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

The Pennsylvania Housing Research Center
University Park, Pennsylvania
The development of the 2021 Pennsylvania Alternative Residential Energy Provisions (PA-Alt) was led by the PHRC with guidance from a subcommittee of the PHRC Industry Advisory Council. The PHRC would like to recognize the following members of the PA-Alt Subcommittee for their contribution of time and knowledge:

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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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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;
- 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.
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 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.

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

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

Notes:
- <sup>a</sup> 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.
- <sup>b</sup> 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

LGHQWL4HGRQFRQVWUXFWRQGRFXPHPQVRUQLOVHGRQWKHDSSOFLDWRQIRUDQLOGLQSHUPLW$RSLWRQVXWHGWRPHHWWKHQQWUDQFHUHTXLUHPHQWVQLQ3$PVXWEHLGQWL4HG

PA106 Definitions. 7PQLPLHFRQIXVLRQWKGHG4OLWLRQVRQWDLQHQLQKDSWUH$5(@RIWKH&)RU

Section N1101.6 of the 2018 IRC apply to this document.

PA107 Identification. 0DWHULDOV\WWHPDQGHTXLSHGWVJKDOOEHHLGHQWL4HGLQDQDUHVSDQGUHKDWZLQG

determination of compliance with the applicable provisions of this chapter.

PA108 Building thermal envelope insulation. $Q5YOXHSLGHQWL4FDLWQRPDUNVKKDOOEHDSOLLHGE\W

manufacturer to each piece of building thermal envelope insulation 12 inches (305 mm) or more wide.

$OWHUSQDQWHO\WKHLQVXODWLQRQLQVWDOOHUVVKDOOSURYLGHDFHUWL4FDLWQRQVWLQJWKHW$SHPD

of insulation installed in each element of the building thermal envelope. For blown or sprayed insulation

4EHUJDQGFOHOOXORVWWKHLQWLQDOOLQVWDOOHGWKLKNQHVWVHWWOHGWLKNQHVWVHWWOHG54
FRYHUDJDUHDQQGQXPEHUREDJLQVWDOOHVGKDOOEHLQWHGRQKWFKHUWL4FDLWRQ)RUVSD(HG

insulation, the installed coverage, thickness, and R-value of each element of the building thermal envelope

shall be noted on the certificate. For spray polyurethane foam (SPF) installed insulation, the density,

coverage area, and number of bags installed shall be noted 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

PDWHULDOVWQDUGVSHFL4HGLQ5&7DEOH5

PA108.1 Blown or sprayed roof/ceiling insulation. The thickness of blown in or sprayed insulation

FHLOLOLQVXODLWQR4EHUJDQGFOHOOXORVWWKHLQWLQDOOLQVWDOOHGWKLKNQHVWVHWWOHG
at least one for every 300 ft² (28 m²) 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

WKLFNQHVSDQGQLQWDOOHG5YOXHVKDOOEHLQWHGRQKWFKHUWL4FDLWHSURYLGHGE\WKHLQ

PA108.2 Insulation mark installation. Insulating materials shall be installed such that the

PDQXIDFWXUHUV5YOXHSHULVQGVSHFWLRQ

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

DQGFWL4HGE\WKHPDQXIDFWXUHU3URGXFVWODFNLOQJVFKDOOEHOHG8IDFWRUVKDOOEHDVVLQJ9
8DFRURUIURP5&7DEOHV1DQG17KHLQVODUKHDWJDLQFRHIFLHQW6+$&DQG
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

FHWL4HGE\WKHPDQXIDFWXUHU3URGXFVWODFNLOQJVFKDOOEHOHG6+$&RU97VKDOOEHDVVLQJQHGDHID
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 • ft² • °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

DFFRUDQFGH2K670&QVWDOODWLQRIRUWHVWLOJVKDOOEHLQDFFRUDQFGH2LWKHPDQXIDFL
installation instructions.

PA111 Installation. All materials, systems and equipment shall be installed in accordance with the

PDQXIDFWXUHUVLQVWDOODLWQLQVWUXFWRQVDGWKHSURYLQLQVRIWKLVFRGH

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

PA111.2 Protection of roofs. Roof insulation shall be protected by a fire barrier. Roof insulation
shall be separated from the attic floor by at least 1 inch (25 mm) and be protected by a fire barrier.

