(2) The separation between light-transmitting plastic roof panels shall not be required in buildings complying with the conditions of 48.7.8.4.2(2) and 48.7.8.4.2(3).

48.7.8.3 Where exterior wall openings are required to be protected, a light-transmitting plastic roof panel shall not be installed within 6 ft (1830 mm) of such exterior wall.

48.7.8.4 Light-transmitting plastic roof panels shall meet the requirements of 48.7.8.4.1 and 48.7.8.4.2.

48.7.8.4.1 Light-transmitting plastic roof panels shall be limited in area, and the aggregate area of panels shall be limited to a percentage of the floor area of the room or space sheltered in accordance with Table 48.7.8.4.1.

48.7.8.4.2 The requirement of 48.7.8.4.1 shall not apply where one of the following conditions exists:

(1) The area limitations of Table 48.7.8.4.1 shall be permitted to be increased by 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.
(2) Low hazard occupancy buildings, such as swimming pool shelters, shall be exempt from the area limitations of Table 48.7.8.4.1, provided that the building does not exceed 5000 ft^2 (465 m^2) and has a minimum fire separation distance of 10 ft (3050 mm).
(3) Greenhouses that are occupied for growing plants on a production or research basis, without public access, shall be exempt from the area limitations of Table 48.7.8.4.1, provided that they have a minimum fire separation distance of 48 in. (1220 mm).
(4) Roof coverings over terraces and patios in residential occupancies shall be exempt from the area limitations of Table 48.7.8.4.1.

48.7.9 Light-Transmitting Plastics Used in Awnings and Canopies. The requirements for light-transmitting plastics used as, or in, awnings and canopies shall be as follows:

(1) Awnings and canopies, and similar structures constructed of light-transmitting plastics, shall be constructed in accordance with the provisions specified in Chapter 13 and Section 32.4 for projections and appendages.
(2) Light-transmitting plastics used in canopies for motor vehicle fuel stations shall comply with the appropriate sections of this *Code*.

48.7.10 Light-Transmitting Plastic Covers on Solar Collectors. Light-transmitting plastic covers on solar collectors having noncombustible sides and bottoms shall be permitted on buildings three or fewer stories in height or 9000 ft^2 (836 m^2) in total floor area, provided that one of the following criteria is met:

(1) The light-transmitting plastic cover shall not exceed 33 ⅓ percent of the roof area for CC1 materials.
(2) The light-transmitting plastic cover shall not exceed 25 percent of the roof area for CC2 materials.
(3) Plastic covers having a thickness of 0.010 in. (0.25 mm) or less shall be permitted to be of any plastic material, provided that the area of the collectors does not exceed 33 ⅓ percent of the roof area.

Table 48.7.8.4.1 Area Limitations for Light-Transmitting Plastic Roof Panels

Class of Plastic	Maximum Area of Individual Roof Panels		Maximum Aggregate Area of Roof Panels (% floor area)
	ft^2	m^2	
CC1	300	27.9	30
CC2	100	9.3	25

48.7.11 Light-Transmitting Plastics Used for Partitions. Light-transmitting plastics used in or as partitions shall comply with the requirements of Chapter 10.

48.7.12 Light-Transmitting Plastics Used in Bathroom Accessories. Requirements for glazing in light-transmitting plastics used in bathroom accessories shall be as follows:

(1) Light-transmitting plastics shall be permitted as glazing in shower stalls, shower doors, bathtub enclosures, and similar accessory units.
(2) Safety glazing shall be provided in accordance with ANSI Z97.1, *For Safety Glazing Materials Used in Buildings — Safety Performance Specifications and Methods of Test.*

48.8 Specific Requirements — Plastic Interior Signs.

48.8.1 Signs installed on the faces of interior walls shall comply with Section 48.8.

48.8.2 Light-transmitting plastic interior wall signs shall comply with the following requirements:

(1) The sign shall have an area not greater than 20 percent of the wall area to which it is attached.
(2) The sign shall have an area not greater than 24 ft^2 (2.23 m^2).
(3) The edges and backs of the sign shall be fully encased in metal.

48.8.3 Plastic interior wall signs in mall concourse buildings shall comply with 27.4.4.12.

48.8.4 Foam plastics shall be permitted to be used as signs in covered mall concourse buildings in accordance with 27.4.4.12.

48.9 Specific Requirements — Light-Transmitting Plastics Used in Greenhouses. Light-transmitting plastics shall be permitted in lieu of glass in greenhouses.

48.10 Specific Requirements — Plastic Composite Exterior Deck Boards, Stair Treads, Handrails, and Guards.

48.10.1 General.

48.10.1.1 Plastic composite exterior deck boards, stair treads, handrails, and guards shall consist of either wood/plastic composites or plastic lumber.

48.10.1.2 Plastic composites shall comply with the provisions of this standard and with the additional requirements of Section 48.10.

48.10.2 Labeling.

48.10.2.1 Plastic composite deck boards and stair treads, or their packaging, shall bear a label that indicates compliance to ASTM D7032, *Standard Specification for Establishing Performance Ratings for Wood-Plastic Composite and Plastic Lumber Deck Boards, Stair Treads, Guards, and Handrails*, and includes the allowable load and maximum allowable span determined in accordance with ASTM D7032.

48.10.2.2 Plastic composite handrails and guards, or their packaging, shall bear a label that indicates compliance to

ASTM D7032 and includes the maximum allowable span determined in accordance with ASTM D7032.

Δ **48.10.3 Flame Spread Index.** Plastic composite deck boards, stair treads, handrails and guards shall exhibit a flame spread index not exceeding 200 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or UL 723, *Test for Surface Burning Characteristics of Building Materials*, with the test specimen remaining in place during the test.

48.10.4 Decay and Termite Resistance. Where required, plastic composite deck boards, stair treads, handrails, and guards containing wood, cellulosic, or any other biodegradable materials shall be decay and termite resistant as determined in accordance with ASTM D7032.

48.10.5 Construction Requirements. Plastic composites shall be permitted to be used as exterior deck boards, stair treads, handrails and guards where combustible construction is permitted.

