

# 2021

# Pennsylvania Alternative Residential Energy Provisions



PENNSYLVANIA HOUSING  
RESEARCH CENTER

The 2021 PA-Alt is equivalent to the 2018 IRC and the 2018 IECC.

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# 2021

# Pennsylvania

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# Provisions

The Pennsylvania Housing Research Center  
University Park, Pennsylvania



**PennState**  
College of Engineering

**PENNSYLVANIA HOUSING  
RESEARCH CENTER**

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The 2021 Pennsylvania Alternative Residential Energy Provisions were developed by the PHRC as a service to the Pennsylvania Department of Labor and Industry on behalf of all the consumers of housing in Pennsylvania.

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# PREFACE

In November 1999, the Pennsylvania Legislature passed Act 45, known as the Uniform Construction Code (UCC), into law mandating a statewide building code across Pennsylvania. Act 45 requires the Pennsylvania Department of Labor and Industry (DLI) to promulgate regulations to implement the requirements of the legislation and in addition, to consider the development of alternative prescriptive methods for energy conservation that account for the various climatic regions within the Commonwealth. In deriving these energy standards, the DLI was to seek to balance energy savings with initial construction costs.

The PHRC developed Pennsylvania Alternative Residential Energy Provisions (PA-Alt) for consideration by DLI to meet their legislated mandate. The PA-Alt was developed with the intent of being:

- simpler to build to and easier to enforce;
- more rational and flexible;
- focused on Pennsylvania in terms of climatic and other conditions; and
- equivalent to the provisions of the International Energy Conservation Code (IECC).

The initial version of the PA-Alt was developed in 2000 and was based on the 2000 IECC and International Residential Code (IRC). The second, third, fourth, and fifth versions were updated to the 2003, 2006, 2009, and 2015 IECC and IRC, respectively. This document is the sixth iteration of the PA-Alt, and it is equivalent to the 2018 IECC and IRC.

The PA-Alt is developed using energy modeling to compare the relative predicted energy savings from a selected energy enhancement option with the additional energy consumption from various envelope trade-offs. This process uses BEopt: Building Energy Optimization Tool for energy modeling and refers to methodology established in Department of Energy Cost-Effectiveness Analyses as well as parameters from the IRC/IECC energy code simulated performance path.

The PA-Alt document is an alternative to chapter 11 of the IRC. It is intended to supplement the IRC and to the extent possible, be consistent in format and general intent. The scope and definitions used in the IRC apply. It is important to note that a choice needs to be made by the builder or design professional between the 2021 PA-Alt, the 2018 IRC, and the 2018 IECC.

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# SECTION PA100

## GENERAL

**PA101 Scope.** The provisions of this document regulate energy efficiency for the design and construction of buildings regulated by the 2018 International Residential Code (IRC) as incorporated in the PA Uniform Construction Code (UCC) in the Commonwealth of Pennsylvania. In addition, the provisions of this document only apply to new construction of one- and two-family dwellings and townhouses not more than three stories above grade plane in height with a separate means of egress and their accessory structures not more than three stories above grade plane in height and are not applicable to alteration, repair, addition, and change of occupancy of existing buildings and structures.

*Exception:* Portions of the building envelope that do not enclose conditioned space.

**PA102 Intent.** This document was developed with the intent of being: simpler to build and easier to enforce; more rational and flexible; focused on Pennsylvania in terms of climatic and other conditions; and, equivalent to the provisions of the International Energy Conservation Code (IECC) in terms of energy efficiency as incorporated in the UCC.

**PA103 Compliance.** Compliance shall be demonstrated by either meeting the requirements of the IECC or the IRC, as incorporated in the UCC, or meeting the requirements of this document. Climate zones from PA201 shall be used in determining the applicable requirements from this document.

**PA104 Entrance requirements.** This compliance path allows for some reductions in energy efficiency that will allow simplified enforcement and construction. To utilize the PA Alternative Energy Provisions, the building owner or agent must choose at least one of the energy enhancement options in Table PA104.

**Table PA104**  
*Energy Enhancement Options*

Option	Description	Minimum efficiency by climate zone			
		South (4)	Central (5)	North (6)	
1	Ductless heat pumps <sup>a</sup>	8.5 HSPF and 15 SEER	10 HSPF and 15 SEER	10 HSPF and 15 SEER	
2	All air ducts located inside the thermal envelope	Compliant	Compliant	Compliant	
3	Geothermal or water source heat pump installed <sup>a</sup>	Compliant	Compliant	Compliant	
4	Improved efficiency air source heat pump installed <sup>a</sup>	9.5 HSPF and 19 SEER	9.5 HSPF and 19 SEER	11 HSPF and 19 SEER	
5	Improved efficiency condensing furnace installed <sup>a</sup>	92 AFUE	95 AFUE	95 AFUE	
6	Exterior continuous insulation	R20+10	R20+10	R20+15	
7	Improved efficiency windows	U-factor = 0.21	U-factor = 0.19	U-factor = 0.15	
8	Package: Improved efficiency windows and higher attic R-value with raised heel truss <sup>b</sup>	Windows	U-factor = 0.25	U-factor = 0.21	U-factor = 0.19
		Attic	R-value = 60	R-value = 60	R-value = 60
9	Package: Improved efficiency windows and heat pump water heater	Windows	U-factor = 0.25	U-factor = 0.21	U-factor = 0.19
		Heat Pump Water Heater	Compliant	Compliant	Compliant

Notes:

- a. For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.
- b. Full height of uncompressed insulation shall extend over the top plate at the eaves.

