2021 IECC® Essentials – Residential Provisions

Based on the 2021 *International Energy Conservation Code®*

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GOAL & OBJECTIVES

This seminar covers the essential concepts of the 2021 *International Energy Conservation Code®* (IECC®) as it applies to the construction of new residential buildings.

1) Identify the importance of the energy code in reducing building energy use and providing other environmental benefits
2) Explain the intent, scope and applicability of the 2021 IECC requirements for residential building projects and how systems covered by the IECC ensure occupant safety and comfort
3) Describe the duties and rights of design professionals and code officials, and how these professions will use key topics and tables to effectively perform their duties
4) Identify essential residential provisions in the 2021 IECC and how compliance with these by the design, plan review and inspection communities help achieve the intended benefits of the code

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INSTRUCTOR

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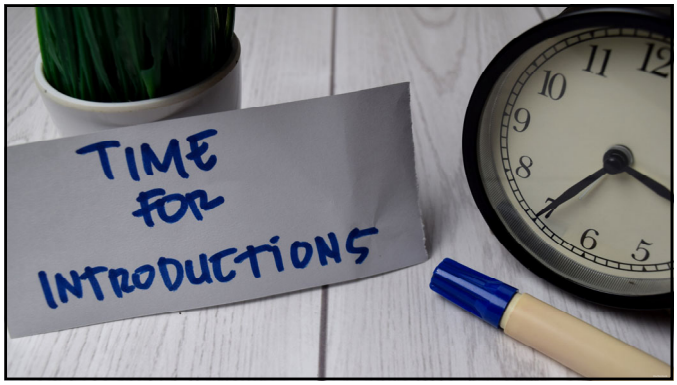

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COURSE OUTLINE

- Overview of the IECC
- Administrative Chapters
  - Chapters 1 – 3 and 6
- Residential Energy Efficiency
  - Chapters 4
- Appendices

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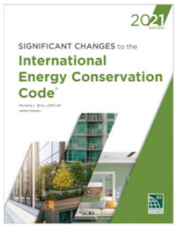

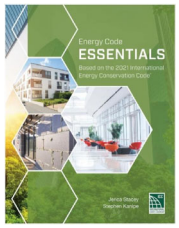

Useful Publications

Available on shop.iccsafe.org

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Overview of the IECC

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Building Codes

- Codes are minimum requirements to safeguard health, safety, and welfare of the public and occupants or users of spaces or buildings
- Adopted by governmental agencies to ensure that buildings are built in a safe manner
- People expect when entering a building to be safe from inherent dangers caused by natural or man-made disasters

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Family of I-Codes

- International Private Sewage Disposal Code
- International Property Maintenance Code
- International Zoning Code
- International Performance Code
- International Swimming Pool & Spa Code
- International Wildlife-Urban Interface Code
- International Fuel Gas Code
- International Mechanical Code
- International Green Construction Code
- International Existing Building Code
- **International Energy Conservation Code**
- International Plumbing Code
- International Fire Code
- International Building Code
- International Residential Code

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About the IECC

- The IECC regulates the design and construction of buildings for the effective use and conservation of energy over the useful life of each building
- This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective
- This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances

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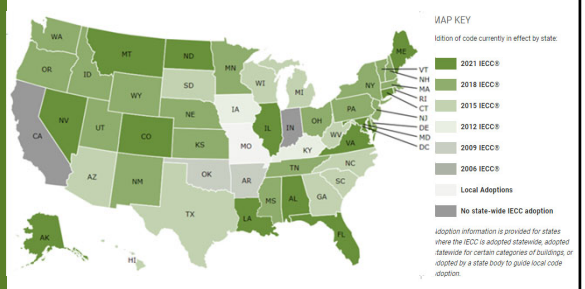
INTERNATIONAL ENERGY CONSERVATION CODE® (IECC®)

ADOPTION MAP



2024: Rhode Island; Nevada; various jurisdictions in Arizona

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The Case for Building Energy Codes: Why Adopt?

1. Synchronicity with Suite of I-Codes
2. Energy savings and emissions reductions
3. Cost savings
4. Life safety benefits

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1 Synchronicity with I-Codes

- International Plumbing Code
- International Fire Code
- International Building Code
- International Residential Code

- International Performance Code
- International Swimming Pool & Spa Code
- International Wildlife-Urban Interface Code
- International Fuel Gas Code
- International Mechanical Code
- International Green Construction Code
- International Existing Building Code
- **International Energy Conservation Code**
- International Private Sewage Disposal Code
- International Property Maintenance Code
- International Zoning Code

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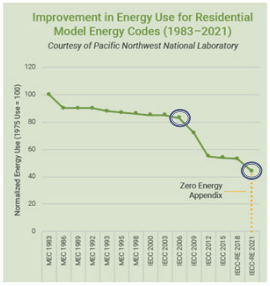
2 Energy Savings and Emissions Reductions – Residential

- 2021 IECC Residential DOE Determination
  - 9% increase in energy savings over the 2018 IECC
  - 9% carbon emissions reductions
- Roughly 40% increase in efficiency from the 2006 IECC



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Energy Savings and Emissions Reductions – Commercial

- Determination for ASHRAE Standard 90.1 – 2019
  - ~ 5% greater energy efficiency than previous version

COMMERCIAL: ANSI/ASHRAE/IES STANDARD 90.1-2019

On July 28, 2021, DOE issued a determination that Standard 90.1-2019 will achieve greater energy efficiency in buildings subject to the code. DOE estimates national savings in commercial buildings of approximately:

- 4.7 percent site energy
- 4.3 percent source energy
- 4.3 percent energy cost
- 4.2 percent carbon emissions

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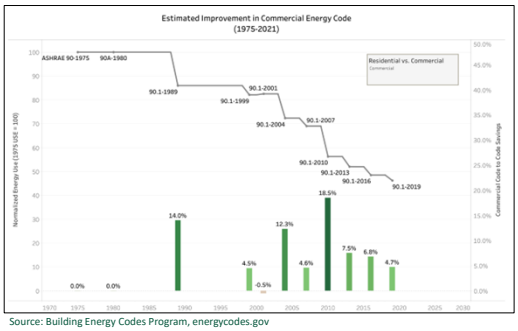

Source: Building Energy Codes Program, energycodes.gov

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DOE analysis of commercial provisions of the 2021 IECC

12.1% More efficient than 2018 IECC commercial provisions

6.5% More efficient than ASHRAE Standard 90.1

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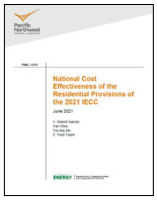
3 Cost Savings

Table 13. Average Annual Energy Cost Savings for the 2021 IECC

Climate Zone	Compared to the 2018 IECC ($/dwelling unit yr)
1	200
2	192
3	200
4	205
5	173
6	123
7	306
8	411
National Average	191



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Highlights

The 2021 IECC provides cost-effective levels of energy efficiency and performance for residential buildings in Pennsylvania

Moving to the 2021 International Energy Conservation Code (IECC) is cost-effective for both single-family and low-rise multifamily residential buildings in Pennsylvania. The 2021 IECC will provide statewide energy savings of 13.5% across all climate zones compared to the current state energy code. This equates to $ 331 of annual utility bill savings for the average Pennsylvania household. It will reduce statewide CO_2 emissions over 30 years by 11,860,000 metric tons, equivalent to the annual CO_2 emissions of 2,579,000 cars on the road (1 MMT CO_2 = 217,480 cars driven/year). Updating the state energy code based on the 2021 IECC will also stimulate the creation of high-quality jobs across the state. Adopting the 2021 IECC in Pennsylvania is expected to result in homes that are energy efficient, more affordable to own and operate, and based on current industry standards for health, comfort and resilience.

