# FAQ:
# What are the significant changes between the 2018 and 2021 International Energy Conservation Code (IECC)?

This document includes a summary of significant changes to the 2021 International Energy Conservation Code (IECC) and includes the PA Uniform Construction Code Review and Advisory Council (RAC) Report Amendments. This document also provides further information for the identified code changes.

**Disclaimer: This document shall be utilized as guidance only. The design professional is responsible for reviewing the provisions of the International Codes, associated reference Standards, and the directives of the PA Department of Labor and Industry. The Department of Licenses and Inspections may only render a decision in response to a formal application for a construction permit or preliminary review.**

## Summary of changes between the 2018 and 2021 International Energy Conservation Code (IECC):

*(Items marked with an asterisk (*) are identified as major code changes)*

### Commercial Energy Provisions: Administration

Chapter 2:

- Section C202- Definition of Biogas and Biomass
- Section C202- Definition of Fan Efficiencies

### Commercial Energy Provisions: Energy Efficiency Requirements

Chapters 4 and 5:

- Section C401.2 - Compliance Paths
- Section C401.3 - Envelope Certificate*
- Section C402 - Building Envelope
- Table C402.1.3 - Minimum *R*-Values
- Table C402.1.4 - Insulation and Fenestration *U*-Factor Criteria
- Sections C402.1.4.1 / C402.2.1 - Roof Assembly and Insulation

- Table C402.4 - *U*-Factor and SHGC Requirements
- Section C402.5 - Air Leakage*
- Section C402.5.5 - Rooms Containing Fuel Burning Appliances
- Section C402.5.11 - Operable Openings Interlocking*
- Section C403 - Building Mechanical Systems
- Section C403.4.2.3 - Automatic Start and Stop
- Section C403.8.3 - Fan Efficiency
- Section C403.8.5 - Low-Capacity Ventilation Fans
- Section C405 - Electrical Power and Lighting Systems
- Section C405.2.1.2 - Occupant Sensor Controls in Warehouse Storage Areas*
- Section C405.2.8 - Parking Garage Lighting Control
- Section C405.4 - Lighting for Plant Growth
- Section C405.11 - Automatic Receptacle Control
- Section C405.11.1 - Automatic Receptacle Control Functions
- Section C405.12 - Energy Monitoring*
- Section C406 - Additional Efficiency Requirements*
- Section C407 - Total Building Performance
- Section C407.2 - Performance-Based Compliance

## Residential Energy Provisions: Administration

### Chapters 1 and 2:

- Section R202 - Definition of High-Efficacy Light Sources
- Section R202 - Definition of Renewable Energy Certificate
- Chapter 2 [RE] Definition – Framing Factor

## Residential Energy Provisions: Energy Efficiency Requirements

### Chapters 4 and 5:

- Section R401.2 - Compliance Paths
- Section R401.2.5 - Additional Energy Efficiency*
- Section R401.3 - Certificate*
- Section R402 - Building Envelope
- Table R402.1.2 - Insulation and Fenestration U-Factors*
- Table R402.1.3 - Insulation Minimum *R*-values and Fenestration Requirements by Component*
- Section R402.2.8 - Basement Walls
- Sections R402.4.1.2 / R402.4.1.3 - Air Leakage Testing*
- Section R402.5 - Maximum Fenestration U-Factor and SHGC
- Section R403 - Systems

- Section R403.3.1 -R403.3.3.1- Duct Locations and Insulation
- Section R403.3.5 - Duct Testing
- Section R403.3.6 – Duct Leakage
- Section R403.3.7 - Building Cavities
- Section R403.5.1.1 -Circulation Systems
- Section R403.6.3 - Mechanical Ventilation System Testing
- Section R404 - Electrical Power and Lighting Systems
- Section R404.1 - Lighting Equipment
- Section R404.1.1 - Exterior Lighting
- Section R404.1.2 - Fuel Gas Lighting
- Section R404.2 - Interior Lighting Controls
- Section R404.3 - Exterior Lighting Controls
- Section R405 - Total Building Performance
- Section R405.2 - Performance-Based Compliance
- Table R405.2 – Total Building Performance
- Section R405.3.2 - Compliance Report
- Section R405.3.2.1 – Compliance Report for Permit Applications
- Section R405.3.2.2 – Compliance Report for Certificate of Occupancy
- Table R405.4.2(1) -Standard Reference and Proposed Designs
- Section R406 - Energy Rating Index Compliance Alternative
- Section R406.2 - ERI Compliance*
- Table R406.2 - ERI Additional Package
- Section R406.3 - Building Thermal Envelope**
- Section R406.3.1 - On-site Renewables
- Section R406.3.2 – On-site Renewables
- Section R406.4 - Energy Rating Index
- Section R406.4.1 - Energy Rating Index Reference Design
- Section R406.7.1 - Compliance Software Tool
- Section R406.7.3 - Renewable Energy Certificate Documentation
- Section R406.8 - Calculation Software Tool
- Section R406.8.1 - Minimum Capabilities
- Section R406.8.2 - Specific Approvals
- Section R406.8.3 - Input Values
- Section R408 - Additional Efficiency Package Options*

# Summary of changes between the 2018 and 2021 International Energy Conservation Code (IECC):

## Commercial Energy Provisions

### Chapter 2 (Definitions)

- **Section C202** adds definitions for biogas, biomass, and renewable energy and clarified the definitions of on-site renewable energy.

> **BIOGAS.** A mixture of hydrocarbons that is a gas at60°F (15.5°C) and 1 atmosphere of pressure that is produced through the anaerobic digestion of organic matter.
>
> **BIOMASS.** Nonfossilized and biodegradable organic material originating from plants, animals and/or microorganisms, including products, by-products, residues and waste from agriculture, forestry and related industries as well as the nonfossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of nonfossilized and biodegradable organic material.

- **Section C202** adds new definitions related to fans that introduce and support the Fan Energy Index, which replaces the Fan Efficiency Grade Metric and aligns the IECC more closely with the fan requirements in ASHRAE 90.1.

> **FAN, EMBEDDED.** A fan that is part of a manufactured assembly where the assembly includes functions other than air movement.
>
> **FAN ARRAY.** Multiple fans in parallel between two plenum sections in an air distribution system.
>
> **FAN ENERGY INDEX (FEI).** The ratio of the electric input power of a reference fan to the electric input power of the actual fan as calculated in accordance with AMCA 208.
>
> **FAN NAMEPLATE ELECTRICAL INPUT POWER.** The nominal electrical input power rating stamped on a fan assembly nameplate.
>
> **FAN SYSTEM ELECTRICAL INPUT POWER.** The sum of the fan electrical power of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the conditioned spaces and/or return it to the source or exhaust it to the outdoors.

### Chapter 4 (Commercial Energy Efficiency)

- **Section C401.2** identifies the compliance path options for the commercial provisions of the IECC and outlines the sections required for each option. Language for “mandatory” provisions removed from the 2021 code standard.

> **C401.2.1 International Energy Conservation Code.**
>
> Commercial buildings shall comply with one of the following:
>
> 1. **Prescriptive Compliance.** The Prescriptive Compliance option requires compliance with Sections C402 through C406 and Section C408. Dwelling units and sleeping units in Group R-2 buildings without systems serving multiple units shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.
> 2. **Total Building Performance.** The Total Building Performance option requires compliance with Section C407.
>
> **Exception:** Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

> **C401.2.2 ASHRAE 90.1.**
>
> Commercial buildings shall comply with the requirements of ANSI/ASHRAE/IESNA 90.1.

- **Section C401.3** introduces a requirement for the completion of a thermal envelope certificate, which serves as a permanent record of the envelope components installed in the building and air leakage testing results. Certificate is required to be posted to the building in an approved location.

> **C401.3 Thermal envelope certificate.**
>
> A permanent thermal envelope certificate shall be completed by an *approved* party. Such certificate shall be posted on a wall in the space where the space conditioning equipment is located, a utility room or other *approved* location. If 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. A copy of the certificate shall also be included in the construction files for the project. The certificate shall include the following:
>
> 1. *R*-values of insulation installed in or on ceilings, roofs, walls, foundations and slabs, *basement walls*, crawl space walls and floors and ducts outside *conditioned spaces*.
> 2. *U*-factors and *solar heat gain coefficients* (SHGC) of fenestrations.
> 3. Results from any *building* envelope air leakage testing performed on the *building*.
>
> Where there is more than one value for any component of the building envelope, the certificate shall indicate the area-weighted average value where available. If the area-weighted average is not available, the certificate shall list each value that applies to 10 percent or more of the total component area.