**PA105 Compliance documents.** If this document is used for energy compliance, it must be clearly identified on construction documents or listed on the application for a building permit. Additionally, the option used to meet the entrance requirements in PA104 must be identified.

**PA106 Definitions.** To minimize confusion, the definitions contained in Chapter 2[RE] of the 2018 IECC or Section N1101.6 of the 2018 IRC apply to this document.

**PA107 Identification.** Materials, systems, and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this chapter.

**PA108 Building thermal envelope insulation.** An R-value identification mark shall be applied by the manufacturer to each piece of building thermal envelope insulation 12 inches (305 mm) or more wide. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and R-value of insulation installed in each element of the building thermal envelope. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled R-value, installed density, coverage area and number of bags installed shall be listed on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the area covered and R-value of installed thickness shall be listed on the certificate. For insulated siding, the R-value shall be labeled on the product's package and shall be listed on the certification. The insulation installer shall sign, date and post the certificate in a conspicuous location on the job site.

*Exception:* For roof insulation installed above the deck, the R-value shall be labeled as required by the material standards specified in 2018 IRC Table R906.2.

**PA108.1 Blown or sprayed roof/ceiling insulation.** The thickness of blown in or sprayed roof/ceiling insulation (fiberglass or cellulose) shall be written in inches (mm) on markers that are installed at least one for every 300 ft<sup>2</sup> (28 m<sup>2</sup>) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers a minimum of 1 inch (25 mm) high. Each marker shall face the attic access opening. Spray polyurethane foam thickness and installed R-value shall be listed on the certificate provided by the insulation installer.

**PA108.2 Insulation mark installation.** Insulating materials shall be installed such that the manufacturer's R-value mark is readily observable upon inspection.

**PA109 Fenestration product rating.** U-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled U-factor shall be assigned a default U-factor from 2018 IRC Tables N1101.10.3(1) and N1101.10.3(2). The solar heat gain coefficient (SHGC) and visible transmittance (VT) of glazed fenestration products such as windows, glazed doors and skylights shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from 2018 IRC Table N1101.10.3(3).

**PA110 Insulation product rating.** The thermal resistance, R-value, of insulation shall be determined in accordance with Part 460 of US-FTC CFR Title 16 in units of h • ft<sup>2</sup> • °F/Btu at a mean temperature of 75°F (24°C).

**PA110.1 Insulated Siding.** The thermal resistance (R-value) of insulated siding shall be determined in accordance with ASTM C1363. Installation for testing shall be in accordance with the manufacturer's installation instructions.

**PA111 Installation.** All materials, systems and equipment shall be installed in accordance with the manufacturer's installation instructions and the provisions of this code.

**PA111.1 Protection of exposed foundation insulation.** Insulation applied to the exterior of

basement walls, crawl space walls, and the perimeter of slab-on-grade floors shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend a minimum of 6 inches (152 mm) below grade.

**PA112 Maintenance information.** Maintenance instructions shall be furnished for equipment and systems that require preventative maintenance. Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.

**PA113 Above code programs.** The building official or other authority having jurisdiction shall be permitted to deem a national, state or local energy efficiency program to exceed the energy efficiency required by this document. Buildings approved in writing by such an energy efficiency program shall be considered in compliance with this document.

**PA114 Certificate.** A permanent certificate shall be completed by the builder or other approved party and posted on a wall in the space where the furnace is located, a utility room or an approved location inside the building. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall indicate the predominant R-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, basement walls, crawl space walls and floors, and ducts outside conditioned spaces; U-factors of fenestration and the solar heat gain coefficient (SHGC) of fenestration, and the results from any required duct system and building envelope air leakage testing performed on the building. Where there is more than one value for each component, the certificate shall indicate the value covering the largest area. The certificate shall indicate the types and efficiencies of heating, cooling and service water heating equipment. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall indicate "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be indicated for gas-fired unvented room heaters, electric furnaces and electric baseboard heaters.

