

## APPENDIX E

# CHAPTER 9B-53 FLORIDA STANDARD FOR MITIGATION OF RADON IN EXISTING BUILDINGS

### 9B-53.001 Purpose and Intent. (Repealed)

### 9B-53.002 Definitions.

### 9B-53.003 Department activities.

### 9B-53.004 Florida Standard for Mitigation of Radon in Existing Buildings, Adopted.

#### 9B-53.001 Purpose and Intent.

Specific Authority 553.98(1) Florida Statutes.

Law Implemented 553.98 Florida Statutes.

History - New 2-26-91, Repealed 2-20-96.

#### 9B-53.002 Definitions.

For the purpose of this rule chapter, the following words, unless the context does not permit such meaning, shall have the meanings indicated:

- (1) Department — the Department of Community Affairs.
- (2) Exempted buildings — structures not intended for human occupancy.
- (3) Existing building — any structure erected prior to the adoption by the local government of the building code presently enforced in that jurisdiction, and which has been issued a certificate of occupancy or has been legally occupied.
- (4) Radon — a naturally occurring, chemically inert, radioactive gas. It is part of the uranium-238 decay series, and is the direct decay product of radium-226.
- (5) Standard — the *Florida Standard for Mitigation of Radon in Existing Buildings*.

Specific 553.98(1) Florida Statutes.

Law Implemented 553.98 Florida Statutes.

History - New 2-26-91.

#### 9B-53.003 Department Activities.

- (1) The Department may interpret and clarify various aspects of the *Florida Standard for Mitigation of Radon in Existing Buildings*. The Department will promulgate such rules and regulations as will from time to time be deemed necessary to carry out its purpose.
- (2) The department shall provide training on the use of the standard.
- (3) Within two years of the date of adoption of the standard, and at least biennially thereafter, the Department shall update and adopt standards based on the most current research. Any person may submit recommenda-

tions for proposed revisions or modifications to the standard to the Department for consideration. Such proposed revisions and modifications shall be submitted in writing on Department of Community Affairs Form #200, the “Proposed Code Change Request” form, incorporated herein by reference, effective 1991. Such proposals shall include an identification of the section of the standard to be revised, the new proposed language, and a justification or reason for the change. The Department shall conduct a public hearing(s) in accordance with the requirements of Chapter 120, Florida Statutes. Proposed revisions or modifications deemed necessary and appropriate by the Department shall then be adopted for implementation pursuant to Chapter 120, Florida Statutes, and Section 553.98, Florida Statutes.

- (4) The Department may contract for supplemental consulting services necessary for performance of its duties.
- (5) Any person may request information or interpretations regarding the application and administration of the standards adopted herein, provided any oral request is later confirmed by the party to the Department in writing.
- (6) The Department shall collect such data as necessary to evaluate the effectiveness and extent of implementation of this standard.

Specific 553.98(1), 120.53(1)(a) Florida Statutes.

Law implemented 553.98 Florida Statutes.

History — New 2-26-91.

9B-53.004 Florida Standard for Mitigation of Radon in Existing Buildings.

- (1) The June 1994 edition of the *Florida Standard for Mitigation of Radon in Existing Buildings*, that edition of the standard having an effective date of June 1, 1994, is herein incorporated by reference. The Department shall revise, update and maintain the *Florida Standard for Mitigation of Radon in Existing Buildings*.
- (2) A copy of the above referenced standard as amended has been filed with these regulations with the Secretary of State. The standard is also available for reference and inspection at the Department offices in Tallahassee, Division of Housing and Community Development.

Specific 553.98(1) Florida Statutes.

Law Implemented 553.98 Florida Statutes.

History - New 2-26-91, Amended 5-10-94.

## FLORIDA STANDARD FOR MITIGATION OF RADON IN EXISTING BUILDINGS

Effective: June 1, 1994

### INTRODUCTION

Radon is a radioactive gas which occurs naturally in soils. It has been found in high concentrations in some areas of many states including Florida. Radon can enter buildings through floor cracks and openings driven by pressure differences which result from space conditioning and ventilation systems, temperatures and wind. Its radioactive decay products can cause lung cancer when breathed.