48.10.6 Span Rating. Plastic composites used as exterior deck boards shall have a span rating determined in accordance with ASTM D7032.

48.10.7 Instructions. Plastic composite deck boards, stair treads, handrails, and guards shall be installed in accordance with this standard and the manufacturer's instructions.

Chapter 49 Interior Environment

49.1 General.

49.2 Ventilation.

49.2.1 Required Ventilation.

49.2.1.1 All rooms and occupied spaces in buildings shall be ventilated by natural or mechanical means in accordance with the provisions of this chapter.

49.2.1.2 Mechanical ventilation systems shall be designed, constructed, and installed in accordance with Chapter 50.

49.2.1.3 Mechanical ventilation systems shall operate to the extent that all occupied rooms are continuously provided with the required ventilation rate while occupied.

49.2.2 Ventilation Rates.

49.2.2.1 Ventilation rates for the following occupancies shall conform to ASHRAE STD 62.1, *Ventilation for Acceptable Indoor Air Quality*:

(1) Assembly
(2) Business
(3) Educational
(4) Day care
(5) Detention
(6) Health care
(7) Mercantile

49.2.2.1.1 Industrial occupancies shall be provided with general ventilation systems for replacing mildly contaminated air by means of natural air currents and openings, or they shall be provided with mechanical fans, ducts, and outlets.

49.2.2.1.2 Contaminated air shall be cleaned and recirculated.

49.2.2.1.3 Local exhaust systems shall be provided to collect and remove moisture and odors, fumes, smoke, gas, mist, heat, dust, or other materials that are in sufficient quantities to irritate or injure occupants.

49.2.2.1.4 Hazardous emissions, such as toxic, corrosive, acidic, and hot materials, that result from industrial processes shall be captured and exhausted to the outdoors.

49.2.2.1.5 Hazardous emissions shall be retained in the area where they originate by methods such as maintaining negative pressure to adjacent spaces and sealing the area of origin from adjacent areas until they are exhausted to the outdoors.

49.2.2.1.6 Air containing hazardous emissions shall be cleaned before it is exhausted outdoors.

49.2.2.2 Ventilation rates for the following occupancies shall conform to ANSI/ASHRAE Standard 62.2, *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*:

(1) One- and two-family dwellings
(2) Multifamily dwelling units
(3) Hotel guest rooms
(4) Residential board and care

49.2.2.3 Storage occupancies shall be provided with ventilation to provide not less than two air changes per hour.

49.2.2.4 Open parking structures complying with 30.8.1.3 shall not require mechanical ventilation.

49.2.2.5 An enclosed parking structure shall have a ventilation system designed to limit the concentration of carbon monoxide to not more than 35 parts per million of air when measured between 36 in. and 48 in. (915 mm and 1220 mm) from the floor.

49.2.2.6 Private parking structures shall be permitted to have a mechanically operated exhaust system that provides four changes of air per hour, with the air taken from within 16 in. (405 mm) of the finished floor. The mechanically operated system shall be operated by a single pole switch or a timer switch.

49.2.2.7 Ventilation rates for one- and two-family dwellings and multifamily dwelling units, hotel guest rooms, and residential board and care occupancies shall provide not less than the air change rates indicated in Table 49.2.2.7 where mechanical ventilation systems are installed. Where mechanical ventilation systems are not provided, the exterior openable window area shall be at least 4 percent of the floor area.

49.2.2.8 Where rooms and spaces without openings to the outdoors are ventilated through an adjoining room, the unobstructed opening to the adjoining room shall be at least 8 percent of the floor area of the interior room or space, but not less than 25 ft^2 (2.33 m^2). The ventilation openings to the outdoors shall be based on the total floor area being ventilated.

49.2.3 Ventilating Systems in Spaces Using Chemicals or Containing Hazardous Agents. Ventilating systems in laboratories or spaces using chemicals or containing hazardous agents shall be in accordance with the applicable provisions of NFPA 45; NFPA 99; and Chapter 34.

49.2.4 Commercial Cooking Equipment. Systems for the ventilation of commercial cooking equipment shall be designed, constructed, and installed in accordance with Chapter 50.

Table 49.2.2.7 Ventilation Rates

Occupancy	Intermittent Local Ventilation Airflow Rates	Continuous Local Exhaust Airflow Rates
Habitable rooms (other than kitchens)	0.35 ach each, but not less than 15 ft^3/min (7.5 L/s) per person	
Kitchens	100 ft^3/min (50 L/s)	5 ach
Residential bathroom and toilet rooms	50 ft^3/min (25 L/s)	20 ft^3/min (10 L/s)

ach: air changes per hour.

Notes:

(1) Intermittent local ventilation is designed to be operated as needed by the occupant.

(2) Continuous local ventilation is designed to operate without occupant intervention.

49.2.5 Radon Control Methods.

49.2.5.1 General. The radon control methods discussed in this chapter represent a combination of good construction practices that have been coupled with specific radon removal strategies. The radon control methods presented are based on radon mitigation procedures that have been used successfully for various foundation types *(see Figure 49.2.5.3.3.4, Figure 49.2.5.3.4, Figure 49.2.5.3.5, and Figure 49.2.5.3.5.1(A))* and include options to accommodate regional construction practices and site conditions. These techniques, in combination with a recommended test by the homeowner after occupancy, provide radon reduction in newly constructed homes.

49.2.5.2 Applicability.

49.2.5.2.1 This chapter shall establish requirements to control radon levels in new construction of one- and two-family dwellings and other residential buildings three or fewer stories in height as defined by this *Code*.