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# SECTION PA200

## CLIMATE ZONES

**PA201 General.** Climate zones listed in PA201.1 shall be used.

### **PA201.1 Climate Zones**

**South (4):** Bucks, Chester, Delaware, Montgomery, Philadelphia, York

**Central (5):** All other counties

**North (6):** Cameron, Clearfield, Elk, McKean, Potter, Susquehanna, Tioga, Wayne

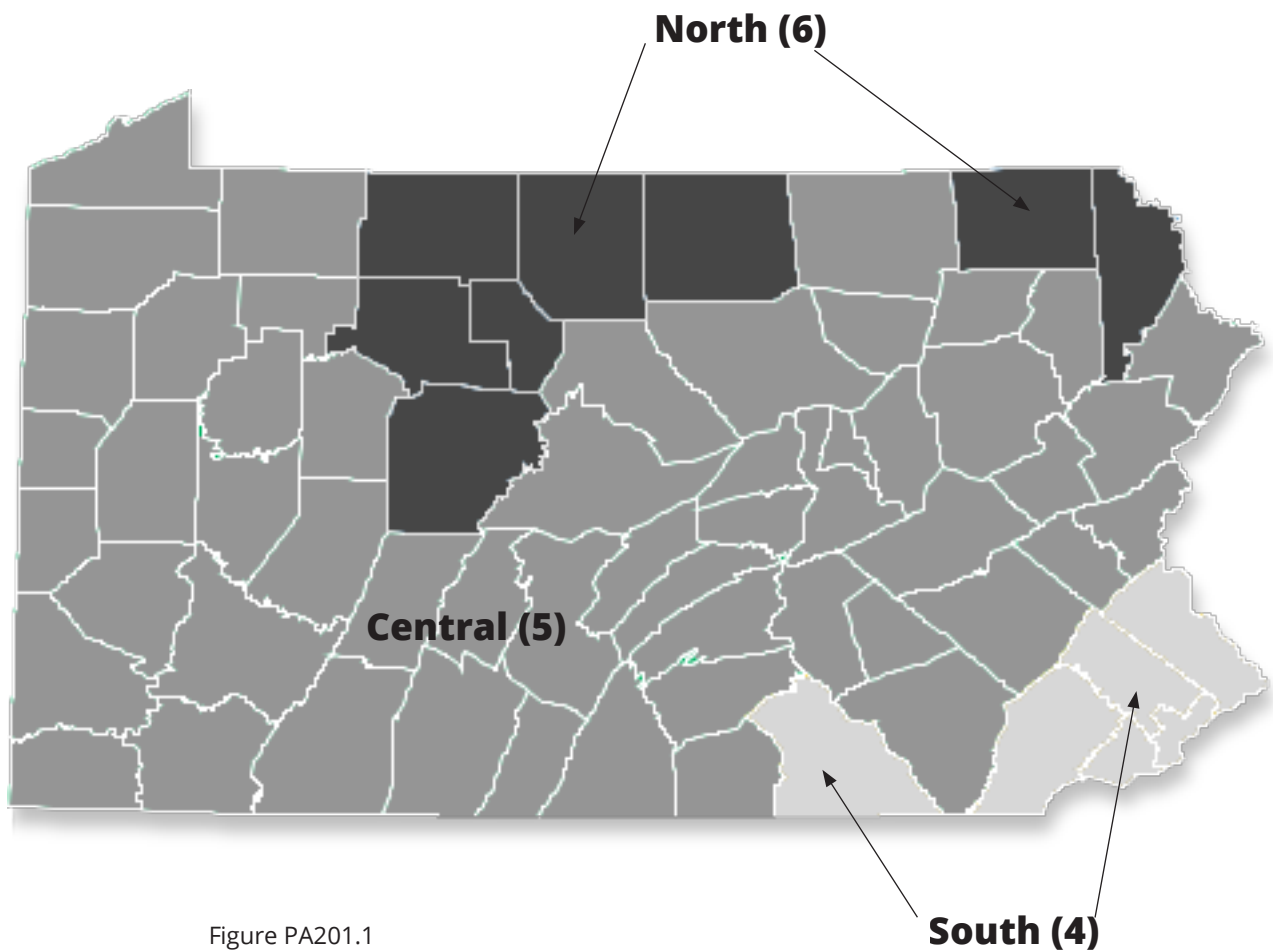


Figure PA201.1  
Pennsylvania Climate Zones

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# SECTION PA300

## BUILDING THERMAL ENVELOPE

**PA301 Insulation and fenestration criteria.** The building thermal envelope shall meet the requirements of Table PA301 based on the climate zone specified in Section PA201.

**PA301.1 R-value computation.** Insulation material used in layers, such as framing cavity insulation and insulating sheathing, shall be summed to compute the component R-value. The manufacturer's settled R-value shall be used for blown insulation. Computed R-values shall not include an R-value for other building materials or air films. Where insulated siding is used for the purpose of complying with the continuous insulation requirements of Table PA301, the manufacturer's labeled R-value for insulated siding shall be reduced by R-0.6.

**Table PA301**  
*Insulation and Fenestration Requirements by Component<sup>a</sup>*

Climate Zone	Fenestration <sup>b</sup> U-factor	Skylights <sup>b</sup> U-factor	Glazed Fenestration SHGC <sup>b,e</sup>	Ceiling R-value	Wood Frame Wall R-value	Mass Wall R-value <sup>h</sup>	Floor R-value	Basement <sup>c</sup> Wall R-value	Slab <sup>d</sup> R-value and depth	Crawlspace <sup>c</sup> Wall R-value
South (4)	0.32	0.55	0.4	38	20 <sup>i</sup> or 13+5 <sup>g</sup>	8/13	19	10/13	10, 2 ft	10/13
Central (5)	0.30	0.55	NR	49	20 <sup>i</sup> or 13+5 <sup>g</sup>	13/17	30 <sup>f</sup>	10/13	10, 2 ft	10/13
North (6)	0.30	0.55	NR	49	23, 20+5 <sup>g</sup> , or 13+10 <sup>g</sup>	15/20	30 <sup>f</sup>	10/13	10, 4 ft	10/13

