Introduction For Reviewers

These proposed revisions apply to harmonization for portions of three different radon and soil gas mitigation standards of practice relative to installation specifics for the Active Soil Depressurization (ASD) mitigation method. These proposed revisions for revised Sections 7, 8 and 9 would replace Sections 7, 8 and 9 in: SGM-SF 2017 Soil Gas Mitigation Standards in Existing Homes; RMS-MF 2018 Radon Mitigation Standards for Multifamily Buildings; and Radon Mitigation Standards for Schools and Large Buildings.

Revisions for other like content and content within each standard that would be inherently different is under review for harmonization in accordance with AARST's continuous maintenance procedures.

Currently published versions of these standards are available to review and purchase at www.standards.aarst.org.

Section 7, 8 and 9 (Mitigation Standards-ASD)

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MIT STANDING COMMITTEE (CONSENSUS BODY MEMBERS)

Instructions for submitting comments are on the next page

Public Review: Mitigation789 *05-2020*

Proposed harmonized updates to Sections 7, 8 and 9 for:

- SGM-SF 2017 *Soil Gas Mitigation Standards in Existing Homes*;
- RMS-MF 2018 *Radon Mitigation Standards for Multifamily Buildings*; and
- RMS-LB 2018 *Radon Mitigation Standards for Schools and Large Buildings*.

COMMENT DEADLINE: June 8th, 2020

REQUESTED PROCESS AND FORM FOR FORMAL PUBLIC REVIEW COMMENTS

Submittals *(MS Word preferred) may be attached by email to StandardsAssist@gmail.com or submitted in paper form by fax to (913) 780-2090*

1) Do not submit marked-up or highlighted copies of the entire document.

2) If a new provision is proposed, text of the proposed provision must be submitted in writing. If modification of a provision is proposed, the proposed text must be submitted utilizing the strikeout/underline format.

3) For substantiating statements: Be brief. Provide abstract of lengthy substantiation. (If appropriate, full text may be enclosed for project committee reference.)

REQUESTED FORMAT

Title of Public Review Draft: **Mitigation789 05-2020**

• **Name:** Affiliation:

• **Clause or Subclause**:

• **Comment/Recommendation**:

• **Substantiating Statements**:

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

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

Requested registration of your contact information and copyright release.

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Commenters are responsible for informing the standards assistant staff a when changing contact information or other preferences.

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

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Rev. 05-01-2019

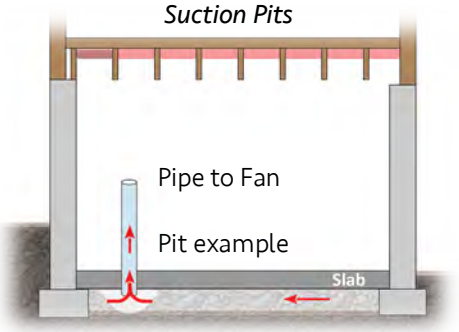
SECTION 7: ASD SYSTEM INSTALLATIONS

7.1 ASD Suction Points

7.1.1 *Suction pits*

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

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



Informative advisory—Where sub-slab material exhibits poor permeability, larger pits are recommended, such as 1 ft^3 (28 dm^3) or larger. This void equates to 7.5 US gallons (28 L) or more of sub-slab soil/aggregate.

Note—Pit size needs are based on permeability of the sub-slab material. If the combined surface area of exposed pore openings between granules of soil, sand or gravel is less than the cross-sectional open surface area of the suction pipe, as shown in Table 7.3.4, a larger pit will likely enhance PFE.

7.1.1.1 Seal the suction point

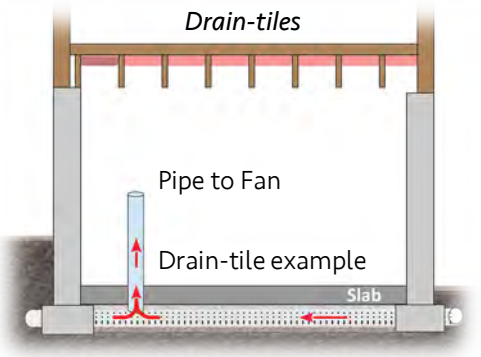
Gaps in concrete surrounding suction pipes shall be sealed in a permanent, airtight manner.

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

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

7.1.1.2 Drain tile suction

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



7.1.2 *Sumps*

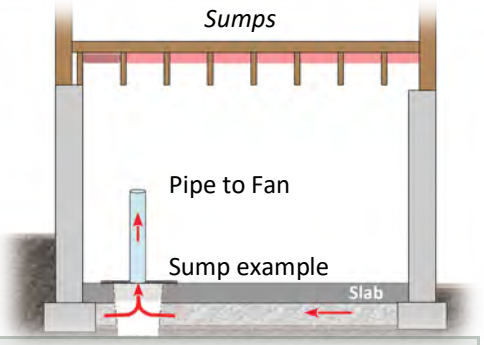
Informative advisory—Sumps that connect to soil air should not be used as the primary suction point unless other options are inadequate for achieving PFE. Concerns include compromised accessibility to pumps, increased noise and observance that some localities disallow use of a sump as the primary suction point.

7.1.2.1 Seal the suction point (sumps)

Where sumps are used as a suction point, sump lids shall be sealed in accordance with Section 8.5 in an airtight manner.

7.1.2.2 Accessibility to sumps

Provisions of Section 8.5 for sealing sumps shall be observed to include that a physical access port or equivalent is required. Flexible coupling disconnects for suction piping, in accordance with Section 7.2.6, shall be provided to ease sump lid removal.



Informative advisories—(1) The suction pipe should not extend lower than 1 inch below the sump lid.

(2) Visual access to conditions in the pit is recommended.

(3) Flexible coupling disconnects should be located such as to facilitate easy removal of the cover.

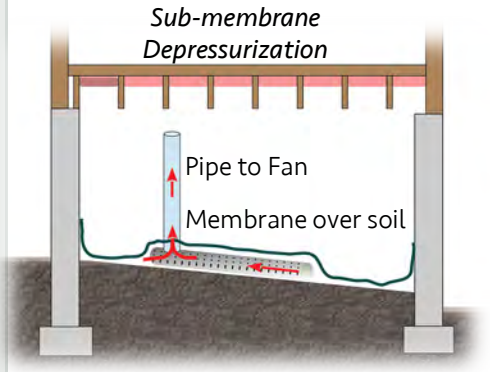
7.1.2.3 Labels required (sumps)
Sump lids shall be labeled in accordance with Section 9.4.6.1.

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

Informative advisories—(1) To prevent membrane material from obstructing suction pipes, it is recommended to attach not less than 3 feet (1 m) of perforated pipe to suction pipe air intakes.

(2) To prevent restricted PFE extension, such as where membrane material might adhere to moist soil, it is best to attach ≥ 10 feet (3 m) of perforated pipe. Geotextile matting can also achieve the intent of this recommendation.

(3) For large membranes, longer lengths of perforated pipe or multiple suction points are recommended.

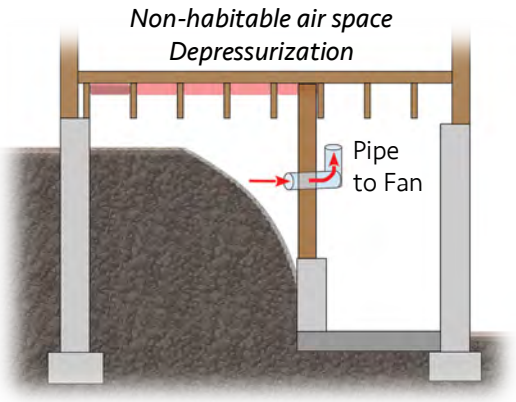


7.1.3.1 Seal the suction point (membranes)
The opening around penetrations of a *soil gas retarder* shall be sealed in a permanent, airtight manner. Appropriate seal materials shall be applied for ASD duct piping and other utility pipe penetrations through the membrane such as gasket fittings, pipe clamps,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

7.1.3.2 Seal the membrane(s)
The *soil gas retarder*, including seams and edges, shall be sealed to resist air movement between soil and air above the membrane and installed in accordance with Sections 8.6 and 8.7.

