

APPENDIX F

PASSIVE RADON GAS CONTROLS

(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)

SECTION AF101 SCOPE

AF101.1 General. This appendix contains requirements for new construction in *jurisdictions* where radon-resistant construction is required. These requirements are intended to provide a passive means of resisting radon gas entry and prepare the *dwelling* for post-construction radon mitigation, if necessary (see Figure AF102). Active construction techniques, rather than passive techniques, shall be permitted to be used where approved.

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 and Table AF101(1).

SECTION AF102 DEFINITIONS

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

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.

ENCLOSED CRAWL SPACE. A crawl space that is enclosed with foundation walls inclusive of any windows, doors, access openings and required vents.

GAS-PERMEABLE LAYER. A gas-permeable layer shall consist of one of the following:

1. A uniform layer of clean aggregate that is not less than 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 $\frac{1}{4}$ -inch (6.4 mm) sieve.
2. A uniform layer of sand (native or fill) that is not less than 4 inches (102 mm) thick and that is overlain by a soil gas collection mat or soil gas matting installed in accordance with the manufacturer's instructions.

RADON GAS. A naturally occurring, chemically inert, radioactive gas.

SOIL-GAS-RETARDER. A continuous membrane of 6-mil (0.15 mm) polyethylene used to retard the flow of soil gases into a *dwelling*.

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

SUBSLAB DEPRESSURIZATION SYSTEM (Passive). A system designed to achieve lower subslab air pressure rela-

tive to indoor air pressure by use of a vent pipe drawing air from beneath concrete floor slabs or other floor assemblies that are in contact with the ground.

VENT PIPE. Not less than a 3-inch-diameter (76 mm) ABS or PVC gas-tight pipe extending from the gas permeable layer through the roof.

SECTION AF103 PASSIVE RADON-RESISTANT SYSTEM REQUIREMENTS

AF103.1 General. The following components of a passive submembrane or subslab depressurization system shall be installed during construction.

AF103.2 Entry routes. Potential radon entry routes shall be closed in accordance with Sections AF103.2.1 through AF103.2.8.

AF103.2.1 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 expanding foam applied in accordance with the manufacturer's instructions.

AF103.2.2 Sumps. Sumps open to soil or serving as the termination point for subslab or exterior drain tile loops shall be covered with a gasketed or sealed lid. Sumps used as the suction point in a subslab 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.

AF103.2.3 Foundation walls. Hollow block masonry foundation walls shall be constructed with a continuous course of *solid masonry*, one course of masonry grouted solid, or a solid concrete beam at or above *grade*. Where a brick veneer or other masonry ledge is installed, the course immediately below that ledge shall be *solid masonry*, one course of masonry grouted solid, or a solid concrete beam. Joints, cracks or other openings around penetrations of both exterior and interior surfaces of foundation walls below *grade* shall be filled with polyurethane caulk.

AF103.2.4 Dampproofing. The exterior surfaces of foundation walls below *grade* shall be dampproofed in accordance with Section R406.

AF103.2.5 Air-conditioning systems. Entry points, joints or other openings into air-conditioning systems in enclosed crawl spaces shall be sealed.

Exception: Systems with gasketed seams or that are otherwise sealed by the manufacturer.

AF103.2.6 Ducts. Ductwork passing through or beneath a slab within a *dwelling* shall be of seamless material unless the air-conditioning system is designed to maintain continuous positive pressure within such ducting. Joints in such ductwork shall be sealed.

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

AF103.2.7 Crawl space access. Access doors and other openings or penetrations between *basements* and adjoining crawl spaces shall be closed, gasketed or sealed.

AF103.3 Basements or enclosed crawl spaces with soil floors. In *dwelling*s with *basements* or enclosed crawl spaces with soil floors, the following components of a passive sub-membrane depressurization system shall be installed during construction.

Exception: *Basements* or enclosed crawl spaces that are provided with a continuously operated mechanical exhaust system in accordance with Section R408.3.

AF103.3.1 Soil-gas-retarder. The soil in *basements* and enclosed crawl spaces shall be covered with a soil-gas-retarder. The soil-gas-retarder shall be lapped not less than 12 inches (305 mm) at joints and shall extend to foundation walls enclosing the *basement* or crawl space. The soil-gas-retarder shall fit closely around any pipe, wire or other penetrations of the material. Punctures or tears in the material shall be sealed or covered with additional sheeting.