The following building standards have been developed in accordance with Section 553.98, Florida Statutes to protect the public by setting standards for mitigation of radon concentrations in existing buildings.

### PRINCIPAL APPROACHES FOR RADON MITIGATION IN EXISTING BUILDINGS

This building standard addresses five principal approaches to mitigating radon accumulation in buildings:

1. Radon control using the building structure as a gas barrier. This is a passive approach which requires no fans (see Chapter 4).
2. Radon control by lowering the air pressure in the soil beneath the building relative to the indoor air pressure of the building. This is an active approach which requires one or more electrically driven fans (see Chapter 6).
3. Radon control by raising the indoor air pressure in the building relative to the air pressure in the soil beneath the building. This is an active approach which may either use an existing heating and air-conditioning system blower or an additional electrically driven fan. This approach may have significant negative impact on the annual energy consumption of the building due to heating and cooling of additional outdoor air in addition to fan power consumption (see Chapter 5).
4. Radon control by ventilating the building with outdoor air. This is an active approach which may either use an existing heating and air-conditioning system blower or an additional electrically driven fan. This approach may have significant negative impact on the annual energy consumption of the building due to heating and cooling of additional outdoor air and to increased fan power consumption (see Chapter 5).
5. Radon control by separating the building and source with a ventilated region of outside air. This approach is generally applicable to buildings with a crawl space, and may be either active or passive (see Chapter 6).

The standard does not mandate the implementation of any of the principal approaches listed above. It establishes minimum standard practices for each of the principal approaches. Implementation of these minimum standard practices does not guarantee successful mitigation. A post-mitigation indoor radon concentration test must be conducted to demonstrate success-

ful mitigation in compliance with the rules of the Department of Health and Chapter 3 of this standard.

### FOREWORD

The practices incorporated in the standard are based on experience, testing and in certain cases expectations founded on interpretation of fundamental physical principles. The demonstration at successful mitigation utilizing the different approaches incorporated in this standard varies.

Subslab depressurization, crawlspace ventilation, and submembrane depressurization have the highest demonstrated success rates. Success with these approaches has in many cases required modification and enhancement of systems based on post mitigation indoor radon tests.

Effective sealing of accessible entry points has been demonstrated to make a significant impact on indoor radon concentrations. However, mitigation by sealing entry points alone has not had a demonstrated level of success equivalent to the aforementioned active mitigation systems. This is understood to be principally because of the difficulty in locating and treating enough entry points to resist the driving forces which cause radon laden soil gas and crawlspace air entry. The significance of entry points and their treatment can be ranked based on their size, location and the degree of depressurization of the building space surrounding them. Design and construction of successful sub-slab depressurization systems also depends on entry point size, location and the magnitude of coincident building depressurization. Attention to limiting entry at points of high depressurization such as space conditioning system return plenums, mechanical closets, etc., is critical to the success of both passive mitigation and minimally designed active mitigation systems.

Building pressurization is expected, based on fundamental principles, to provide a potentially effective mitigation strategy. The effectiveness for individual cases may rely on occupant behavior as well as building leakage characteristics. Pressurization systems also have potentially major impacts on occupant comfort, humidity control and energy use.

Building ventilation has potential application where low indoor radon concentrations exist initially. This approach can have significant impacts on the ability of a building's climate control systems to perform adequately in the hot and humid climate and on energy consumption for comfort conditioning.

None of the techniques in this standard are guaranteed to provide adequate mitigation. The complexities of existing buildings and the inherent limitations in the ability to determine the building's construction characteristics result in conditions too diverse for a standard to anticipate. Successful mitigation depends on the experience of the mitigator to make an effective selection of mitigation options. A post mitigation indoor radon test is essential for determining if initial mitigation has been successful. Proper maintenance and operation of mechanical systems implemented as part of active mitigation approaches are critical to the long term effectiveness of mitigation where such systems are used. Periodic retests of indoor radon concentrations at least every two years, and when the building undergoes significant structural alterations, are ad-

vised for all mitigation approaches to provide continued assurance of safe indoor radon levels.