7.1.3.3 Labeling required (membranes or *crawl space* access)
Membranes or *crawl space* access locations shall be labeled in accordance with Section 9.4.6.2.

7.1.4 *Non-habitable air spaces*
Note—These ASD systems depressurize an entire airspace that is not used or constructed for habitation. Examples include *crawl spaces*, utility tunnels, under raised flooring, behind partitioned walls and sometimes entire rooms.



7.1.4.1 Sealing (non-habitable air spaces)
When depressurizing a *non-habitable airspace,* sealing of all surfaces of the *non-habitable airspace* that adjoin both indoor and outside air shall be performed in accordance with Section 8.9 *Sealed Isolation Assemblies.*

7.1.4.2 Prohibition 1
Depressurization of *non-habitable airspaces*, such as *crawl space depressurization*, shall not be installed unless conditions exist where an area cannot be safely accessed or has insufficient height to work in.

7.1.4.3 Prohibition 2
Depressurization of *non-habitable airspaces* shall not be used as a mitigation system when:

a) atmospherically vented combustion appliances are installed within the airspace to be depressurized;

b) adequate isolation cannot be created between the *non-habitable airspace* and surrounding airspaces containing one or more atmospherically vented combustion appliances. Resulting configurations shall not induce *flue gas spillage*; and

c) the extent of inaccessible openings between the isolated space and both interior and exterior areas surrounding the isolated space has not been evaluated and accounted for in system design and installation.

Regardless if creation of access is needed or if extensive efforts are required to seal or further partition the isolated airspace, the resulting system shall not cause the structure to become unsafe or adversely affect the performance of the building to include:

a) Adverse impacts to building systems (with the most notable being *flue gas spillage* from atmospherically vented combustion appliances located elsewhere in the building); and

b) Excessive energy penalties and damage to building components (with the most notable being hot, cold and humid outside air drawn into a *non-habitable airspace* by the mitigation system).

Note—Sub-membrane *depressurization* (SMD) for open earth *crawl spaces* is a preferred mitigation method to minimize energy penalties and damage to building components, even if access needs to be created.

7.1.4.2 Safety requirements (*non-habitable airspaces*)

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

a) Access ports to non-habitable air spaces shall be labeled in accordance with Section 9.4.6.3 to provide warning and instructions, such as for ventilating the airspace prior entry or, as warranted, other precautions and instructions;

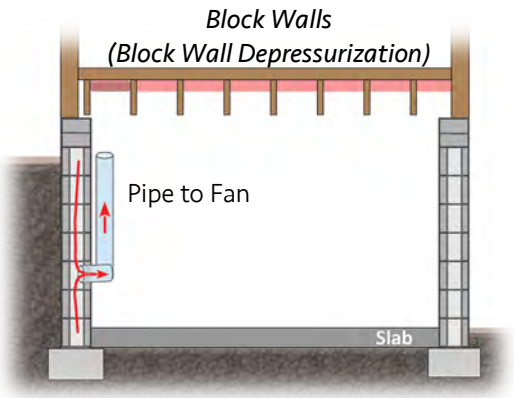
b) Doors and access port hatches that can be opened without the use of tools shall be provided hardware to facilitate adding a lock to prevent incidental entry; and

c) Fan monitors required in accordance with Section 9.2 shall be located where they can be accessed without entering the depressurized non-habitable air space.

7.1.5 *Block walls*

7.1.5.1 Suction pipe locations

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



7.1.5.2 Sealing (block walls)

For Block Wall *Depressurization*, all accessible openings and gaps in the wall that surround the hollow void network being depressurized shall be closed in accordance with Section 8.4.1 to resist air movement between the depressurized void network and both indoor and outdoor air.

Informative advisory—If the top or wall surfaces of the void network cannot be closed to resist air entry into the voids, *depressurization* of the block wall(s) may not be possible. Where openings are not accessible, closure of voids in a course of blocks below the inaccessible openings at a location above outside grade should be considered to isolate a smaller void network for *depressurization*.

7.2 ASD Piping

7.2.1 *Air and water-tight*

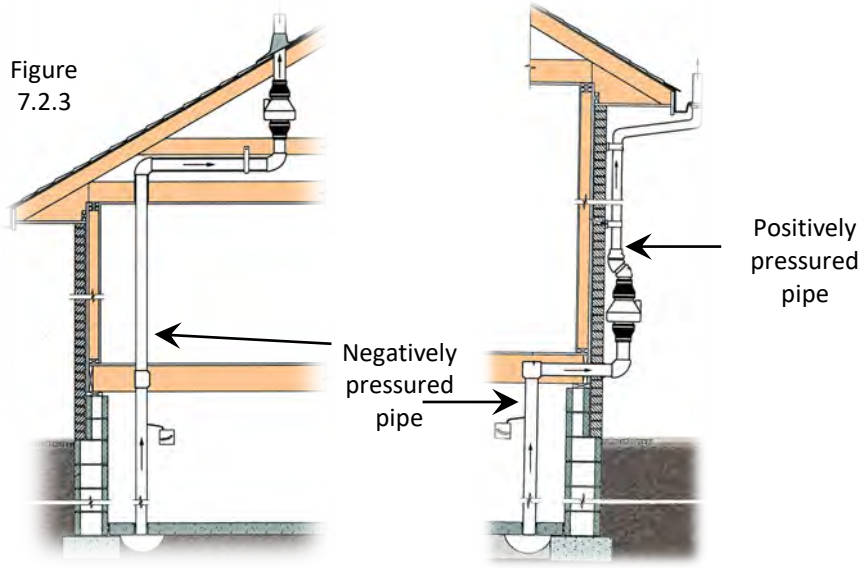
All duct piping and fittings that transport air shall result in being air- and water-tight, except at soil gas intake locations, exhaust locations and fan monitor test ports.

7.2.2 *Slope required*

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

7.2.3 *Positively-pressurized pipe*

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



7.2.4 *Labels required (duct piping)*

Duct piping shall be labeled in accordance with 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:

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

b) PVC piping shall comply with ASTM D2665, F891 or F1488. Pipe wall thickness shall be Schedule 40 with solid, cellular core or composite wall. PVC plastic pipe joints shall be joined in accordance with the pipe manufacturer's instructions with cement conforming to ASTM D2564. The joint surfaces for PVC plastic pipe and fittings to be solvent welded shall be prepared with:
   - a primer conforming to ASTM F656; or
   - a self-priming product; or
   - as otherwise stipulated in the pipe manufacturer instructions.

c) All ASD plastic pipe fittings shall be of the same material as the plastic piping they are joined to and solvent welded unless joined with flexible couplings in accordance with Section 7.2.5.3.

Exception 1: Alternative pipe materials

Alternative materials specified in codes for "Above-Ground Drainage and Vent Pipe" [3] are permitted. Alternative pipe materials that include iron, steel and copper piping shall be joined in accordance with the pipe manufacturer's instructions and as required by code.

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

a) Local state licensing/certifying programs that provide written acceptability for the product; or

b) Local code authorities for locations that have no state licensing/certifying program.

Exception 2: Downspout material on exteriors

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

a) The material shall be installed only at exterior locations at the pressure side of the ASD system;

b) Duct size shall be in accordance with Section 7.3.7;

c) Materials shall be no less than equal to the commercial durability of existing downspout materials used for such buildings where the system is being installed.

