APPENDIX F

RADON CONTROL METHODS

SECTION AF101 SCOPE

AF101.1 General. This appendix contains requirements for new construction in *jurisdictions* where radon-resistant construction is required.

Inclusion of this appendix by *jurisdictions* shall be determined through the use of locally available data or determination of Zone 1 designation in Figure AF101.

SECTION AF102 DEFINITIONS

AF102.1 General. For the purpose of these requirements, the terms used shall be defined as follows:

SUBSLAB DEPRESSURIZATION SYSTEM (Passive). A system designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a vent pipe routed through the *conditioned space* of a building and connecting the sub-slab area with outdoor air, thereby relying on the convective flow of air upward in the vent to draw air from beneath the slab.

SUBSLAB DEPRESSURIZATION SYSTEM (Active). A system designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a fan-powered vent drawing air from beneath the slab.

DRAIN TILE LOOP. A continuous length of drain tile or perforated pipe extending around all or part of the internal or external perimeter of a *basement* or crawl space footing.

RADON GAS. A naturally-occurring, chemically inert, radioactive gas that is not detectable by human senses. As a gas, it can move readily through particles of soil and rock and can accumulate under the slabs and foundations of homes where it can easily enter into the living space through construction cracks and openings.

SOIL-GAS-RETARDER. A continuous membrane of 6-mil (0.15 mm) polyethylene or other equivalent material used to retard the flow of soil gases into a building.

SUBMEMBRANE DEPRESSURIZATION SYSTEM. A system designed to achieve lower-sub-membrane air pressure relative to crawl space air pressure by use of a vent drawing air from beneath the soil-gas-retarder membrane.

SECTION AF103 REQUIREMENTS

AF103.1 General. The following construction techniques are intended to resist radon entry and prepare the building for post-construction radon mitigation, if necessary (see Figure AF102). These techniques are required in areas where designated by the *jurisdiction*.

AF103.2 Subfloor preparation. A layer of gas-permeable material shall be placed under all concrete slabs and other floor systems that directly contact the ground and are within the walls of the living spaces of the building, to facilitate future installation of a sub-slab depressurization system, if needed. The gas-permeable layer shall consist of one of the following:

- A uniform layer of clean aggregate, a minimum of 4 inches (102 mm) thick. The aggregate shall consist of material that will pass through a 2-inch (51 mm) sieve and be retained by a ¹/₄-inch (6.4 mm) sieve.
- 2. A uniform layer of sand (native or fill), a minimum of 4 inches (102 mm) thick, overlain by a layer or strips of geotextile drainage matting designed to allow the lateral flow of soil gases.
- Other materials, systems or floor designs with demonstrated capability to permit depressurization across the entire sub-floor area.

AF103.3 Soil-gas-retarder. A minimum 6-mil (0.15 mm) [or 3-mil (0.075 mm) cross-laminated] polyethylene or equivalent flexible sheeting material shall be placed on top of the gas-permeable layer prior to casting the slab or placing the floor assembly to serve as a soil-gas-retarder by bridging any cracks that develop in the slab or floor assembly and to prevent concrete from entering the void spaces in the aggregate base material. The sheeting shall cover the entire floor area with separate sections of sheeting lapped at least 12 inches (305 mm). The sheeting shall fit closely around any pipe, wire or other penetrations of the material. All punctures or tears in the material shall be sealed or covered with additional sheeting.

AF103.4 Entry routes. Potential radon entry routes shall be closed in accordance with Sections AF103.4.1 through AF103.4.10.

AF103.4.1 Floor openings. Openings around bathtubs, showers, water closets, pipes, wires or other objects that penetrate concrete slabs or other floor assemblies shall be filled with a polyurethane caulk or equivalent sealant applied in accordance with the manufacturer's recommendations.

AF103.4.2 Concrete joints. All control joints, isolation joints, construction joints and any other joints in concrete slabs or between slabs and foundation walls shall be sealed with a caulk or sealant. Gaps and joints shall be cleared of loose material and filled with polyurethane caulk or other elastomeric sealant applied in accordance with the manufacturer's recommendations.

AF103.4.3 Condensate drains. Condensate drains shall be trapped or routed through nonperforated pipe to daylight.