## CHAPTER E1 ADMINISTRATION

### E101 General.

**E101.1 Title.** Provisions in the following chapters and sections shall constitute and be known as, and may be cited as, the *Florida Standard For Mitigation of Radon in Existing Buildings*, hereinafter referred to as “this standard.”

### E101.2 Intent.

**E101.2.1 General.** This standard applies to those alterations to existing buildings that are implemented to reduce indoor radon concentrations, in order to enable control of human exposure to indoor radon and its progeny.

**E101.2.2 Limits.** This standard is intended to improve indoor air quality with respect to radon. These standards are based on the principle of limiting radon concentrations to levels as low as reasonably achievable, within the limitations at current technology and economic feasibility. Use of this standard does not guarantee radon will be limited to any specific concentrations in a building; however, experience indicates a reduction in radon and its progeny can be realized by using the mitigation strategies described in this standard.

**E101.2.3 Durability.** Experience with the radon-resistant construction details contained herein has been limited to a fraction of the average life of a building. Implementation of radon mitigation measures described herein does not guarantee that mitigation effects will be permanent. Periodic inspection and maintenance of the radon mitigation measures and retesting of indoor radon levels is the responsibility of the building owner.

### E101.3 Scope.

**E101.3.1 Applicability.** The provisions of this standard shall apply to the construction or alteration associated with the mitigation of indoor radon in every building or structure not specifically exempted. Exempted occupancies shall include structures not intended for human occupancy.

**E102 Alternate materials and methods.** The provisions of this standard are not intended to prevent the use of any material or method of construction not specifically prescribed by this standard, provided any such alternate is demonstrated according to the provisions of Chapter E3 of this standard, to be effective at the control of radon.

**E103 Compliance.** All mitigation shall be deemed to be in compliance with this standard when: (a) the techniques utilized in mitigation meet the minimum standard practices established herein; and (b) the building is determined to meet the “not to exceed” exposure standard established by the Department of Health (DOH) or the level specified in any warranty or guarantee provided to the client. The Department of Health (DOH) has set an exposure standard for radon decay products in build-

ings at an annual average of 0.02 working levels. Under conditions often encountered in homes, this is equivalent to an annual average radon level of 4.0 picocuries per liter. Radon levels in most buildings can be reduced to 4.0 picocuries per liter or below.

Testing must be conducted in accordance with all applicable sections of the DOH *Florida Administrative Code* Chapter 64E-5 and in accordance with Chapter E3 of this standard.

## CHAPTER E2 DEFINITIONS

**E201 General.** For the purposes of this standard, certain abbreviations, terms, phrases, words and their derivatives shall be set forth in this chapter. Where terms are not defined therein, they shall have the meaning as noted in the applicable locally adopted code. Words not defined in any locally adopted code shall have the meanings in *Webster’s Ninth New Collegiate Dictionary*, as revised.

### E202 Definitions.

**AUTOMATIC.** Self-acting, operating by its own mechanism when activated by some personal influence, as for example, a change in current, pressure, temperature or mechanical configuration.

**CAULKS AND SEALANTS.** Those materials which will significantly reduce the flow of gases through small openings in the building shell. Among those used are:

**CONDITIONED SPACE.** All spaces which are provided with heated and/or cooled air or which are maintained at temperatures over 50°F (10°C) during the heating season, including adjacent connected spaces separated by an uninsulated component (e.g. basements, utility rooms, garages, corridors).

**CONTRACTOR.** A building trades professional licensed by the state, including certified mitigation business.

**CRAWLSPACE.** An area beneath the living space in some houses, where the floor of the lowest living area is elevated above grade level. This space (which generally provides only enough head room for a person to crawl in), is not living space, but often contains utilities.

**DEPRESSURIZATION.** A condition that exists when the measured air pressure is lower than the reference air pressure.

**ELASTOMERIC.** That property of macromolecular material of returning rapidly to approximately the initial dimensions and shape, after substantial deformation by a weak stress and release of stress.