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

d) Use of the specific material shall be acceptable to the *Client* and, if applicable, state licensing or certifying authorities; and

e) Joined connections for downspout materials and joints shall be welded to achieve a watertight seal or sealed and *mechanically fastened* at each joined connection using hardware fasteners that are weather-rated for outdoor use. When joined connections are sealed and *mechanically fastened*:

1. Sealants shall be applied to the inner junction between joined downspout materials in a manner to both establish a complete seal and protect sealants at the bonded location from degradation. Sealants shall be durable and suitable for use on gutter materials; and
2. Where pre-formed or modified flange connections are used to join sections of duct material, the upper portion of duct material at each connection shall be flanged inward and inserted downward into the lower portion of duct material to allow water and condensate to fully drain downward without collecting water and ice at joint connections.

7.2.6 *Flexible couplings*

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

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

[3] As point of reference for alternative piping, see the International Residential Code (IRC) Section 3002.1(1) or the International Plumbing Code (IPC) (as published by the International Code Council).

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

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

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

e) where local codes allow temporary removal and airtight replacement of ASD pipe sections to provide access to areas requiring maintenance or inspection of equipment as described in Section 7.2.9.

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. To durably withstand natural forces such as wind, ice and degradation over time, requirements include:

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

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

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

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

7.2.7.2 Supports for ASD plastic piping shall be installed no less than every 10 feet (3 m) on vertical piping and ~~at least~~ every ~~6~~ 4 feet (1.2 m) on horizontal piping~~, or as required by code~~. Alternate ASD duct materials identified in Section 7.2.5, such as iron, steel or copper, shall be secured in a manner that meets codes [4] and manufacturer recommendations.

Informative advisory—Configurations that prevent both lateral and vertical movement of duct piping are far less vulnerable to failed joint connections, dislodged rubber couplings and water leaks.

Warning: Where exposed, such as in basements and attics, pipe lengths that can move laterally or vertically are witnessed to cause failed or leaking joint connections as a result of occupants or workers merely jarring or bumping into pipes or by natural forces such as wind.

7.2.8 *Unnecessary noise*

Duct piping, fans and support configurations shall be installed in a manner that minimizes transfer of vibration to the structural framing of the building.

Suction pipe openings, such as under membranes and in *non-habitable airspaces,* shall be configured to minimize unnecessary objectionable air-rushing noise if the noise can be heard inside occupiable spaces.

Note—Section 7.3.8 *Air Velocities* provides guidance on air-rushing noise at the point of exhaust. Common methods to reduce other objectionable air-rushing noise, such as under a membrane, include:

a) reducing the size of air inlet pipe openings (if air volume flow of the duct pipe is greater than needed to establish a vacuum);

b) extending perforated pipe under a membrane or into a *non-habitable airspace* to allow the same air volume to enter more slowly through dozens of slits or holes; and

c) altering whole system airflow (when pipe or fan are transporting significantly more air than needed to establish a vacuum in all airspaces being depressurized).

[4] As point of reference for securing alternative piping, see, as applicable, the International Mechanical Code (IMC), the International Plumbing Code (IPC) or the International Residential Code (IRC) that are published by the International Code Council.

7.2.9 *Provide access clearance*

Duct pipe routing shall not:

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

c) compromise effectiveness of fire suppression systems; or

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

Exception: Flexible coupling disconnects or equivalent methods prescribed in Section 7.2.6 are permitted where allowed by code to provide access by temporary removal and airtight replacement of ASD pipe sections.

7.2.10 *Protect ducts from the elements (insulation)*

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

a) Where it is likely on a regular basis (e.g., annually or every few years) that freezing temperatures will result in ice buildup within duct piping that would adversely affect system performance, duct piping shall be provided with thermal insulation that is protected from the elements. Under this condition the insulation R-value shall be not less than 4.
Note—For more extreme climates, greater R-values may be appropriate; and

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

7.2.11 *Observe codes* [5]

Informative advisory—Codes that impact choices for pipe routing include but are not limited to:

a) Codes 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. In example, codes normally prohibit:
1. notches in solid wood joists, rafters and beams within the middle 1/3rd of its span and notches greater than 1/6th of its width, and
2. holes that are closer than 2 inches to the top or bottom of solid wood members;

b) Fire codes intended to inhibit the spread of fire and smoke.
In example, national codes normally prohibit flammable materials such as plastic pipe from:
1. touching or being too close to heat sources to include flues and chimneys,
2. compromising fire/smoke barriers between floors (e.g., metal barriers in flue chases), and
3. penetrating a fire-rated assembly unless specific procedures are taken, such as installing fire collars to control the spread of fire and smoke (e.g., a garage wall or ceiling if constructed as a fire-rated component and at penetrations into upper floor dwellings); and

c) Codes and local utility company restrictions regarding proximity of piping and electrical components that could:
1. inhibit access for inspection and repairs, and
2. be ignition sources for flammable materials (such as an electrical switch that is located near natural gas meters and liquid propane or gasoline holding tanks).

[5] 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 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.

7.3.1 *Minimum inside diameter—air volume capacity*

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

Note—Section 6.2 provides guidance on PFE Analysis. Pipe sizing dictates air volume capacity.

7.3.2 *When larger air volume needs are indicated*

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

7.3.3 *When smaller air volume needs are verified*

Where PFE Analysis indicates the necessary airflow for the entire system is equal to or less than 40 *CFM* (1.1 m^3/min), 2-inch (50-mm) ID duct piping from the exhaust point to the *soil gas collection plenum(s)* is permitted. If airflow exceeds 40 CFM (1.1 m^3/min) due to fan pressures much stronger than normally employed for ASD, such as greater than 6 inches WC (1500 Pa), 2-inch (50-mm) ID pipe is only permitted if both:

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 *Equivalent cross-sectional area*

Multiple pipes of various sizes that are joined in a parallel manner to result in a combined air volume capacity that is not less than the equivalent cross-sectional area of pipe diameters required in Sections 7.3.1 and 7.3.2 shall be permitted.

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

Note—Three 2-inch (50-mm) pipes in parallel are necessary to meet this requirement when connecting to a single 3-inch pipe.

Informative Table 7.3.4
Cross-sectional Area Dimensions

ID (inner diameter)	Cross-sectional Area
2-inch (50-mm)	3.1 sq. in. (20 cm^2)
3-inch (75-mm)	7.1 sq. in. (46 cm^2)
4-inch (100-mm)	12.6 sq. in. (81 cm^2)
6-inch (150-mm)	28.3 sq. in. (182 cm^2)

7.3.5 *Maintain whole-system air volume capacity*

The configuration shall not reduce duct pipe diameters or dimensions in the direction of airflow from the soil gas inlet(s) to the exhaust location to result in less whole-system air volume capacity than achieved with pipe sizes specified in Sections 7.3.1, 7.3.2 or 7.3.3. All components of the ducting system that reduce air volume transport capacity shall be accounted for in meeting this requirement, to include any rain caps or other obstructions at exhausts and circumference or size of slab penetration connections to soil gas.

7.3.6 *Multiple suction points*

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

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

a) their location, settings and design shall be included in "as built records" for the system; and
b) they shall be marked or labeled to indicate their purpose, settings and instructions, such as "Radon System Air Valve. Do Not Alter From Marked Setting," or similar wording.

7.3.6.1 Drainage

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

7.3.7 *Sizing for gutter downspout duct materials*

A natural reduction to airflow capacity shall be accounted for when using gutter downspout in accordance with Section 7.3.5. Because crimped downspout flange connections reduce airflow capacity, gutter downspout materials employed shall be:

a) no less than 3 x 4 inch downspout material (75 x 100 mm) to meet capacities stipulated in Section 7.3.1 for 3-inch (75-mm) ID pipe; and

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

Gutter downspout material that is less than 3 x 4 inches (75 x 100 mm) shall not be permitted unless, in accordance with Section 7.3.3, PFE Analysis indicates that the necessary airflow for the entire system is equal to or less 40 *CFM* (1.1 m^3/min).