- **Section C402** provides building thermal envelope provisions for commercial buildings, including limitations on air filtration, or air leakage. Significant changes to the building envelope are addressed in the following sections:
  - Increased insulation requirements
  - Clarifying language for roof and ceiling assembly insulation
  - Reduced fenestration *U*-factors and solar heat gain coefficients (SHGCs), and the elimination of orientation as a factor in these values
  - Expanded air leakage requirements
  - New operable openings interlocking requirement

- **Table C402.1.3** increased the minimum *R*-values in the table to improve the efficiency of the building envelope and align with ASHRAE 90.1

**TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, *R*-VALUE METHOD[a]**

| CLIMATE ZONE | 4 EXCEPT MARINE | | 5 AND MARINE 4 | |
|---|---|---|---|---|
| | All other | Group R | All other | Group R |
| **Roofs** | | | | |
| Insulation entirely above roof deck | R-30ci | R-30ci | R-30ci | R-30ci |
| Metal buildings[b] | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS |
| Attic and other | R-49 | R-49 | R-49 | R-49 |
| **Walls, above grade** | | | | |
| Mass[f] | R-9.5ci | R-11.4ci | R-11.4ci | R-13.3ci |
| Metal building | R-13 + R-13ci | R-13 + R-14ci | R-13 + R-14ci | R-13 + R-14ci |
| Metal framed | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-10ci | R-13 + R-10ci |
| Wood framed and other | R-13 + R-3.8ci or R-20 | R-13 + R-3.8ci or R-20 | R-13 + R-7.5ci or R-20 + R-3.8ci | R-13 + R-7.5ci or R-20 + R-3.8ci |
| **Walls, below grade** | | | | |
| Below-grade wall[d] | R-7.5ci | R-10ci | R-7.5ci | R-10ci |
| **Floors** | | | | |
| Mass[e] | R-14.6ci | R-16.7ci | R-14.6ci | R-16.7ci |
| Joist/framing | R-30 | R-30 | R-30 | R-30 |
| **Slab-on-grade floors** | | | | |
| Unheated slabs | R-15 for 24" below | R-15 for 24" below | R-15 for 24" below | R-20 for 24" below |

- **Table C402.1.4** decreases the *U*-factor requirements to improve the efficiency of the building envelope and to align with ASHRAE 90.1

- **Sections C402.1.4.1 / C402.2.1** clarifies and separates roof insulation requirements by compliance with either *U*-factor or *R*-value method for specified roof/ceiling assembly elements.

**C402.1.4.1 Roof/ceiling assembly.**

The maximum roof/ceiling assembly *U*-factor shall not exceed that specified in Table C402.1.4 based on construction materials used in the roof/ceiling assembly.

**C402.1.4.1.1 Tapered, above-deck insulation based on thickness.**

Where used as a component of a maximum roof/ceiling assembly *U*-factor calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *U*-factor compliance as prescribed in Section C402.1.4.

**C402.1.4.1.2 Suspended ceilings.**

Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly *U*-factor of the roof/ceiling construction.

**C402.1.4.1.3 Joints staggered.**

Continuous insulation board shall be installed in not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

**C402.2.1 Roof assembly.**

The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.1.3, based on construction materials used in the roof assembly.

**C402.2.1.1 Tapered, above-deck insulation based on thickness.**

Where used as a component of a roof/ceiling assembly *R*-value calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *R*-value compliance as prescribed in Section 402.1.3.

**C402.2.1.2 Minimum thickness, lowest point.**

The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

**C402.2.1.3 Suspended ceilings.**

Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the minimum thermal resistance (*R*-value) of roof insulation in roof/ceiling construction.

**C402.2.1.4 Joints staggered.**

Continuous insulation board shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

- **Table C402.4** increases the energy efficiency of windows, doors, and skylights through changes to the *U*-factor and SHGC requirements in Table C402.4 and revises the table to classify SHGC on the operable/fixed properties of the fenestration rather than orientation.

**TABLE C402.4 BUILDING ENVELOPE FENESTRATION MAXIMUM *U*-FACTOR AND SHGC REQUIREMENTS**

| CLIMATE ZONE | 4 EXCEPT MARINE | | AND MARINE 4 | |
|---|---|---|---|---|
| | Vertical fenestration | | | |
| | *U*-factor | | | |
| Fixed fenestration | 0.36 | | 0.36 | |
| Operable fenestration | 0.45 | | 0.45 | |
| Entrance doors | 0.63 | | 0.63 | |
| | SHGC | | | |
| | Fixed | Operable | Fixed | Operable |
| PF < 0.2 | 0.36 | 0.33 | 0.38 | 0.33 |
| 0.2 ≤ PF < 0.5 | 0.43 | 0.40 | 0.4 | 0.40 |
| PF ≥ 0.5 | 0.58 | 0.53 | 0.61 | 0.53 |
| | Skylights | | | |
| *U*-factor | 0.50 | | 0.50 | |
| SHGC | 0.40 | | 0.40 | |

- **Section C402.5** expands air leakage requirements to include requirements for residential and nonresidential air leakage testing and for building envelope performance verification for buildings not used. Dwelling units are required to be individually tested. Non-Residential occupancies may undergo whole building air infiltration testing or may test portions of the building enclosure area to provide an area-weighted average air leakage rate. Air barrier construction compliance requirements are also identified under these provisions.

**C402.5: Air leakage—thermal envelope.**

The *building thermal envelope* shall comply with Sections C402.5.1 through Section C402.5.11.1, or the building *thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9.

**C402.5.1: Air barriers.**

A continuous air barrier shall be provided throughout the *building thermal envelope*. The continuous air barriers shall be located on the inside or outside of the building thermal envelope, located within the assemblies composing the building thermal envelope, or any combination thereof. The air barrier shall comply with Sections C402.5.1.1, and C402.5.1.2.

**Exception:** Air barriers are not required in buildings located in *Climate Zone* 2B.

**C402.5.1.2: Air barrier compliance.**

A continuous air barrier for the opaque building envelope shall comply with the following:

1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.

   **Exception:** Buildings in Climate Zones 2B, 3C and 5C.

2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.

   **Exceptions:**

   1. Buildings in Climate Zones 2B, 3B, 3C and 5C.
   2. Buildings larger than 5,000 square feet (464.5 $m^2$) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.
   3. Buildings between 5,000 square feet (464.5 $m^2$) and 50,000 square feet (4645 $m^2$) floor area in Climate Zones 0A, 3A and 5B.

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

**C402.5.1.5: Building envelope performance verification.**

The installation of the continuous air barrier shall be verified by the *code official*, a *registered design professional* or *approved* agency in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section C402.5.1.
2. Inspection of continuous air barrier components and assemblies shall be conducted during construction while the air barrier is still accessible for inspection and repair to verify compliance with the requirements of Sections C402.5.1.3 and C402.5.1.4.
3. A final commissioning report shall be provided for inspections completed by the *registered design professional* or *approved* agency. The commissioning report shall be provided to the building owner or owner's authorized agent and the *code official*. The report shall identify deficiencies found during the review of the construction documents and inspection and details of corrective measures taken.

**C402.5.2: Dwelling and sleeping unit enclosure testing.**

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft$^2$ (1.5 L/s m$^2$) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

**C402.5.3: Building thermal envelope testing.**

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed 0.40 cfm/ft$^2$ (2.0 L/s × m$^2$) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.
2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

**Exception:** Where the measured air leakage rate exceeds 0.40 cfm/ft$^2$ (2.0 L/s × m$^2$) but does not exceed 0.60 cfm/ft$^2$ (3.0 L/s × m$^2$), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where such sealing can be made without destruction of existing building components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the code official and the building owner, and shall be deemed to comply with the requirements of this section.

- **Section C402.5.5** Rooms containing fuel-burning appliances was modified as a part of Pennsylvania 2018 IECC adoption, maintaining both exceptions from the 2015 IECC. The national language was not modified in the 2021 code, and as such this language for direct vent exemption was maintained in the current Pennsylvania 2021 IECC adoption.

***C402.5.5 Rooms containing fuel-burning appliances.*** *In Climate Zones 3 through 8, where combustion air is supplied through openings in an exterior wall to a room or space containing a space-conditioning fuel-burning appliance, one of the following shall apply:*

1. *The room or space containing the appliance shall be located outside of the building thermal envelope.*

2. *The room or space containing the appliance shall be enclosed and isolated from conditioned spaces inside the building thermal envelope. Such rooms shall comply with all of the following:*

   2.1. *The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be insulated to be not less than equivalent to the insulation requirement of below-grade walls as specified in Table C402.1.3 or C402.1.4.*

   2.2. *The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be sealed in accordance with Section C402.5.1.1.*

   2.3. *The doors into the enclosed room or space shall be fully gasketed.*

   2.4. *Water lines and ducts in the enclosed room or space shall be insulated in accordance with Section C403.*

   2.5. *Where an air duct supplying combustion air to the enclosed room or space passes through conditioned space, the duct shall be insulated to an R-value of not less than R-8.*

***Exception:***

1. *Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.*

2. *Fireplaces and stoves complying with Sections 901 through 905 of the International Mechanical Code, and Section 2111.14 of the International Building Code.*

- **Section C402.5.11** requires large, operable openings such as roll up doors and windows to be interlocked with a heating and cooling system.