Mil - 1 mil = 1/1000 of an inch

**MITIGATION.** The act of making less severe, reducing or relieving. For the purposes of this standard, a building shall not be considered as mitigated until it has been demonstrated to meet the standards of compliance specified in Section 103.

**OUTSIDE AIR.** Air taken from the outdoors and, therefore, not previously circulated through the system.

**PICOCURIE (pCi).** A unit of measurement of radioactivity. A curie is the amount of any radionuclide that undergoes exactly 3.7 x 10<sup>10</sup> radioactive disintegrations per second. A

picocurie is one trillionth (10-12) of a curie, or 0.037 disintegrations per second.

**PICOCURIES PER LITER (pCi/l).** A common unit of measurement of the concentration of radioactivity in a gas. A picocurie per liter corresponds to 0.037 radioactive disintegrations per second in every liter of air.

**RADIUM (Ra).** A naturally occurring radioactive element resulting from the decay of uranium. It is the parent of radon.

**RADON (Rn).** A naturally occurring, chemically inert, radioactive gas. It is part of the uranium-238 decay series, it is the direct decay product of radium-226.

**SOIL DEPRESSURIZATION SYSTEM.** A system designed to withdraw air below the slab through means of a vent pipe and fan arrangement (active).

**SOIL GAS.** Gas which is always present underground, in the small spaces between particles of the soil or in crevices in rock. Major constituents of soil gas include nitrogen, water vapor, carbon dioxide, and (near the surface) oxygen. Since radium-226 is essentially always present in the soil or rock, varying levels of radon-222 will exist in the soil gas.

**SOIL GAS RETARDER.** A concrete slab; polyvinylchloride (PVC) ethylenepropylene diene terpolymer (EPDM), neoprene or other flexible sheet material; or other system of materials placed between the soil and the building for the purpose of reducing the flow of soil gas into the building.

**URETHANE.** A crystalline ester-amide used as a gelatinizing agent for cellulose acetate or cellulose nitrate. A component of polyurethane used in making flexible and rigid foams, elastomers, and resins for coatings and adhesives.

**VENTILATION.** The process of supplying or removing air, by natural or mechanical means, to or from any space. Such air may or may not have been conditioned.

## CHAPTER E3 TESTING

**E301 General.** Where mitigation projects are performed by commercial mitigation contractors, all tests performed to demonstrate compliance with this standard must be performed by a certified radon measurement business certified by the Florida Department of Health and Rehabilitative Services. Compliance tests must be performed by a measurement business independent of the mitigation contractor.

**E301.1 Test procedures.** Testing shall be conducted according to the procedures in the appropriate sections of EPA 402-R-92-004, *Indoor Radon and Radon Decay Product Measurement Device Protocols* (US EPA, July, 1992) and EPA 402-R-92-003, *Protocols for Radon and Radon Decay Product Measurements in Homes* (US EPA, June 1993).

**E301.2 Acceptable devices and test periods.** Selection of devices, operational devices, and test periods shall be in accordance with EPA 402-R-92-004.

**E301.2.1 Acceptance criteria.** The building will be deemed to comply with the standard if post mitigation test results performed in accordance with this chapter and all applicable sections of Chapter 64E-5, *Florida*

*Administrative Code*, Part XII, Subpart A, meet the “not to exceed” exposure standard established by the DOH or the level specified in any warranty or guarantee to the client.

## CHAPTER E4 STRUCTURAL SEALING AND HVAC SYSTEM BALANCING

**E401 General.** When accessible cracks, penetrations, and joints in floors and walls in contact with the soil, or separating conditioned space from a crawl space, are sealed to reduce radon entry, they shall as a minimum be sealed in accordance with the provisions of this chapter. In addition, when acceptable indoor radon concentrations are attained by the sealing of ducts and plenums, they shall be done in accordance with the provisions of this chapter.