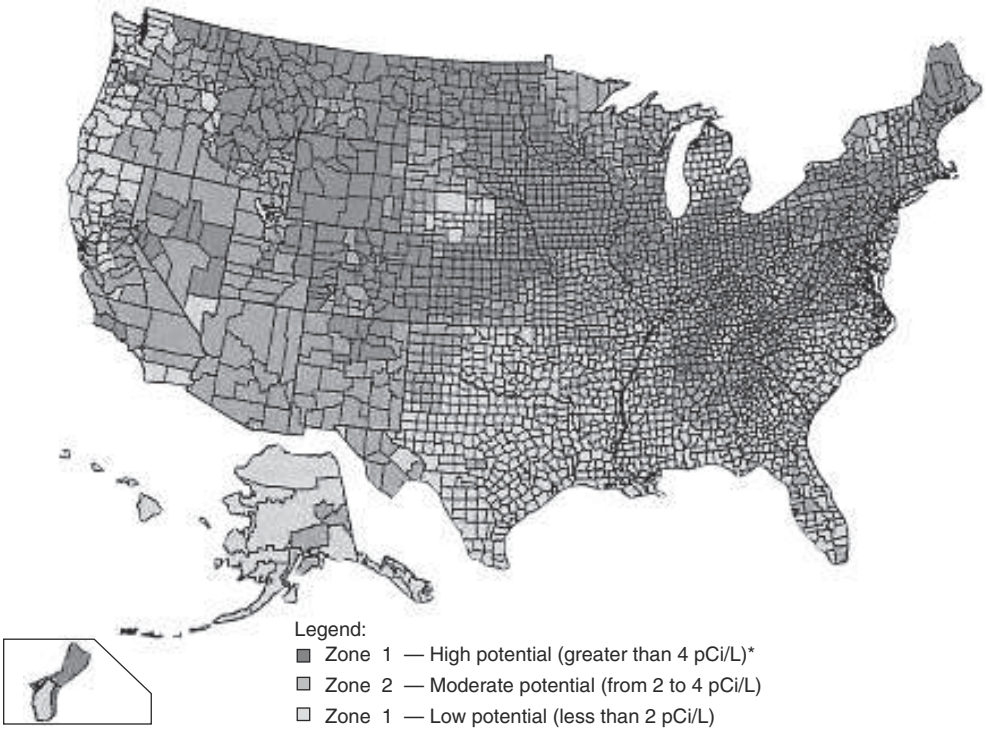
49.2.5.2.2 The requirements of this chapter shall be applicable when additions are made to the foundations of existing one- and two-family dwellings that result in extension of the building footprint.

49.2.5.2.3* The requirements of this chapter shall be applicable in all Zone 1 counties, as designated by the map of radon zones shown in Figure 49.2.5.2.3, developed by the U.S. Geological Survey and U.S. Environmental Protection Agency. In addition, the requirements of this chapter shall be applicable in all areas designated by local officials as Zone 1, based on locally available data.

49.2.5.3 Requirements.

49.2.5.3.1 Subfloor Preparation. A layer of gas-permeable material shall be placed under all concrete slabs and wood-framed basement floors, 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:

(1) Uniform layer of clean aggregate that is a minimum of 4 in. (100 mm) thick and that consists of material that will



* A list of high potential (Zone 1) counties can be found in Annex A, Table A.49.2.5.2.3.

FIGURE 49.2.5.2.3 EPA Map of Radon Zones. EPA Document ID: EPA-402-R-93-017.

pass through a 2 in. (51 mm) sieve and be retained by a ¼ in. (6.3 mm) sieve

(2) Uniform layer of sand (native or fill), a minimum of 4 in. (100 mm) thick, overlain by a layer or strips of 1 in. (25 mm) geotextile drainage matting designed to allow the lateral flow of soil gases

(3) Other materials, systems, or floor designs with demonstrated capability to allow depressurization across the entire subfloor area

49.2.5.3.2 Soil-Gas Retarder. Minimum 6 mil (0.15 mm) [or 3 mil (0.075 mm) cross-laminated] polyethylene or equivalent flexible sheeting shall be placed on top of the gas-permeable layer prior to casting the slab or constructing the floor. The sheeting shall cover the entire 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 in. (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.

49.2.5.3.3 Entry Routes. Potential soil-gas entry routes shall be closed in accordance with 49.2.5.3.3.1 through 49.2.5.3.3.10.

49.2.5.3.3.1 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.

49.2.5.3.3.2 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.

49.2.5.3.3.3 Condensate Drains. Condensate drains shall be trapped or routed through nonperforated pipe to daylight.

49.2.5.3.3.4 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 in accordance with Figure 49.2.5.3.3.4. 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.

49.2.5.3.3.5 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 the finished ground level 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 hollow foundation walls below the finished ground level shall be filled with polyurethane caulk or equivalent sealant. Penetrations of concrete walls shall be filled.

49.2.5.3.3.6 Dampproofing. The exterior surfaces of portions of walls below the finished ground level shall be dampproofed as required by Chapter 36 of this *Code*.

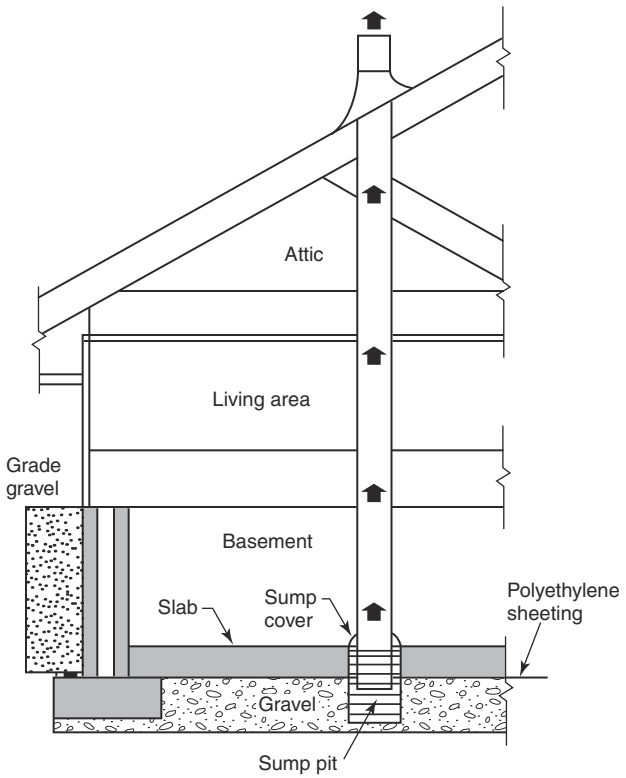


FIGURE 49.2.5.3.3.4 Passive Radon System Vented Through Sump.