**C402.5.11: Operable openings interlocking.**

Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 $m^2$) in area, such openings shall be interlocked with the heating and cooling system so as to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.

**Exceptions:**

1. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
2. Warehouses that utilize overhead doors for the function of the occupancy, where approved by the code official.
3. The first entrance doors where located in the exterior wall and are part of a vestibule system.

- **Section C403** addresses the efficiency, construction, and operation of building mechanical systems. Significant changes to the building of mechanical systems in the 2021 IECC include:
  - Refined HVAC control requirements
  - Added requirements for low-capacity ventilation fans
  - Updated fan efficiency requirements

- **Section C403.4.2.3** requires HVAC systems, with direct digital controls, serving individuals to have automatic stop controls, in addition to automatic start controls.

**C403.4.2.3: Automatic start and stop.**

Automatic start and stop controls shall be provided for each HVAC system. The automatic start controls shall be configured to automatically adjust the daily start time of the HVAC system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy. Automatic stop controls shall be provided for each HVAC system with direct digital control of individual *zones*. The automatic stop controls shall be configured to reduce the HVAC system's heating temperature setpoint and increase the cooling temperature setpoint by not less than 2°F (1.11°C) before scheduled unoccupied periods based on the thermal lag and acceptable drift in space temperature that is within comfort limits.

- **Section C403.8.3** updates the fan efficiency metric to the Fan Energy Index, providing consistent fan efficiency requirements across the IECC and ASHRAE 90.1.

**C403.8.3: Fan efficiency.**

Each fan and fan array shall have a fan energy index (FEI) of not less than 1.00 at the design point of operation, as determined in accordance with AMCA 208 by an *approved* independent testing laboratory and labeled by the manufacturer. Each fan and fan array used for a variable-air-volume system shall have an FEI of not less than 0.95 at the design point of operation, as determined in accordance with AMCA 208 by an approved independent testing laboratory and labeled by the manufacturer. The FEI for fan arrays shall be calculated in accordance with AMCA 208 Annex C.

**Exceptions:** The following fans are not required to have a fan energy index:

1. Fans that are not embedded fans with motor nameplate horsepower of less than 1.0 hp (0.75 kW) or with a nameplate electrical input power of less than 0.89 kW.
2. Embedded fans that have a motor nameplate horsepower of 5 hp (3.7 kW) or less, or with a fan system electrical input power of 4.1 kW or less.
3. Multiple fans operated in series or parallel as the functional equivalent of a single fan that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less.
4. Fans that are part of equipment covered in Section C403.3.2.
5. Fans included in an equipment package certified by an *approved agency* for air or energy performance.
6. Ceiling fans, which are defined as nonportable devices suspended from a ceiling or overhead structure for circulating air via the rotation of the blades.
7. Fans used for moving gases at temperatures above 482°F (250°C).
8. Fans used for operation in explosive atmospheres.
9. Reversible fans used for tunnel ventilation.
10. Fans that are intended to operate only during emergency conditions.
11. Fans outside the scope of AMCA 208.

- **Section C403.8.5** adds new requirements for low-capacity ventilation fans that apply the efficiencies of ventilation fans typical of residential construction to mid-rise residential occupancies and small commercial buildings.

**C403.8.5: Low-capacity ventilation fans.**

Mechanical ventilation system fans with motors less than 1/12 hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.5 at one or more rating points.

**Exceptions:**

1. Where ventilation fans are a component of a listed heating or cooling appliance.
2. Dryer exhaust duct power ventilators, domestic range hoods and domestic range booster fans that operate intermittently.

**TABLE C403.8.5 LOW-CAPACITY VENTILATION FAN EFFICACY[a]**

| FAN LOCATION | AIRFLOW RATE MINIMUM (CFM) | MINIMUM EFFICACY (CFM/WATT) | AIRFLOW RATE MAXIMUM (CFM) |
|---|---|---|---|
| HRV or ERV | Any | 1.2 cfm/watt | Any |
| In-line fan | Any | 3.8 cfm/watt | Any |
| Bathroom, utility room | 10 | 2.8 cfm/watt | < 90 |
| Bathroom, utility room | 90 | 3.5 cfm/watt | Any |

For SI: 1 cfm/ft = 47.82 W.

a. Airflow shall be tested in accordance with HVI 916 and listed. Efficacy shall be listed or shall be derived from listed power and airflow. Fan efficacy for fully ducted HRV, ERV, balanced and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c.

- **Section C405** includes significant changes to electrical power and lighting systems provisions in new buildings, additions, tenant finishes, alterations to an existing lighting system and any change in occupancy. Revisions include reference to ASHRAE 90.4 compliance for data center system equipment.

**C405.1: General.**

Lighting system controls, the maximum lighting power for interior and exterior applications, and electrical energy consumption shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with either Section C405.1.1 or C405.3. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

- **Section C405.2.1.2** updates occupant sensor control functions for warehouse storage areas, providing further guidance on how occupant sensors should operate within warehouses.

**C405.2.1.2: Occupant sensor control function in warehouse storage areas.**

Lighting in warehouse storage areas shall be controlled as follows:

1. Lighting in each aisleway shall be controlled independently of lighting in all other aisleways and open areas.
2. Occupant sensors shall automatically reduce lighting power within each controlled area to an unoccupied setpoint of not more than 50 percent of full power within 20 minutes after all occupants have left the controlled area.
3. Lights that are not turned off by occupant sensors shall be turned off by time-switch control complying with Section C405.2.2.1.
4. A manual control shall be provided to allow occupants to turn off lights in the space.

- **Section C405.2.8** adds a new provision for lighting in parking garages that recognizes parking garages as a unique space and requires such spaces to have either occupant sensors of time-switch controls.

**C405.2.8: Parking garage lighting control.**

Parking garage lighting shall be controlled by an *occupant sensor* complying with Section C405.2.1.1 or a *time-switch control* complying with Section C405.2.2.1. Additional lighting controls shall be provided as follows:

1. Lighting power of each luminaire shall be automatically reduced by not less than 30 percent when there is no activity detected within a lighting zone for 20 minutes. Lighting zones for this requirement shall be not larger than 3,600 square feet (334.5 $m^2$).

   **Exception:** Lighting zones provided with less than 1.5 footcandles of illumination on the floor at the darkest point with all lights on are not required to have automatic light-reduction controls.

2. Where lighting for eye adaptation is provided at covered vehicle entrances and exits from buildings and parking structures, such lighting shall be separately controlled by a device that automatically reduces lighting power by at least 50 percent from sunset to sunrise.
3. The power to luminaires within 20 feet (6096 mm) of perimeter wall openings shall automatically reduce in response to daylight by at least 50 percent.

**Exceptions:**

1. Where the opening-to-wall ratio is less than 40 percent as viewed from the interior and encompassing the vertical distance from the driving surface to the lowest structural element.
2. Where the distance from the opening to any exterior daylight blocking obstruction is less than one-half the height from the bottom of the opening or fenestration to the top of the obstruction.
3. Where openings are obstructed by permanent screens or architectural elements restricting daylight entering the interior space.

- **Section C405.4** adds a provision for regulating lighting for plant growth and maintenance has been added to ensure indoor agriculture operations are energy efficient.

**C405.4: Lighting for plant growth and maintenance.**

Not less than 95 percent of the permanently installed luminaires used for plant growth and maintenance shall have a photon efficiency of not less than 1.6 µmol/J as defined in accordance with ANSI/ASABE S640.

- **Section C405.11** was modified under the PA UCC RAC to revise for optional installation of automatic receptacle controls as follows:

***C405.11 Automatic receptacle control.*** *The following ~~shall~~ may have automatic receptacle control complying with Section C405.11.1:*

1. *At least 50 percent of all 125V, 15- and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms and individual workstations, including those installed in modular partitions and module office workstation systems.*
2. *At least 25 percent of branch circuit feeders installed for modular furniture not shown on the construction documents.*

- **Section C405.11.1** was modified under the PA UCC RAC to revise time delay period of occupant sensor controls to 120 minutes, where automatic receptacle controls are used, as follows:

***C405.11.1 Automatic receptacle control function.*** *Automatic receptacle controls shall comply with the following:*

1. *Either split controlled receptacles shall be provided with the top receptacle controlled, or a controlled receptacle shall be located within 12 inches (304.8 mm) of each uncontrolled receptacle.*

2. *One of the following methods shall be used to provide control:*

   2.1. *A scheduled basis using a time-of-day operated control device that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be configured to provide an independent schedule for each portion of the building of not more than 5,000 square feet (464.5 m2) and not more than one floor. The occupant shall be able to manually override an area for not more than 2 hours. Any individual override switch shall control the receptacles of not more than 5,000 feet (1524 m).*

   2.2. *An occupant sensor control that shall turn off receptacles within ~~20~~ 120 minutes of all occupants leaving a space.*

   2.3. *An automated signal from another control or alarm system that shall turn off receptacles within ~~20~~ 120 minutes after determining that the area is unoccupied.*

3. *All controlled receptacles shall be permanently marked in accordance with NFPA 70 and be uniformly distributed throughout the space.*

4. *Plug-in devices shall not comply.*

*Exceptions: Automatic receptacle controls are not required for the following:*

1. *Receptacles specifically designated for equipment requiring continuous operation (24 hours per day, 365 days per year).*

2. *Spaces where an automatic control would endanger the safety or security of the room or building occupants.*

3. *Within a single modular office workstation, noncontrolled receptacles are permitted to be located more than 12 inches (304.8 mm), but not more than 72 inches (1828 mm) from the controlled receptacles serving that workstation.*

- **Section C405.12** adds energy monitoring requirements to measure and retain the intended energy performance of a building. Provisions include requirements for data acquisition and maintenance on building systems required to be provided with energy monitoring.