7.3.8 *Air velocities*

Informative advisory—Maximum airflow speed

Air speed/velocity within duct piping should be less than 2,000 *feet per minute (FPM)* (610 m/min) to prevent condensed vapor from being drawn upward within piping rather than naturally falling by virtue of gravity to its intended destination (e.g., soil).

In addition, air rushing noise will usually reach an objectionable threshold at ASD exhaust locations with air velocities of about 1,600 FPM (488 m/min) or faster. Air velocities of 1,600 FPM (488 m/min) result when air is driven at:

a) 80 CFM (2.3 m^3/min) through a 3-inch (75-mm) pipe or the commonly resulting equivalent of 3 x 4 inch (75 x 100 mm) downspout material;

b) 140 CFM (4.0 m^3/min) through a 4-inch (100-mm) pipe or the commonly resulting equivalent of 4 x 5 inch (100 x 127 mm) downspout material; and

c) 35 CFM (1.0 m^3/min) through a 2-inch (50-mm) pipe or the commonly resulting equivalent of 2 x 3 inch (50 x 75 mm) downspout material.

Informative advisory—Minimum airflow speed

Air speed/velocity at the system exhaust that is much lower than 300 FPM (92 m/min) should be considered a benchmark that might indicate:

- more work to enhance PFE may be needed to achieve mitigation goals;
- enhanced expectations of exhaust icing or freeze-up during extreme cold weather;
- expectations of premature fan failure, if the cause is poor PFE; or
- a high vacuum fan is not aiding PFE but may cause adverse effects, such forcing liquid from U-tube manometers or forcing sand under the building out the exhaust of a system.

300 FPM (92 m/min) equates to:

a) Less than 20 CFM (0.6 m^3/min) through a 3-inch (75-mm) pipe;

b) Less than 26 CFM (0.7 m^3/min) through a 4-inch (100-mm) pipe; and

c) Less than 9 CFM (0.2 m^3/min) through a 2-inch (50-mm) pipe.

7.4 ASD Exhaust Discharge — Design and Location

7.4.1 *General*

7.4.1.1 Measuring distances

Distances shall be measured between the closest point of the exhaust opening to the closest point of all location requirements specified in Section 7.4 using the shortest distance, as if a string were stretched between them.

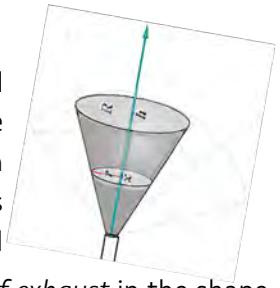
7.4.1.2 Definitions

Definitions a), b), c) and d) of this Section 7.4.1.2 shall apply to exhaust requirements in Section 7.4:

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

b) *Operable openings* — The operable or constantly open portion of windows, skylights, doors and other openings designed to readily operate for increasing ventilation with outdoor air;

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



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

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

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

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

7.4.2 *Outdoors*

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

7.4.3 *Directional spread (restrictions)*

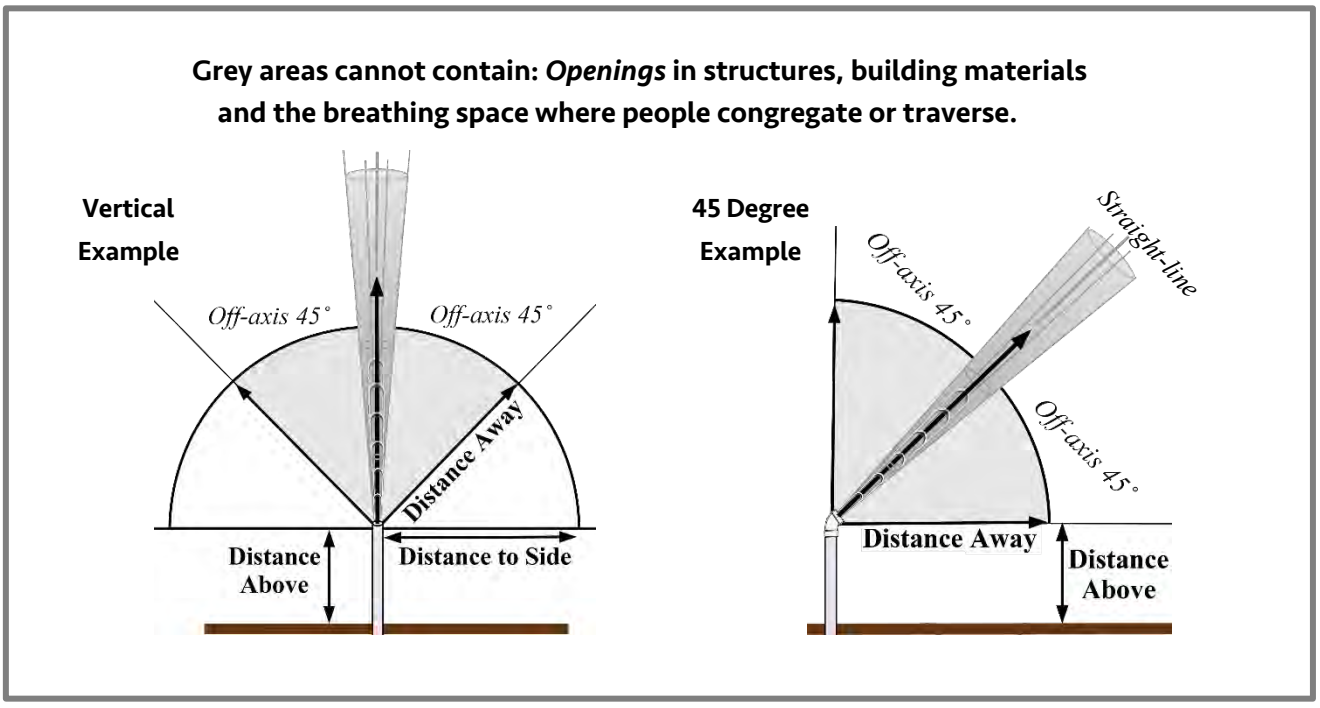
The *exhaust trajectory* with an *exhaust spread radius* of 45˚ shall not encounter *openings* in any structures, building materials or the breathing space where individuals congregate or traverse within 10 feet (3 m) from the *point of exhaust*.

Exception: Composite or otherwise layered water-tight roofing materials.

7.4.4 *Straight-line trajectory (restrictions)*

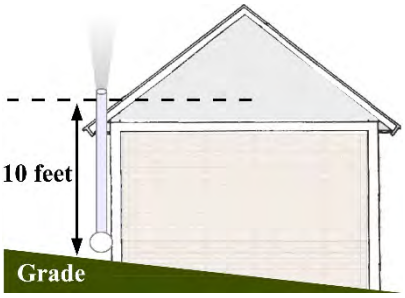
The *straight-line exhaust trajectory* with an *exhaust spread radius* of 11˚ shall not encounter *openings* in any structures, attic ventilation openings, building materials or the breathing space where individuals congregate or traverse within 20 feet (6 m) from the *point of exhaust*.

Figure 7.4



7.4.5 *Elevation above grade*

The *point of exhaust* shall be located not less than 10 feet (3 m) above grade nearest to the *point of exhaust* and shall be compliant with Section 7.4.3 *Directional spread* and Section 7.4.4 *Straight-line trajectory.*

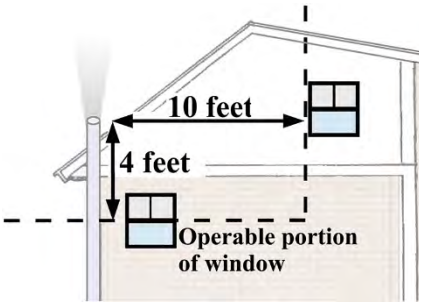


7.4.6 *Separation from operable openings in structures*

The *point of exhaust* shall be compliant with Section 7.4.3 *Directional spread* and located either:

a) not less than 10 feet (3 m) horizontally to the side of *operable openings* in structures; or

b) not less than 4 feet (120 cm) above *operable openings* in structures.