49.2.5.3.3.7 Air-Handling Units. Air-handling units in crawl spaces shall be sealed to prevent air from being drawn into the unit, either by the manufacturer or in the field.

49.2.5.3.3.8 Ducts. Ductwork passing through a crawl space 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.

49.2.5.3.3.9 Crawl Space Floors. Openings around all penetrations through floors above crawl spaces shall be caulked or otherwise filled to prevent air leakage.

49.2.5.3.3.10 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.

49.2.5.3.4 Passive Submembrane Depressurization System. In buildings with crawl space foundations, the following components of a passive submembrane depressurization system shall be installed during construction in accordance with Figure 49.2.5.3.4, unless an approved mechanical crawl space ventilation system or other equivalent system is installed.

49.2.5.3.4.1 Ventilation. Crawl spaces shall be provided with vents to the exterior of the building. The minimum net area of ventilation openings shall comply with this chapter.

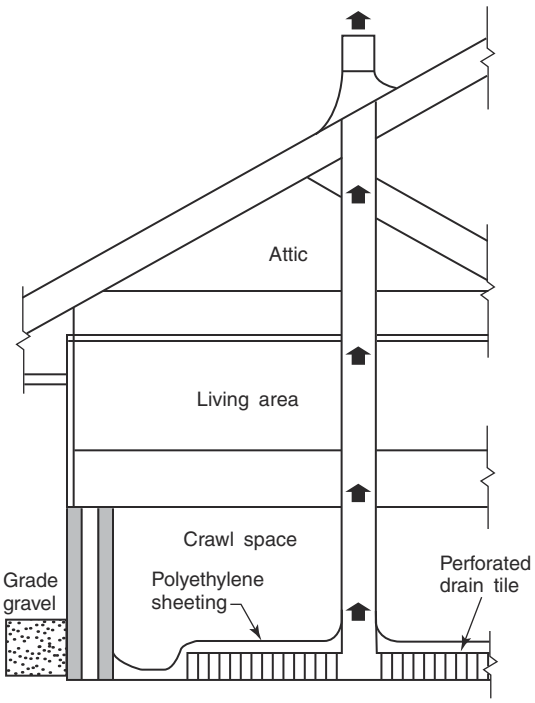


FIGURE 49.2.5.3.4 Passive Submembrane Depressurization System for Crawl Space.

49.2.5.3.4.2 Soil-Gas Retarder. The soil in crawl spaces shall be covered with a continuous layer of minimum 6 mil (0.15 mm) polyethylene sheeting or equivalent material. The ground cover shall be lapped a minimum of 12 in. (305 mm) at joints, shall be sealed to any piers and around any penetrations, and shall extend to all foundation walls enclosing the crawl space area walls.

49.2.5.3.4.3 Vent Pipe.

(A) A plumbing tee or other approved connection shall be inserted horizontally beneath the sheeting and connected to a minimum 3 in. (75 mm), maximum 4 in. (100 mm), diameter fitting with a vertical vent pipe installed through the sheeting.

(B) The vent pipe shall meet the following criteria:

(1) It shall extend up through the building floors, terminating at least 12 in. (305 mm) above the surface of the roof at a location at least 10 ft (3050 mm) away from any window or other opening into the conditioned spaces of the building that is less than 24 in. (610 mm) below the exhaust point.
(2) It shall terminate at least 10 ft (3050 mm) from any window or other opening in adjoining or adjacent buildings.

49.2.5.3.5 Passive Sub-Slab Depressurization System. In basement or slab-on-ground buildings, the components of a passive sub-slab depressurization system, as specified in 49.2.5.3.5.1 through 49.2.5.3.5.8, shall be installed during construction in accordance with Figure 49.2.5.3.5.

Δ **49.2.5.3.5.1 Vent Pipe.**

(A) A minimum 3 in. (75 mm) diameter 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 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 in accordance with Figure 49.2.5.3.5.1(A).

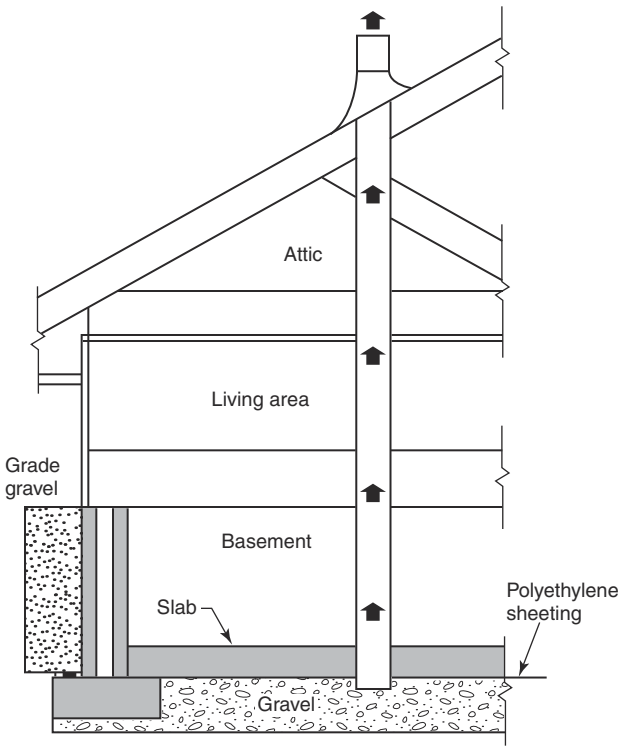


FIGURE 49.2.5.3.5 Passive Sub-Slab Depressurization Radon System.

(B) The vent pipe shall meet the following criteria:

(1) It shall extend up through the building floors, terminating at least 12 in. (305 mm) above the surface of the roof, at a location at least 10 ft (3050 mm) away from any window or other opening into the conditioned spaces of the building that is less than 24 in. (610 mm) below the exhaust point.
(2) It shall terminate at least 10 ft (3050 mm) from any window or other opening in adjoining or adjacent buildings.

49.2.5.3.5.2 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.