AF103.4.4 Sumps. Sump pits open to soil or serving as the termination point for sub-slab or exterior drain tile loops shall

be covered with a gasketed or otherwise sealed lid. Sumps used as the suction point in a sub-slab depressurization system shall have a lid designed to accommodate the vent pipe. Sumps used as a floor drain shall have a lid equipped with a trapped inlet.

AF103.4.5 Foundation walls. Hollow block masonry foundation walls shall be constructed with either a continuous course of *solid masonry*, one course of masonry grouted solid, or a solid concrete beam at or above finished ground surface to prevent passage of air from the interior of the wall into the living space. Where a brick veneer or other masonry ledge is installed, the course immediately below that ledge shall be sealed. Joints, cracks or other openings around all penetrations of both exterior and interior surfaces of masonry block or wood foundation walls below the ground surface shall be filled with polyurethane caulk or equivalent sealant. Penetrations of concrete walls shall be filled.

AF103.4.6 Dampproofing. The exterior surfaces of portions of concrete and masonry block walls below the ground surface shall be dampproofed in accordance with Section R406 of this code.

AF103.4.7 Air-handling units. Air-handling units in crawl spaces shall be sealed to prevent air from being drawn into the unit.

Exception: Units with gasketed seams or units that are otherwise sealed by the manufacturer to prevent leakage.

AF103.4.8 Ducts. Ductwork passing through or beneath a slab shall be of seamless material unless the air-handling system is designed to maintain continuous positive pressure within such ducting. Joints in such ductwork shall be sealed to prevent air leakage.

Ductwork located in crawl spaces shall have all seams and joints sealed by closure systems in accordance with Section M1601.4.1.

AF103.4.9 Crawl space floors. Openings around all penetrations through floors above crawl spaces shall be caulked or otherwise filled to prevent air leakage.

AF103.4.10 Crawl space access. Access doors and other openings or penetrations between *basements* and adjoining crawl spaces shall be closed, gasketed or otherwise filled to prevent air leakage.

AF103.5 Passive submembrane depressurization system. In buildings with crawl space foundations, the following components of a passive sub-membrane depressurization system shall be installed during construction.

Exception: Buildings in which an *approved* mechanical crawl space ventilation system or other equivalent system is installed.

AF103.5.1 Ventilation. Crawl spaces shall be provided with vents to the exterior of the building. The minimum net area of ventilation openings shall comply with Section R408.1 of this code.

AF103.5.2 Soil-gas-retarder. The soil in crawl spaces shall be covered with a continuous layer of minimum 6-mil (0.15 mm) polyethylene soil-gas-retarder. The ground cover shall be lapped a minimum of 12 inches (305 mm) at joints and

shall extend to all foundation walls enclosing the crawl space area.

AF103.5.3 Vent pipe. A plumbing tee or other *approved* connection shall be inserted horizontally beneath the sheeting and connected to a 3- or 4-inch-diameter (76 mm or 102 mm) fitting with a vertical vent pipe installed through the sheeting. The vent pipe shall be extended up through the building floors, terminate at least 12 inches (305 mm) above the roof in a location at least 10 feet (3048 mm) away from any window or other opening into the *conditioned spaces* of the building that is less than 2 feet (610 mm) below the exhaust point, and 10 feet (3048 mm) from any window or other opening in adjoining or adjacent buildings.

AF103.6 Passive subslab depressurization system. In *basement* or slab-on-grade buildings, the following components of a passive sub-slab depressurization system shall be installed during construction.

AF103.6.1 Vent pipe. A minimum 3-inch-diameter (76 mm) ABS, PVC or equivalent gas-tight pipe shall be embedded vertically into the sub-slab aggregate or other permeable material before the slab is cast. A "T" fitting or equivalent method shall be used to ensure that the pipe opening remains within the sub-slab permeable material. Alternatively, the 3-inch (76 mm) pipe shall be inserted directly into an interior perimeter drain tile loop or through a sealed sump cover where the sump is exposed to the sub-slab aggregate or connected to it through a drainage system.

The pipe shall be extended up through the building floors, terminate at least 12 inches (305 mm) above the surface of the roof in a location at least 10 feet (3048 mm) away from any window or other opening into the *conditioned spaces* of the building that is less than 2 feet (610 mm) below the exhaust point, and 10 feet (3048 mm) from any window or other opening in adjoining or adjacent buildings.