The average expected statewide economic impact (per dwelling unit) of upgrading to the 2021 IECC is shown in the tables below based on cost-effectiveness and carbon metrics established by the U.S. Department of Energy.[1]

Consumer Impact

Metric	Compared to the 2015 IECC with amendments
Life-cycle cost savings of the 2021 IECC	$5,303
Net annual consumer cash flow in year 1 of the 2021 IECC[2]	$142
Annual (first year) energy cost savings of the 2021 IECC ($)[3]	$331
Annual (first year) energy cost savings of the 2021 IECC (%)[4]	13.5%

Statewide energy savings of 13.5%

Emission reductions equivalent to 2.6m cars

$331 of annual utility bill savings

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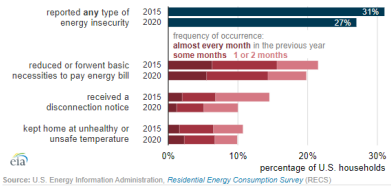
Cost Savings

APRIL 11, 2022

In 2020, 27% of U.S. households had difficulty meeting their energy needs

U.S. household energy insecurity measures (2015 and 2020)



Source: U.S. Energy Information Administration, *Residential Energy Consumption Survey* (RECS)

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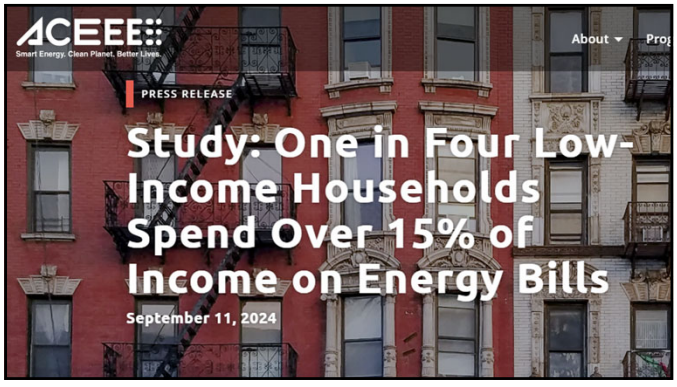

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Life Safety Benefits

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How the Code is Organized

There are two separate sets of provisions

- **Commercial** and **residential** energy efficiency requirements
  - Apply to the building thermal envelope, mechanical and service water heating systems, and lighting and electrical systems
  - Additional energy efficiency requirements
- Administrative provisions and definitions specific to each commercial and residential set of regulations are also included

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TABLE OF CONTENTS

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Chapter 1: Administration and Enforcement

Commercial and Residential

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Chapter 1: Scope and Administration

- Establishes the limits of applicability of the code and describes how the code is to be applied and enforced

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Chapter 1: Scope and Administration

- Establishes the limits of applicability of the code and describes how the code is to be applied and enforced
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Chapter 1: Scope and Administration

- Establishes the limits of applicability of the code and describes how the code is to be applied and enforced
- Establishes authority and duties of the code official appointed by the authority having jurisdiction
- Establishes the rights and privileges of the design professional, contractor and property owner

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R101.2 – Scope

- This code applies to residential buildings and the buildings' sites and associated systems and equipment

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Commercial and Residential Buildings Defined

- **Residential:** For this code, includes one- and two-family dwellings and townhouses, as well as group R-2, R-3, and R-4 buildings three stories or less in height above grade plane
- **Commercial:** For this code, all buildings that are not included in the definition of "Residential building"

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Commercial and Residential Buildings Defined

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C101.4.1 and R101.4.1 – Mixed Residential and Commercial Buildings

- Where a building includes both residential building and commercial building portions
  - Each portion considered separately
  - Meet the applicable residential or commercial provisions

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C101.4.1 and R101.4.1 – Mixed Occupancy

- Each occupancy to be separately considered as residential or commercial

Condominiums	Residential provisions
Apartments	Residential provisions
Retail	Commercial provisions

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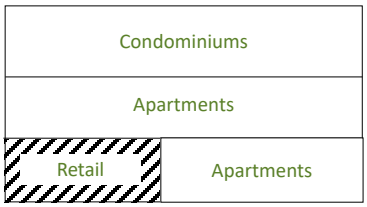
C101.4.1 and R101.4.1 – Mixed Occupancy

- Each occupancy to be separately considered as residential or commercial



Residential provisions

Residential provisions

Commercial and Residential provisions

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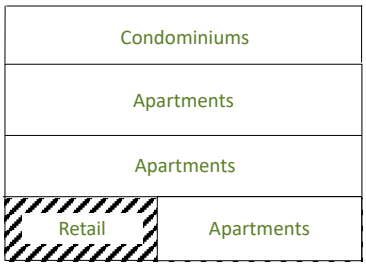
C101.4.1 and R101.4.1 – Mixed Occupancy



Building is now 4 stories

Commercial provisions throughout

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C102.1.1 and R102.1.1 – Above Code Programs

- Code official or other AHJ has authority to deem "above code" program as exceeding the energy efficiency required by the code
- Burden of proof to establish equivalency is on applicant

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C102.1.1 and R102.1.1 – Above Code Programs

- For residential buildings:
  - Requirements identified in Table R405.2 must be met
  - Building thermal envelope and SHGCs must be at least as efficient as the 2009 IECC

TABLE R405.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION*	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration *U*-factor and SHGC
Mechanical	
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation

partial table

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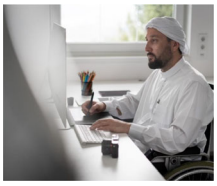
C103.1 and R103.1 – Digital Construction Documents

- Submitted in 1 or more sets
- Construction documents may be submitted in digital format



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R103.2 – Information on Construction Documents for Residential Projects

1. Energy compliance path
2. Insulation materials and their R-values
3. Fenestration U-factors and SHGC
4. Area-weighted U-factor and SHGC calculations
5. Mechanical system design criteria
6. Mechanical and service water-heating systems and equipment types, sizes, and efficiencies
7. Equipment and system controls
8. Duct sealing, duct and pipe insulation and location
9. Air sealing details

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C103.2 and R103.2 – Information and Construction Documents

Information can be presented in several ways

- On the drawings
- On sections and in schedules
- Through notes and callouts
- Through supplementary worksheets or calculations

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C105 and R105 – Inspections

- All construction is subject to inspection
- Construction must not be concealed without inspection approval
- A final inspection is required before occupancy
- A building must be reinspected when determined necessary by a code official

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C105.2 and R105.2 – Required Inspections

Commercial

- Footing and foundation
- Thermal envelope
- Plumbing system
- Mechanical system
- Electrical system
- Final

Residential

- Footing and foundation
- Framing and rough-in
- Plumbing rough-in
- Mechanical rough-in
- Final

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C108.1.1 and R108.1.1 – Conflicts

IECC takes precedence when the requirements of the referenced code or standard conflict with the requirements of the code

C108.3 and R108.3 – Other laws

The provisions of this code shall not be deemed to nullify any provisions of local, state, or federal law

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Chapter 2: Definitions

Residential

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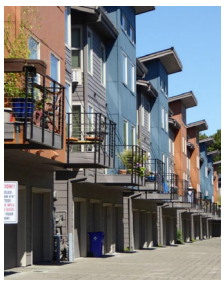
Chapter 2: Definitions



- IECC includes definitions for specific terms
- Most defined terms are *italicized* in code text
  - When definition is key to understanding a particular code provision
- Undefined terms
  - Other I-Code definitions apply
  - Common-use definitions apply

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On-site Renewable Energy and Renewable Energy Resources

- **ON-SITE RENEWABLE ENERGY.** Energy from renewable energy resources harvested at the building project site.
- **RENEWABLE ENERGY RESOURCE.** Energy derived from solar radiation, wind, waves, tides, landfill gas, biogas, biomass, or extracted from hot fluid or steam heated within the earth.

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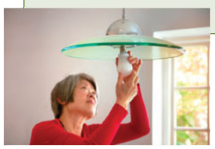
High-Efficacy Light Sources

Any lamp with an efficacy of not less than 65 lumens per watt, or luminaires with an efficacy of not less than 45 lumens per watt.