AF103.3.2 “T” fitting and vent pipe. A 3- or 4-inch “T” fitting shall be inserted beneath the soil-gas-retarder and be connected to a vent pipe. The vent pipe shall extend through the *conditioned space* of the *dwelling* and terminate not less than 12 inches (305 mm) above the roof in a location not less than 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.

AF103.4 Basements or enclosed crawl spaces with concrete floors or other floor systems and slab-on-grade dwellings. The following components of a passive subslab depressurization system shall be installed during construction in slab-on-grade *dwelling*s or in *dwelling*s with *basements* or crawl spaces with concrete or other floor systems.

AF103.4.1 Sub-slab preparation. A layer of gas-permeable material shall be placed under concrete slabs and other floor systems that directly contact the ground and are within the walls of the dwelling.

AF103.4.2 Soil-gas-retarder. A soil-gas-retarder shall be placed on top of the gas-permeable layer prior to casting

the slab or placing the floor assembly. The soil-gas-retarder shall cover the entire floor area with separate sections lapped not less than 12 inches (305 mm). The soil-gas-retarder shall fit closely around any pipe, wire, or other penetrations of the material. Punctures or tears in the material shall be sealed or covered.

AF103.4.3 “T” fitting and vent pipe. Before a slab is cast or other floor system is installed, a “T” fitting shall be inserted below the slab or other floor system and the soil-gas-retarder. The “T” fitting shall be connected to a vent pipe. The vent pipe shall extend through the *conditioned space* of the *dwelling* and terminate not less than 12 inches (305 mm) above the roof in a location not less than 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.

AF103.5 Drain tile and sump used for depressurization.

As an alternative to inserting a vent pipe into a “T” fitting, a vent pipe shall be permitted to be inserted directly into an interior perimeter drain tile loop or through a sump cover where the drain tile or sump is exposed to the gas-permeable layer.

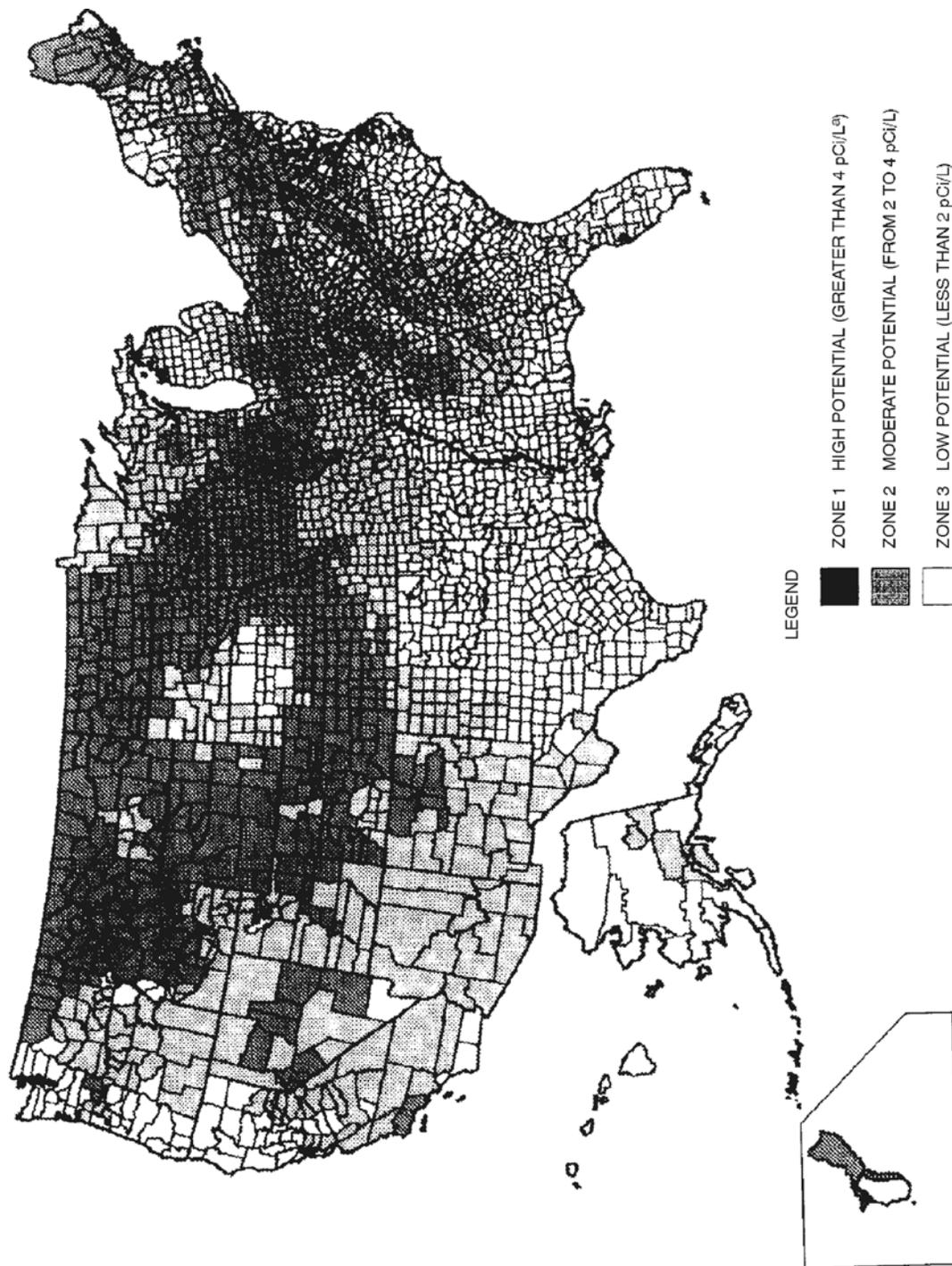
AF103.6 Multiple vent pipes. In *dwelling*s where interior footings or other barriers separate the gas-permeable layer, each area shall be fitted with an individual vent pipe. Vent pipes shall connect to a single vent that terminates above the roof or each individual vent pipe shall terminate separately above the roof.