AF103.6.2 Multiple vent pipes. In buildings where interior footings or other barriers separate the sub-slab aggregate or other gas-permeable material, each area shall be fitted with an individual vent pipe. Vent pipes shall connect to a single vent that terminates above the roof or each individual vent pipe shall terminate separately above the roof.

AF103.7 Vent pipe drainage. All components of the radon vent pipe system shall be installed to provide positive drainage to the ground beneath the slab or soil-gas-retarder.

AF103.8 Vent pipe accessibility. Radon vent pipes shall be accessible for future fan installation through an *attic* or other area outside the *habitable space*.

Exception: The radon vent pipe need not be accessible in an *attic* space where an *approved* roof-top electrical supply is provided for future use.

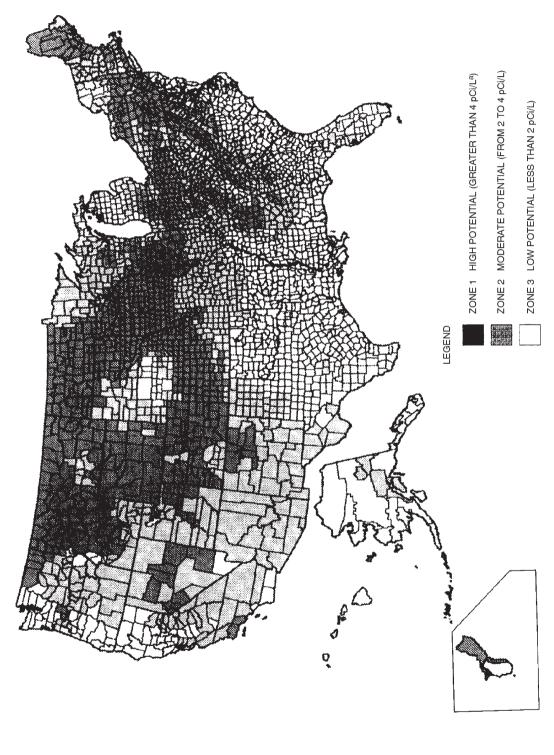
AF103.9 Vent pipe identification. All exposed and visible interior radon vent pipes shall be identified with at least one *label* on each floor and in accessible *attics*. The *label* shall read: "Radon Reduction System."

AF103.10 Combination foundations. Combination *base-ment*/crawl space or slab-on-grade/crawl space foundations shall have separate radon vent pipes installed in each type of

foundation area. Each radon vent pipe shall terminate above the roof or shall be connected to a single vent that terminates above the roof.

AF103.11 Building depressurization. Joints in air ducts and plenums in un*conditioned spaces* shall meet the requirements of Section M1601. Thermal envelope air infiltration requirements shall comply with the energy conservation provisions in Chapter 11. Fireblocking shall meet the requirements contained in Section R302.11.

AF103.12 Power source. To provide for future installation of an active sub-membrane or sub-slab depressurization system, an electrical circuit terminated in an *approved* box shall be installed during construction in the *attic* or other anticipated location of vent pipe fans. An electrical supply shall also be accessible in anticipated locations of system failure alarms.



pCi/L standard for picocuries per liter of radon gas. EPA recommends that all homes that measure 4 pCi/L and greater be mitigated.

The United States Environmental Protection Agency and the United States Geological Survey have evaluated the radon potential in the United States and have developed a map of radon zones designed to assist building officials in deciding whether radon-resistant features are applicable in new construction.

The map assigns each of the 3,141 counties in the United States to one of three zones based on radon potential. Each zone designation reflects the average short-term radon measurement that can be expected to be measured in a building without the implementation of radon control methods. The radon zone designation of highest priority is Zone 1. Table AF101 of this appendix lists the Zone 1 counties illustrated on the map. More detailed information can be obtained from state-specific booklets (EPA-402-R-93-021 through 070) available through State Radon Offices or from U.S. EPA Regional Offices.

FIGURE AF101 EPA MAP OF RADON ZONES

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TABLE AF101(1) HIGH RADON POTENTIAL (ZONE 1) COUNTIES^a

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Weld McLean Tipton Sherman MICHIGAN Wabasha Valley Yuma Menard Union Smith Branch Wadena Wibaux	Washington		Tippecanoe	Sheridan		Traverse	Toole
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a. EPA recommends that this county listing be supplemented with other available State and local data to further understand the radon potential of Zone 1 area.