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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).

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Other New or Revised Definitions - Residential

- Residential New
  - Access (to)
  - Cavity insulation
  - Dimmer
  - Dwelling unit enclosure area
  - Occupant sensor control
  - On-site renewable energy
  - Ready access (to)
  - Renewable energy sources
  - Thermal distribution efficiency (TED)
- Residential Revised
  - Demand Recirculation Water System
  - Skylights
  - Roof recover

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Chapter 3: General Requirements

Commercial and Residential

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Chapter 3: General Requirements

- Includes broadly applicable requirements not found in other chapters
- Establishes climate zones for US counties and territories
  - Includes methodology for determining climate zones elsewhere
- Contains product rating, marking and installation requirements for materials
  - Insulation, windows, doors, and siding

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C301 and R301 – Climate Zones

Climate zones updated in 2021 IECC

- New Climate Zone 0
- Align with ASHRAE 169, ASHRAE Standard 90.1, 2018 IgCC
- 10% of US counties assigned new CZ

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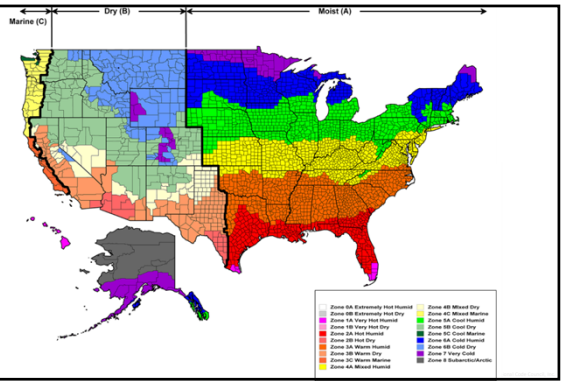

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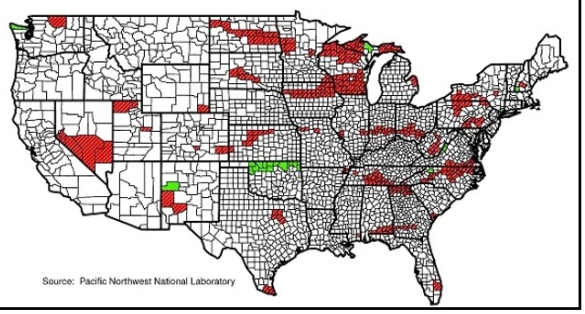
County-Level Climate Zone Changes



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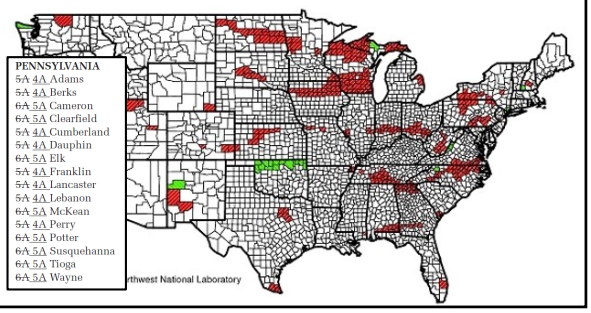
County-Level Climate Zone Changes



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C302.1 and R302.1 – Interior Design Conditions

- Interior design temperatures used for heating and cooling load calculations
  - Maximum of 72°F (22°C) for heating
  - Minimum of 75°F (24°C) for cooling

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C303.1 and R303.1 - Identification

- Requires materials to be labeled on site with the rated *R-value* or *U-factor*
- Thickness of insulation must be written on markers

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C303.1.3 and R303.1.3 – Fenestration Product Rating

- "Label or Table"
- U-factors determined by an accredited, independent laboratory, and labeled and certified by the manufacturer
  - NFRC 100 for windows, doors and skylights
  - NFRC 100 or ANSI/DASMA 105 for garage doors and rolling doors, where required
- SHGCs and VT determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer

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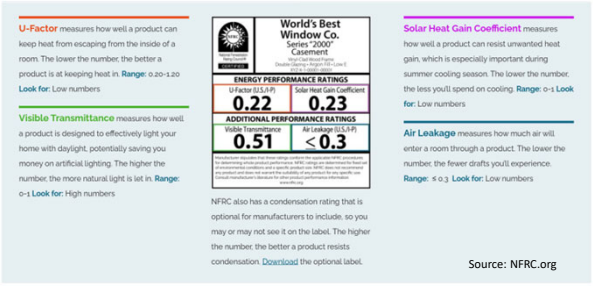
NFRC Label



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C303.1.3 and R303.1.3 – Fenestration Product Rating

- "Label or Table"
- Products lacking a labeled U-factor, SHGC, or VT are assigned a default U-factor from Tables C/R303.1.3(1) through C/R303.1.3(3)

TABLE R303.1.3(1)
DEFAULT GLAZED WINDOW, GLASS DOOR AND SKYLIGHT *U*-FACTORS

FRAME TYPE	WINDOW AND GLASS DOOR		SKYLIGHT	
	Single pane	Double pane	Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

TABLE R303.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC AND VT

	SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
	Clear	Tinted	Clear	Tinted	
SHGC	0.8	0.7	0.7	0.6	0.6
VT	0.6	0.3	0.6	0.3	0.6

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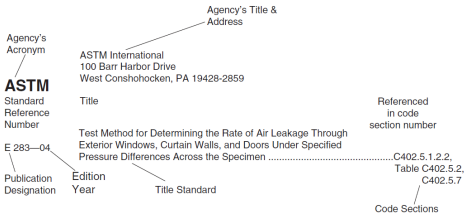
Chapter 6: Referenced Standards



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Improved Useability of the 2021 IECC

Mandatory and *Prescriptive* labels removed in favor of mandatory tables

- Total Building Performance
- Energy Rating Index

2018 IECC

C402.5 Air leakage—thermal envelope (Mandatory). The *thermal envelope* of buildings shall comply with Section C402.5.1 through C402.5.8, or the building *thermal envelope* shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official and deemed to comply with the provisions of this section when the tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft² (2.0 L/s • m²). Where compliance is based on such testing, the building shall also comply with Sections C402.5.5, C402.5.6 and C402.5.7.

2021 IECC

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.

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Improved Useability of the 2021 IECC

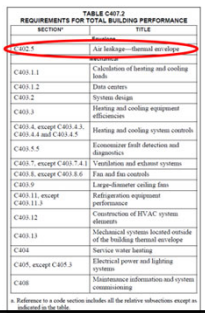

TABLE C407.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

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 commissioning

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

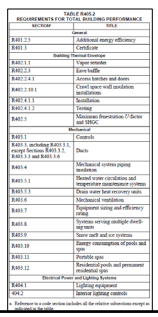

TABLE R405.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
	General
R401.2.3	Additional energy efficiency
R401.3	Certificate
	Building Thermal Envelope
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration U-factor and SHGC
	Mechanical
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
	Electrical Power and Lighting Systems
R404.1	Lighting equipment
404.2	Interior lighting controls

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

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Chapter 4: Residential Energy Efficiency

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Residential Energy Efficiency, Chapter 4 Overview

- R401 General
- R402 Building Thermal Envelope
- R403 Systems
- R404 Electrical Power and Lighting Systems
- R405 Total Building Performance
- R406 Energy Rating Index Compliance Alternative
- R407 Tropical Climate Region Compliance Path
- R408 Additional Efficiency Package Options

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R401.1 – Scope

- Pertains to detached one- and two-family dwellings and townhouses as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane
- New construction
  - Existing buildings as specified by Chapter 5
- Apply to residential buildings, building sites and associated systems and equipment.

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R401.2 – Application

- Compliance path options for the residential provisions of the IECC are named and the sections required for each option are outlined
- Tropical Climate Region Option formally recognized as a compliance path

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.