**C405.12: Energy monitoring.**

New buildings with a gross *conditioned floor area* of 25,000 square feet (2322 $m^2$) or larger shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

**Exception:** R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 square feet (464.5 $m^2$) of *conditioned floor area*.

### C405.12.1: Electrical energy metering.

For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.12.2.

### C405.12.2: End-use metering categories.

Meters or other *approved* measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

**Exceptions:**

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet (232 $m^2$) where a dedicated source meter complying with Section C405.12.3 is provided.

### TABLE C405.12.2 ENERGY USE CATEGORIES

| LOAD CATEGORY | DESCRIPTION OF ENERGY USE |
|---|---|
| Total HVAC system | Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use. |
| Interior lighting | Lighting systems located within the building. |
| Exterior lighting | Lighting systems located on the building site but not within the building. |
| Plug loads | Devices, appliances and equipment connected to convenience receptacle outlets. |
| Process load | Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens. |
| Building operations and other miscellaneous loads | The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, inground spas and snow-melt systems. |

### C405.12.3: Meters.

Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.12.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ±2 percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.12.4 and C405.12.5.

### C405.12.4: Data acquisition system.

A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.12.2.

### C405.12.5: Graphical energy report.

A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the energy consumption for each end-use category required by Section C405.12.2 at least every hour, day, month and year for the previous 36 months.

- **Section C406** allows designers to select from eleven (11) additional energy efficiency options for a credit-based compliance program that now consider climate zone and occupancy type when complying with the Prescriptive Compliance option based on Table C406.1(1) through Table C406.1(5). Note that tenant spaces are also required to demonstrate additional energy efficiency packaging compliance per C406.1.1.

**C406.1: Additional energy efficiency credit requirements.**

New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.

**C406.1.1: Tenant spaces.**

Tenant spaces shall comply with sufficient options from Tables C406.1(1) through C406.1(5) to achieve a minimum number of 5 credits, where credits are selected from Section C406.2, C406.3, C406.4, C406.6, C406.7 or C406.10. Where the entire building complies using credits from Section C406.5, C406.8 or C406.9, tenant spaces shall be deemed to comply with this section.

**Exception:** Previously occupied tenant spaces that comply with this code in accordance with Section C501.

- **Section C407** adds a new, comprehensive table of required provisions to the Total Building Performance.

- **Section C407.2** outlines code requirements applicable to the Total Building Performance in a new, user-friendly table to reduce code application confusion.

**C407.2: Mandatory requirements.**

Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to 80 percent of the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

**Exception:** Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

**TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE**

| SECTION[a] | TITLE |
|---|---|
| | **Envelope** |
| C402.5 | Air leakage—thermal envelope |
| | **Mechanical** |
| C403.1.1 | Calculation of heating and cooling loads |
| C403.1.2 | Data centers |
| C403.2 | System design |
| C403.3 | Heating and cooling equipment efficiencies |
| C403.4, except C403.4.3, C403.4.4 and C403.4.5 | Heating and cooling system controls |
| C403.5.5 | Economizer fault detection and diagnostics |
| C403.7, except C403.7.4.1 | Ventilation and exhaust systems |
| C403.8, except C403.8.6 | Fan and fan controls |
| C403.9 | Large-diameter ceiling fans |
| C403.11, except C403.11.3 | Refrigeration equipment performance |
| C403.12 | Construction of HVAC system elements |
| C403.13 | Mechanical systems located outside of the building thermal envelope |
| C404 | Service water heating |
| C405, except C405.3 | Electrical power and lighting systems |
| C408 | Maintenance information and system commisioning |

a. Reference to a code section includes all the relative subsections except as indicated in the table.

## Residential Energy Provisions

### Chapter 2 (Definitions)

- **Section R202** revises the definition of high-efficacy light sources to 65 lumens per watt for lamp and 45 lumens per watt for luminaires.

> **HIGH-EFFICACY LIGHT SOURCES.** Compact fluorescent lamps, light-emitting diode (LED) lamps, T-8 or smaller diameter linear fluorescent lamps, or other lamps with an efficacy of not less than 65 lumens per watt, or luminaires with an efficacy of not less than 45 lumens per watt.

- **Section R202** adds a new definition for Renewable Energy Certificates to ensure homeowners can provide legal documentation of their ownership of the credits for renewable energy.

> **RENEWABLE ENERGY CERTIFICATE (REC).** An instrument that represents the environmental attributes of one megawatt hour of renewable energy; also known as an energy attribute certificate (EAC).

- **Chapter 2 [RE] Definitions,** were adopted with some modifications to the PA UCC. Section R202 General definition for framing factor was modified as part of the 2015 IECC adoptions. The definition language that was added in Pennsylvania was not modified in the 2018 code nor 2021 code and, as such, will remain as pulished in the 2015 as follow.

> ***Framing Factor.*** *The fraction of the total building component area that is structural framing*

### Chapter 4 (Residential Energy Efficiency)

- **Section R401.2** names the compliance path options for the residential provisions of the IECC and outlines the sections required for each option.

> **R401.2: Application.**
>
> Residential buildings shall comply with Section R401.2.5 and either Sections R401.2.1, R401.2.2, R401.2.3 or R401.2.4.
>
> **Exception:** Additions, *alterations*, repairs and changes of occupancy to existing buildings complying with Chapter 5.
>
> **R401.2.1: Prescriptive Compliance Option.**
>
> The Prescriptive Compliance Option requires compliance with Sections R401 through R404.
>
> **R401.2.2: Total Building Performance Option.**
>
> The Total Building Performance Option requires compliance with Section R405.
>
> **R401.2.3: Energy Rating Index Option.**
>
> The Energy Rating Index (ERI) Option requires compliance with Section R406.
>
> **R401.2.4: Tropical Climate Region Option.**
>
> The Tropical Climate Region Option requires compliance with Section R407.

- **Section R401.2.5**, Additional energy efficiency requirements were not adopted as a part of the current Pennsylvania adoption of the 2021 IECC/IRC per the PA UCC RAC. However, pending local legislation, the 2021 language under the IECC/IRC may be adopted through local ordinance in Philadelphia to require compliance with an additional energy efficiency package of the project's choice.

**R401.2.5: Additional energy efficiency.**

This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.

1. For buildings complying with Section R401.2.1, one of the additional efficiency package options shall be installed according to Section R408.2.
2. For buildings complying with Section R401.2.2, the building shall meet one of the following:
    2.1. One of the additional efficiency package options in Section R408.2 shall be installed without including such measures in the proposed design under Section R405; or
    2.2. The proposed design of the building under Section R405.2 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.
3. For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.

The option selected for compliance shall be identified in the certificate required by Section R401.3.

- **Section R401.3** expanded requirements for the thermal envelope certificate to include the code edition and compliance path for the project as well as information related to insulation rating, photovoltaic systems and Energy Rating Index score, if applicable.

**R401.3: 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 following:

1. 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*.
2. *U*-factors of fenestration and the *solar heat gain coefficient* (SHGC) of fenestration. Where there is more than one value for any component of the building envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.
3. The results from any required duct system and building envelope air leakage testing performed on the building.
4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment. Where a gasfired 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.
5. Where on-site *photovoltaic panel* systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.
6. For buildings where an Energy Rating Index score is determined in accordance with Section R406, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate.
7. The code edition under which the structure was permitted, and the compliance path used.