**Notes:**

- R-values are minimums. U-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed R-value of the insulation shall be not less than the R-value specified in the table.
- The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.  
*Exception:* In Climate Zones 1 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.
- "10/13" means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation on the interior of the basement wall. "15/19" means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation on the interior of the basement wall. Alternatively, compliance with "15/19" shall be R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home.
- For heated slabs, refer to requirements in 2018 IRC Table N1102.1.2 (R402.1.2) and 2018 IRC Section N1102.2.10 (R402.2.10).
- There are no SHGC requirements in the Marine Zone.
- Alternatively, insulation sufficient to fill the framing cavity providing not less than an R-value of R-19.
- The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, "13+5" means R-13 cavity insulation plus R-5 continuous insulation.
- Mass walls shall be in accordance with Section N1102.2.5. The second R-value applies where more than half of the insulation is on the interior of the mass wall.
- R-18 insulation shall be permitted in place of R-20 requirement provided the wall framing factor is 20% or less or exterior walls with 24" on center nominal vertical stud spacing.

### **PA302 Specific insulation requirements.**

**PA302.1 Ceilings with attic spaces.** When Section PA301 would require R-38 in the ceiling, R-30 shall be deemed to satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Similarly R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves.

**PA302.2 Ceilings without attic spaces.** Where the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, such as cathedral ceilings, the minimum required

insulation for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section PA301 shall be limited to 75% of the total living space square footage area.

**PA302.3 Eave Baffle.** For air-permeable insulations in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain an opening equal or greater than the size of the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material.

**PA302.4 Access hatches and doors.** Access hatches and doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces) shall be weather stripped. Both vertical and horizontal access hatches shall be insulated to a minimum of R-20 with rigid foam permanently attached to the access hatch. This is not intended to restrict the use of proprietary products meeting the intent of this provision. Side hinged access door shall meet the fenestration requirements of Table PA301.

A wood framed or equivalent baffle or retainer is required to be provided when loose fill insulation is installed. The purpose of which is to prevent the loose fill insulation from spilling into the living space when the attic access is opened. Areas around access hatches required to service equipment shall provide a permanent means of maintaining the installed R-value of the insulation.

*Exception:* Vertical doors that provide access from conditioned to unconditioned spaces shall be permitted to meet the fenestration requirements of Table PA301 based on the applicable climate zone specified in Section PA201.1.

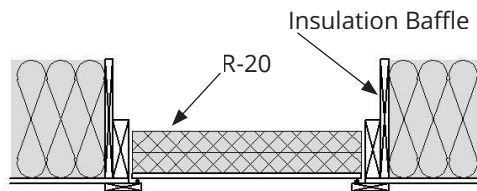


Figure PA302.4 (1)  
Attic Hatch

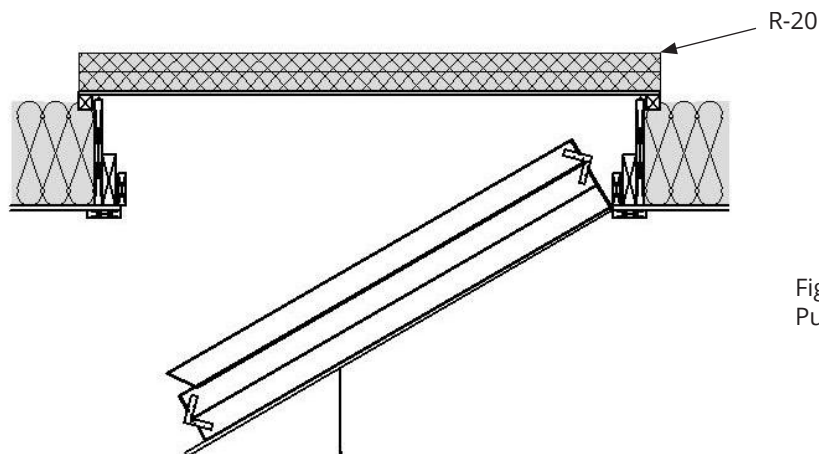


Figure PA302.4 (2)  
Pull-Down Stairs

**PA302.5 Mass walls.** Mass walls where used as a component of the building thermal envelope shall be one of the following:

1. Above-ground walls of concrete block, concrete, insulated concrete form, masonry cavity, brick but not brick veneer, adobe, compressed earth block, rammed earth, solid timber or solid logs.
2. Any wall having a heat capacity greater than or equal to  $6 \text{ Btu/ft}^2 \cdot ^\circ\text{F}$  ( $123 \text{ kJ/m}^2 \cdot \text{K}$ ).

**PA302.6 Walls with partial structural sheathing.** Where PA301 requires continuous insulation on exterior walls and structural sheathing covers 40 percent or less of the gross area of all exterior walls, the required continuous insulation R-value shall be permitted to be reduced by an amount necessary, but not more than R-3, to result in a consistent total sheathing thickness on areas of the walls covered by structural sheathing.

**PA302.7 Floors.** Floor framing-cavity insulation shall be installed to maintain permanent contact with the underside of the subfloor decking.