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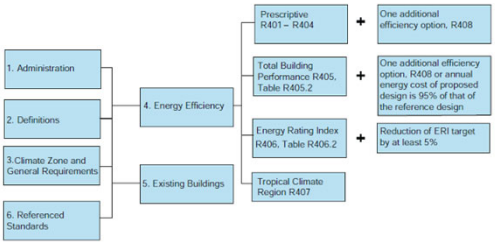
R401.2 – Application



72

R401.2.5 – Additional Energy Efficiency

- Prescriptive Compliance Option
  - Select one additional efficiency package option in Section R408.2
- Total Building Performance option
  - Select one additional efficiency package option in Section R408.2

    OR
  - Proposed design must have annual energy cost less than or equal to 95% of the referenced design
- Energy Rating Index
  - ERI value must be at least 5% less than ERI target

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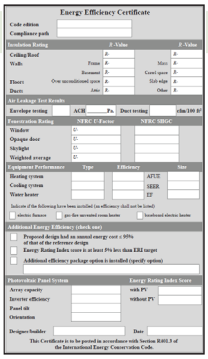
R401.3 - Certificate

- Requirements for the certificate are expanded to include
  - Code edition
  - Compliance path
  - Additional energy efficiency option
  - PV system information
  - Energy Rating Index score


Energy Efficiency Certificate

Code edition

Compliance path

Insulation Rating — R-Value

Ceiling/Roof — R-

Walls: Frame R- Mass R-

Basement R- Crawl space R-

Floors: Over unconditioned space R- Slab edge R-

Ducts: Attic R- Other R-

Air Leakage Test Results

Envelope testing: ACH ___ Pa | Duct testing: ___ cfm/100 ft²

Fenestration Rating — NFRC U-Factor — NFRC SHGC

Window: U-

Opaque door: U-

Skylight: U-

Weighted average: U-

Equipment Performance — Type — Efficiency — Size

Heating system: AFUE

Cooling system: SEER

Water heater: EF

Indicate if the following have been installed (an efficiency shall not be listed)

electric furnace | gas-fire unvented room heater | baseboard electric heater

Additional Energy Efficiency (check one)

Proposed design had an annual energy cost ≤ 95% of that of the reference design

Energy Rating Index score is at least 5% less than ERI target

Additional efficiency package option is installed (specify option)

Photovoltaic Panel System — Energy Rating Index Score

Array capacity — with PV

Inverter efficiency — without PV

Panel tilt

Orientation

Designer/builder — Date

This Certificate is to be posted in accordance with Section R401.3 of the International Energy Conservation Code.

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Section R402

Residential Building Envelope

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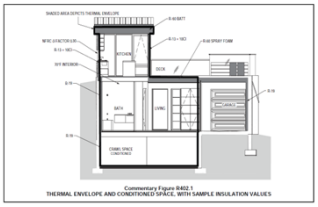
Key Building Envelope Provisions

- Insulation and fenestration values
- Eave baffles
- Steel frame wall values
- Sunrooms
- Air leakage controls



Commentary Figure R402.1
THERMAL ENVELOPE AND CONDITIONED SPACE, WITH SAMPLE INSULATION VALUES

77

Building Envelope Exceptions

Some buildings exempt from envelope provisions

- Low-energy buildings
  1. Peak design rate of energy usage less than 1 watt/ft^2 for space conditioning purposes
  2. No conditioned space
- Log homes designed in accordance with ICC 400

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C402.1 – General (Prescriptive Compliance)

Prescriptive compliance path

- Thermal requirements of either
  - U-factor-based method of Section R402.1.2
  - R-value based method of Section R402.1.3
  - Total UA Alternative R402.1.5

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C402.1 – General (Prescriptive Compliance)

Prescriptive compliance path

- Thermal requirements of either
  - U-factor-based method of Section R402.1.2
  - R-value based method of Section R402.1.3
  - Total UA Alternative R402.1.5
- Specific insulation requirements of Section R402.2
- Fenestration performance requirements
- Air leakage requirements
- Remember: some requirements are MANDATORY for other compliance paths as well

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Amendment

U-factors and Fenestration Requirements

TABLE R402.1.2 (N1102.1.2) MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS , is adopted 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
1	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.25	0.030	0.084	0.165	0.064	0.360	0.477
3	0.32	0.55	0.25	0.030	0.060	0.098	0.047	0.091	0.136
4 except Marine	0.30	0.55	0.40	0.026	0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	NR	0.026	0.051	0.082	0.033	0.050	0.055
6	0.30	0.55	NR	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	NR	0.026	0.045	0.057	0.028	0.050	0.055

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Table R402.1.2 – Footnotes

a. Nonfenestration U-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall U-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In Warm Humid locations as defined by Figure R301.1 and Table R301.1, the basement wall U-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration. Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum U-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation above sea level, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the International Residential Code.

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Amendment

Minimum R-values and Fenestration Requirements

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
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.32	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	20 or 13 + 5[h]	8/13	19	10/13	10, 2ft	10/13
5 and Marine 4	0.30	0.55	NR	49	23 or 13 + 7.5[h] or 20 + 3.8[h]	13/17	30[g]	15/19	10, 4ft or 15, 3ft	15/19
6	0.30	0.55	NR	49	23 or 20 + 5[h] or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	23 or 20 + 5[h] or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

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Climate Zone 4A and 4B – Insulation R-Values

IECC Edition	Ceiling	Wood Frame Wall	Mass Wall	Floor	Basement Wall	Slab & Depth	Crawl Space Wall
2009	38	13	5/10	19	10/13	10, 2ft	10/13
2012	49	20 or 13+5	8/13	19	10/13	10, 2ft	10/13
2015	49	20 or 13+5	8/13	19	10/13	10, 2ft	10/13
2018	49	20 or 13+5	8/13	19	10/13	10, 2ft	10/13
2021	60	30 or 20 & 5ci or 13 & 10ci or 0 & 20ci	8/13	19	10ci or 13	10ci, 4ft	10ci or 13

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Climate Zone 5 and 4C– Insulation R-Values

IECC Edition	Ceiling	Wood Frame Wall	Mass Wall	Floor	Basement Wall	Slab & Depth	Crawl Space Wall
2009	38	20 or 13+5	13/17	30	10/13	10, 2ft	10/13
2012	49	20 or 13+5	13/17	30	15/19	10, 2ft	15/19
2015	49	20 or 13+5	13/17	30	15/19	10, 2ft	15/19
2018	49	20 or 13+5	13/17	30	15/19	10, 2ft	15/19
2021	60	30 or 20 & 5ci or 13 & 10ci or 0 & 20ci	13/17	30	15ci or 19 or 13 & 5ci	10ci, 4ft	15ci or 19 or 13 & 5ci

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Alternatives to Wood Frame Construction

- Steel Framing
  - Non-combustible, recyclable
  - Higher cost, thermal bridging concerns
- Insulated Concrete Forms (ICF)
  - Better insulated, soundproof, fire and disaster resistant
  - Higher cost, few contractors to install
- Structural Insulated Panels (SIPs)
  - More energy efficient, airtight, reduced construction time
  - Higher cost, requires special equipment to install, limited design flexibility
- Cross-laminated Timber (CLT) and Mass Timber
  - Strong, renewable, reduced construction time
  - Availability, newer to market
- Modular Systems
  - Reduced construction time, less waste
  - Limited design flexibility, transportation and other logistics

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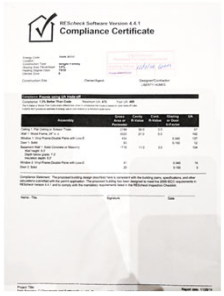
R402.1.5 Total UA Alternative

- Envelope component trade-off option
  - Trade-off of SHGCs not allowed, U-factor only
- Key concept is that the overall building thermal flow (UA) complies with code
- Calculated by hand or software - RES*check*
- Encourages flexibility in design


REScheck Software Version 4.4.1
Compliance Certificate

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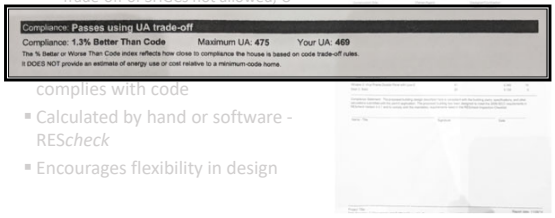
R402.1.5 Total UA Alternative

- Envelope component trade-off option
  - Trade-off of SHGCs not allowed, U-
- Calculated by hand or software - RES*check*
- Encourages flexibility in design


Compliance: **Passes using UA trade-off**
Compliance: **1.3% Better Than Code** Maximum UA: **475** Your UA: **469**
The % Better or Worse Than Code index reflects how close to compliance the house is based on code trade-off rules.
It DOES NOT provide an estimate of energy use or cost relative to a minimum-code home.