**E402 Sealing cracks and joints in concrete floors and walls.**

**E402.1 Small cracks and joints.** Cracks and joints with widths less than  $1/16$  inch (1.6 mm) shall be repaired by the application of an elastomeric material capable of withstanding at least 25 percent extension and extending at least 4 inches (102 mm) beyond the length and width of the crack, or by the method described in Section E402.2.

**E402.2 Large cracks and joints.** Cracks with widths larger than  $1/16$  inch (1.6 mm) shall be enlarged to a recess with minimum dimensions of  $1/4$  inch by  $1/4$  inch (6 mm by 6 mm) and sealed with an approved caulk or sealant applied over a sealant backer in accordance with the manufacturer’s recommendations. Cracks and joints with widths less than  $1/16$  inch (1.6 mm) may also be sealed in this manner if traffic, floor covering material or other conditions are inconsistent with the provisions of Section E402.1.

**E402.3 Utility penetrations, work spaces and large slab openings.** Where large openings through the slab exist, such as at a bath tub drain or a toilet flange, an acceptable method for sealing the exposed soil shall include fully covering the exposed soil with a solvent based plastic roof cement or other approved material as per Section E405.1 to a minimum depth of 1 inch (25 mm). Where voids between masonry foundation walls and the slab edge are accessible, and are sealed in order to reduce radon entry, nonshrinking cementitious material may be used.

**E402.4 Utility penetrations in crawlspace walls.** Utility penetrations or other openings through hollow cavity walls that separate conditioned space from soil, or conditioned space from a crawl space, shall be sealed with an approved material on both the interior and exterior faces of the wall. Penetrations and openings through solid concrete floors or walls may be sealed on only the interior face.

**E402.5 Hollow masonry walls.** All openings for electrical boxes or plumbing or other wall penetrations in hollow masonry walls, that are sealed in order to reduce radon entry, shall be sealed with an approved caulk and/or gasket on the interior face of the wall.

**E402.6 Sumps.** Any sump located in a conditioned portion of a building, or in an enclosed space directly attached to a conditioned portion of a building, shall be covered by a lid.

An air tight seal shall be formed between the sump and lid and at any wire or pipe penetrations.

#### **E403 Floors over crawlspace.**

**E403.1 Reinforced concrete floors.** Cracks and penetrations through concrete floors constructed over crawlspaces, and that are sealed in order to reduce radon entry, shall be sealed in conformance with all applicable provisions of Section E402.

**E403.2 Wood-framed floors.** All penetrations through the subfloor, including but not limited to plumbing pipes, wiring and ductwork, that are sealed in order to reduce radon entry, shall be sealed with an approved caulk in accordance with the manufacturer's recommendations. Where large openings are created by plumbing, such as at bath tub drains, sheet metal or other rigid and durable materials shall be used in conjunction with sealants to close and seal the opening.

#### **E404 Combined construction types.**

**E404.1 Structural chases.** Openings which connect a crawlspace and the space between floor or ceiling joists, wall studs, or any other hollow chase adjoining conditioned space, that are sealed in order to reduce radon entry concentrations, shall be closed and sealed in accordance with the appropriate portions of this chapter.

**E404.2 Wall penetrations.** Openings for electrical or plumbing connections in a wall between a crawlspace and a conditioned space, that are sealed in order to reduce radon entry, shall be closed and sealed with an approved caulk and/or gasket.

**E404.3 Doors.** When a door is located in a wall between a crawlspace and the conditioned space, it shall be fully weatherstripped or gasketed.

#### **E405 Approved sealant materials.**

**E405.1 Sealants.** Acceptable caulks and sealants shall conform with ASTM C 920-87, *Standard Specifications for Elastomeric Joint Sealants*, and ASTM C 962-86, *Standard Guide for Use of Elastomeric Joint Sealants*. All sealant materials and methods of application shall be compatible with the location, function and material of the surface or surfaces being sealed.

#### **E406 Space conditioning and ventilation systems.**

**E406.1 Mechanical system connections.** Condensate drains and pipe chases for freon lines that provide a direct connection between the indoor air and the soil shall be sealed in accordance with the provisions of this section.