*Exception:* As an alternative, the floor framing-cavity insulation shall be permitted to be in contact with the topside of sheathing or continuous insulation installed on the bottom side of floor framing where combined with insulation that meets or exceeds the minimum wood frame wall R-value in Table PA301 and that extends from the bottom to the top of all perimeter floor framing members.

**PA302.8 Basement walls.** Exterior walls associated with conditioned basements shall be insulated from the top of the basement wall down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with Sections PA301.

**PA302.9 Slab-on-grade floors.** Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table PA301. The insulation can be installed on either the exterior or interior of the foundation wall.

**PA302.9.1 Exterior Insulation.** Exterior insulation shall be installed from the top of the slab and extend below grade the distance listed in Table PA301 by any combination of vertical insulation or horizontal insulation extending away from the building. Insulation extending away from the building shall be protected by pavement or by a minimum of 10 inches (254 mm) of soil. Insulation shall also meet PA 111.1.

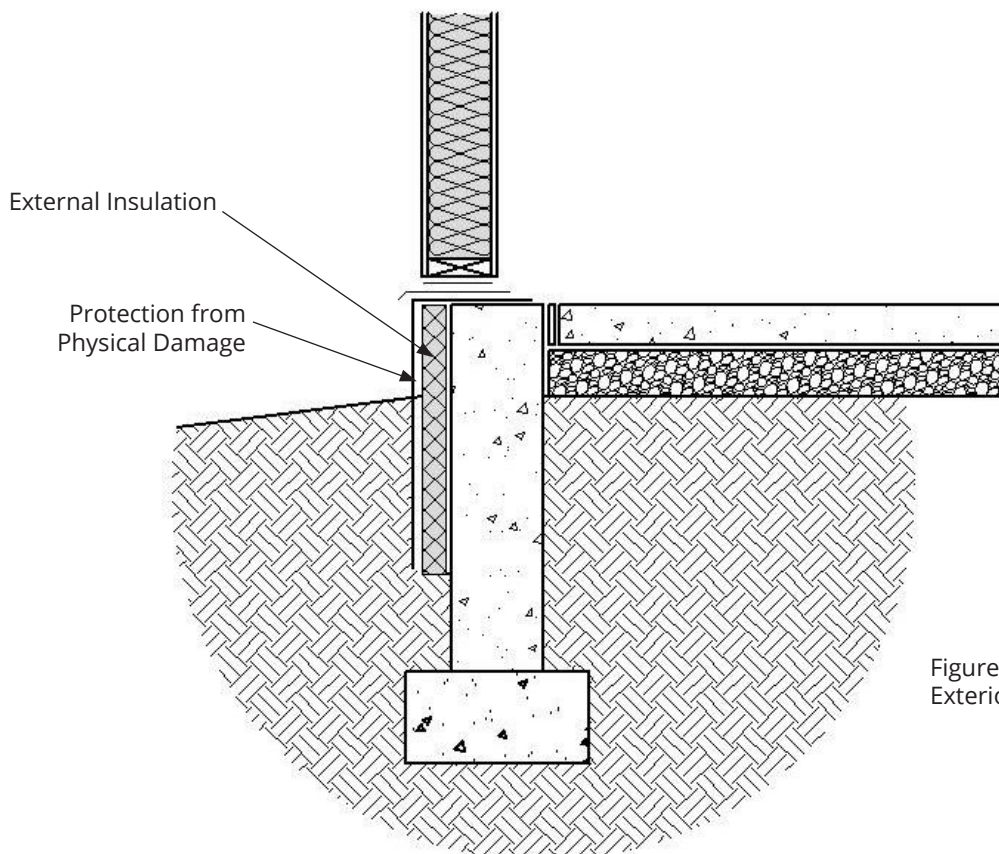


Figure PA302.9.1  
Exterior Slab Insulation

**PA302.9.2 Interior Insulation.** Interior insulation shall be installed from the bottom of the slab and extend the distance provided in Table PA301 by any combination of vertical insulation or horizontal insulation extending under the slab. The slab edge shall be separated from the foundation wall by a continuous ½ inch thermal break as per Figure PA302.9.2 A thermal break shall be created by a material suitable for ground contact, which includes, but is not limited to, asphalt impregnated fiber board or extruded polystyrene. Slab-edge insulation is not required in jurisdictions designated by the code official as having a very heavy termite infestation.

Note: The provisions in PA302.9.2 only apply to unheated slabs. For heated slabs, refer to requirements in 2018 IRC Table N1102.1.2 (R402.1.2) and 2018 IRC Section N1102.2.10 (R402.2.10).

