilution can fail during the time periods of freezing outdoor temperatures or Freeze-stat failure.* For general maintenance, confirm that any freeze stats are functional as designed.
MIXED AIR THERMOSTATS: Ensure that the mixed air stat for heating mode is set no higher than 65°F and for cooling mode, it is set no lower than the room thermostat setting.
ECONOMIZERS: ***A RADON MITIGATION CONCERN:*** *Economizer systems vary the amounts of cool outdoor air supplied to the building to assist with the cooling load of the room or rooms. Either in failure mode or as*

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

designed, unless economizer systems leave dampers adequately open for meeting minimum mitigation requirements, mitigation systems based upon pressurization or dilution are likely to fail during the time periods of either high or low outdoor temperatures and including times of high humidity.

There are two types of economizers, dry-bulb and enthalpy. The dry-bulb is typically set at 65°F or lower. Dry-bulb economizers vary the amount of outdoor air based on outdoor temperature, and enthalpy economizers vary the amount of outdoor air based on outdoor temperature and humidity level.

Confirm proper economizer settings are based on design specifications or local practices and in conformance with design criteria required for mitigation.

Ensure that dampers operate properly (for outside air, return air, exhaust/relief air, and recirculated air), per the design specifications.

FANS: Ensure that all fans (supply fans and associated return or relief fans) that move outside air indoors continuously operate during occupied hours (even when room thermostat is satisfied).

4. AIR DISTRIBUTION

AIR DISTRIBUTION:

Ensure that supply and return vents are open and unblocked.

Ensure that supply and return air pathways in the existing ventilation system perform as required. This includes passive gravity relief ventilation systems and transfer grilles between rooms and corridors are functioning. *If ventilation systems are closed or blocked to meet current fire codes, consult with a professional engineer for remedies.*

Ensure every occupied space has supply of outdoor air (mechanical system or operable windows).

PRESSURIZATION IN BUILDINGS:

Ensure that the system, including any exhaust fans, is operating on the "occupied" cycle when evaluating pressurization.

Ensure that air flows out of the building through windows, doors, or other cracks and holes in exterior wall (for example, floor joints, pipe openings).

5. EXHAUST SYSTEMS

Exhaust systems are designed to keep certain rooms or areas under negative pressure (as compared to surrounding spaces). Exhaust systems are employed often to prevent migration of indoor contaminants from areas such as bathrooms, kitchens and labs to other areas of the building.

EXHAUST FAN OPERATION: Ensure that air flows into exhaust fan grille(s)

EXHAUST AIRFLOW:

Ensure that air is drawn inwards into the room from adjacent spaces.

Ensure that air is flowing toward the exhaust intake.

EXHAUST DUCTWORK: Ensure ductwork downstream of the fan is sealed and in good condition

6. QUANTITY OF OUTDOOR AIR

OUTDOOR AIR MEASUREMENTS AND CALCULATIONS:

Measure the quantity of outdoor air supplied to each ventilation unit.

- Calculate the number of occupants served by the ventilation unit under consideration.
- Divide outdoor air supply by the number of occupants to determine the existing quantity of outdoor air supply per person.

ACCEPTABLE LEVELS OF OUTDOOR AIR QUANTITIES:

Compare the existing outdoor air per person to the recommended levels in ANSI/ASHRAE Standard 62.1-2010 "Ventilation for Acceptable Indoor Air Quality" for buildings that are more than three stories tall or ANSI/ASHRAE Standard 62.2-2010 "Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings".

Correct problems with ventilation units that supplied inadequate quantities of outdoor air.

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

REFERENCED AND INFORMATIONAL PUBLICATIONS

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

- The International Building Code®
- The International Mechanical Code®
- The International Plumbing Code®
- The International Residential Code®
- ICC 700-2008, "National Green Building Standard for Residential Construction".