- **Section 402** provides building thermal envelope provisions for residential buildings, including limitations on air filtration, or air leakage. Changes to the residential building envelope provisions include:
  - Increased insulation requirements
  - Reduced fenestration *U*-factors and solar heat gain coefficients (SHGCs)
  - Increased air leakage requirements
  - Revised duct testing requirements

- **Table R402.1.2**, Maximum assembly U-factors fenestration requirements, is revised by the Pennsylvania UCC for increased U-factor ratings per PA CC RAC as follows:

**TABLE R402.1.2 (R1102.1.2)**
**MAXIMUM ASSEMBLY *U*-FACTORS[a] AND FENESTRATION REQUIREMENTS**

| CLIMATE ZONE | FENESTRATION U-FACTOR[b] | SKYLIGHT U-FACTOR | GLAZED FENESTRATION SHGC[d,e] | CEILING U-FACTOR | FRAME WALL U-FACTOR | MASS WALL U-FACTOR[b] | FLOOR U-FACTOR | BASEMENT WALL U-FACTOR | CRAWL SPACE WALL U-FACTOR |
|---|---|---|---|---|---|---|---|---|---|
| 4 except Marine | 0.30 | 0.55 | 0.40 | 0.026 | 0.060 | 0.098 | 0.047 | 0.059 | 0.065 |

- **Table 402.1.3**, Insulation minimum *R*-values and fenestration requirements by component, is revised by the Pennsylvania UCC for decreased R-value ratings per PA UCC RAC as follows:

**TABLE R402.1.3 (N1102.1.3)**
**INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]**

| CLIMATE ZONE | FENESTRATION U-FACTOR[b] | SKYLIGHT[b] U-FACTOR | GLAZED FENESTRATION SHGC[b,e] | CEILING R-FACTOR | WOOD FRAME WALL R-VALUE | MASS WALL R-VALUE[i] | FLOOR R-VALUE | BASEMENT[c] WALL R-VALUE | SLAB[d] R-VALUE & DEPTH | CRAWL SPACE[c] WALL R-VALUE |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 except Marine | 0.32 | 0.55 | 0.40 | 49 | 20 or 13 + 5[h] | 8/13 | 19 | 10/13 | 10, 2ft | 10/13 |

- **Section R402.2.8** includes exceptions to the basement wall insulation provisions to clearly define the compliance requirements of unconditioned basements.

**R402.2.8: Basement walls.**

Basement walls shall be insulated in accordance with Table R402.1.3.

**Exception:** Basement walls associated with unconditioned basements where all of the following requirements are met:

1. The floor overhead, including the underside stairway stringer leading to the basement, is insulated in accordance with Section R402.1.3 and applicable provisions of Sections R402.2 and R402.2.7.
2. There are no uninsulated duct, domestic hot water, or hydronic heating surfaces exposed to the basement.
3. There are no HVAC supply or return diffusers serving the basement.
4. The walls surrounding the stairway and adjacent to conditioned space are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2.
5. The door(s) leading to the basement from conditioned spaces are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2, and weatherstripped in accordance with Section R402.4.
6. The building thermal envelope separating the basement from adjacent conditioned spaces complies with Section R402.4.

**R402.2.8.1: Basement wall insulation installation.**

Where *basement walls* are insulated, the insulation shall be installed from the top of the *basement wall* down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less.

- **Section R402.4.1.2 & R402.4.1.3** revises air leakage requirements and adds a new definition for dwelling unit enclosure area. Based on R402.4.1.3, air leakage testing requirements for prescriptive compliance (including UA Trade-off compliance) per R401.2.1 will continue to require compliance with maximum air leakage rates of 3.0 ACH. Where compliance methods other than prescriptive paths are proposed, maximum air leakage rates shall not exceed 5.0 ACH. Exceptions to air leakage testing also introduced for heated attached/detached private garages. (Alternative air leakage testing compliance requirements are permitted by exception for attached single & multi-family building dwelling unit, and buildings or dwelling units that are 1,500 sf or smaller. Alternative air leakage rates results shall not exceed 0.30 cfm/sf of dwelling unit enclosure area.)

**R402.4.1.2: Testing.**

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch 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 creation of all penetrations of the *building thermal envelope* have been sealed.

**Exception:** For heated, attached private garages and heated, detached private garages accessory to oneand two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

**Exception:** When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single and multiple-family building *dwelling units*.
2. Buildings or *dwelling units* that are 1,500 square feet (139.4 $m^2$) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

**R402.4.1.3: Leakage rate.**

When complying with Section R401.2.1, the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 0, 1 and 2, and 3.0 air changes per hour in Climate Zones 3 through 8, when tested in accordance with Section R402.4.1.2.

- **Section R402.5** reduces the maximum fenestration *U*-factor and provides an exception for installations in storm shelters.

**R402.5 Maximum fenestration U-factor and SHGC.**

The area-weighted average maximum fenestration *U*-factor permitted using tradeoffs from Section R402.1.5 or R405 shall be 0.48 in Climate Zones 4 and 5 and 0.40 in Climate Zones 6 through 8 for vertical fenestration, and 0.75 in Climate Zones 4 through 8 for skylights. The area-weighted average maximum fenestration SHGC permitted using tradeoffs from Section R405 in *Climate Zones* 0 through 3 shall be **0.40**.

**Exception:** The maximum *U*-factor and solar heat gain coefficient (SHGC) for fenestration shall not be required in storm shelters complying with ICC 500.

- **Section R403** address the efficiency, construction and operation of building mechanical systems that are not regulated by the U.S. Department of Energy. Section R403 is divided into 12 parts:
  - **Sections R403.1** and **R403.2** address controls for residential systems, including thermostats and hot water boiler outdoor temperature
  - **Section R403.3** covers ducts and air handlers
  - **Section R403.4** addresses insulation for system piping
  - **Section R403.5** addresses service hot water systems
  - **Section R403.6** covers mechanical ventilation provisions, including whole house fan efficiencies and system testing
  - **Section R403.7** addresses equipment sizing and efficiency rating
  - **Section R403.8** provides requirements for systems serving multiple dwelling units
  - **Section R403.9** addresses snow melt and ice system controls
  - **Sections R403.10** through **R403.12** address pool and spa energy consumption

  Significant changes to the building mechanical systems requirements in the 20211 IECC include:
  - Clarified insulation requirements for ducts located outside of conditioned space, in conditioned space, buried
  - Expanded duct testing requirements
  - New mechanical ventilation system testing requirements

- **Section R403.3.1- R403.3.3.1** clarifies the three locations ducts can be located (outside the conditioned space, in conditioned space, and buried) and the insulation requirements for each. Requirements are clarified for insulation surrounding ductwork located within the building thermal envelope assembly. (No significant changes to existing requirements for buried duct insulation.)

**R403.3.1: Ducts located outside conditioned space.**

Supply and return ducts located outside *conditioned space* shall be insulated to an *R*-value of not less than R-8 for ducts 3 inches (76 mm) in diameter and larger and not less than R-6 for ducts smaller than 3 inches (76 mm) in diameter. Ducts buried beneath a building shall be insulated as required per this section or have an equivalent *thermal distribution efficiency*. Underground ducts utilizing the *thermal distribution efficiency* method shall be listed and *labeled* to indicate the *R*-value equivalency.

**R403.3.2: Ducts located in conditioned space.**

For ductwork to be considered inside a *conditioned space*, it shall comply with one of the following:

1. The duct system shall be located completely within the *continuous air barrier* and within the building thermal envelope.
2. Ductwork in ventilated attic spaces shall be buried within ceiling insulation in accordance with Section R403.3.3 and all of the following conditions shall 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 postconstruction total system leakage test to outside the *building thermal envelope* in accordance with Section R403.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 $m^2$) 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.
3. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:
    - 3.1. A *continuous air barrier* installed between unconditioned space and the duct.
    - 3.2. Insulation installed in accordance with Section R402.2.7.
    - 3.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.
4. Ductwork located within *exterior walls* of the *building thermal envelope* shall comply with the following:
    - 4.1. A *continuous air barrier* installed between unconditioned space and the duct.
    - 4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.
    - 4.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

- **Section R403.3.5 (N1103.3.5)**, Duct testing (originally Section RA403.3.3(N1103.3.3) Duct testing, [2018 IECC/IRC]), was not modified as part of the Pennsylvania adoption of the 2021 IECC/IRC per PA UCC RAC, to remain as published in the 2018 IECC/IRC. However, pending local legislation, the 2021 IECC/IRC language is proposed to be adopted in Philadelphia to remove previous exception language, and to require that duct leakage testing also be performed for any ductwork located within the building thermal envelope.

**R403.3.5 Duct testing.**

Ducts shall be pressure tested in accordance with ANSI/RESNET/ICC 380 or ASTM E1554 to determine air leakage by one of the following methods:

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.
2. Postconstruction 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.

**Exception:**

A duct air-leakage test shall not be required for ducts serving heating, cooling or ventilation systems that are not integrated with ducts serving heating or cooling systems.

- **Section R403.3.6 (N1103.3.6)** Duct leakage (originally Section R403.3.4 (N1103.3.4) Duct Leakage, [2018 IECC/IRC]), was not modified as part of the Pennsylvania adoption of the 2021 IECC/IRC, to remain as published in the 2018 IECC/IRC under the PA UCC RAC. However, pending local legislation, the 2021 IECC/IRC language is proposed to be adopted in Philadelphia to require that duct leakage testing also be performed for any ductwork located within the building thermal envelope under R403.3.6 (N1103.3.6), Item #3.