**E406.1.1 Condensate drains.** Condensate drains shall connect to air outside the building perimeter at a height of at least 6 inches (172 mm) above the finished grade ground level. Chases through which the condensate and refrigerant lines run shall not terminate in the air return plenum or duct. If a portion of the condensate pipe does not drop below the height of the condensate outlet, then a trap should be installed to prevent suction of outdoor air into the air handler.

**E406.1.2 Freon chases.** Freon chases that terminate within the house or garage shall be sealed with closed

cell expanding foam material. Pipe insulation shall be removed from the freon lines at the point of the seal to provide for complete bond between the freon line and the foam.

#### **E406.2 Air distribution systems.**

**E406.2.1 Sealing.** All ducts and plenums that are modified or sealed in order to achieve acceptable indoor radon concentrations, shall be made airtight in accordance with the current edition Chapter 13 of the *Florida Building Code, Building*. If ductboard is used, the seal must be on the foil side of the ductboard. Mastic sealing systems designed specifically for the conditions of use shall be used in accordance with the manufacturer's recommendations to close and seal leaks in ducts or plenums. Modifications to ducts located in crawlspaces or service areas of attics shall incorporate support, cover or other protection from accidental damage.

**E406.2.2 Return plenums.** If acceptable indoor radon concentrations are achieved in part by construction or modification of a return plenum, it shall be constructed with materials and closures which produce a continuous air barrier for the life of the building. Construction of the return plenum shall be done such that a continuous air barrier completely separates the plenum from adjacent building structures. If duct board is the primary air barrier, then the joints shall be sealed by fabric and mastic on the foil side of the board.

### **CHAPTER E5 ENGINEERED SYSTEMS**

**E501 General.** Design of radon mitigation systems must be signed by a certified radon mitigation specialist. Additionally, for radon mitigation systems that rely upon ventilation or pressurization of the conditioned space for radon control, the plans and specifications for the ventilation or pressurization system shall be signed and where appropriate sealed according to the provisions of Section 471.003, Florida Statutes and Section 553.79, Florida Statutes. Such systems may include, but are not limited to, one of the following:

**E501.1 Air pressure control.** Indoor pressure may be elevated relative to subslab levels.

**E501.2 Ventilation.** An indoor air exchange rate may be maintained in a sufficient quantity to satisfy Section E502.1.

#### **E502 Design criteria.**

**E502.1 Compliance.** Any engineered radon mitigation system in compliance with this standard must maintain an indoor radon concentration equal to or less than the "not to exceed" radon exposure standard established by the Florida DOH during the primary hours of occupancy. The interior surfaces of buildings pressurized as the primary means of radon control, must be sealed to Section 606, Air infiltration, Chapter 13, Energy Efficiency, of the *Florida Building Code, Building*. The design values for total ventilation and air exchange rates for each space occupancy shall not exceed the minimums provided for each space occupancy

classification in Chapter M4, Ventilation, of the *Florida Building Code, Mechanical* or the ASHRAE 62 Alternative. When these air quantities are not sufficient to maintain indoor concentrations below the acceptable level, other mitigation options shall be used.

**E502.2 Tests.** The indoor radon concentration must be measured in accordance with Chapter 3 and certified as acceptable according to current Florida DOH rules.

**E502.3 System monitoring device.** Any engineered system must have a mechanism installed to automatically indicate failure of the system to building occupants, which shall be either a visual device conveniently visible to building occupants, or a device that produces a minimum 60 db audible signal.

## CHAPTER E6 SOIL DEPRESSURIZATION SYSTEMS

**E601 General.** This chapter provides minimum design and construction criteria for active soil depressurization systems. The operating soil depressurization system shall maintain under the building a pressure less than the indoor air pressure. Systems for buildings with slab on grade floors shall as a minimum comply with Section E603.1. Systems for buildings with off grade floors shall as minimum comply with Section E603.2 or E604.