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

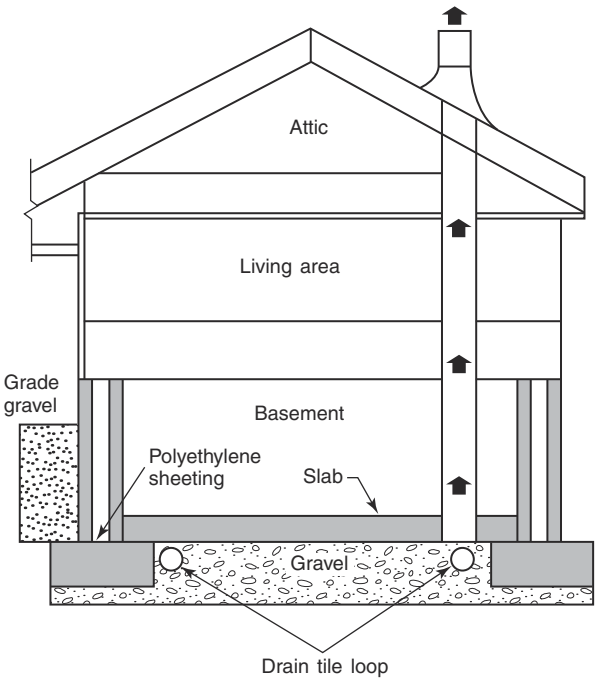


FIGURE 49.2.5.3.5.1(A) Passive Radon System Using Drain Tile Loop.

49.2.5.3.5.4 Vent Pipe Accessibility.

(A) Radon vent pipes shall be accessible for future fan installation through an attic or other area outside the habitable space.

(B) The radon vent pipe shall not be required to be accessible in an attic space where an approved rooftop electrical supply is provided for future use.

49.2.5.3.5.5 Vent Pipe Identification.

(A) All exposed and visible interior vent pipes shall be identified with at least one label on each floor and in accessible attics, and the label shall read as follows:

PASSIVE RADON REDUCTION SYSTEM

(B) In addition to the label specified in 49.2.5.3.5.5(A), a notice to the homeowner shall be placed in a conspicuous area near the vent pipe that states the following:

THERE ARE NO REQUIREMENTS FOR THIS RADON REDUCTION SYSTEM TO BE TESTED BY THE BUILDER. IT IS RECOMMENDED THAT OCCUPANTS TEST FOR RADON AND TAKE REMEDIAL ACTION AS NECESSARY. CALL 1-800-SOS-RADON FOR MORE INFORMATION.

49.2.5.3.5.6 Combination Foundations. Combination basement/crawl space or slab-on-ground/crawl space foundations shall have separate vent pipes installed in each type of foundation area. Each vent pipe shall terminate above the roof or shall be connected to a single vent that terminates above the roof.

49.2.5.3.5.7 Building Depressurization. Joints in air ducts and plenums in unconditioned spaces shall meet the requirements of Chapter 50. Thermal envelope air infiltration requirements shall comply with the energy conservation provisions in Chapter 51. Firestopping shall meet the requirements contained in Chapter 8 of this *Code*.

49.2.5.3.5.8 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 in the attic or other anticipated location of the vent pipe fan during construction. An electrical supply shall also be accessible in anticipated locations of system failure alarms.

49.2.6* Flood Hazard Areas. For new construction of buildings and structures located wholly or partly within flood hazard areas established by 39.4.2, including substantial improvements and restoration of substantial damage, ventilation openings required by this chapter shall be located above the design flood elevation.

49.3 Lighting.

49.3.1 Natural or fixed artificial lighting shall be provided to all rooms used by human beings in accordance with 49.3.2 and 49.3.3. Lighting for means of egress shall be provided in accordance with 49.3.4.

49.3.2 Where natural light is provided, the net glazed area shall be not less than 8 percent of the total area of the room served.

49.3.3 Fixed artificial lighting shall be permitted to be substituted for natural lighting. Fixed artificial lighting shall be capable of providing an average of 10 foot-candles (10 lumens/ft^2) of illumination, measured at a height of 30 in. (760 mm) above the floor.

49.3.4 Lighting of the means of egress shall be provided in accordance with Sections 11.8 and 11.9 of this *Code*.

49.4 Sound Transmission.

49.4.1 General. The provisions of Section 49.4 shall apply to dwelling units in two-family dwellings, townhouses, and apartment buildings; guest rooms and guest suites in hotels and dormitories; and sleeping rooms in lodging and rooming houses and residential board and care occupancies, hereinafter referred to as living units.

49.4.2 Airborne Sound Transmission.

49.4.2.1 All interior walls and floor/ceiling assemblies that separate living units, and that separate living units and spaces not a part of the living unit, shall have a sound transmission class (STC) of not less than 50 for airborne noise when tested in accordance with ASTM E90, *Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*.

49.4.2.2 The requirement of 49.4.2.1 shall not apply to entrance doors to living units, provided that the door is tight-fitting to the frame and sill.

49.4.3 Structure-Borne Sound Transmission. All floor/ceiling assemblies between living units, and between living units and spaces not a part of the living unit, shall have an impact insulation class (IIC) of not less than 45 when tested in accordance with ASTM E492, *Standard Test Method for Laboratory Measurement of Impact Sound Through Floor-Ceiling Assemblies Using the Tapping Machine*.

49.5 Interior Space Dimensions.

49.5.1 Ceiling Heights.

49.5.1.1 In all occupancies, other than within dwelling units, ceilings of habitable rooms shall be designed and maintained to provide headroom as provided in other sections of this *Code* and shall be not less than 7 ft 6 in. (2285 mm), with projections from the ceiling not less than 6 ft 8 in. (2030 mm) nominal height above the finished floor. The minimum ceiling height shall be maintained for not less than two-thirds of the ceiling area of any room or space, provided that the ceiling height of the remaining ceiling area is not less than 6 ft 8 in. (2030 mm).

49.5.1.2 Hallways in one- and two-family dwellings shall comply with 22.2.6.2.

49.5.1.3 Rotary fan blades in all occupancies shall be protected where the blades of the fan are located within 7 ft (2135 mm) of the finished floor. They shall be protected with guards with openings that will prohibit the passage of a ½ in. (13 mm) sphere.

49.5.1.4 Rotary fan blades in dwelling units located not less than 6 ft 8 in. (2030 mm) above the finished floor shall not be required to be protected with guards.