**R403.3.6: Duct leakage.**

The total leakage of the ducts, where measured in accordance with Section R403.3.5, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 $m^2$) of *conditioned floor area* where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 $m^2$) of *conditioned floor area*.
2. Postconstruction test: Total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 $m^2$) of *conditioned floor area*.
3. Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the *building thermal envelope*, total leakage shall be less than or equal to 8.0 cubic feet per minute (226.6 L/min) per 100 square feet (9.29 $m^2$) of *conditioned floor area*.

- **Section R403.3.7 (N1103.3.7)** Building cavities (Mandatory), (originally Section R403.3.5 (N1103.3.5) Building cavities, [2015 and 2018 IECC/IRC]), was modified as part of the Pennsylvania 2015 IECC/IRC adoption. The national language was not modified in the 2018 IECC/IRC and the modified language was maintained in the Pennsylvania 2018 IECC/IRC adoption. The language was not modified as a part of the current Pennsylvania adoption of the 2021 IECC/IRC and will remain as follows:

***R403.3.7 (N1103.3.7) Building cavities (Mandatory).*** *Building framing cavities shall not be used as supply ducts.*

- **Section 403.5.1.1 (N1103.5.1.1)**, Circulation systems is adopted per PA UCC RAC as follows:

***R403.5.1.1 (N1103.5.1.1) Circulation systems.*** *Heated water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity and thermosyphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water. The controls shall limit the temperature of the water entering the cold water piping to not greater than 104°F (40°C).*

***Exception:*** *Where the entire hot water piping system (both supply and return) are insulated with a minimum R3 insulation, the stated controls shall not be required.*

- **Section R403.6.3** requires mechanical ventilation systems be tested to ensure they are installed and operating as intended.

> **R403.6.3: Testing.**
>
> Mechanical ventilation systems shall be tested and verified to provide the minimum ventilation flow rates required by Section R403.6. Testing shall be performed according to the ventilation *equipment* manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals or grilles, outlet terminals or grilles, or in the connected ventilation ducts. 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.
>
> **Exception:** Kitchen range hoods that are ducted to the outside with 6-inch (152 mm) or larger duct and not more than one 90-degree (1.57 rad) elbow or equivalent in the duct run.

- **Section R404** broadly addresses electrical power and lighting systems including both the introduction of exterior lighting requirements for some residential occupancies and controls into the residential provisions.

- **Section R404.1 (N1104.1)** Lighting equipment, was not modified as part of the current Pennsylvania 2021 IECC/IRC adoption, to remain the 2018 IECC/IRC language under the PA UCC RAC. However, pending local legislation, the 2021 IECC/IRC language is proposed to be adopted in Philadelphia to require all permanent light fixture installations to be high-efficacy lighting sources.

> **R404.1: Lighting equipment.**
>
> All permanently installed lighting fixtures, excluding kitchen appliance lighting fixtures, shall contain only high-efficacy lighting sources.

- **Section R404.1.1 (N1104.1.1)** Lighting equipment, was not modified as part of the current Pennsylvania 2021 IECC/IRC adoption and remains the 2018 IECC/IRC language as follows:

> ***R404.1.1 (N1104.1.1) Lighting equipment (Mandatory).*** *Fuel gas lighting systems shall not have continuously burning pilot lights.*

- **Section R404.1.2 (N1104.1.2)** fuel gas lighting provision under 2021 IECC was not adopted as part of the current Pennsylvania 2021 IECC/IRC adoption per PA UCC RAC.

- **Section R404.2** interior lighting controls, was not adopted as part of the current Pennsylvania 2021 IECC/IRC adoption per PA UCC RAC. However, pending local legislation, the 2021 IECC/IRC language is proposed to be adopted in Philadelphia to require either a dimmer, occupant sensor, or other control on all permanently installed lighting fixtures, unless exempted.

**R404.2: Interior lighting controls.**

Permanently installed lighting fixtures shall be controlled with either a dimmer, an occupant sensor control or other control that is installed or built into the fixture.

**Exception:** Lighting controls shall not be required for the following:

1. Bathrooms.
2. Hallways.
3. Exterior lighting fixtures.
4. Lighting designed for safety or security.

- **Section R404.3** Exterior lighting controls, was not adopted as part of the Pennsylvania 2021 IECC/IRC adoption per PA UCC RAC. However, pending local legislation, the 2021 IECC/IRC language is proposed to be adopted in Philadelphia to require a manual on/off switch that permits automatic shutoff on all exterior lighting installations.

**R404.3: Exterior lighting controls.**

Where the total permanently installed exterior lighting power is greater than 30 watts, the permanently installed exterior lighting shall comply with the following:

1. Lighting shall be controlled by a manual on and off switch which permits automatic shut-off actions.

   **Exception:** Lighting serving multiple *dwelling units*.

2. Lighting shall be automatically shut off when daylight is present and satisfies the lighting needs.
3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

- **Section 405** is restructured to clarify the required provisions of the Total Building Performance method (formerly referred to as 'mandatory' provisions) and updates the standard design reference.

- **Section 405.2** lists required provisions for performance-based compliance in Table R405.2 and efficiency levels that must be demonstrated based on annul energy cost and building thermal envelope performance.

**R405.2 Performance-based compliance.**

Compliance based on total building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table R405.2.
2. The building thermal envelope greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 *International Energy Conservation Code*.
3. An annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations.

   **Exception:** The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

- **Table R405.2 (N1105.2)** Requirements for Total Building Performance, was modified under the PA UCC RAC to remove reference to additional energy efficiency package requirements for the Total Building Performance method, which is adopted as follows:

TABLE N1105.2 (R405.2)
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

| SECTION[a] | TITLE |
|---|---|
| General | |
| ~~N1101.13.5~~ | ~~Additional energy efficiency~~ |
| N1101.14 | Certificate |
| Building Thermal Envelope | |
| N1102.1.1 | Vapor retarder |
| N1102.2.3 | Eave baffle |
| N1102.2.4.1 | Access hatches and doors |
| N1102.2.10.1 | Crawl space wall insulation installation |
| N1102.4.1.1 | Installation |
| N1102.4.1.2 | Testing |
| N1102.5 | Maximum fenestration *U*-factor and SHGC |
| Mechanical | |
| N1103.1 | Controls |
| N1103.3, including N1103.3.1, except Sections N1103.3.2, N1103.3.3 and N1103.3.6 | Ducts |
| N1103.4 | Mechanical system piping insulation |
| N1103.5.1 | Heated water circulation and temperature maintenance systems |
| N1103.5.3 | Drain water heat recovery units |
| N1103.6 | Mechanical ventilation |
| N1103.7 | Equipment sizing and efficiency rating |
| N1103.8 | Systems serving multiple dwelling units |
| N1103.9 | Snow melt system controls |
| N1103.10 | Energy consumption of pools and spas |
| N1103.11 | Portable spas |
| N1103.12 | Residential pools and permanent residential spas |
| Electrical Power and Lighting Systems | |
| N1104.1 | Lighting equipment |
| N1104.2 | Interior lighting controls |

a. Reference to a code section includes all the relative subsections except as indicated in the table.

- **Section R405.3.2 (N1105.3.2)** Compliance report, (Originally Section R405.4.2 Compliance report, [2015 and 2018 IECC/IRC]), was not modified as part of the Pennsylvania 2018 IECC/IRC adoption per the PA UCC RAC. The language was not modified as part of the current Pennsylvania adoption of the 2021 IECC/IRC per PA UCC RAC, and will remain as follows:

***R405.3.2 (N1105.3.2) Compliance report.*** *Compliance software tools shall generate a report that documents that the proposed design complies with Section R405.4 (N1105.4). A compliance report on the proposed design shall be submitted with the application for the building permit. Upon completion of the building, a compliance report based on the as-built condition of the building shall be submitted to the code official before a certificate of occupancy is issued. Batch sampling of buildings to determine energy code compliance for all buildings in the batch shall be prohibited.*

*Compliance reports shall include information in accordance with Sections R405.4.2.1 (N1105.4.2.1) and R405.4.2.2 (N1105.4.2.2). Where the proposed design of a building could be built on different sites where the cardinal orientation of the building on each site is different, compliance of the proposed design for the purposes of the application for the building permit shall be based on the worst-case orientation, worst-case configuration, worst-case building air leakage and worst-case duct leakage. Such worst-case parameters shall be used as inputs to the compliance software for energy analysis.*

- **Section R405.3.2.1 (N1105.3.2.1)** Compliance report for permit application, (Originally Section R405.4.2.1 (N1105.4.2.1) Compliance report for permit application, [2018 IECC/IRC]), was not modified as part of the current adoption of the 2021 IECC/IRC per the PA UCC RAC, and will remain as follows:

***R405.3.2.1 (N1105.3.2.1) Compliance report for permit application.*** *A compliance report submitted with the application for building permit shall include the following:*