(continued)

TABLE AF101(1)—continued HIGH RADON POTENTIAL (ZONE 1) COUNTIES^a

		HIGH RADON	POTENTIAL (ZONE	I) COUNTIES		
Yellowstone	NEW JERSEY	Auglaize	Delaware	Miner	Bristol	Marshall
National Park	Hunterdon	Belmont	Franklin	Minnehaha	Brunswick	Mercer
Tuttona Tan	Mercer	Butler	Fulton	Moody	Buckingham	Mineral
NEBRASKA	Monmouth	Carroll	Huntingdon	Perkins	Buena Vista	
Adams	Morris	Champaign	Indiana	Potter	Campbell	Monongalia
Boone	Somerset	Clark	Juniata	Roberts	Chesterfield	Monroe
Boyd		Clinton	Lackawanna	Sanborn	Clarke	Morgan
	Sussex					Ohio
Burt	Warren	Columbiana	Lancaster	Spink	Clifton Forge	Pendleton
Butler		Coshocton	Lebanon	Stanley	Covington	Pocahontas
Cass	NEW MEXICO	Crawford	Lehigh	Sully	Craig	Preston
Cedar	Bernalillo	Darke	Luzerne	Turner	Cumberland	
Clay	Colfax	Delaware	Lycoming	Union	Danville	Summers
Colfax	Mora	Fairfield	Mifflin	Walworth	Dinwiddie	Wetzel
Cuming	Rio Arriba	Fayette	Monroe	Yankton	Fairfax	
Dakota	San Miguel	Franklin	Montgomery		Falls Church	WISCONSIN
Dixon	Santa Fe	Greene	Montour	TENNESEE	Fluvanna	Buffalo
Dodge	Taos	Guernsey	Northampton	Anderson	Frederick	Crawford
Douglas		Hamilton	Northumberland	Bedford	Fredericksburg	Dane
Fillmore	NEW YORK	Hancock	Perry	Blount	Giles	
Franklin	Albany	Hardin	Schuylkill	Bradley	Goochland	Dodge
Frontier		Harrison	Snyder	Claiborne	Harrisonburg	Door
Furnas	Allegany	Holmes	Sullivan	Davidson	Henry	Fond du Lac
Gage	Broome	Huron	Susquehanna	Giles	Highland	Grant
Gosper	Cattaraugus	Jefferson	Tioga	Grainger	Lee	Green
Greeley	Cayuga	Knox	Union	Greene	Lexington	Green Lake
Hamilton	Chautauqua	Licking	Venango	Hamblen	Louisa	Iowa
	Chemung		Westmoreland			
Harlan	Chenango	Logan		Hancock	Martinsville	Jefferson
Hayes	Columbia	Madison	Wyoming	Hawkins	Montgomery	Lafayette
Hitchcock	Cortland	Marion	York	Hickman	Nottoway	Langlade
Hurston	Delaware	Mercer		Humphreys	Orange	Marathon
Jefferson	Dutchess	Miami	RHODE ISLAND	Jackson	Page	Menominee
Johnson	Erie	Montgomery	Kent	Jefferson	Patrick	Pepin
Kearney	Genesee	Morrow	Washington	Knox	Pittsylvania	Pierce
Knox	Greene	Muskingum		Lawrence	Powhatan	
Lancaster		Perry	S. CAROLINA	Lewis	Pulaski	Portage
Madison	Livingston	Pickaway	Greenville	Lincoln	Radford	Richland
Nance	Madison	Pike		Loudon	Roanoke	Rock
Nemaha	Onondaga	Preble	S. DAKOTA	Marshall	Rockbridge	Shawano
Nuckolls	Ontario	Richland	Aurora	Maury	Rockingham	St. Croix
Otoe	Orange	Ross	Beadle	McMinn	Russell	Vernon
Pawnee	Otsego	Seneca	Bon Homme	Meigs	Salem	Walworth
Phelps	Putnam	Shelby	Brookings	Monroe	Scott	Washington
Pierce	Rensselaer	Stark	Brown	Moore	Shenandoah	_
Platte	Schoharie	Summit	Brule	Perry	Smyth	Waukesha
Polk	Schuyler	Tuscarawas	Buffalo	Roane	Spotsylvania	Waupaca
Red Willow	Seneca	Union		Rutherford	Stafford	Wood
Richardson	Steuben		Campbell	Smith	Staunton	
	Sullivan	Van Wert	Charles Mix			WYOMING
Saline	Tioga	Warren	Clark	Sullivan	Tazewell	Albany
Sarpy	Tompkins	Wayne	Clay	Trousdale	Warren	Big Horn
Saunders	Ulster	Wyandot	Codington	Union	Washington	_
Seward	Washington		Corson	Washington	Waynesboro	Campbell
Stanton	Wyoming	PENNSYLVANIA	Davison	Wayne	Winchester	Carbon
Thayer	Yates	Adams	Day	Williamson	Wythe	Converse
Washington	Taics	Allegheny	Deuel	Wilson		Crook
Wayne	N. CAROLINA	Armstrong	Douglas		WASHINGTON	Fremont
Webster	N. CAROLINA	Beaver	Edmunds	UTAH	Clark	Goshen
York	Alleghany	Bedford	Faulk	Carbon	Ferry	Hot Springs
	Buncombe	Berks	Grant	Duchesne	Okanogan	Johnson
NEVADA	Cherokee	Blair	Hamlin	Grand	Pend Oreille	
Carson City	Henderson	Bradford	Hand	Piute	Skamania	Laramie
Douglas	Mitchell	Bucks	Hanson	Sanpete	Spokane	Lincoln
Eureka	Rockingham	Butler	Hughes	Sevier	Stevens	Natrona
Lander	Transylvania	Cameron	Hutchinson	Uintah		Niobrara
Lincoln	Watauga	Carbon	Hyde		W. VIRGINIA	Park
Lyon	····· 8···	Centre	Jerauld	VIRGINIA	Berkeley	Sheridan
Mineral	N. DAKOTA	Chester	Kingsbury	Alleghany	Brooke	Sublette
Pershing	All Counties	Clarion	Lake	Amelia	Grant	
White Pine	1 111 Counties	Clarion			Grant Greenbrier	Sweetwater
William I lile	ОНЮ		Lincoln	Appomattox		Teton
NIEW		Clinton	Lyman	Augusta	Hampshire	Uinta
NEW	Adams	Columbia	Marshall	Bath	Hancock	Washakie
HAMPSHIRE	Allen	Cumberland	McCook	Bland	Hardy	
Carroll	Ashland	Dauphin	McPherson	Botetourt	Jefferson	