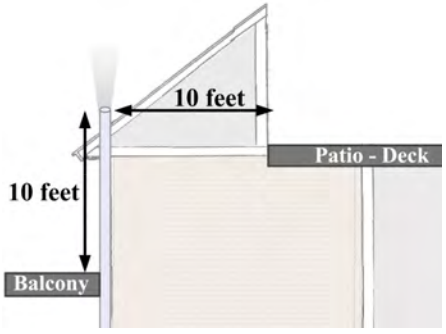


7.4.7 *Separation from people*

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

a) not less than 10 feet (3 m) above or horizontally to the side of exterior flooring surfaces; and

b) compliant with Section 7.4.3 *Directional spread* for an elevation of not less than 10 feet (3 m) above exterior flooring surfaces.

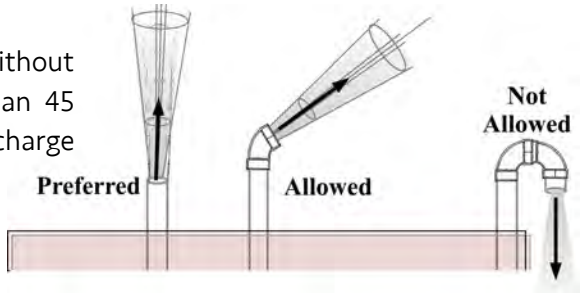


7.4.8 *Equipment Wells and Parapet roofs*

The *point of exhaust* relative to open equipment well airspaces or parapet roof construction, where areas are enclosed by more than two walls, shall comply with Section 7.4.3 *Directional spread*, to include the breathing space where individuals conduct maintenance.

7.4.9 *Angled Trajectories*

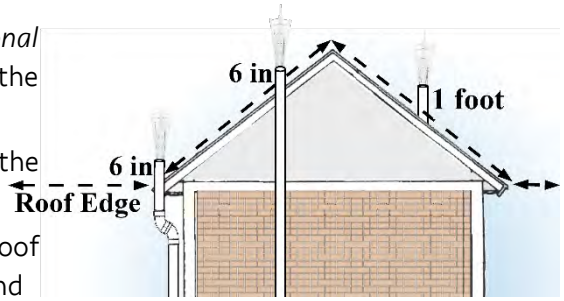
The *point of exhaust* shall be directed upward without obstruction at an angle that does not deviate more than 45 degrees from a vertical exhaust trajectory. The exhaust discharge shall not exhaust downward.



Exceptions: 90 degree horizontal exhausts shall comply with requirements in Section 7.4.12

7.4.10 *Roof*

The *point of exhaust* shall comply with Section 7.4.3 *Directional spread* and, unless all requirements of Section 7.4.11 are met, the *point of exhaust* shall be:



a) not less than 1 foot (30 cm) above a pitched roof at the point penetrated;

b) not less than 6 inches (15 cm) above the edge of the roof when ASD piping is attached to the side of a building; and

c) not less than 18 inches (46 cm) above a flat roof.

7.4.11 *Below the roof*

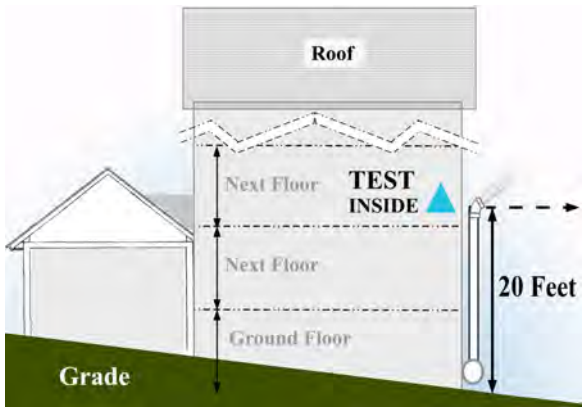
The *point of exhaust* shall be permitted to be located below the edge of the roof if the configuration complies with all other requirements of Section 7.4 and all of the following requirements are met:

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

1. the inability to comply with other requirements of Section 7.4 if the *point of exhaust* were located above the roof, or
2. the edge of the roof exceeds ~~30~~ 20 feet (6m) above grade nearest to the *point of exhaust*;

b) The *point of exhaust* shall be not less than ~~30~~ 20 feet (6m) above grade nearest to the *point of exhaust*; and

c) Testing shall be conducted within the occupiable area that immediately adjoins the 45˚ *Directional spread* required in Section 7.4.3. This testing is required no later than in conjunction with the initial post-mitigation test and shall be recommended for inclusion in all future post-mitigation tests.



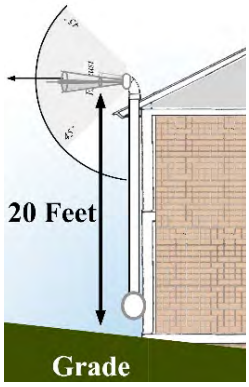
Informative advisory—Where time constraints allow, long-term testing subsequent to an initial short-term test is recommended.

7.4.12 *Horizontal trajectory*

While it is best practice to avoid horizontal trajectories, 90 degree horizontal exhaust trajectories are permitted if compliant with all other distances required in Section 7.4 and Section 7.4.12.1 or Section 7.4.12.2.

7.4.12.1 90-Degree horizontal discharges

If passing the edge of the roof, the *point of exhaust* for a 90-Degree horizontal discharge shall not be less than 20 feet (7.5 m) above grade nearest to the *point of exhaust*. The *point of exhaust* shall comply with Section 7.4.3 *Directional spread* including for distances above the breathing space where individuals congregate or traverse as stipulated in Section 7.4.7.

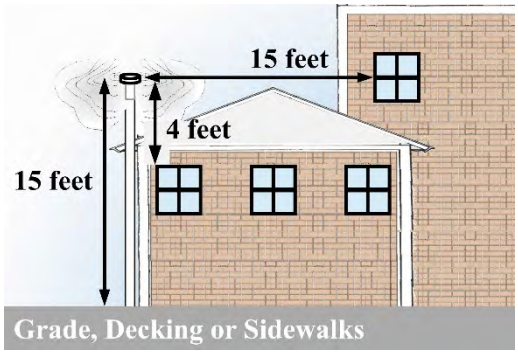


Where "T" style rain caps are configured for 90-Degree horizontal discharge in two directions, both discharge trajectories shall meet these requirements.

Informative advisory—Exhausts at a 90-degree angle are prone to form icicles during freezing weather that can fall to cause harm to property or individuals.

7.4.12.2 Rain caps

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



7.4.13 *Increased distances for large capacity systems*

When the ASD system is designed for larger airflow capacities with duct piping larger than 4-inch (100-mm), distances shall be increased beyond what is required in Section 7.4 to comply with Table 7.4.13.

Table 7.4.13

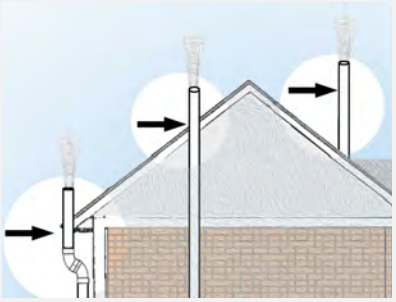
Pipe ID *As in Section 7.4* **3"- 4" Pipe** (10 cm)	Distance Away **Directional spread** *As in Section 7.4.3* **10 ft** (3 m)	Distance Away **Straight-line** *As in Section 7.4.4* **20 ft** (6 m)	Distance Above or To Side **Grade, *Operable Openings* and People** *Sections 7.4.5, 7.4.6 and 7.4.7*
For Larger Pipe ID	***Increase to***	***Increase to***	***Increase by***
6" (15 cm)	12 ft (3.6 m)	25 ft (7.6 m)	2 ft (1.8 m)
8" (20 cm)	18 ft (5.5 m)	30 ft (9 m)	4 ft (2.4 m)
10" (25 cm)	20 ft (6 m)	40 ft (12 m)	6 ft (1.8 m)
For pipe larger than 10" (25 cm)	Shall be increased to meet or exceed ASHRAE 62.1 2016, Appendix B, *Separation of Exhaust Outlets and Outdoor Air Intakes*		

7.4.14 *Protection from the elements*

7.4.14.1 *Informative Advisory*—Installation of an ASD system should include efforts to:

a) Provide support directly below fan locations and the discharge location that is adequate to ensure structural integrity of the pipe configuration.