49.5.2 Minimum Room Dimensions — Residential Occupancies.

49.5.2.1 Where habitable rooms *(see 3.3.561.4, Habitable Room)* are created, other than a kitchen, they shall be not less than 7 ft (2135 mm) in any plan dimension.

49.5.2.2 Where habitable rooms *(see 3.3.561.4, Habitable Room)* are created space, they shall have a ceiling height of not less than 7 ft 6 in. (2286 mm).

Exception No. 1: The requirement of 49.5.2.2 shall not apply to beams, girders, ducts, or pipes spaced not less than 4 ft (1220 mm) on center and projecting not more than 6 in. (150 mm) below the required ceiling height.

Exception No. 2: For rooms with a sloped ceiling, the minimum 7 ft 6 in. (2286 mm) ceiling height shall be exempted for all but 35 ft^2 (3.25 m^2) of the floor area of the room. Any portion of the room measuring less than 5 ft (1525 mm) from the finished floor to the finished ceiling shall not be considered usable floor area and shall not be included in any computation of the minimum area thereof.

49.6 Access to Attics.

49.6.1 Where mechanical or electrical equipment or utility piping is installed in attics, access shall be provided.

49.6.2 Attic access openings shall be not less than 22 in. × 30 in. (560 mm × 760 mm).

49.7 Design Conditions.

49.7.1 General. All rooms and occupied spaces in buildings shall have indoor winter design comfort conditions in accordance with the provisions of this chapter.

49.7.2 Outdoor Climatic Data.

49.7.2.1 The outdoor climatic data required for the design of indoor comfort conditioning equipment shall be the climatic data published in the *ASHRAE Handbook — Fundamentals*, unless otherwise established by the authority having jurisdiction.

49.7.2.2 The outside winter design temperatures shall be those listed for the heating dry bulb (DB), 99 percent annual cumulative frequency of occurrence, and the outside cooling design temperatures shall be those listed for the cooling dry bulb (DB) and wet bulb (WB), 1 percent annual cumulative frequency of occurrence, unless otherwise established by the authority having jurisdiction.

49.7.3 Indoor Design Conditions.

49.7.3.1 Indoor winter design conditions for all occupancies shall be within the winter comfort zone as published in ASHRAE STD 55, *Thermal Environmental Conditions for Human Occupancy*, and the *ASHRAE Handbook — Fundamentals*, unless otherwise established by the authority having jurisdiction.

49.7.3.2 Indoor design conditions for residential board and care occupancies shall be within the winter and summer comfort zones, as published in ASHRAE STD 55 and the *ASHRAE Handbook — Fundamentals*, unless otherwise established by the authority having jurisdiction.

49.8 Special Requirements for Occupancies. Where either natural or artificial lighting is provided in educational occupancies, the minimum light level values in Table 49.8 shall be maintained at work levels.

49.9 Vermin Proofing. (Reserved) See Annex B.

Chapter 50 Mechanical Systems

50.1 General. All mechanical systems and equipment shall be designed and constructed in accordance with the following:

(1) Fuel gas appliances shall be designed and constructed in accordance with NFPA 54.
(2) Oil-burning appliances shall be designed and constructed in accordance with NFPA 31.
(3) The following shall be designed and installed in accordance with NFPA 85:
   (a) The following with a fuel input rating of 12.5 million Btu/hr (3663 MW)
      i. Single-burner boilers
      ii. Multiple-burner boilers
      iii. Stokers
      iv. Atmospheric fluidized bed boilers with a fuel input rating of 12.5 million Btu/hr (3663 MW) or greater
   (b) Pulverized fuel systems
   (c) Fired or unfired steam generators used to recover heat from combustion turbine heat recovery steam

Table 49.8 General Lighting Levels

Area	Minimum Light Level (ft-candle or lumens/ft^2)
Lecture/demonstration	150
Sewing	150
Drafting	100
Cooking	50
Other	70

Note: There is no general listing of lighting level. The requirements for special occupancies are in Section 11.9.

generators (HRSG), including associated fuel systems
(4) Solid fuel appliances shall be designed and constructed in accordance with NFPA 211.
(5) Exhaust systems for air conveying of materials shall be designed and constructed in accordance with NFPA 91.
(6) Commercial kitchens shall be designed and constructed in accordance with NFPA 96.
(7) Stationary fuel cell power plants shall be constructed, designed, and installed in accordance with NFPA 853.
(8) Air-conditioning and ventilating systems shall be designed and constructed in accordance with NFPA 90A.
(9) Warm air heating and air-conditioning systems shall be designed and constructed in accordance with NFPA 90B.
(10) All other mechanical systems and equipment shall be designed and constructed in accordance with the *Uniform Mechanical Code*.

50.2 Flood Resistance. For new construction of buildings and structures that are located wholly or partly within flood hazard areas established by 39.4.2, including substantial improvements and restoration of substantial damage, all mechanical systems and equipment below the design flood elevation, including ductwork, shall meet the requirements of Section 8 of ASCE/SEI 24, *Flood Resistant Design and Construction*.

50.3 Refrigeration Machinery Room. Refrigeration systems shall comply with this *Code*. Where a refrigeration machinery room is required, it shall be separated from the remainder of the building or located on the property, as required by ANSI/ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*. Structural supporting elements shall be protected only for the type of construction and not the occupancy separation. Means of egress from the machinery room shall comply with 50.3.1. Nothing contained herein shall be used to limit the height or area of the building or the machinery room. The refrigeration system, its refrigerant, and its safety devices shall be maintained in accordance with the *Uniform Mechanical Code* and ASHRAE STD 15.

50.3.1 Refrigeration Machinery Room Egress.

50.3.1.1 Access to Exits. Machinery rooms larger than 1000 ft^2 (93 m^2) shall have access to not less than two exits.

50.3.1.2 Travel Distance. Travel distance shall be determined as specified in Section 29.2, but all portions of the machinery room shall be within 150 ft (45 m) of an exit or exit access doorway.