REScheck Software Version 4.4.1
Compliance Certificate

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Specific Insulation Requirements

- Requirements must be met in addition to U-factor or R-value compliance
  - Ceilings with and without attics
  - Eave baffles
  - Access hatches and doors
  - Mass walls
  - Steel-framed assemblies
  - Floors
  - Basement walls
  - Slab-on-grade floors
  - Crawl space walls
  - Masonry veneer
  - Sunroom and heated garage insulation

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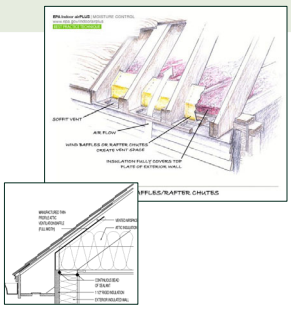
R402.2.3 – Eave Baffle

- For air-permeable insulation in vented attics, a baffle must be installed adjacent to soffit and eave vents
- Must extend over top of insulation
- Permitted to be any solid material
- Must be installed to the outer edge of the exterior wall top plate



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R402.2.4 – Access Hatches and Doors

- From conditioned to unconditioned spaces
  - attics & crawl spaces
- Insulated to the same R-value for surround wall or ceiling surrounding
- Weatherstripped
- Blocked for loose fill
- Access provided to all equipment without damaging or compressing insulation

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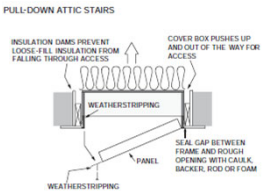
R402.2.4 – Exception



- Drop-down stairs (horizontal pull-down) in Climate Zones 0-4 not required to meet the surrounding insulation level where
  - Hatch has a U-factor of 0.10 or less, or average R-Value of R-10 or greater
  - At least 75% of panel area has R-13 or greater insulation
  - Opening is less than 13.5 ft^2
  - Perimeter is weather-stripped
- **Does not apply to the total UA alternative in Section R402.1.5**

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R402.2.7 – Floor Insulation

- Three compliance methods
  1) Cavity insulation underside of subfloor
  2) Cavity insulation top side of ceiling
  3) Cavity and continuous insulation top side of ceiling

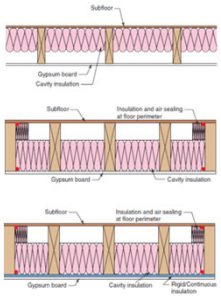

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Table R402.2.6 Steel-Frame Insulation R-Values, partial

TABLE R402.2.6
STEEL-FRAME CEILING, WALL AND FLOOR INSULATION *R*-VALUES

WOOD FRAME *R*-VALUE REQUIREMENT	COLD-FORMED STEEL-FRAME EQUIVALENT *R*-VALUE[a]
Steel Truss Ceilings[b]	
R-30	R-38 or R-30 + 3 or R-26 + 5
R-38	R-49 or R-38 + 3
R-49	R-38 + 5
Steel Joist Ceilings[b]	
R-30	R-38 in 2 × 4 or 2 × 6 or 2 × 8 R-49 in any framing
R-38	R-49 in 2 × 4 or 2 × 6 or 2 × 8 or 2 × 10
Steel-frame Wall, 16 inches on center	
R-13	R-13 + 4.2 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1
R-13 + 5	R-0 + 15 or R-13 + 9 or R-15 + 8.5 or R-19 + 8 or R-21 + 7
R-13 + 10	R-0 + 20 or R-13 + 15 or R-15 + 14 or R-19 + 13 or R-21 + 13

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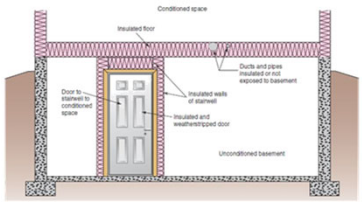
R402.2.8 – Basement Walls

- Specific criteria must be met for a space to qualify as an unconditioned basement



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Exceptions

Exceptions to the basement walls provision clearly define the characteristics of unconditioned basements

1) The floor overhead, including the underside stairway stringer leading to the basement, is insulated
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
5) The door(s) leading to the basement from conditioned spaces are insulated and weather-stripped
6) The building thermal envelope separates the basement from adjacent conditioned spaces

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R402.2.12 and R402.3.5 – Sunroom & Heated Garage Insulation and Fenestration

Ceiling	Walls	Windows	Skylights
▪ CZ 0 – 4: R-19 ▪ CZ 5 – 8: R-24	▪ R-13 ▪ Walls separating sunroom/ garage from conditioned space, follow code	▪ CZ 2 – 8: U-0.45	▪ CZ 2 – 8: 0.70
Compared to CZ 4 R-60	R-30	U-0.30	U-0.55

Applies to thermally isolated sunrooms and heated garages with enclosed conditioned space

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Table R402.1.3 Minimum R-values and Fenestration Requirements

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

CLIMATE ZONE	FENESTRATION U-FACTOR[b,c]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC[b,e]	CEILING R-VALUE	WOOD FRAME WALL R-VALUE[g]	MASS WALL R-VALUE[h]	FLOOR R-VALUE	BASEMENT[c,g] WALL R-VALUE	SLAB[i] R-VALUE & DEPTH	CRAWL SPACE[c,g] WALL R-VALUE
0	NR	0.75	0.25	30	13 or 0&10ci	3/4	13	0	0	0
1	NR	0.75	0.25	30	13 or 0&10ci	3/4	13	0	0	0
2	0.40	0.65	0.25	49	13 or 0&10ci	4/6	13	0	0	0
3	.30	0.55	0.25	49	20 or 13&5ci[j] or 0&15ci[k]	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]
4 except Marine	.30	0.55	0.40	60	30 or 20&5ci[j] or 13&10ci[k] or 0&20ci[k]	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5 and Marine 4	0.30[f]	0.55	0.40	60	30 or 20&5ci[j] or 13&10ci[k] or 0&20ci[k]	13/17	30	15ci or 19 or 13&5ci	10ci, 4 ft	15ci or 19 or 13&5ci
6	0.30[f]	0.55	NR	60	30 or 20&5ci[j] or 13&10ci[k] or 0&20ci[k]	15/20	30	15ci or 19 or 13&5ci	10ci, 4 ft	15ci or 19 or 13&5ci
7 and 8	0.30[f]	0.55	NR	60	30 or 20&5ci[j] or 13&10ci[k] or 0&20ci[k]	19/21	38	15ci or 19 or 13&5ci	10ci, 4 ft	15ci or 19 or 13&5ci

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R402.4 – Air Leakage

- The building thermal envelope must be constructed to limit air leakage
- Sealing methods between dissimilar materials must allow for differential expansion
- **Building components must be installed in accordance with Table R402.4.1.1**
- Where required by the code official, an approved third party must inspect all components and verify code compliance

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Table R402.4.1.1 Air Barrier, Air Sealing, and Insulation Installation, Partial

TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, R-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.