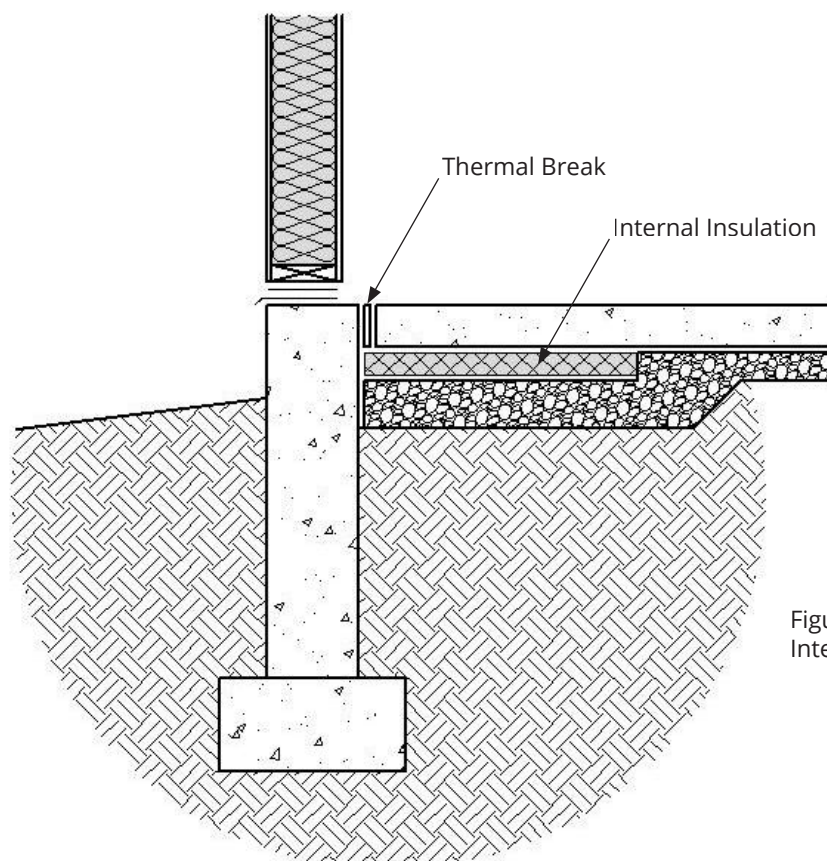


Figure PA302.9.2  
Interior Slab Insulation

**PA302.10 Crawl space walls.** As an alternative to insulating floors over crawl spaces, insulation of crawl space walls shall be permitted when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder. All joints of the vapor retarder shall overlap by 6 inches (152 mm) and be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (152 mm) up the stem wall and shall be attached to the stem wall.

**PA302.11 Masonry veneer.** Insulation shall not be required on the horizontal portion of the foundation that supports a masonry veneer.

**PA302.12 Thermally isolated sunroom insulation.** The minimum ceiling insulation R-values shall be R-24. The minimum wall R-value shall be R-13. New wall(s) separating the sunroom from conditioned space shall meet the building thermal envelope requirements.

### **PA303 Fenestration.**

**PA303.1 U-factor.** An area-weighted average of fenestration products shall be permitted to satisfy the U-factor requirements.

**PA303.2 Glazed Fenestration SHGC.** An area-weighted average of fenestration products more than 50% glazed shall be permitted to satisfy the SHGC requirements.

**PA303.3 Glazed fenestration exemption.** Up to 15 square feet (1.4 m<sup>2</sup>) of glazed fenestration per dwelling unit shall be permitted to be exempt from U-factor requirements Table PA301.

**PA303.4 Opaque door exemption.** One door assembly, including side hinged opaque doors, sidelights and transoms, up to 54 square feet (5.02 m<sup>2</sup>) in area is exempted from the U-factor requirement in Table PA301.

**PA303.5 Thermally isolated sunroom U-factor.** Maximum fenestration U-factor shall be 0.45 and the maximum skylight U-factor shall be 0.70. New windows and doors separating the sunroom from conditioned space shall meet the building thermal envelope requirements.

**PA303.6 Replacement fenestration.** Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factor in Table PA301.

### **PA304 Air leakage.**

**PA304.1 Building thermal envelope.** The building thermal envelope shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

**PA304.1.1. Installation.** The components of the building thermal envelope as listed in Table PA304.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table PA304.1.1, as applicable to the method of construction. Where required by the building official, an approved third party shall inspect all components and verify compliance.

**PA304.1.2 Testing.** The building or dwelling unit shall be tested and verified as having an air leakage rate or not exceeding three air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E 779, or ASTM E 1827 and reported at a pressure of 0.2 inches w.g. (50 Pascals). Where required by the code official, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the code official. Testing shall be performed at any time after the creation of all penetrations of the building thermal envelope.

#### **During testing:**

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers shall be closed, but not sealed beyond intended infiltration control measures; including exhaust, intake, makeup air, back draft, and flue dampers;
3. Interior doors, if installed at the time of test, shall be open;

4. Exterior or interior terminations for continuous ventilation systems shall be sealed;
5. Heating and cooling system(s), if installed at the time of the test, shall be turned off;
6. Supply and return registers, if installed at the time of the test, shall be fully open.

**PA304.2 Fireplaces.** New wood-burning fireplaces shall have tight-fitting flue dampers or doors, and outdoor combustion air. Where using tight-fitting doors on factory-built fireplaces listed and labeled in accordance with UL 127, the doors shall be tested and listed for the fireplace.

**PA304.3 Fenestration air leakage.** Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cubic foot per minute per square foot [1.5 (L/s)/m<sup>2</sup>], and swinging doors no more than 0.5 cubic foot per minute per square foot [2.5 (L/s)/m<sup>2</sup>], when tested according to NFRC400 or AAMA/WDMA/CSA101/I.S.2/A440 by an accredited, independent laboratory, and listed and labeled by the manufacturer.

*Exception:* Site-built windows, skylights and doors.