For example, a physical support should be provided within 3 feet (91 cm) of the *point of exhaust* or within 18 inches (46 cm) above and below fans located in attics when pipe configurations might otherwise allow lateral or vertical movement of duct piping;



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

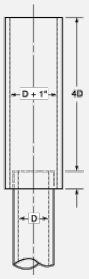
c) Secure and meet code requirements for any piping that extends high enough to require tethering or other means of lateral stability.

7.4.14.2 *Informative Advisory*—Icing

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

7.4.14.3 *Informative Advisory*—Rain and debris

In locations that experience blockage from debris or pervasive torrential rain or high winds each season, rain caps may sometimes be warranted. For concerns of debris or small animals that may enter the piping, the best choice is usually wire mesh described in Section 7.4.14.4. For torrential rain, a better choice is often a rain diverter as shown in this the diagram.



7.4.14.4 *Informative Advisory*—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 exhaust*, or that fan blades might cause injury to occupants. The resulting configuration required by Section 7.3.5 would not substantially diminish whole-system air volume capacity of the ASD system.

7.5 ASD Fan Installation Requirements

7.5.1 *Fan design*

ASD fans chosen shall be:

a) designed for *continuous duty* over a durable life span;

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

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

d) designed for ASD application, which includes a fan that is listed:

1. for thermal protection integral to the fan that prevents dangerous overheating of the motor;
2. for outdoor use when mounted on the exterior of buildings or installed in a weatherproof protective housing to result in code compliant protection against electrical shock; and
3. by the manufacturer to indicate ASD is one of the fans intended uses.

Note—Choosing a fan designed to minimize objectionable noise is also important.

7.5.2 *Safe locations required*

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

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

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

7.5.3 *Approved locations*

Where compliant with requirements in Section 7.5.2:

a) ASD fans are to be installed in attics, on the exteriors of buildings, or in garages that are not beneath conditioned or otherwise occupiable spaces.

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

b) ASD fans shall not be installed below ground.

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

7.5.4 *Fan Installation*

Installation of ASD fans shall comply with the following requirements:

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

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

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

d) ASD fans subject to extreme climate conditions shall be protected with thermal insulation, as needed, in accordance with Section 7.2.10.

SECTION 8: SEALING

8.1 Background and Accessibility

Sealing is not to be regarded as a permanent, stand-alone mitigation method. The purpose and viable goal of sealing efforts are limited to achieving a continuous air barrier that resists air movement between soil and indoor air.

Note—The use of sealing alone has not been shown to significantly or consistently reduce radon and soil gas entry into buildings.

8.1.1 *Accessibility to cracks and openings*

For the purpose of sealing requirements herein, the term "accessible" shall mean accessible without destructive or significant disassembly of building components or finishes. Inaccessible openings or cracks shall be disclosed to the *Client* and included in operation, maintenance and monitoring (OM&M) documentation if they may compromise the performance of a mitigation system and are determined to be beyond the ability of the *Contractor* to seal.

8.2 Sealant Materials

8.2.1 *Caulking cracks*

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

> *Informative advisory*—The chances of adverse effects on occupants from exposure to curing compounds are likely to increase with increased volumes of product application. When using such products, it is recommended to notify occupants of related hazards. Products that emit low volumes of chemical vapors during curing are recommended for protection all occupants and prospective occupants as a public health matter, and especially for sensitive occupants.

8.2.2 *For larger gaps*

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

8.2.3 *For larger openings*

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 for the application.

8.2.4 *For heated pipes and flues*

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

8.2.5 *For sump lids and hatchway doors*

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

8.3 Accessible Slab Cracks

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

> *Informative advisory*—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 accessible expansion or control joints in a slab.

8.3.1 *Perimeter channel drains*

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

8.4 Other Openings in Slabs or Foundation Walls

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

Note—Sealing of cracks and openings in foundation walls may sometimes be needed.

8.4.1 *Block walls*

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

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

Materials used to close openings and gaps shall be in accordance with Sections 8.2.3, 8.2.4 or equivalent.

8.4.2 *Basement de-watering systems*

If an ASD suction point must be installed into a basement de-watering system, exposed openings into the drainage system that can be sealed without compromising water drainage features shall be sealed, to include as required in Section 8.3.1.

Informative advisory—The intended vacuum extension under a slab will most often not occur if the suction point is drawing most of its air from nearby openings in the slab. The suction point location compared to nearby openings in a slab must be considered for achieving mitigation system goals. Consistent with this concern, it is best to close any exposed block wall foundation openings that are above the floor adjacent to a depressurized de-watering system.

8.5 Sumps and Pits

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

8.5.1 *Sump cover specifications*

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

8.5.1.1 Access

Sump covers shall include a removable port or section of the lid no less than 4 inches (10 cm) in diameter or equivalent method when a sump pump is installed in the pit to allow physical access for routine verification that pumps are operational.

Informative advisory—It is recommended that sump covers are designed to allow visual access to permit observations of conditions in the sump by way of a lid window, transparent lid or similar method.

8.5.1.2 Labeling required (sump covers)

Sump lid labels shall be provided in compliance with Section 9.4.6.1.

8.5.3 *Sump pump water discharge*

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

8.5.2 *Surface water relief (slabs)*

An alternative drainage system shall be provided and installed in accordance with guidance in Section 8.8.1 when sealing a sump or other slab opening that is the only drain relief for excess water on the slab surface.

8.6 Membranes Over Exposed Soil

Informative advisory—To break the connection between soil gas and the air within the building, soil and other fill material in *accessible crawl spaces* should be covered with concrete or a *soil gas retarder* membrane.

8.6.1 *Soil gas retarder material (membranes general)*

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

Note—These specifications include permeance, tensile strength and puncture resistance.

Informative advisory—Thicker sheeting or other means to protect the membrane are recommended where *crawl spaces* are used for storage or frequently entered for maintenance of utilities or equipment.

8.6.2 *Seams (membranes general)*

Seams where membrane materials are joined shall be sealed in accordance with Section 8.7.1 when sub-membrane *depressurization* (SMD) is employed. Otherwise, seams between adjacent membrane sheets shall be overlapped not less than 12 inches (30 cm).

8.6.3 *Repairs*

Tears or punctures in the membrane shall be sealed by one or more of the following methods:

a) A tape recommended by the membrane manufacturer; or
b) An additional sheet of the membrane material that covers and overlaps the tear or puncture not less than ~~12~~ 6 inches (~~30~~ 15 cm) on all sides and that is sealed with a caulk complying with ASTM C920 class 25 or greater or an equivalent method.

8.6.4 *Label membranes of access ports*

Membranes or the *crawl space* access port shall be labeled in accordance with Section 9.4.6.2.

8.6.5 *Surface water relief (membranes)*

Informative advisory—When observing indications that water is likely to collect on the surface of a membrane, it is best to inform the *Client* of observations, and to include any maintenance recommendations in OM&M documentation. Recommended solutions to consider include installing drainage for surface water in the lowest location in accordance with guidance in Section 8.8.1.

8.6.6 *Secure the membrane*

The membrane shall be durably secured to the walls or other surfaces for *crawl spaces* or portions of a *crawl space* that are expected to be regularly accessed for maintenance, storage or other purposes.