AF103.7 Combination foundations. Where *basement* or crawl space floors are on different levels, each level shall have a separate vent pipe. Multiple vent pipes shall be permitted to be connected to a single vent pipe that terminates above the roof. **

AF103.8 Vent pipe drainage. Components of the radon vent pipe system shall be installed to provide positive drainage to the ground beneath the soil-gas-retarder.

AF103.9 Vent pipe identification. Exposed and visible interior vent pipes shall be identified with not less than one *label* on each floor and in accessible *attics*. The *label* shall read: “Radon Reduction System.”

AF103.10 Power source and access for future radon fan. To provide for future installation of a radon fan, an electrical circuit terminated in an *approved* box shall be installed during construction in the anticipated location of the radon fans. An accessible clear space 24 inches (610 mm) in diameter by 3 feet (914 mm) in height adjacent to the vent pipe shall be provided at the anticipated location of a future radon fan.



LEGEND

- ZONE 1 HIGH POTENTIAL (GREATER THAN 4 pCi/L^a)
- ZONE 2 MODERATE POTENTIAL (FROM 2 TO 4 pCi/L)
- ZONE 3 LOW POTENTIAL (LESS THAN 2 pCi/L)

FIGURE AF101
EPA MAP OF RADON ZONES

a. pCi/L standard for picocuries per liter of radon gas. The U.S. Environmental Protection Agency (EPA) recommends that homes that measure 4 pCi/L and greater be mitigated. The EPA and the U.S. 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 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 EPA Regional Offices.