**PA304.4 Rooms containing fuel-burning appliances.** Where open combustion air ducts provide combustion air to open combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room that is isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table PA301, where the walls, floors and ceilings shall meet a minimum of the basement wall R-value requirement. The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with PA401. The combustion air duct shall be insulated where it passes through conditioned space to an R-value of not less than R-8.

*Exceptions:*

1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.
2. Fireplaces and stoves complying with PA304.2 and 2018 IRC Section R1006.

**PA304.5 Recessed lighting.** Recessed luminaires installed in the building thermal envelope shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and labeled as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

**Table PA304.1.1**  
*Air Barrier and Insulation Installation*

<b>Component</b>	<b>Air Barrier Criteria</b>	<b>Insulation Installation Criteria</b>
<b>General requirements</b>	<p>A continuous air barrier shall be installed in the building envelope.</p> <p>The exterior thermal envelope contains a continuous air barrier.</p> <p>Breaks or joints in the air barrier shall be sealed.</p>	<p>Air-permeable insulation shall not be used as a sealing material.</p>
<b>Ceiling / attic</b>	<p>The air barrier in any dropped ceiling / soffit shall be aligned with the insulation and any gaps in the air barrier sealed.</p> <p>Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.</p>	<p>The insulation in any dropped ceiling / soffit shall be aligned with the air barrier.</p>
<b>Walls</b>	<p>The junction of the foundation and sill plate shall be sealed.</p> <p>The junction of the top plate and the top of exterior walls shall be sealed.</p> <p>Knee walls shall be sealed.</p>	<p>Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum.</p> <p>Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.</p>
<b>Windows, skylights and doors</b>	<p>The space between window / door jambs and framing, and skylights and framing shall be sealed.</p>	
<b>Rim joists</b>	<p>Rim joists shall include the air barrier.</p>	<p>Rim joists shall be insulated.</p>
<b>Floors (including above garage and cantilever floors)</b>	<p>The air barrier shall be installed at any exposed edge of insulation.</p>	<p>Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing; and extends from the bottom to the top of all perimeter floor framing members.</p>
<b>Crawl space walls</b>	<p>Exposed earth in unvented crawl space shall be covered with a Class I vapor retarder with overlapping joints taped.</p>	<p>Where provided instead of floor insulation, insulation shall be permanently attached to the crawl space walls.</p>
<b>Shafts, penetrations</b>	<p>Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.</p>	
<b>Narrow cavities</b>		<p>Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.</p>
<b>Garage separation</b>	<p>Air sealing shall be provided between the garage and conditioned spaces.</p>	
<b>Recessed lighting</b>	<p>Recessed light fixtures installed in the building thermal envelope shall be sealed to the finished surface.</p>	<p>Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.</p>
<b>Plumbing and wiring</b>		<p>Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring</p>
<b>Shower / tub on exterior wall</b>	<p>The air barrier installed at exterior walls adjacent to shower and tubs shall separate them from the shower and tubs</p>	<p>Exterior walls adjacent to showers and tubs shall be insulated.</p>
<b>Electrical / phone box on exterior walls</b>	<p>The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.</p>	
<b>HVAC register boots</b>	<p>HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.</p>	
<b>Concealed Sprinklers</b>	<p>When required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.</p>	

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# SECTION PA400

## SYSTEMS

**PA401 Controls.** Not less than one thermostat shall be installed for each separate heating and cooling system.

**PA401.1 Programmable thermostat.** The thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C).

**PA401.2 Heat pump supplementary heat.** Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

**PA402 Hot water boiler outdoor temperature setback.** Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have an outdoor setback control that decreases the boiler water temperature based on the outdoor temperature.

### **PA403 Ducts.**

**PA403.1 Insulation.** Supply and return ducts in attics shall be insulated to a minimum of R-8 where 3 inches (76.2 mm) in diameter and greater and R-6 where less than 3 inches (76.2 mm) in diameter. Supply and return ducts in other portions of the building shall be insulated to a minimum of R-6 where 3 inches (76.2 mm) in diameter or greater and R-4.2 where less than 3 inches (76.2 mm) in diameter.

*Exception:* Ducts or portions thereof located completely inside the building thermal envelope.

**PA403.2 Sealing.** Ducts, air handlers, filter boxes and building cavities used as returns shall be sealed. Joints and seams shall comply with 2018 IRC Section M1601.4.1.

**PA403.2.1 Sealed air handler.** Air handlers shall have a manufacturer's designation for an air leakage of no more than 2% of the design air flow rate when tested in accordance with ASHRAE 193.

**PA403.3. Duct testing.** Duct tightness shall be verified by either of the following:

**Option 1: Rough-in test.** Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. Registers shall be taped or otherwise sealed during the test.

**Option 2: Post-construction test.** Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.

*Exceptions:*

1. A duct air-leakage test shall not be required where the ducts and air handlers are located entirely within the building thermal envelope.
2. A duct air-leakage test shall not be required for ducts serving heat or energy recovery ventilators that are not integrated with ducts serving heating or cooling systems.

A written report of the results of the test shall be signed by the party conducting the test and provided to the building official.

**PA403.4. Duct Leakage.** The total leakage of the ducts, where measured in accordance with Section PA402.3, shall be less than or equal to the values shown in Table PA402.4.