### E602 Soil depressurization system installation criteria.

#### E602.1 Suction fans.

**E602.1.1 Fan.** Suction shall be provided by a fan, rated for continuous operation and having thermal overload with automatic reset features.

**E602.1.2 Seal.** The suction fan shall be designed and manufactured to provide an air-tight seal between the inlet and outlet ducts and the fan housing. The fan housing must remain air-tight at air pressure equal to the rated maximum operating pressure.

**E602.1.3 Rating.** The rating specific to system type shall apply (see Sections E603.1 and E603.2).

**E602.1.4 Location.** The suction fan shall be located where any leakage of air from the exhaust portion of the fan or vent system shall be into outside air. No pressurized portion of the vent system shall pass through conditioned space.

**E602.1.5 Power supply.** Electrical power shall be supplied to the fan in compliance with the provisions of Chapter 27 of the *Florida Building Code, Building* and any additional local regulations.

**E602.2 System monitoring device.** The soil depressurization system shall include a system monitoring device which shall be either a visual device, conveniently visible to building occupants, or a device that produces a minimum 60 db audible signal, activated by the loss of pressure or flow in the vent pipe.

#### E602.3 Vents.

**E602.3.1 Material.** Piping material shall be of any type approved by locally adopted codes for plumbing vents.

**E602.3.2 Slope.** The vent piping shall have a minimum slope of  $\frac{1}{8}$  inch (3.2 mm) per foot in order to drain any condensation back to soil beneath the soil gas retarder. The system shall be designed and installed so that no portion will allow the excess accumulation of condensation.

**E602.3.3 Terminals.** Vent pipes shall be terminated in locations that will minimize human exposure to their exhaust air. Locations shall be above the eave of the roof. To prevent reentrainment of radon, the point of discharge from vents of fan-powered soil depressurization shall meet all of the following requirements:

- (1) be 10 feet (3048 mm) or more above ground level,
- (2) be 10 feet (3048 mm) or more from any window, door, or other opening (e.g., operable skylight, or air intake) into conditioned spaces of the structure, and
- (3) be 10 feet (3048 mm) or more from any opening into an adjacent building. The total required distance [10 feet (3048 mm)] from the point of discharge to openings in the structure shall be measured either directly between the two points or be the sum of measurements made around intervening obstacles. If the point of discharge is at or below any window, door, or other opening into conditioned spaces of the structure the total required distance [10 feet (3048 mm)] shall be measured horizontally between the two points.

**E602.3.4 Labeling.** All exposed components of the soil depressurization system shall be labeled “Soil Gas System” to prevent accidental damage or misuse. Labels shall be on a yellow band, 2 inches (51 mm) wide and spaced three feet apart on all components.

**E602.3.5 Clearance.** All vent piping shall be located in compliance with existing and applicable codes, with regards to clearances from mechanical equipment and flues and notching of structural members. No vent shall penetrate a fire wall or party wall.

### E603 Soil depressurization system design criteria.

**E603.1 Subslab depressurization systems.** Depressurization systems in sands or other granular soils shall as a minimum and within the practical limits posed by the building, meet the following requirements:

**E603.1.1 Arrangement.** Within the practical limits posed by the building, suction points shall be distributed as nearly equally as possible, and as follows:

- (1) A maximum of 1,300 square feet (121 m<sup>2</sup>) per suction point, and
- (2) Each required suction point shall be located not less than 6 feet (1829 mm) nor more than 18 feet (5486 mm) from the perimeter; and
- (3) Multiple suction points shall be located within 36 feet (10 973 mm) of each other.

**E603.1.2 Pipe size.** Suction pipe should be of a size appropriate to the air-flows of the system, a minimum of  $\frac{1}{2}$  inches (38 mm) in diameter at the fan, and shall not be reduced between the fan outlet and the final termination point.

**E603.1.3 Pits.** Suction point pits excavated below the slab shall be sized to provide adequate pressure distribution beneath the slab. Dimensions of 22 inches (559 mm) in diameter and 11 inches (279 mm) deep, or excavation of 1 cubic foot (.02832 m<sup>3</sup>) of soil, shall be presumed to meet this requirement. Further the pit shall be filled with 1 inch (25 mm) size gravel.