50.3.1.3 Doors. Doors and door swing shall be in accordance with ANSI/ASHRAE STD 15.

Chapter 51 Energy Efficiency

51.1 General. The requirements of this chapter shall regulate the energy-efficient design of the building envelope; the conditioning of the enclosed environment through heating, venting, and air-conditioning equipment and systems; and other equipment and systems that contribute to the building's energy consumption.

51.1.1 Application. Energy-efficient design requirements shall govern the following:

(1) New construction
(2) Additions, alterations, modernizations, or renovations to existing buildings or structures

51.1.2 Occupancy Classification. For the purposes of this chapter, each occupancy within the building or structure shall be subject to the applicable requirements for that occupancy. Where an occupancy contains another occupancy whose area is less than 10 percent of the area of the total floor area in which it is located, the primary occupancy shall be considered the occupancy.

51.1.3 Special Definitions. (Reserved)

51.2 Commercial.

51.2.1 The following occupancies shall meet the requirements of ANSI/ASHRAE/IES Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*:

(1) Assembly
(2) Educational
(3) Health care
(4) Ambulatory health care
(5) Detention and correctional
(6) Lodging or rooming house
(7) Hotels and dormitory
(8) Apartment buildings of four or more stories in height
(9) Mercantile
(10) Business

51.2.2 The following occupancies shall be exempt from the provisions of this chapter:

(1) Storage
(2) Industrial

51.3 Residential. Low-rise residential buildings shall meet the requirements of ASHRAE STD 90.2, *Energy Efficient Design of Low-Rise Residential Buildings*.

51.4 Manufactured Homes. One- and two-family dwellings shall meet the requirements of Chapter 8, Thermal Protection, and Chapter 10, Heating, Cooling, and Fuel Burning Systems, of NFPA 501.

51.5 Day Care.

51.5.1 Day care homes located within a one- or two-family dwelling shall be classified as residential occupancies for the purposes of this chapter and shall comply with the requirements of Section 51.3.

51.5.2 Day care occupancies, other than those specified in 51.5.1, shall be classified as commercial occupancies for the purposes of this chapter and shall comply with the requirements of 51.2.1.

51.6 Residential Board and Care.

51.6.1 Small facilities located within a one- or two-family dwelling shall be classified as residential occupancies for the purposes of this chapter and shall comply with the requirements of Section 51.3.

51.6.2 Residential board and care facilities, other than those specified in 51.6.1, shall be classified as commercial occupancies for the purposes of this chapter and shall comply with the requirements of 51.2.1.

Chapter 52 Electrical Systems

52.1* General. All electrical systems and equipment shall be designed and constructed in accordance with *NFPA 70*.

52.2 Flood Resistance. For new construction of buildings and structures that are located wholly or partly within flood hazard areas established by 39.4.2, including substantial improvements and restoration of substantial damage, electrical systems and equipment below the design flood elevation shall meet the requirements of Section 8 of ASCE/SEI 24, *Flood Resistant Design and Construction*.

52.3* Stationary Storage Battery Systems. Stationary storage battery systems shall be designed and constructed in accordance with Chapter 52 of NFPA 1.

Chapter 53 Plumbing Systems

Δ **53.1 General.** All plumbing systems and equipment shall be designed and installed in accordance with the following:

(1) The installation of fuel gas distribution piping and equipment, fuel-gas-fired water heaters, and water heater venting systems shall be designed and installed in accordance with NFPA 54.
(2) The installation of liquefied gas distribution piping, equipment, and systems shall be designed and installed in accordance with NFPA 58.
(3) The installation of piping and equipment in health care facilities shall be designed and installed in accordance with NFPA 99.
(4) All other plumbing systems shall be designed and installed in accordance with the *Uniform Plumbing Code*.

53.2 Flood Resistance. For new construction of buildings and structures that are located wholly or partly within flood hazard areas established by 39.4.2, and including substantial improvements and restoration of substantial damage, plumbing systems and equipment below the design flood elevation shall meet the requirements of Section 8 of ASCE/SEI 24, *Flood Resistant Design and Construction*.

Chapter 54 Elevators and Conveying Systems

54.1 General. An elevator shall not be considered a component in a required means of egress but shall be permitted as a component in an accessible means of egress and as permitted by 11.2.13.

54.2 Installation.

54.2.1 Except as modified herein, elevators, escalators, dumbwaiters, and moving walkways shall be installed in accordance with the requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

54.2.2 Elevators in accordance with ASME A17.7/CSA B44.7, *Performance-Based Safety Code for Elevators and Escalators,* shall be deemed to comply with ASME A17.1/CSA B44.

54.2.3 For other than elevators used for occupant-controlled evacuation in accordance with Section 11.4, the elevator corridor call station pictograph specified in 2.27.9 of ASME A17.1/CSA B44 shall be provided at each elevator landing.

54.3 Ambulance Stretcher Accommodation.

54.3.1 In buildings of more than three stories, a minimum of one elevator shall be provided for fire fighter emergency operation to all floors.

54.3.2 The elevator car shall be sized and arranged to accommodate a 2 ft × 7 ft (610 mm × 2130 mm) ambulance stretcher with minimum 5-in. (125-mm) radius corners in the horizontal, open position.

54.3.3 The elevator car shall be identified by the international symbol for emergency medical services (star of life). The symbol shall be minimum 3 in. (75 mm) in height and shall be located inside the car on both sides of the door frame.

54.4 Openings to Exit Enclosures. Conveyors, elevators, dumbwaiters, and pneumatic conveyors serving various stories of a building shall not open to an exit enclosure.

54.5 Elevator Machine/Control Rooms and Machinery/Control Spaces. Elevator machine/control rooms and machinery/control spaces that contain solid-state equipment for elevators that have a travel distance of more than 50 ft (15 m) above the level of exit discharge, or more than 30 ft (9.1 m) below the level of exit discharge, shall be provided with ventilation or air-conditioning systems to maintain the required temperature during fire fighter service operations for elevator operation.

54.5.1 The operating temperature shall be established by the elevator equipment manufacturer's specifications.

54.5.2 Where standby power is connected to the elevator, the machine/control room and machinery/control space ventilation or air-conditioning shall be connected to standby power.