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Table R402.4.1.1 – Plumbing, Wiring, or Other Obstructions

- All holes created by wiring, plumbing or other obstructions in the air barrier assembly must be air sealed
- Insulation must be installed to fill the available space
  - Unless required R-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions
  - FILL does not mean COMPRESS

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Example

Compliant

Not Compliant

Source: Newport Ventures

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Example

Not Compliant

Source: Newport Ventures

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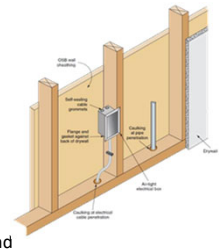
R402.4.6 – Air-Sealed Electrical Boxes

- Electrical and communication outlet boxes installed in the building thermal envelope
  - Sealed
  - Tested NEMA OS 4
  - Marked "NEMA OS 4" or "OS 4"
  - Installed per manufacturer's instructions and NEMA OS 4
- Only applicable when used as the alternative to air barrier installed behind boxes



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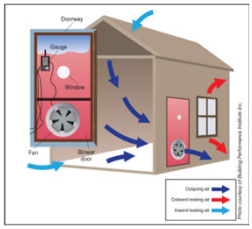
R402.4.1.2 – Testing

- The building or dwelling unit must be tested for air leakage
- Maximum air leakage rates
  - 5 ACH for all compliance paths
  - 3 ACH for CZ 3 – 8 complying prescriptively



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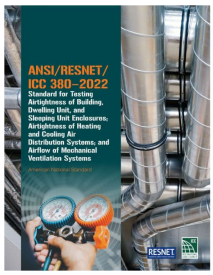
R402.4.1.2 – Testing



- Testing conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827
- Testing performed at any time after creation of all penetrations of the building thermal envelope have been sealed

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R402.4.1.2 - Testing

- Exception for heated attached and detached private garages that are thermally isolated from all other habitable, conditioned spaces
  - Must be field verified to comply with Table R402.4.1.1
  - Code official may require third party inspection

TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION*

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, R-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.

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R402.4.1.2 - Testing

- Additional exception for testing individual dwelling units
- Air leakage rate of 0.30 cfm/ft^2 at 50 Pa permitted in all climate zones for
  - Attached single and multi-family dwelling units
  - Detached dwelling units that are 1,500 ft^2 or smaller

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Example

- Randy Williams's *Blower Door Testing a Small Home*
- 952ft^2, newly constructed home with a volume of 7616 cubic feet
  - Leakage rate of 416 CFM, or 3.28 ACH50
  - Instead, calculate the surface area of all sides plus the floor and ceiling
    - Total surface area 2896 ft^2
    - Plug into CFM50/ft^2 of enclosure area to get 0.14 CFM/ft^2

https://building-performance.org/bpa-journal/blower-door-testing-a-small-home/

119

R402.4.3 – Fenestration Air Leakage

- Maximum air infiltration rate
  - Windows, skylights, sliding glass doors: 0.3 cfm/ft^2
  - Swinging doors: 0.5 cfm/ft^2
- Tested in accordance with NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and listed and labeled by the manufacturer
  - **Exception:** Site-built windows, skylights and doors.

121

NFRC Label

U-Factor measures how well a product can keep heat from escaping from the inside of a room. The lower the number, the better a product is at keeping heat in. **Range:** 0.20-1.20 **Look for:** Low numbers

Visible Transmittance measures how well a product is designed to effectively light your home with daylight, potentially saving you money on artificial lighting. The higher the number, the more natural light is let in. **Range:** 0-1 **Look for:** High numbers

NFRC also has a condensation rating that is optional for manufacturers to include, so you may or may not see it on the label. The higher the number, the better a product resists condensation. Download the optional label.

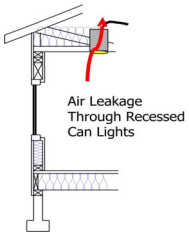
Solar Heat Gain Coefficient measures how well a product can resist unwanted heat gain, which is especially important during summer cooling season. The lower the number, the less you'll spend on cooling. **Range:** 0-1 **Look for:** Low numbers

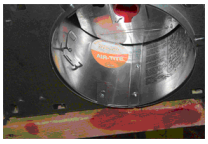
Air Leakage measures how much air will enter a room through a product. The lower the number, the fewer drafts you'll experience. **Range:** ≤ 0.3 **Look for:** Low numbers

122

122

R402.4.5 – Recessed Lighting





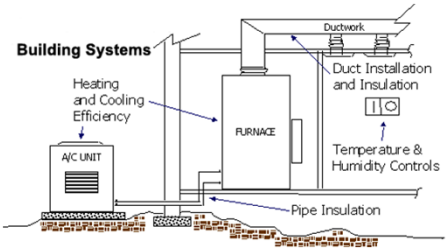
123

Section 403

Residential Systems

126

Key Building Systems Provisions



348

127

R403.1 - Controls

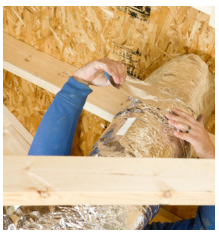
- At least one thermostat must be provided for each separate heating and cooling system
- Programmable thermostat required for primary heating or cooling system
  - Daily schedule to maintain different set points at different times of day and days of week
  - Set back capabilities 55°F - 85°F
  - Initial programming by manufacturer
    - Maximum heating setpoint of 70°F
    - Minimum cooling setpoint of 78°F

349

128

R403.3 – Ducts

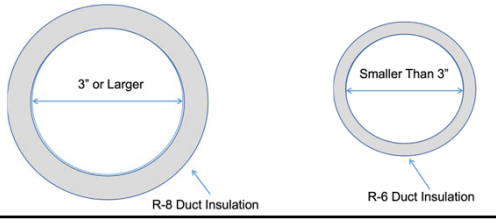
- Duct locations and the insulation requirements for each clarified
  - Outside conditioned space
  - In conditioned space
  - Buried



130

R403.3.1 – Ducts Located Outside Conditioned Spaces

- Minimum R-8 for ducts over 3" diameter
- Minimum R-6 for ducts under 3" diameter
- Buried ducts insulated per section or have an equivalent thermal distribution efficiency, listed and labeled



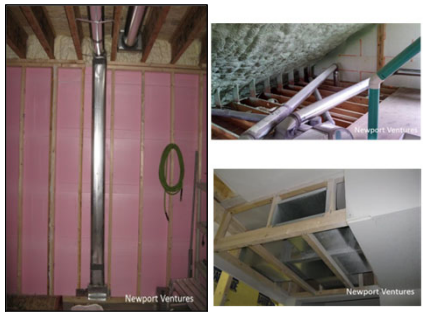
131

R403.3.2 – Ducts Located Inside Conditioned Space

Duct system located completely within continuous air barrier and building thermal envelope	Ductwork in ventilated attic spaces is buried within ceiling insulation and the following	Ductwork in floor cavities over unconditioned space complies with the following	Ductwork located with exterior walls of thermal envelope complies with the following
	▪ Air handler located within air barrier and thermal envelope ▪ Duct leakage is less than 1.5 cfm/100ft^2 ▪ Ceiling insulation R-value installed against and above duct is equivalent to proposed ceiling R-value, less R-value of duct insulation	▪ Continuous air barrier installed between unconditioned space and duct ▪ Insulation installed correctly ▪ Minimum R-19 installed in cavity width separating duct from unconditioned space	▪ Continuous air barrier installed between unconditioned space and duct ▪ Minimum R-10 installed in cavity width separating duct from outside sheathing ▪ Remainder of cavity insulation fully insulated to the drywall side

132

R403.3.2 – Ducts Located in Conditioned Space: Examples



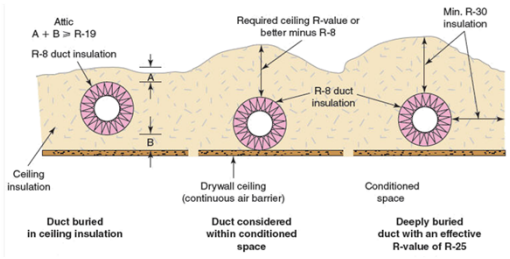
133

R403.3.3 – Ducts Buried Within Ceiling Insulation

- R-8 • Minimum for supply and return ducts
- R-19 • Minimum ceiling insulation, excluding R-value of duct insulation
- R-13 • Plus vapor retarder in CZs 0A, 1A, 2A, 3A

134

Duct Location and Insulation



135

R403.3.4 – Sealing

Ducts, air handlers and filter boxes must be sealed

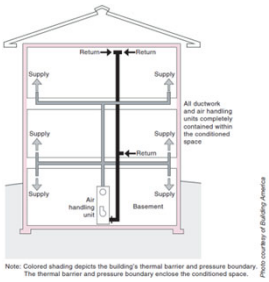
Joints and seams must comply with either the IMC or IRC

Air handlers must have a manufacturer's designation for an air leakage of no more than 2% of the design airflow rate when tested

136

R403.3.5 – Duct Testing

- Testing in accordance with ANSI/RESNET/ICC 380 or ASTM E1554
  - Rough-in test
  - Postconstruction test
- Testing not required for ducts serving ventilation systems that are not integrated with ducts serving heating or cooling systems



Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.