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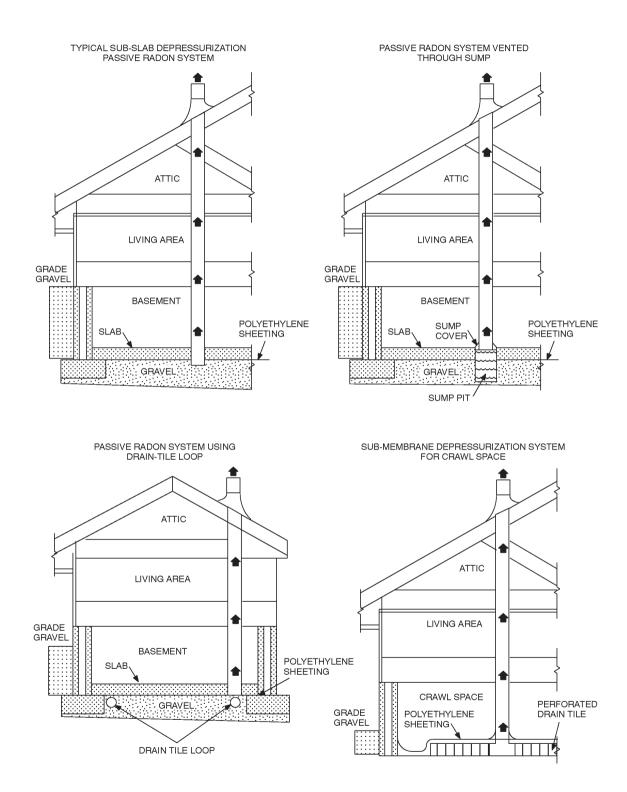


FIGURE AF102
RADON-RESISTANT CONSTRUCTION DETAILS FOR FOUR FOUNDATION TYPES