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

ALABAMA	CONNECTICUT	Morgan	Wabash	Trego	Hillsdale	Watsonwan
Calhoun	Fairfield	Moultrie	Warren	Wallace	Jackson	Wilkin
Clay	Middlesex	Ogle	Washington	Washington	Kalamazoo	Winona
Cleburne	New Haven	Peoria	Wayne	Wichita	Lenawee	Wright
Colbert	New London	Piatt	Wells	Wyandotte	St. Joseph	Yellow Medicine
Coosa		Pike	White		Washtenaw	
Franklin	GEORGIA	Putnam	Whitley	KENTUCKY		MISSOURI
Jackson	Cobb	Rock Island		Adair		Andrew
Lauderdale	De Kalb	Sangamon	IOWA	Allen	MINNESOTA	Atchison
Lawrence	Fulton	Schuyler	All Counties	Barren	Becker	Buchanan
Limestone	Gwinnett	Scott		Bourbon	Big Stone	Cass
Madison		Stark	KANSAS	Boyle	Blue Earth	Clay
Morgan	IDAHO	Stephenson	Atchison	Bullitt	Brown	Clinton
Talladega	Benewah	Tazewell	Barton	Casey	Carver	Holt
	Blaine	Vermilion	Brown	Clark	Chippewa	Iron
CALIFORNIA	Boise	Warren	Cheyenne	Cumberland	Clay	Jackson
Santa Barbara	Bonner	Whiteside	Clay	Fayette	Cottonwood	Nodaway
Ventura	Boundary	Winnebago	Cloud	Franklin	Dakota	Platte
	Butte	Woodford	Decatur	Green	Dodge	
COLORADO	Camas		Dickinson	Harrison	Douglas	
Adams	Clark	INDIANA	Douglas	Hart	Faribault	MONTANA
Arapahoe	Clearwater	Adams	Ellis	Jefferson	Fillmore	Beaverhead
Baca	Custer	Allen	Ellsworth	Jessamine	Freeborn	Big Horn
Bent	Elmore	Bartholomew	Finney	Lincoln	Goodhue	Blaine
Boulder	Fremont	Benton	Ford	Marion	Grant	Broadwater
Chaffee	Gooding	Blackford	Geary	Mercer	Hennepin	Carbon
Cheyenne	Idaho	Boone	Gove	Metcalfe	Houston	Carter
Clear Creek	Kootenai	Carroll	Graham	Monroe	Hubbard	Cascade
Crowley	Latah	Cass	Grant	Nelson	Jackson	Chouteau
Custer	Lemhi	Clark	Gray	Pendleton	Kanabec	Custer
Delta	Shoshone	Clinton	Greeley	Pulaski	Kandiyohi	Daniels
Denver	Valley	De Kalb	Hamilton	Robertson	Kittson	Dawson
Dolores		Decatur	Haskell	Russell	Lac Qui Parle	Deer Lodge
Douglas	ILLINOIS	Delaware	Hodgeman	Scott	Le Sueur	Fallon
El Paso	Adams	Elkhart	Jackson	Taylor	Lincoln	Fergus
Elbert	Boone	Fayette	Jewell	Warren	Lyon	Flathead
Fremont	Brown	Fountain	Johnson	Woodford	Mahnomen	Gallatin
Garfield	Bureau	Fulton	Kearny		Marshall	Garfield
Gilpin	Calhoun	Grant	Kingman	MAINE	Martin	Glacier
Grand	Carroll	Hamilton	Kiowa	Androscoggin	McLeod	Granite
Gunnison	Cass	Hancock	Lane	Aroostook	Meeker	Hill
Huerfano	Champaign	Harrison	Leavenworth	Cumberland	Mower	Jefferson
Jackson	Coles	Hendricks	Lincoln	Franklin	Murray	Judith Basin
Jefferson	De Kalb	Henry	Logan	Hancock	Nicollet	Lake
Kiowa	De Witt	Howard	Marion	Kennebec	Nobles	Lewis and Clark
Kit Carson	Douglas	Huntington	Marshall	Lincoln	Norman	Madison
Lake	Edgar	Jay	McPherson	Oxford	Olmsted	McCone
Larimer	Ford	Jennings	Meade	Penobscot	Otter Tail	Meagher
Las Animas	Fulton	Johnson	Mitchell	Piscataquis	Pennington	Missoula
Lincoln	Greene	Kosciusko	Nemaha	Somerset	Pipestone	Park
Logan	Grundy	LaGrange	Ness	York	Polk	Phillips
Mesa	Hancock	Lawrence	Norton		Pope	Pondera
Moffat	Henderson	Madison	Osborne	MARYLAND	Ramsey	Powder River
Montezuma	Henry	Marion	Ottawa	Baltimore	Red Lake	Powell
Montrose	Iroquois	Marshall	Pawnee	Calvert	Redwood	Prairie
Morgan	Jersey	Miami	Phillips	Carroll	Renville	Ravalli
Otero	Jo Daviess	Monroe	Pottawatomie	Frederick	Rice	Richland
Ouray	Kane	Montgomery	Pratt	Harford	Rock	Roosevelt
Park	Kendall	Noble	Rawlins	Howard	Roseau	Rosebud
Phillips	Knox	Orange	Republic	Montgomery	Scott	Sanders
Pitkin	La Salle	Putnam	Rice	Washington	Sherburne	Sheridan
Prowers	Lee	Randolph	Riley		Sibley	Silver Bow
Pueblo	Livingston	Rush	Rooks	MASS.	Stearns	Stillwater
Rio Blanco	Logan	Scott	Rush	Essex	Steele	Teton
San Miguel	Macon	Shelby	Saline	Middlesex	Stevens	Toole
Summit	Marshall	St. Joseph	Scott	Worcester	Swift	Valley
Teller	Mason	Steuben	Sheridan		Todd	Wibaux
Washington	McDonough	Tippecanoe	Sherman	MICHIGAN	Traverse	Yellowstone
Weld	McLean	Union	Smith	Branch	Wabasha	
Yuma	Menard	Vermillion	Stanton	Calhoun	Wadena	
	Mercer		Thomas	Cass	Waseca	
					Washington	

(continued)

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

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

a. The EPA recommends that this county listing be supplemented with other available State and local data to further understand the radon potential of a Zone 1 area.