358

137

Amendment

R403.3.5 – Duct Testing

- Exception for duct testing of ducts in conditioned spaces is deleted
- PA Amendment – exception remains

138

R403.3.6 – Duct Leakage

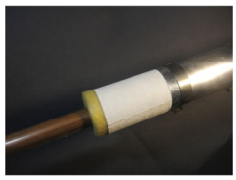
Rough-in Test	Postconstruction	Ducts within thermal envelope
▪ 4.0 cfm/100ft² of conditioned floor area where the air handler is installed at the time of the test ▪ 3.0 cfm/100ft² where air handler not installed	▪ 4.0 cfm/100ft² of conditioned floor area	▪ 8.0 cfm/100ft² of conditioned floor area ▪ All ducts and air handlers entirely within building thermal envelope

361

140

R403.4 – Mechanical System Piping Insulation

- Minimum R-value of HVAC piping capable of carrying fluids greater than 105°F or less than 55°F is R-3
- Applies to refrigerant piping and piping for hydronic heating systems
- Piping insulation exposed to weather must be protected



142

R403.5.2 – Hot Water Pipe Insulation

Minimum R-3 insulation

1. Piping larger than 3/4-inch nominal diameter inside conditioned space
2. Piping serving more than one dwelling unit
3. Piping located outside the conditioned space
4. Piping from the water heater to a distribution manifold
5. Piping located under a floor slab
6. Buried piping
7. Supply and return piping in recirculation systems other than demand recirculation systems

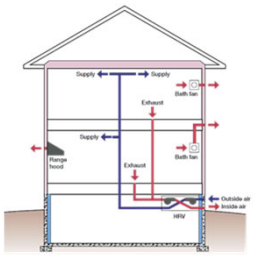
144

R403.6 – Mechanical Ventilation

- Ventilation must meet the IRC or IMC, or other means applicable
- Outdoor air intakes and exhausts must have automatic or gravity dampers that close when the ventilation system is not operating

145

R403.6 – Mechanical Ventilation



- HRV or ERV system is required in Climate Zones 7 and 8
- Mechanical ventilation systems require testing

146

R403.6.1 – Whole-dwelling Mechanical Ventilation System Fan Efficacy

TABLE R403.6.2
WHOLE-DWELLING MECHANICAL VENTILATION SYSTEM FAN EFFICACY[a]

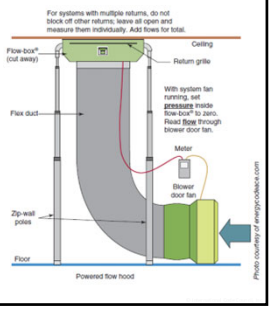
FAN LOCATION	AIRFLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)
HRV, ERV	Any	1.2 cfm/watt
In-line supply or exhaust fan	Any	3.8 cfm/watt
Other exhaust fan	< 90	2.8 cfm/watt
Other exhaust fan	≥ 90	3.5 cfm/watt
Air-handler that is integrated to tested and *listed* HVAC equipment	Any	1.2 cfm/watt

- Fans used to provide whole-dwelling mechanical ventilation must meet the efficacy requirements of Table R403.6.2 at one or more rating points

147

R403.6.3 – Mechanical Ventilation System Testing

- Each dwelling is required to have a minimum mechanical ventilation rate per IRC Section M1505
- New provisions for testing not only the whole-house ventilation referenced in the IRC, but also spot ventilation such as bathroom fans
- Kitchen range hoods with ducts 6 inches or larger in diameter are exempt from the requirement



148

R403.7 – Equipment Sizing

- Heating and cooling equipment sizing
  - ACCA Manual S, Residential Equipment Selection
  - ACCA Manual J, Residential Load Calculations
- New or replacement heating and cooling equipment must have efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed

149

R403.10 – Pools and Permanent Spa Energy Consumption

- Heater, time switch and cover requirements for pools and in ground, permanently installed spas
  - Pool heaters equipped with a readily accessible on-off switch
  - No continuously burning pilot lights
  - Time switches to automatically turn off and on heaters and pumps according to a preset schedule required

150

Section 404

Residential Electrical Power and Lighting Systems

151

Amendment

R404.1 – Lighting Equipment

- High-efficacy lighting is required in **90% of ~~all~~** permanent lighting fixtures
- New provisions regulate lighting controls for interior and exterior lighting
  - **Not adopted**

152

Section R405

Residential Total Building Performance

157

R405.1 - Scope

- This section establishes criteria for compliance using total building performance analysis
- Analysis includes heating, cooling, mechanical ventilation and service water-heating energy only

158

R405.2 – Performance-Based Compliance

Table R405.2

2009 IECC backstop for envelope, SHGCs

Annual energy cost less than or equal to annual energy cost of standard reference design

TABLE R405.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration *U*-factor and SHGC
Mechanical	
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperture maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
404.2	Interior lighting controls

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

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Table R405.2, Partial

TABLE R405.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
~~R401.2.5~~	~~Additional energy efficiency~~
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration *U*-factor and SHGC
Mechanical	

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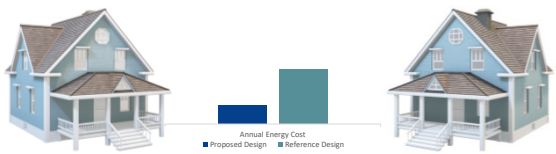
Annual Energy Cost Comparison



Proposed Design

Reference Design

162

Calculation Procedure

- Identical methods and techniques for proposed design and reference design except those intentionally traded off
- Proposed design and reference design to be configured and analyzed according to Tables R405.4.2(1) and R405.4.2(2)

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Table R405.4.2(1) Specifications for the Standard Reference and Proposed Designs

TABLE R405.4.2(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 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

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Additional Required Documentation

- Compliance software tool report
- Compliance report for permit application
- Compliance report for Certificate of Occupancy


Harford County Inspections, Licenses and Permits

Compliance and Testing Documents

Approved Third Parties

1. An architect licensed by the Maryland State Board of Architects,
2. an engineer licensed by the Maryland State Board of Professional Engineers, or
3. an entity issued credentials relative to the subject matter being certified by an accreditation body where the accrediting body is independently verified through a formal independent verification process, validating that the program or institution meets established quality standards and is competent to carry out specific conformity assessment tasks. Conformity assessment tasks may include, but are not limited to, compliance design, testing, inspection, or certification.

Permitting and CO Compliance Reports

- Permitting Compliance Reports and CO Compliance Reports required by Sections R405.3 and R406.7 shall be completed by an approved third party and shall be generated from approved software. Submitted reports shall include the original signature of the certified or licensed individual generating the report, their printed name, their applicable certification or license number issued by the accrediting or licensing entity, and date of signature.