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 insects or otherwise protected.

8.7 Sub-Membrane Depressurization (SMD)

In addition to all requirements in Section 8.6, *soil gas retarder* membranes associated with *SMD* shall be sealed in accordance with Section 8.7.1 through Section 8.7.4 to result in a closed *soil gas collection plenum* under the membrane that resists air movement between soil and air above the membrane.

8.7.1 *SMD—Seams*

The seams between adjacent membrane sheets shall be overlapped and sealed with a compatible sealant or a caulk complying with ASTM C920 class 25 or greater, or a method such as membrane tape recommended by the manufacturer that results in an equivalent durable bond.

8.7.2 *SMD—Pipe penetrations*

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

Note—Gasket fittings, pipe clamps, roof flashing or an appropriate sealant are commonly used.

8.7.3 *SMD—Walls and foundation supports*

Membranes attached to foundation walls and at penetrations for foundation support components shall be sealed in a manner to resist soil gas movement between the soil and air above the membrane, to include:

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

8.7.4 *SMD—Inaccessible areas*

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

Where it can be demonstrated to be warranted, systems are permitted with a portion of the membrane edges to remain unclosed. Because this mitigation design inevitably combines sub-membrane *depressurization* (SMD), crawl space *depressurization* (CSD) and/or soil gas dilution, open membrane edges shall be disclosed to the *Client(s)* in accordance with Sections 10.3.1.4 and 12.1.4 along with justification for the design. Such design and installation shall also meet any additional requirements applicable in Sections 7.1.4 *Non-habitable air spaces* and Section 10.5 *Soil gas dilution*.

Note—The larger the area addressed by Sub-membrane *depressurization*, the greater the effectiveness of soil gas control while minimizing adverse effects of energy penalties and moisture within the *crawl space*.

8.8 Drains

8.8.1 *Drains to soil*

Informative advisory—It is recommended that a one-way flow drain or equivalent method with adequate flow capacity be installed for 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.

Considerations to weigh regarding use of one-way flow valves include: 1) potential for debris to clog the valves and designed capacity of the valve to drain adequate volumes of water, and 2) whether the airflow leaks between soil and indoor air could contribute to backdraft of atmospherically vented combustion appliances or defeat efforts to establish PFE.

8.8.2 *Utility drains to soil*

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

8.8.3 *Drains to daylight*

Informative advisory—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 prevents outside air from entering the ASD system while allowing an unobstructed flow of drain water to drain out of the water control system.

8.9 Sealed Isolation Assemblies

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

Note—*Sealed isolation assemblies* are sometimes employed to help break the connection between soil air and living spaces in order to isolate an airspace for *depressurization* or *pressurization*. A *sealed isolation assembly* might be the entire building shell when whole-building *pressurization* is applied, or an isolated airspace such as a *crawl space*; false floor, wall or ceiling; or other room below or adjacent to occupied spaces. Sealing can include sealants or gaskets on hatches or doors; sealed partition walls, floors or ceilings; and other configurations that resist air migration across a partition or any component of the isolation assembly. *Sealed isolation assemblies* can sometimes prevent adverse effects on combustion appliances located in an adjoining airspace. *Sealed isolation assemblies* are critical for appropriate implementation of *crawl space depressurization* (CSD).

8.9.1 *Sealing (isolation assemblies)*

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

8.9.2 *Labeling required (isolation assemblies):*

Access ports into *sealed isolation assemblies* shall be labeled in accordance with Section 9.4.8 c).

SECTION 9: REQUIREMENTS FOR ALL SYSTEMS

9.1 Long-Term OM&M Plan Required

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

9.2 Fan or Airflow Monitors

9.2.1 *Viewable operating range monitors*

All mitigation systems shall include a fan monitor mechanism to directly indicate if the fan, blowers or other integral mechanical components are operating within the established operating range. Design and installation of such monitors shall comply with requirements in both a) and b) of this Section 9.2.1.

a) Continuous Display
The monitoring device shall provide continuous display of a measured value within the established operating range, such as displayed on a manometer pressure gauge or electrical amperage gauge. The monitor shall be located inside or outside the building at a location where it is readily seen and protected from damage or degradation.

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

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

9.2.2 *Active notification monitors*

In addition to monitoring features required in Section 9.2.1, a monitoring mechanism is required that actively alerts occupants or other responsible individuals in the event of ASD fan or other mechanical failure. The alert mechanism shall include one or more of the following warning signals:

a) audible notification that is clear and distinct; or
b) visual light notification that is vividly observable; or
c) notification by telemetric means, such as by email or other electronic communication.

Notes—Sensors that trigger active notification are typically air pressure sensors, airflow sensors or circuits that detect electrical flow. Each method has its strengths and weaknesses. Product features that deserve strong considerations include but are not limited to:

a) Lasting service: For example, products that expose electrical or sensitive components to humid airflow within ASD piping can be prone to premature failure;
b) False notifications: Examples are temporary or seasonal conditions that can result in power outages, low pressure or low airflow. Delayed notification in terms of hours or even weeks is an example of methods that circumvent false notifications; and
c) Use restrictions: Monitors that can reliably detect fan failure for ASD systems that inherently generate weak pressure or airflow.

9.2.3 *Required for all fan or airflow monitor systems*

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

a) Fan monitors shall be protected from the elements, including if located outside of a building, and durable for the ambient environmental conditions;
b) Fan monitors shall be labeled in accordance with Section 9.4.3;

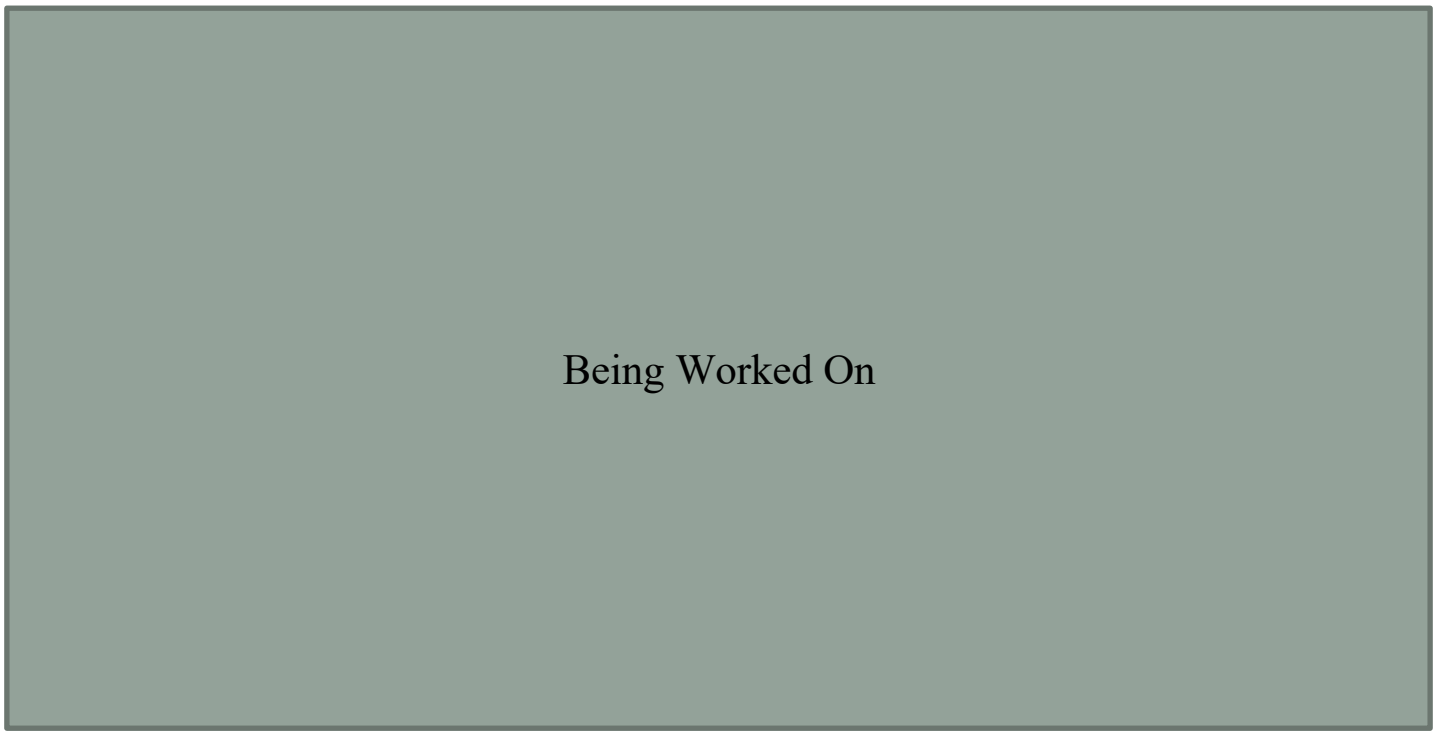
c) Battery operated components shall not be used unless they are equipped with a low-power warning feature;