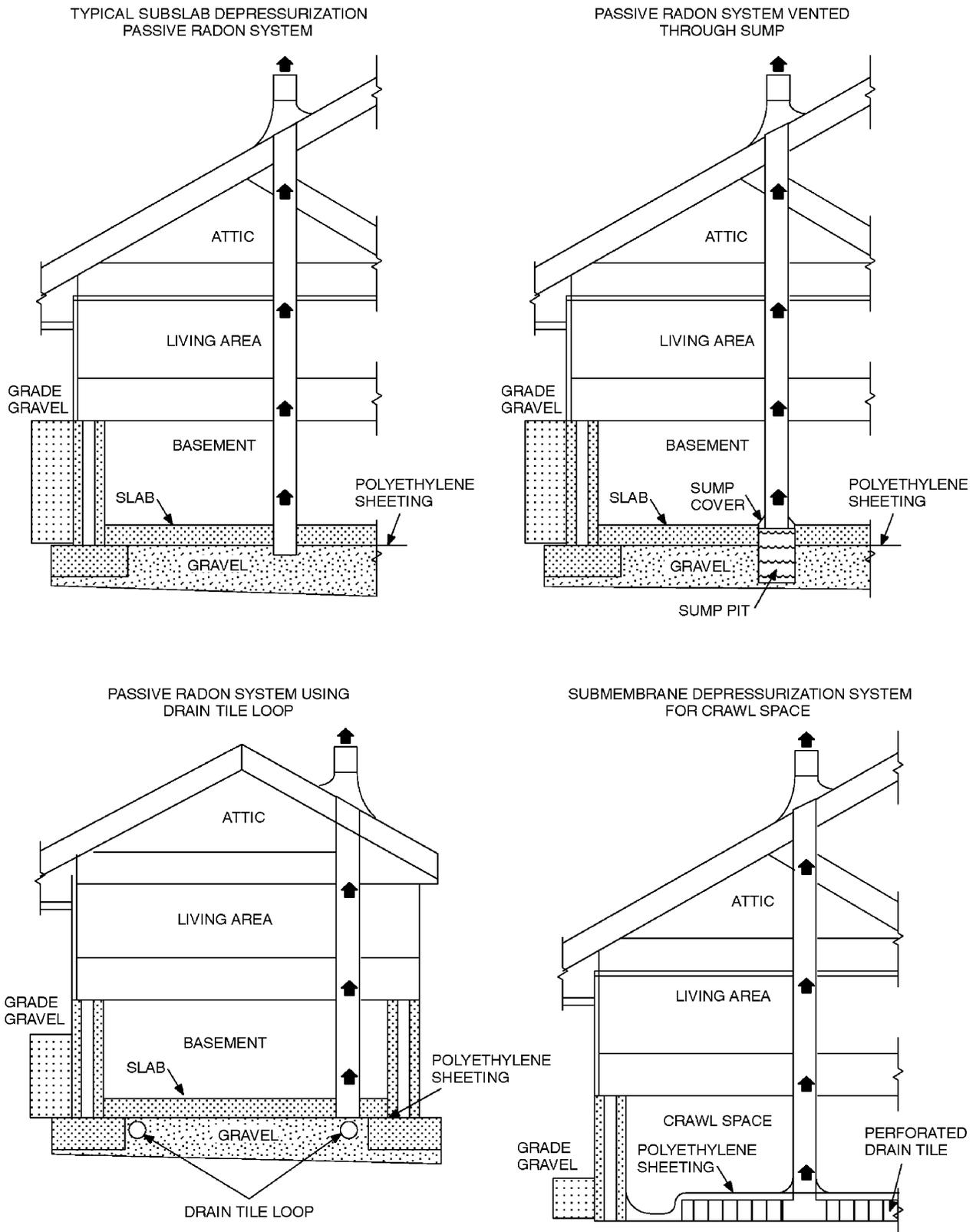


FIGURE AF102
RADON-RESISTANT CONSTRUCTION DETAILS FOR FOUR FOUNDATION TYPES