**Table PA402.4**  
*Duct Leakage Targets*

Duct Testing Option	Total Leakage (cfm/100ft <sup>2</sup> )
Rough-in with air handler	4
Rough-in without air handler	3
Post-construction	4

**PA403.5 Building cavities.** Building framing cavities shall not be used as supply ducts.

**PA403.6 Ducts buried within ceiling insulation.** Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return duct shall have an insulation R-value not less than R-8.
2. At all points along each duct, the sum of the ceiling insulation R-values against and above the top of the duct, and against and below the bottom of the duct shall be not less than R-19, excluding the R-value of the duct insulation.
3. In Climate Zones 1A, 2A and 3A, the supply ducts shall be completely buried within ceiling insulation, insulated to an R-value of not less than R-13 and in compliance with the vapor retarder requirements of Section M1601.4.6.

*Exception:* Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.

**PA403.7 Ducts located in conditioned space.** For ducts to be considered as inside a conditioned space, such ducts shall comply with either of the following:

1. The duct system is located completely within the continuous air barrier and within the building thermal envelope.
2. The ducts are buried within ceiling insulation in accordance with Section N1103.3.6 and all of the following conditions exist:
  - 2.1. The air handler is located completely within the continuous air barrier and within the building thermal envelope.
  - 2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the building thermal envelope in accordance with Section N1103.3.4, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area served by the duct system.
  - 2.3. The ceiling insulation R-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation R-value, less the R-value of the insulation on the duct.

**PA404 Mechanical system piping insulation.** Mechanical system piping capable of carrying fluids above 105°F (40°C) or below 55°F (13°C) shall be insulated to a minimum of R-3.

**PA404.1 Protection of piping insulation.** Piping insulation exposed to weather shall be protected from damage including that caused by sunlight, moisture, equipment maintenance, and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted.

**PA405 Service hot water systems.** Energy conservation measures for service hot water systems shall be in accordance with Sections N1103.5.1 through N1103.5.4 of the 2018 IRC, including Pennsylvania Uniform Construction Code amendments.

**PA406 Mechanical ventilation.** The building shall be provided with mechanical ventilation that meets the requirements of Section M1505 of the 2018 IRC or the International Mechanical Code, as applicable, or with other approved means of ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

**PA406.1 Whole-house mechanical ventilation system fan efficacy.** Fans used to provide whole-house mechanical ventilation shall meet the efficacy requirements of Table PA406.1.

*Exception:* Where an air handler that is integral to tested and listed HVAC equipment is used to provide whole-house mechanical ventilation, the air handler shall be powered by an electronically commutated motor.

**Table PA406.1**  
*Whole-House Mechanical Ventilation System Fan Efficacy<sup>a</sup>*

Fan Location	Air Flow Rate Minimum (cfm)	Minimum Efficacy (cfm/watt)	Air Flow Rate Maximum (cfm)
HRV or ERV	Any	1.2	Any
Range hoods	Any	2.8	Any
In-line fan	Any	2.8	Any
Bathroom, utility room	10	1.4	< 90
Bathroom, utility room	90	2.8	Any

For SI: 1 cfm = 28.3 L/min.

**Notes:**

- a. When tested in accordance with HVI Standard 916.

**PA407 Equipment sizing and efficiency rating.** Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies. New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed.

**PA408 Snow melt system controls.** Snow- and ice-melting systems supplied through energy service to the building shall include automatic controls capable of shutting off the system when the pavement temperature is above 50°F (10°C) and no precipitation is falling and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F (5°C).

**PA409 Pools and permanent spa energy consumption.** The energy consumption of pools and permanent spas shall be in accordance with Sections PA408.1 through PA408.5.

**PA409.1 Heaters.** The electric power to heaters shall be controlled by a readily accessible on-off switch that is an integral part of the heater mounted on the exterior of the heater or external to and within 3 feet (914 mm) of the heater. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be equipped with continuously burning ignition pilots.

**PA409.2 Time switches.** Time switches or other control methods that can automatically turn off and on according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built-in time switches shall be in compliance with this section.

*Exceptions:*

1. Where public health standards require 24-hour pump operation.
2. Where pumps are required to operate solar- and waste-heat-recovery pool heating systems.

**PA409.3 Covers.** Outdoor heated pools and outdoor permanent spas shall be provided with a vapor retardant cover or other approved vapor retardant means.

*Exception:* Where more than 75 percent of the energy for heating, computed over an operation season of not less than 3 calendar months, is from a heat pump or an on-site renewable energy system, covers or other vapor retardant means shall not be equipped.

**PA409.4 Portable Spas.** The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP-14.

**PA409.5 Residential pools and permanent residential spas.** Residential swimming pools and permanent residential spas that are accessory to detached one- and two-family dwellings and townhouses 3 stories or less in height above grade plane and that are available only to the household and its guests shall be in accordance with APSP-15.

# SECTION PA500

## ELECTRICAL POWER AND LIGHTING SYSTEMS

**PA501 Lighting equipment.** Not less than 90 percent of the permanently installed lighting fixtures shall contain only high-efficacy lamps..

**PA501.1. Fuel gas lighting systems.** Fuel gas lighting systems shall not have continuously burning pilot lights.

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