d) Components 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; and

e) Components that require electricity for indication of fan failure shall not be powered by the same branch circuit as the mitigation system fan(s) unless the monitoring system has an independent means, such as a battery backup system, that actively alerts occupants or other individuals of component failure or branch circuit deactivation.

9.3 Electrical Requirements

All electrical components installed shall comply meet electrical code requirements. [6]



9.4 Labeling

9.4.1 *Materials and lettering for labels*

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).

9.4.2 *Label radon system(s)—primary label*

A system description label shall be placed on a primary component of each system, such as on duct piping near an ASD fan monitor, or within 12 inches (30 cm) of the electric service panel or other prominent location. The label title for radon mitigation systems shall state, "Radon Reduction System" or similar description of the systems purpose and the label shall include:

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

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;

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

e) notice of state or federal resources for radon information such as at: www.epa.gov/radon; the radon hotline 1-800-SOS-RADON (Persons with hearing or speech difficulties should call 711.); or at www.epa.gov/radon/find-information-about-local-radon-zones-and-state-contact-information; and

f) the party responsible for OM&M.

Note—The label might clarify that a homeowner is responsible for OM&M.

9.4.3 *Independent maintenance label*

When system maintenance and monitoring is the responsibility of someone other than the occupant:

a) At least one system description label shall be observable to maintenance staff or occupants; and

b) The observable label shall provide the following or equivalent message:

"This system is under the care, custody and control of _____."

(Insert name / phone number of the responsible party)

Informative advisory—Observable notices should include the dates of the latest radon test and inspection.

9.4.4 *Label fan monitors*

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 Section 9.4.1, the label title shall state "Radon Reduction System" or similar wording.

9.4.5 *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.

Informative advisory—For ASD systems, duct piping labels should be affixed at intervals not greater than 10 feet (3 m) along the developed length of piping.

9.4.6 *Label electrical disconnects*

Disconnects such as switches or outlets providing power to plugged connections for mitigation system fans shall be labeled or 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 – Do Not Turn Off," or "Radon Fan – Do Not Unplug."

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

9.4.7 *Label other mechanical and system control equipment*

Any major mechanical system installed, repaired or altered that is intended to aid mitigation 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. 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. System control settings for any mechanical equipment shall be clearly marked to indicate the settings that existed at the time mitigation goals were achieved.

9.4.8 *Label sealed components*

Certain components that are sealed to resist air movement between soil and indoor air shall be labeled in accordance with requirements in a), b), c) and d) of this Section 9.4.8.

a) Label Sump Covers (Section 8.5)
   Sump lids 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.

b) Label *Crawl Space*s or Membranes (Section 8.6)
   Where *soil gas retarder* membranes have been installed, a label or marking shall be located in a conspicuous place or places such as at access panels or immediately visible once entering the crawl space, such as on membrane material near the access location. The label title shall state:
   a) "Radon Reduction System" or similar wording; and
   b) "Do Not Alter. Damage or alteration to plastic membrane sheeting can negatively impact system performance" or similar wording.

c) Label Access Locations into *Non-habitable Airspaces* and *Sealed Isolation Assemblies*
   Where mitigation methods address air within a *non-habitable airspace* or other *sealed isolation assembly* that can be accessed, labels shall be provided in a conspicuous place on the outside of access ports, hatches and doors into the airspace or immediately visible once entering the airspace. to warn and instruct about hazards if entering. The label title shall state:
   a) "Radon Reduction System" or similar wording; and
   b) "Keep closed. Leaving open can negatively impact building safety" or similar wording.

d) Access to hazardous conditions
   Labeling shall additionally warn and instruct about known health and safety hazards where access is available into a *sealed isolation assembly,* such as an enclosed *crawl space,* addressed by the mitigation system. Label titles shall include essential health and safety guidance, such as:
   a) "Warning—Entry into this airspace can be hazardous. Precautions to ventilate this area are recommended."; and
   b) Descriptions of recommended personal safety procedures, such as the need for protective gloves, clothing or the use of respirators.

9.5 Inspection for Compliance

Prior to delivery and release of the completed system(s) for use, a *Qualified Radon Mitigation Professional* or *Qualified Soil Gas Mitigation Professional*, as applicable, shall have verified:

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

Any items found to not be in compliance with this standard and local statutes or codes shall be changed to be in compliance.

Exceptions: Professional obligations to identify and correct items that are noncompliant with this standard of practice or local statutes or codes shall have limits in accordance with Section 9.5.1.

9.5.1 *Limitations of professional obligations*

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

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

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

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

9.6 Review With Clients

Informative advisory—After installation(s), it is recommended that the *Contractor* 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.

9.7 Retention of Records

9.7.1 *Jobsites*

Records of all mitigation work performed shall be kept for no less than: 6 years, as long as state regulations require, or for the period of any warranty, whichever is longest.

9.7.2 *Health and safety records*

Health and safety records including *Mitigation Installer* radon exposure logs, as applicable, and other appropriate medical monitoring records shall be maintained for as long as required by state or federal statutes.

Informative advisory—Health and safety records should be maintained for a minimum of 20 years.

MIT Committee — Consensus Body Members

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

Non-voting Chair: Steve Tucker (OR)

Non-voting Assistance Team: Gary Hodgden (KS)

Stakeholder Group	Delegate	Affiliation
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(Regulated States *alternate*)	Patrick Daniels (IL)	Illinois Radon Program (IEMA)
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(Federal HUD)	Warren Friedman (DC)	HUD Office of Healthy Homes
(Federal EPA-VI)	Henry Shuver (DC)	EPA Office of Emergency Response (OSWER)
(Proficiency Program)	Shawn Price (NC)	National Radon Proficiency Program (NRPP)
(Proficiency Prog. *alternate*)	Kyle Hoylman (KY)	National Radon Proficiency Program (NRPP)
(Mitigation Prof. Homes)	Bill Brodhead (PA)	Professional Service Provider (Retired)
(Mitigation Prof. Homes *alternate*)	Aaron Fisher (PA)	Professional Service Provider
(Mitigation Lg. Bldgs)	Tony McDonald (OH)	Professional Service Provider
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(Building Inspectors)	Nate Burden (PA)	Professional Service Provider
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(Ventilation Manufacturer)	Hamid Massali (KS)	Systemair
(Ventilation Manufacturer *alternate*)	Michelle Festa (PA)	Festa Radon Technologies

The Consensus Process and Continuous Maintenance

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

This standard is under continuous maintenance by the AARST Consortium on National Radon Standards a program has been established for regular publication of addenda or revisions, including procedures for timely consensus action on requests for change to any part of the standard.

User Tools: User tools are posted online (https://standards.aarst.org/public-review/) as they become available such as interpretations and approved addenda updates across time.

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