**E603.1.4 Rating.** Suction fans must be capable of developing minimum flows appropriate to the system at 1 inch water column pressure. Fans producing 100 cubic foot per minute (cfm) (.047 m<sup>3</sup>/s) at 1 inch water column pressure are presumed to meet this requirement.

### E603.2 Submembrane depressurization systems.

**E603.2.1 General.** Submembrane soil depressurization systems are essentially the same as subslab depressurization systems, but without the cover of a concrete slab. The membrane shall be protected from wind uplift in accordance with locally adopted codes. Systems may be of suction pit or continuous ventilation mat design.

**E603.2.2 Membrane soil-gas retarder.** A membrane soil-gas retarder shall consist of a 8 mil or thicker single ply polyethylene sheet or other sheeting material of equal or lower permeability and equal or greater strength. Place sheeting to minimize seams and to cover all of the soil below the building floor. Retarders must provide excellent environmental stress crack resistance, impact strength and high tensile strength including additives to retard polymer oxidation and UV degradation. Where pipes, columns or other objects penetrate the soil-gas retarder, it shall be cut and sealed to the pipe, column or penetration. All seams of the membrane shall be lapped at least 12 inches (305 mm). Punctures or tears in the membrane shall be repaired with the same or compatible material.

**E603.2.3 Depressurization systems in sands or granular soils with suction pit design.** Submembrane soil depressurization systems covering sand or other granular soils shall meet the requirements of Section E602.1, with the suction pits filled with 1 inch (25 mm) size gravel which shall be covered by 1/8 inch (3.2 mm) thick steel plate, 16 gage corrugated sheet metal, or equivalent sheets of other termite resistant structural materials, in compliance with existing and applicable codes.

**E603.2.4 Depressurization systems in sands or granular soils with continuous ventilation mat(s) design.** Depressurization systems in sands or other granular soils and utilizing a continuous ventilation mat shall have at least 216 square inches (.14 m<sup>2</sup>) of suction area per lineal foot and shall meet the following requirements:

**E603.2.4.1 Arrangement.** Suction points shall be equally distributed as follows:

- (1) The suction point should be centrally located along the length of each unconnected strip of mat; and

- (2) Mat strips should be oriented along the central axis of the longest dimension of the crawlspace; and
- (3) A minimum of one strip shall be used for crawlspaces having widths up to 50 feet (15 240 mm) [additional strips should be added for each additional crawlspace width of up to 50 feet (15 240 mm) width]; and
- (4) The mat strip shall extend to not closer than 6 feet (1828 mm) of the inner stemwall at both ends of the building; and
- (5) A separate suction point and fan shall be installed for each 100 feet (30 480 mm) linear length of ventilation mat.

**E603.2.4.2 Pipe size.** Suction pipe shall be a minimum 3 inch (76 mm) diameter and shall be carried full size to the final termination point.

**E603.2.4.3 Rating.** Suction fans must be capable of developing minimum flows of at least 100 cfm (.047 m<sup>3</sup>/s), at 1-inch water column (.2488 kPa) pressure.

### E604 Crawlspace ventilation.

**E604.1 Active ventilation of the crawlspace.** Structures that rely upon active (fan-driven) ventilation of the crawlspace for radon control, shall utilize fans rated for continuous operation, and shall be equipped with a fan failure warning device as specified in Section 603.2, and shall have a thermal overload with automatic reset feature.

**E604.1.1 Vents.** Vents connecting the crawlspace with outside air shall be sized and located as required to provide mitigation of the indoor radon concentration as demonstrated by post-mitigation test, and shall not be equipped with operable louvers or other means for adjustment by building occupants. Where adjustable vents are used, they shall be permanently fixed in the proper adjustment by the mitigation contractor.

**E604.1.2 Plumbing.** Plumbing located in the crawlspace shall be adequately protected from freezing by insulation or means other than restriction of ventilation air.