1. *Building street address, or other building site identification.*
2. *A statement indicating that the proposed design complies with Section R405.4 (N1105.4).*
3. *An inspection checklist documenting the building component characteristics of the proposed design as indicated in Table R405.4.2(1) (N1105.4.2(1)). The inspection checklist shall show results for both the standard reference design and the proposed design with user inputs to the compliance software to generate the results.*
4. *A site-specific energy analysis report that is in compliance with Section R405.4 (N1105.4).*
5. *The name of the individual performing the analysis and generating the report.*
6. *The name and version of the compliance software tool.*

- **Section R405.3.2.2 (N1105.3.2.2)** Compliance report for certificate of occupancy, is adopted as follows based on the PA UCC RAC:

***R405.3.2.2 (N1105.3.2.2) Compliance report for certificate of occupancy.*** *A compliance report submitted for obtaining the certificate of occupancy shall include the following:*

1. *Building street address, or other building site identification.*
2. *Declaration of the total building performance path on the title page of the energy report ~~and the title page of the building plans~~.*
3. *A statement, bearing the name of the individual performing the analysis and generating the report, indicating that the as-built building complies with Section R405.3 (N1105.3).*
4. *The name and version of the compliance software tool.*
5. *A site-specific energy analysis report that is in compliance with Section R405.3 (N1105.3).*
6. *A final confirmed certificate indicating compliance based on inspection, and a statement indicating that the confirmed rated design of the built home complies with Section R405.3 (N1105.3). The certificate shall report the energy features that were confirmed to be in the home, including component-level insulation R-values or U-factors; results from any required duct system and building envelope air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical ventilation and service water heating equipment installed.*
7. *Where on-site renewable energy systems have been installed, the certificate shall report the type and production size of the installed system.*

- **Table R405.4.2.(1) (N1105.4.2(1))** Specifications for the Standard Reference and Proposed Designs (Originally Table R405.5.2.1 (N1105.5.2(1)) Specifications for the Standard Reference and Proposed Designs, [2018 IECC/IRC]), was not modified as part of the current Pennsylvania adoption of the 2021 IECC/IRC per PA UCC RAC, and will remain as follows:

**TABLE R405.4.2(1) [N1105.4.2(1)]**
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

| BUILDING COMPONENT | STANDARD REFERENCE DESIGN | PROPOSED DESIGN |
|---|---|---|
| Above-grade walls | Type: mass where the proposed wall is a mass wall; otherwise wood frame. | As proposed |
| | Gross area: same as proposed. | As proposed |
| | *U*-factor: as specified in Table [TABLE R402.1.2 | As proposed |
| | Solar absorptance = 0.75. | As proposed |
| | Emittance = 0.90. | As proposed |
| Basement and crawl space walls | Type: same as proposed. | As proposed |
| | Gross area: same as proposed. | As proposed |
| | *U*-factor: as specified in TABLE R402.1.2, with the insulation layer on the interior side of the walls. | As proposed |
| Above-grade floors | Type: wood frame. | As proposed |
| | Gross area: same as proposed. | As proposed |
| | *U*-factor: as specified in TABLE R402.1.2 | As proposed |
| Ceilings | Type: wood frame. | As proposed |
| | Gross area: same as proposed. | As proposed |
| | *U*-factor: as specified in TABLE R402.1.2 | As proposed |
| Roofs | Type: composition shingle on wood sheathing. | As proposed |
| | Gross area: same as proposed. | As proposed |
| | Solar absorptance = 0.75. | As proposed |
| | Emittance = 0.90. | As proposed |
| Attics | Type: vented with an aperture of 1 $ft^2$ per 300 $ft^2$ of ceiling area. | As proposed |
| Foundations | Type: same as proposed. | As proposed |
| | Foundation wall area above and below grade and soil characteristics: same as proposed. | As proposed |
| Opaque doors | Area: 40 $ft^2$. | As proposed |
| | Orientation: North. | As proposed |
| | *U*-factor: same as fenestration as specified in TABLE R402.1.2 | As proposed |
| Vertical fenestration other than opaque doors | Total area[b] =<br>(a) The proposed glazing area, where the proposed glazing area is less than 15 percent of the conditioned floor area.<br>(b) 15 percent of the conditioned floor area, where the proposed glazing area is 15 percent or more of the conditioned floor area. | As proposed |
| | Orientation: equally distributed to four cardinal compass orientations (N, E, S & W). | As proposed |
| | *U*-factor: as specified in TABLE R402.1.2 | As proposed |
| | SHGC: as specified in Table N1102.1.2 except for *climate zones* without an SHGC requirement, the SHGC shall be equal to 0.40. | As proposed |
| | Interior shade fraction: 0.92-(0.21 × SHGC for the standard reference design). | Interior shade fraction: 0.92-(0.21 × SHGC as proposed) |
| | External shading: none | As proposed |
| Skylights | None | As proposed |
| Thermally isolated sunrooms | None | As proposed |

*(continued)*

**TABLE R405.4.2(1) [N1105.4.2(1)]-continued**
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

| BUILDING COMPONENT | STANDARD REFERENCE DESIGN | PROPOSED DESIGN |
|---|---|---|
| Thermal distribution systems | Duct insulation: in accordance with Section N1103.3.1.<br><br>A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems.<br>**Exception:** For nonducted heating and cooling systems that do not have a fan, the standard reference design thermal distribution system efficiency (DSE) shall be 1.<br>For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft² (9.29 m²) of ***conditioned floor area*** at a pressure of differential of 0.1 inch w.g. (25 Pa). | Duct insulation: as proposed.<br>As tested or, where not tested, as specified in **TABLE R405.4.2(2)**. |
| Thermostat | Type: Manual, cooling temperature setpoint = 75°F;<br>Heating temperature setpoint = 72°F. | Same as standard reference design. |

For SI: 1 square foot = 0.93 m², 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m², 1 gallon (US) = 3.785 L, °C = (°F-32)/1.8, 1 degree = 0.79 rad.

a. Where required by the *building official*, testing shall be conducted by an *approved* party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals*, or the equivalent, shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals*, page 26.24 and the "Whole-house Ventilation" provisions of 2001 ASHRAE *Handbook of Fundamentals*, page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

f. For a proposed design home without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

g. For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater having the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For a proposed design without a proposed water heater, a 40-gallon storage-type water heater with the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.

h. For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:

$AF = A_s \times FA \times F$

where:

$AF$ = Total glazing area.
$A_s$ = Standard reference design total glazing area.
$FA$ = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).
$F$ = (above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.

and where:

Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.
Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.
Below-grade boundary wall is any thermal boundary wall in soil contact.
Common wall area is the area of walls shared with an adjoining dwelling unit. L and *CFA* are in the same units.

- **Section R406** clarifies required provisions (formerly referred to as mandatory), updates to the target ERI scores and the introduction of provisions for renewable energy certificate documentation.

- **Section R406.2** lists required provisions for the Energy Rating Index compliance option in Table R406.2 based on maximum ERI allowance.

**R406.2 ERI compliance.**

Compliance based on the Energy Rating Index (ERI) requires that the rated design meets all of the following:

1. The requirements of the sections indicated within Table R406.2.
2. Maximum ERI of Table R406.5.

- **Table R406.2 (N1106.2)** Requirements for Energy Rating Index, is adopted without reference to Additional Energy Efficiency Package requirements as follows by the Pennsylvania adoption of the 2021 IECC/IRC per the PA UCC RAC.

**TABLE N1106.2 (R406.2)**
**REQUIREMENTS FOR ENERGY RATING INDEX**

| SECTION[a] | TITLE |
|---|---|
| General | |
| ~~N1101.13.5~~ | ~~Additional efficiency packages~~ |
| N1101.14 | Certificate |
| Building Thermal Envelope | |
| N1102.1.1 | Vapor retarder |
| N1102.2.3 | Eave baffle |
| N1102.2.4.1 | Access hatches and doors |
| N1102.2.10.1 | Crawl space wall insulation installation |
| N1102.4.1.1 | Installation |
| N1102.4.1.2 | Testing |
| Mechanical | |
| N1103.1 | Controls |
| N1103.3 except Sections N1103.3.2, N1103.3.3 and N1103.3.6 | Ducts |
| N1103.4 | Mechanical system piping insulation |
| N1103.5.1 | Heated water circulation and temperature maintenance systems |
| N1103.5.3 | Drain water heat recovery units |
| N1103.6 | Mechanical ventilation |
| N1103.7 | Equipment sizing and efficiency rating |
| N1103.8 | Systems serving multiple dwelling units |
| N1103.9 | Snow melt system controls |
| N1103.10 | Energy consumption of pools and spas |
| N1103.11 | Portable spas |
| N1103.12 | Residential pools and permanent residential spas |
| Electrical Power and Lighting Systems | |
| N1104.1 | Lighting equipment |
| N1104.2 | Interior lighting controls |
| N1106.3 | Building thermal envelope |

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

- **Section R406.3 (N1106.3)** Building thermal envelope, was not adopted as part of the Pennsylvania 2021 IECC/IRC adoption and is reserved as per PA UCC RAC.