Building Thermal Envelope Air Leakage Testing, Duct Pressure Testing and Mechanical Ventilation Testing

- All third-party reports submitted to the Department shall be a complete automated testing report produced from the testing equipment manufacturer. All submitted reports shall also include the certified or licensed individuals' signature, printed name, the applicable certification or license number by the accrediting or licensing entity, and signature date.

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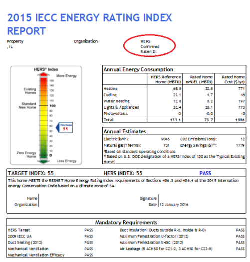
Section R406

Residential Energy Rating Index Compliance Alternative

170

R406 – Energy Rating Index Overview

- ERI compliance requires the design to be a specified percentage better than the reference home
- Rated Home with Index of 100 = Reference Home meeting 2006 IECC
- Each 1% reduction in energy use = 1 point deduction from index
- Zero Energy Home = ERI Index of 0
- Essentially a HERS score with modified ventilation rate



2015 IECC ENERGY RATING INDEX REPORT

Property
, IL

Organization

HERS Confirmed Rater ID:

Annual Energy Consumption	HERS Reference Home (MBTU)	Rated Home nMUEL (MBTU)	Rated Home Cost ($/yr)
Heating	65.8	32.8	771
Cooling	22.1	4.7	46
Water Heating	12.8	8.2	197
Lights & Appliances	32.4	28.1	773
Photovoltaics	0	-0.0	-0
Total	133.1	73.7	1986

Annual Estimates

Electric(kWh):	9046	CO2 Emissions(Tons):	12
Natural gas(Therms):	731	Energy Savings ($)**:	1779

*Based on standard operating conditions
**Based on U.S. DOE designation of a HERS Index of 130 as the 'Typical Existing Home'

TARGET INDEX: 55 HERS INDEX: 55 PASS

This home MEETS the RESNET Home Energy Rating Index requirements of Sections 406.3 and 406.4 of the 2015 International energy Conservation Code based on a climate zone of 5A.

Name
Organization
Signature
Date 12 January 2016

Mandatory Requirements			
HERS Target	PASS	Duct Insulation (Ducts outside R-6, inside is R-0)	PASS
2009 IECC UA	PASS	Maximum Fenestration U-factor (2012)	PASS
Duct Sealing (2012)	PASS	Maximum Fenestration SHGC (2012)	PASS
Mechanical Ventilation	PASS	Air Leakage (5 ACH50 for CZ1-2, 3 ACH50 for CZ3-8)	PASS
Mechanical Ventilation Efficacy	PASS		

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R406.2 – ERI Compliance

1. Table R406.2

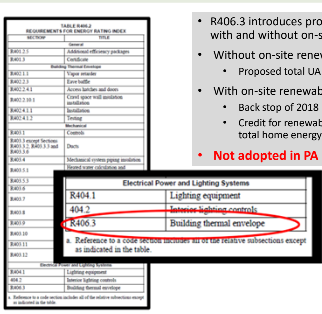

TABLE R406.2
REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
General	
R401.2.5	Additional efficiency packages
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
Mechanical	
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and
R403.5.3	
R403.6	
R403.7	
R403.8	
R403.9	
R403.10	
R403.11	
R403.12	
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
404.2	Interior lighting controls
R406.3	Building thermal envelope

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

- R406.3 introduces provisions for buildings with and without on-site renewables
- Without on-site renewables
  - Proposed total UA ≤ prescriptive UA × 1.15
- With on-site renewables
  - Back stop of 2018 IECC
  - Credit for renewables limited to 5% of the total home energy use
- **Not adopted in PA**

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R406.5 – ERI Compliance

2. Maximum ERI of Table R406.5

TABLE R406.5
MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX
0-1	52
2	52
3	51
4	54
5	55
6	54
7	53
8	53

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R406.7.3 – Renewable Energy Certificate (REC) Documentation

Where on-site renewable energy is included in ERI, either:

- Substantiation that the RECs are owned by, or retired on behalf of, the homeowner
- Contract that conveys to the homeowner the RECs associated with the 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).

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Additional Required Documentation

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- Compliance report for permit application
- Compliance report for Certificate of Occupancy

Harford County Inspections, Licenses and Permits

Compliance and Testing Documents

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Section 408

Residential Additional Efficiency Package Options

183

R408.2 – Additional Energy Efficiency Package Options

1. Enhanced envelope performance
2. More efficient HVAC equipment performance
3. Reduced energy use in service water heating
4. More efficient duct thermal distribution system
5. Improved air sealing and efficient ventilation system

184

R408.2.1 – Enhanced Envelope Performance

- Total building thermal envelope UA must be ≤ to 95% 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
  - Calculation performed in accordance with Section R402.1.5
- Area-weighted average SHGC of all glazed fenestration must be ≤ 95% of the maximum glazed fenestration SHGC in Table R402.1.2

185

R408.2.2 – More Efficient HVAC Equipment Performance

Heating and cooling equipment must meet one of the following

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 systems, all systems must meet or exceed efficiency requirements of this section and be sized to serve 100% of the cooling or heating design load

186

R408.2.3 – Reduced Energy Use in SWH

Hot water system must meet one of the following

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.

187

R408.2.4 – More Efficient Duct Thermal Distribution System

Duct system must meet one of the following

1. All ducts and air handlers located entirely within the building thermal envelope
2. Entire 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

188

R408.2.5 – Improved Air Sealing and Efficient Ventilation System

- Measured air leakage rate must be less than or equal to 3.0 ACH50
- Must have either an Energy Recovery Ventilator or Heat Recovery Ventilator installed

189

R408.2.5 – Improved Air Sealing and Efficient Ventilation System

- Measured air leakage rate must be less than or equal to 3.0 ACH50
- Must have either an Energy Recovery Ventilator or Heat Recovery Ventilator installed
- Minimum ERV and HRV requirements, measured at the lowest tested net supply airflow:
  - Must be at least 75% Sensible Recovery Efficiency (SRE)
  - No more than 1.1 cubic feet per minute per watt
  - Not use recirculation as a defrost strategy
- ERV must be 50% Latent Recovery/Moisture Transfer (LRMT)

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Residential Appendices

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Appendix RA – Board of Appeals

- Appendix RA provides guidance for establishing a board of appeals, including criteria for membership and instruction for developing rules and procedures
- Consistent with other I-Codes

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Appendix RB – Solar-Ready Provisions

- Appendix RB does not require solar systems to be installed for a building
- Requires space for installing such systems, providing pathways for connections and requiring adequate structural capacity of roof systems to support the systems
- Shading
  - Panel placement zones based on existing or permanently installed site elements
- Capped roof penetration sleeve
  - Provided on roofs with less than 1/12 pitch

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Appendix RC – Zero Energy Residential Building Provisions

ERI zero energy score for compliance

- The rated design must have a score less than or equal to the values in Table RC102.2 when compared to the ERI reference design for both of the following:
  1. ERI value not including on-site power production (OPP)
     - Calculated in accordance with RESNET/ICC 301
  2. ERI value including on-site power production
     - Calculated with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation RC-1.

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Appendix RC – Zero Energy Residential Building Provisions

Adjusted OPP = OPP + CREF + REPC

CREF = Community Renewable Energy Facility power production

REPC = Renewable Energy Purchase Contract power production

- Contract term duration of at least 15 years

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RC102.2 Energy Rating Index Zero Energy Score

TABLE RC102.2
MAXIMUM ENERGY RATING INDEX[a]

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING OPP	ENERGY RATING INDEX INCLUDING ADJUSTED OPP (as proposed)
1	43	0
2	45	0
3	47	0
4	47	0
5	47	0
6	46	0
7	46	0
8	46	0

a. The building shall meet the requirements of Table R406.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or R402.1.3 of the 2015 *International Energy Conservation Code*.

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Thanks for allowing us to serve you!

Please complete a course evaluation

iccsafe.org/eval

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