Exception: In no case shall roof insulation be installed within 2 feet (610 mm) of a wall, window, or skylight.
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.
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): &DHURQ&OHDU4HOG\ON0F.HDQ3RW\H6XVTXHKDQQD7L\D:DHQH

Figure PA201.1
Pennsylvania Climate Zones

SECTION PA300
BUILDING THERMAL ENVELOPE

PA301 Insulation and fenestration criteria. The building thermal envelope shall meet the requirements of Section PA201.

PA301.1 R-value computation. Insulation material used in layers, such as framing cavity insulation, 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 Section 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

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Fenestration U-factor</th>
<th>Skylights U-factor</th>
<th>Glazed Fenestration SHGC</th>
<th>Ceiling R-value</th>
<th>Wood Frame Wall R-value</th>
<th>Mass Wall R-value</th>
<th>Floor R-value</th>
<th>Basement Wall R-value</th>
<th>Slab R-value and depth</th>
<th>Crawlspace Wall R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>South (4)</td>
<td>0.32</td>
<td>0.55</td>
<td>0.4</td>
<td>38</td>
<td>20(\text{or } 13\oplus 5)(\text{f})</td>
<td>8/13</td>
<td>19</td>
<td>10/13</td>
<td>10, 2 ft</td>
<td>10/13</td>
</tr>
<tr>
<td>Central (5)</td>
<td>0.30</td>
<td>0.55</td>
<td>NR</td>
<td>49</td>
<td>20(\text{or } 13\oplus 5)(\text{f})</td>
<td>13/17</td>
<td>30(\text{f})</td>
<td>10/13</td>
<td>10/13</td>
<td>10/13</td>
</tr>
<tr>
<td>North (6)</td>
<td>0.30</td>
<td>0.55</td>
<td>NR</td>
<td>49</td>
<td>23, 20(\text{or } 13\oplus 10)(\text{g})</td>
<td>15/20</td>
<td>30(\text{f})</td>
<td>10/13</td>
<td>10, 4 ft</td>
<td>10/13</td>
</tr>
</tbody>
</table>

Notes:
- 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).
- 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.
- Insulation plus R-5 continuous insulation on the interior or exterior of the home.
- Insulation plus R-5 continuous insulation on the interior or exterior of the home.
- R-18 insulation shall be permitted in place of R-20 requirement wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves.

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 whenever 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 provide sufficient space for the required insulation, such as cathedral ceilings, the minimum required is as follows:

| South (4) | 0.32 | 0.55 | 0.4 | 38 | 20 or 13+5 | 8/13 | 19 | 10/13 | 10, 2 ft | 10/13 |
| Central (5) | 0.30 | 0.55 | NR | 49 | 20 or 13+5 | 13/17 | 30 | 10/13 | 10/13 |
| North (6) | 0.30 | 0.55 | NR | 49 | 23, 20 or 13+10 | 15/20 | 30 | 10/13 | 10, 4 ft | 10/13 |
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.

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.

**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 Btu/ft² • °F (123 kJ/m² • 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:* 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.
**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).

**PA302.10 Crawl space walls.** Crawl space walls shall be permitted when the crawl space is not vented to the outside. Crawl space walls 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 m²) 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 m²) 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 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). 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 \([1.5 \text{ (L/s)/m}^2]\), and swinging doors no more than 0.5 cubic foot per minute per square foot \([2.5 \text{ (L/s)/m}^2]\), 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 HQYHORSHUHTXLUHHPQWVR17DEOH3SZKUHWHKHZDOOV5RRUVDQGFHLOLQJVVKDOOPHHWDPLQL 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 WHVWHGLQDFRUGDQFHZLWK5670DWSVBDSUHVVXUHGLHUHQLDQSO0UHFFVHGOXPLQDLUV 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**