- **Section R406.3.1 (N1106.3.1)** On-site renewables are not included, was not adopted as part of the Pennsylvania 2021 IECC/IRC adoption as per PA UCC RAC.

- **Section R406.3.2 (N1106.3.2)** On-site renewables are included, was not adopted as part of the Pennsylvania 2021 IECC/IRC adoption as per PA UCC RAC.

- **Section R406.4 (N1106.4)** Energy Rating Index, (Originally Section R406.3 (N1106.3) Energy Rating Index, [2015 and 2018 IECC/IRC]), was not modified as part of the Pennsylvania 2018 IECC/IRC adoption per the PA UCC RAC. The language was not modified as part of the current Pennsylvania adoption of the 2021 IECC/IRC, and will remain as follows:

> ***R406.4 (N1106.4) Energy rating index.*** *The Energy Rating Index (ERI) shall be a numerical integer value that is based on a linear scale constructed such that the ERI reference design has an Index value of 100 and a residential building that uses no net purchased energy has an Index value of 0. Each integer value on the scale shall represent a 1 percent change in the total energy use of the rated design relative to the total energy use of the ERI reference design. The ERI shall consider all energy used in the residential building.*

- **Section R406.4.1 (N1106.4.1)** ERI referenced design, (Originally Section R406.3.1 (N1106.3.1) ERI referenced design, [2015 and 2018 IECC/IRC]), was not modified as part of the Pennsylvania 2018 IECC/IRC adoption as per PA UCC RAC. The language was not modified as part of the current Pennsylvania adoption of the 2021 IECC/IRC, and will remain as follows:

> ***R406.4.1 (N1106.4.1) ERI reference design.*** *The ERI reference design shall be configured such that it meets the minimum requirements of the 2006 International Energy Conservation Code prescriptive requirements. The proposed residential building shall be shown to have an annual total normalized modified load less than or equal to the annual total loads of the ERI reference design.*

- **Section R406.7.1 (N1106.7.1)** Compliance software tool, (Originally Section R406.6.1 (N1106.6.1) Compliance software tools, [2015 and 2018 IECC/IRC]), was not modified as part of the Pennsylvania 2018 IECC/IRC adoption as per PA UCC RAC. The language was not modified as part of the current Pennsylvania adoption of the 2021 IECC/IRC, and will remain as follows:

> ***R406.7.1 (N1106.7.1) Compliance software tools.*** *Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this section shall be provided to the code official.*

- **Section R406.7.3** introduces renewable energy certificate (REC) documentation to ensure homeowners are able to legally document ownership of the RECs associated with their homes.

> **R406.7.3 Renewable energy certificate (REC) documentation.**
>
> Where on-site renewable energy is included in the calculation of an ERI, one of the following forms of documentation shall be provided to the code official:
>
> 1. Substantiation that the RECs associated with the on-site renewable energy are owned by, or retired on behalf of, the homeowner.
> 2. A contract that conveys to the homeowner the RECs associated with the on-site renewable energy, or conveys to the homeowner an equivalent quantity of RECs associated with other renewable energy.

- **Section R406.8 (N1106.8)** Calculation software tools, (Originally Section R406.7 (N1106.7) Calculation software tools, [2015 and 2018 IECC/IRC]), was not modified as part of the Pennsylvania 2018 IECC/IRC adoption as per PA UCC RAC. The language was not modified as part of the current Pennsylvania adoption of the 2021 IECC/IRC, and will remain as follows:

> ***R406.8 (N1106.8) Calculation software tools.*** *Calculation software, where used, shall be in accordance with Sections R406.8.1 (N1106.8.1) through R406.8.3 (N1106.8.3).*

- **Section R406.8.1 (N1106.8.1)** Minimum capabilities, (Originally Section R406.7.1 (N1106.7.1) Minimum capabilities, [2015 and 2018 IECC/IRC]), was not modified as a part of the Pennsylvania 2018 IECC/IRC adoption as per PA UCC RAC. The language was not modified as part of the current Pennsylvania adoption of the 2021 IECC/IRC, and will remain as follows:

> ***R406.7.1 (N1106.7.1) Minimum capabilities.*** *Calculation procedures used to comply with this section shall be software tools capable of calculating the ERI as described in Section R406.3 (N1106.3), and shall include the following capabilities:*
>
> 1. *Computer generation of the ERI reference design using only the input for the rated design.*
>
>    *The calculation procedure shall not allow the user to directly modify the building component characteristics of the ERI reference design.*
>
> 2. *Calculation of whole-building, as a single zone, sizing for the heating and cooling equipment in the ERI reference design residence in accordance with Section R403.7 (N1103.7).*
>
> 3. *Calculations that account for the effects of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.*
>
> 4. *Printed code official inspection checklist listing each of the rated design component characteristics determined by the analysis to provide compliance, along with their respective performance ratings.*

- **Section R406.8.2 (N1106.8.2)** Specific approval, (Originally Section R406.7.2 (N1106.7.2) Specific Approval, [2015 and 2018 IECC/IRC]), was not modified as part of the Pennsylvania 2018 IECC/IRC adoption per PA UCC RAC. The language was not modified as part of the Pennsylvania adoption of the 2021 IECC/IRC, and will remain as follows:

> ***R406.7.2 (N1106.7.2) Specific approval.*** *Performance analysis tools meeting the applicable sections of Section R406 (N1106) shall be approved. Tools are permitted to be approved based on meeting a specified threshold for a jurisdiction. The code official shall approve tools for a specified application or limited scope.*

- **Section R406.8.3 (N1106.8.3)** Input values, (Originally Section R406.7.3 (N1106.7.3) Minimum capabilities, [2015 and 2018 IECC/IRC]), was not modified as part of the Pennsylvania 2018 IECC/IRC adoption per PA UCC RAC. The language was not modified as part of the current Pennsylvania adoption of the 2021 IECC/IRC, and will remain as follows:

> ***R406.7.3 (N1106.7.3) Input values.*** *When calculations require input values not specified by Sections R402 (N1102), R403 (N1103), R404 (N1104) and R405 (N1105), those input values shall be taken from an approved source.*

- **Section R408** was modified under the PA UCC RAC to remove reference to additional energy efficiency package requirements. However, pending local legislation, 2021 IECC provisions under Section R408 will be maintained to require residential projects to include additional energy efficiency measures as specified by the compliance path option selected. This selection outlines the additional energy efficiency package options for the Prescriptive and Total Building Performance paths.

**R408.1 Scope.**

This section establishes additional efficiency package options to achieve additional energy efficiency in accordance with Section R401.2.1.

**R408.2 Additional efficiency package options.**

Additional efficiency package options for compliance with Section R401.2.1 are set forth in Sections R408.2.1 through R408.2.5.

**R408.2.1 Enhanced envelope performance option.**

The total *building thermal envelope* UA, the sum of *U*-factor times assembly area, shall be less than or equal to 95 percent of the total UA resulting from multiplying the *U*-factors in Table R402.1.2 by the same assembly area as in the proposed building. The UA calculation shall be performed in accordance with Section R402.1.5. The area-weighted average SHGC of all glazed fenestration shall be less than or equal to 95 percent of the maximum glazed fenestration SHGC in Table R402.1.2.

**R408.2.2 More efficient HVAC equipment performance option.**

Heating and cooling *equipment* shall meet one of the following efficiencies:

1. Greater than or equal to 95 AFUE natural gas furnace and 16 SEER air conditioner.
2. Greater than or equal to 10 HSPF/16 SEER air source heat pump.
3. Greater than or equal to 3.5 COP ground source heat pump.

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.

**R408.2.3 Reduced energy use in service water-heating option.**

The hot water system shall meet one of the following efficiencies:

1. Greater than or equal to 82 EF fossil fuel service water-heating system.
2. Greater than or equal to 2.0 EF electric service water-heating system.
3. Greater than or equal to 0.4 solar fraction solar water-heating system.

**R408.2.4 More efficient duct thermal distribution system option.**

The thermal distribution system shall meet one of the following efficiencies:

1. 100 percent of ducts and air handlers located entirely within the *building thermal envelope*.
2. 100 percent of ductless thermal distribution system or hydronic thermal distribution system located completely inside the *building thermal envelope*.
3. 100 percent of duct thermal distribution system located in *conditioned space* as defined by Section R403.3.2.

**R408.2.5 Improved air sealing and efficient ventilation system option.**

The measured air leakage rate shall be less than or equal to 3.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed. Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent Sensible Recovery Efficiency (SRE), less than or equal to 1.1 cubic feet per minute per watt (0.03 $m^3$/min/watt) and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent Latent Recovery/Moisture Transfer (LRMT).