Published by the NFPA
For the latest versions of NFPA documents see: ***http://www.nfpa.org***

- The National Electric Code® (NEC)

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

- Indoor Air Quality Guide – Best Practices for Design Construction and Commissioning
- 62.1 "Ventilation for Acceptable Indoor Air Quality for buildings that are more than three stories tall"
- 62.2 "Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings"
- 189.1, "Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings"

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

- C920 Elastomeric Joint Sealants
- C1173 Flexible Transition Couplings for Underground Piping Systems
- D2235 Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
- D2661 Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
- D2564 Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
- D2665 Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
- D2949 Standard Specification for 3.25-in. Outside Diameter 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
- F628 Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core
- F891 Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core
- F1488. Coextruded Composite Pipe

Guidance **published by the US EPA**
For the latest versions of USEPA documents see: **http://www.epa.gov/radon/pubs**

- A Citizen's Guide To Radon [EPA 402/K-12/002, May 2012]
- Home Buyers and Sellers Guide to Radon [EPA 402K-09/002, January 2009]
- Tools for schools
- Reducing Radon In Schools: A Team Approach [EPA 402-R-74-008 April 1994]

Other Health and Safety Publications

- World Health Organization, "WHO Handbook on Indoor Radon: A Public Health Perspective." 2009
- Swedish Radiation Protection Authority, "Radon in Estonia Dwellings, Stockholm" 2003
- Silvia Bucci, Gabriele Pratesi, Maria Letizia Viti, Marta Pantani, Francesco Bochicchio and Gennaro Venoso, "Radon in workplaces: first results of an extensive survey and comparison with radon in homes", 2011
- National Academy of Sciences, "Biological Effects of Ionizing Radiation" (BEIR VI Report) 1999
- *OSHA "Safety and Health Regulations for Construction, Ionizing Radiation," 29 CFR 1926.53*
- *OSHA "Occupational Safety and Health Regulations, Ionizing Radiation," 29 CFR 1910.96*
- *NIOSH "Guide to Industrial Respiratory Protection," DHHS (NIOSH) Publication No. 87-116, September, 1987*

This is a preview of "ANSI/AARST RMS-LB-20...". Click here to purchase the full version from the ANSI store.

ANSI/AARST **RMS-LB** 2014

Radon Mitigation Standards for Schools and Large Buildings

Acknowledgement

This standard was developed through the efforts and deliberations of the consensus body on Radon Mitigation Standards for Large Buildings (RMS-LB), representing a broad cross-section of stakeholder interests and vantage points.

Deep appreciation is both expressed and deserved for years of contributions in time and wisdom provided by the following consensus body members and staff:

Acting Chair: Gary Hodgden (KS)

Stakeholder Group	Delegate	Affiliation
(Educators)	Bill Angell (MN)	Midwest University Radon Consortium (MURC)
(Regulated States)	Matt Shields (PA)	Pennsylvania Department of Environmental Health
Proficiency Program)	David Wilson (TN)	Technical and Science Committee (AARST-NRPP)
(Federal EPA)	Jani Palmer (DC)	U.S. Environmental Protection Agency (EPA)
(Mitigation prof.)	David Grammer (NJ)	Professional Service Provider
(Mitigation prof. *Alt*)	John Mallon (PA)	Professional Service Provider
(Measurement prof.)	Charlie Lamb (NY)	Professional Service Provider
(Home Inspectors)	Nate Burden (PA)	Professional Services
(Home Builder)	Steve Tucker (OR)	Specialty Services
(Vapor Intrusion)	Thomas Hatton (NJ)	Specialty Services
(Manufacturer)	Dave Hill (MA)	Manufacturer (Spruce)
Credit is also acknowledged for a contributing committee member through 2013:		
(Non-regulated States)	Joshua Miller (MN)	Minnesota Department of Health - Indoor Air Unit

Appreciation is also extended to all Assistance Team members over the years to include: Mert Oktem, Beth Anne Purvis, Kelsey Wallace , Meghan Walker, Diana Degan, Sarah Consaga, Tara Fortier, Nanci Hemberger, Joanne Brodsky and Tricia Wallich