54.5.3 Elevator machine/control rooms and machinery/control spaces shall be enclosed with fire barrier walls meeting one of the following criteria:

(1) The fire barrier walls shall have a fire resistance rating of not less than the required rating of the hoistway enclosure the machine/control rooms or machinery/control spaces serve.
(2) The fire barrier walls, for other than fire service access elevators, shall have a minimum 1-hour fire resistance rating where the machine/control rooms and machinery/control spaces do not abut, and do not have openings to, the hoistway enclosure they serve.
(3) The fire barrier walls shall have a minimum 1-hour fire resistance rating where the machine/control rooms or machinery/control spaces serve a hoistway that is not required to be fire resistance rated.

54.5.4 Openings shall be protected with assemblies having a fire protection rating meeting one of the following criteria:

(1) The opening protective assembly shall have a minimum rating not less than that required for the hoistway enclosure doors.
(2) The opening protective assembly shall have a minimum ¾-hour rating where the machine/control rooms and machinery/control spaces do not abut, and do not have openings to, the hoistway enclosure they serve.
(3) The opening protective assembly shall have a minimum ¾-hour rating where the machine/control rooms and machinery/control spaces serve a hoistway that is not required to be fire resistance rated.

54.6 Number of Cars in a Hoistway.

54.6.1 Where four or more cars serve all or the same portion of a building, the elevators shall be located in at least two separate hoistways.

54.6.2 Not more than four elevator cars shall be located in any single hoistway enclosure.

54.7 Hoistway Enclosure.

54.7.1 Hoistway enclosures shall be permitted to be glass, provided that both of the following criteria are met:

(1) The hoistway enclosure is not required to be fire resistance rated.
(2) The glass is laminated glass meeting the requirements of one of the following:
   (a) ANSI Z97.1, *For Safety Glazing Materials Used in Buildings — Safety Performance Specifications and Methods of Test*
   (b) CPSC 16 CFR 1201, *Safety Standard for Architectural Glazing Materials*

54.7.2 Each separate piece of laminated glass used in the hoistway enclosure shall be marked as required by the applicable standard specified in 54.7.1.

54.7.3 The marking required by 54.7.2 shall remain visible after installation.

54.8* Flood Resistance. For new construction of buildings and structures that are located wholly or partly within flood hazard areas established by 39.4.2, including substantial improvements and restoration of substantial damage, all elevator equipment shall meet the requirements of Section 8 of ASCE/SEI 24, *Flood Resistant Design and Construction.*

54.9 Vents Required. Hoistways of elevators and dumbwaiters penetrating more than three stories shall be provided with a means of venting smoke and hot gases to the outer air in case of fire.

54.9.1 Location of Vents. Vents shall be located below the ceiling at the top of the hoistway and shall open either directly to the outer air or through noncombustible ducts to the outer air.

54.9.1.1 Noncombustible ducts shall be permitted to pass through the elevator machine room, provided that portions of the ducts located outside of the hoistway or machine room are enclosed by construction having not less than the fire resistance rating required for the hoistway.

54.9.1.2 Holes in machine room floors for the passage of ropes, cables, or other moving elevator equipment shall be limited so as not to provide greater than 2 in. (51 mm) of clearance on all sides.

54.9.2 Area of Vents.

54.9.2.1 The area of vents shall be not less than 3½ percent of the area of each elevator car in the hoistway or not less than 3 ft^2 (0.028 m^2), whichever is greater.

54.9.2.2 The area of vents shall be not less than 3½ percent of the area of each dumbwaiter car in the hoistway or not less than 0.5 ft^2 (0.047 m^2), whichever is greater.

54.9.2.3 The requirements of 54.9.2.1 and 54.9.2.2 shall not apply where mechanical ventilation conforming to the *Uniform Mechanical Code* provides equivalent venting, in which case the required vent area shall be permitted to be reduced, provided that the building is not used for health care, hotel, apartment, lodging or rooming house, residential board and care, or similar occupancies with overnight sleeping accommodations.

54.9.3* Closed Vents. Vents shall be permitted to be closed. Closed vents shall open upon detection of smoke in any elevator lobby. In addition, closed vents shall open upon power failure. A manual override shall also be provided at an approved location.

54.10 Conveying Systems. Conveying systems shall be installed in accordance with ASME B20.1, *Safety Standard for Conveyors and Related Equipment.*

54.11 Wheelchair Lifts. Wheelchair lifts shall be installed in accordance with ASME A18.1, *Safety Standard for Platform Lifts and Stairway Chair Lifts.*

54.12 Fire Service Access Elevators.

54.12.1 General. Where fire service access elevators are provided, and except as modified by this section, each fire service access elevator shall be installed in accordance with Chapter 54 and ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators.*

54.12.1.1 A minimum of one fire service access elevator shall be sized in accordance with 54.3.2.

54.12.2 Fire Service Access Elevator Lobbies.

54.12.2.1 General. Each fire service access elevator shall open into a fire service access elevator lobby complying with 54.12.2.

Exception: Where a fire service access elevator has two entrances onto a floor, the second entrance shall not be required to open into an elevator lobby complying with 54.12.2.

54.12.2.2 Access.

54.12.2.2.1 Each fire service access elevator lobby shall have direct access to an exit stair enclosure.

54.12.2.2.2 The exit stair enclosure shall also have access to the floor without passing through the fire service access elevator lobby.

54.12.2.3 Lobby Enclosure. Each fire service access elevator lobby shall be enclosed with a smoke barrier having a minimum 1-hour fire resistance rating, except that lobby door assemblies shall comply with 54.12.2.4.

Exception: Enclosed fire service access elevator lobbies shall not be required at the street floor or level of exit discharge.

54.12.2.4 Lobby Door Assemblies. Each fire service access elevator lobby door shall have not less than a ¾-hour fire protection rating and shall be self-closing or automatic-closing in accordance with 11.2.1.8.

54.12.3 Standpipe Hose Connection. Each building exit stair having direct access to the fire service access elevator lobby shall be provided with a standpipe hose connection in accordance with Section 55.4.

54.12.4 Elevator System Monitoring. The fire service access elevator shall be continuously monitored at the emergency command center by a standard emergency service interface system meeting the requirements of *NFPA 72.*