<table>
<thead>
<tr>
<th>Component</th>
<th>Air Barrier Criteria</th>
<th>Insulation Installation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>General requirements</td>
<td>A continuous air barrier shall be installed in the building envelope.</td>
<td>Air-permeable insulation shall not be used as a sealing material.</td>
</tr>
<tr>
<td></td>
<td>The exterior thermal envelope contains a continuous air barrier.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Breaks or joints in the air barrier shall be sealed.</td>
<td></td>
</tr>
<tr>
<td>Ceiling / attic</td>
<td>The air barrier in any dropped ceiling / soffit shall be aligned with the insulation and any gaps in the air barrier sealed.</td>
<td>The insulation in any dropped ceiling / soffit shall be aligned with the air barrier.</td>
</tr>
<tr>
<td></td>
<td>Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.</td>
<td></td>
</tr>
<tr>
<td>Walls</td>
<td>The junction of the foundation and sill plate shall be sealed.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>The junction of the top plate and the top of exterior walls shall be sealed.</td>
<td>Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.</td>
</tr>
<tr>
<td></td>
<td>Knee walls shall be sealed.</td>
<td></td>
</tr>
<tr>
<td>Windows, skylights and doors</td>
<td>The space between window / door jambs and framing, and skylights and framing shall be sealed.</td>
<td></td>
</tr>
<tr>
<td>Rim joists</td>
<td>Rim joists shall include the air barrier.</td>
<td>Rim joists shall be insulated.</td>
</tr>
<tr>
<td>Floors (including above garage and cantilever floors)</td>
<td>The air barrier shall be installed at any exposed edge of insulation.</td>
<td>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.</td>
</tr>
<tr>
<td>Crawl space walls</td>
<td>Exposed earth in unvented crawl space shall be covered with a Class I vapor retarder with overlapping joints taped.</td>
<td>Where provided instead of floor insulation, insulation shall be permanently attached to the crawl space walls.</td>
</tr>
<tr>
<td>Shafts, penetrations</td>
<td>Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.</td>
<td></td>
</tr>
<tr>
<td>Narrow cavities</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Garage separation</td>
<td>Air sealing shall be provided between the garage and conditioned spaces.</td>
<td></td>
</tr>
<tr>
<td>Recessed lighting</td>
<td>Recessed light fixtures installed in the building thermal envelope shall be sealed to the finished surface.</td>
<td>Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.</td>
</tr>
<tr>
<td>Plumbing and wiring</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Shower / tub on exterior wall</td>
<td>The air barrier installed at exterior walls adjacent to shower and tubs shall separate them from the shower and tubs</td>
<td>Exterior walls adjacent to showers and tubs shall be insulated.</td>
</tr>
<tr>
<td>Electrical / phone box on exterior walls</td>
<td>The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.</td>
<td></td>
</tr>
<tr>
<td>HVAC register boots</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Concealed Sprinklers</td>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>
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. Supply and return ducts in the building thermal envelope 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. Total leakage 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>
<thead>
<tr>
<th>Duct Testing Option</th>
<th>Total Leakage (cfm/100ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rough-in with air handler</td>
<td>4</td>
</tr>
<tr>
<td>Rough-in without air handler</td>
<td>3</td>
</tr>
<tr>
<td>Post-construction</td>
<td>4</td>
</tr>
</tbody>
</table>

**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 m²) 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. 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

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 WRWKHEXQGLQJVKDQOLLQFOXGHDXWRPDLFFRQWUROVFDSEOHVIRKXWWLQJRHKHVVWHPZKHQ
temperature is above 50°F (10°C) and no precipitation is falling and an automatic or manual control that ZLOODOORZVXWRZHQWKRWUGRRUWHPSUDWXUHLDERYHr&
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. 7K HH O HF WULFSRZHUWRKHDWUH V V K DQ O EH FW Q WUOOHGE\DUHDGLO\DJFHV\V 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 KHDWHU*DV4UHG KHDWUHV VKDOOQRWEHHTXLSHGCZLWKFQWXLQXRVQ\EXUQLQ\LJQLWLRQSLG.

PA409.2 Time switches. 7LPHVZLWKHVVRWKHUFQWUORPHKGVWKDFDQDXWRPDWLFDQ 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.
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.