2006 International Energy Conservation Code With Wisconsin Amendments

- **Training As Developed by**
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- **Web Site:**
- **COMMERCE.STATE.WI.US/SB**

International Energy Conservation Code (IECC) Breakdown

- Ch. 1 Administration
- Ch. 2 Definitions
- Ch. 3 Climate Zones
- Ch. 4 Residential Energy Efficiency
- Ch. 5 Commercial Energy Efficiency
- Ch. 6 Reference Standards

Scope and Application

COMM 63.0002(2)

- Exemptions to the IECC Buildings or portions of buildings
  - Buildings without conditioned space, service water heating or illumination are exempt from the code
  - Glazed structures or glazed portion of buildings used for the production of plant life or for maintaining plant life as the primary purpose.

Scope and Application

COMM 63.0002(2)(a)

- Buildings & or portions separated by bldg envelope assemblies, that have a **peak** design rate of energy usage < 3.4 Btu/hr/sf or 1.0 watt/sf of floor area **for all purposes** (ie. heating/ cooling/ lighting/ water heater) are exempt from the code

Additions, Alterations & Renovations

Comm 62.0300 (Ch. 3 Not adopted), 66.0607, IEBC 711, & 808

- Apply International Existing Building Code
- Such actions in an existing building, building system or portion shall conform to the provisions of the (IEBC/IECC) as they relate to new construction without requiring the unaltered portions of the existing building or building system to comply with this code. Such actions are not allowed to create an unsafe or hazardous condition or overload existing building systems. **Exceptions---**

Change in Occupancy

International Existing Building Code (IEBC)

- **IEBC 711/808** Alterations shall conform to the energy requirements of the International Energy Conservation Code (IECC) or the International Residential Code (IRC) as they relate to new construction only.

Heated Sidewalks Prohibited

COMM 63.0102(1)

- Does NOT include:
  - Exterior pedestrian traffic surface used for ingress or egress by physically disabled (limited to req'd widths ONLY)
  - Systems using waste thermal energy
  - Inpatient Health Care Facility
  - Community Based Residential Facility (CBRF)

Who Can Prepare and Stamp Building Envelope Calculations?

COMM 61.20(2)

- Buildings < 50,000 cubic feet
  - Anyone using acceptable practices
- Buildings ≥ 50,000 cubic feet
  - WI Registered Professional Engineers- **OK**
  - WI Registered Architects- **OK**
  - *WI Registered HVAC/Electrical Designers* ***NOT ALLOWED to prepare & stamp***

Misc. Building Envelope Requirements

Comm 63.0102, 63.0402, 63.0502(1)

- Vapor Retarders
  - W/Perm Rating < 1.0 required for ABOVE GRADE **Framed Walls, Floors & Ceilings** unless exceptions are met (Differs from UDC)
  - Located on Warm-In-Winter Side of Insulation
- Insulated Concrete Masonry Systems will Require Performance Evaluation from the National Concrete Masonry Association (NCMA) Evaluation Procedures

Misc. Building Envelope Requirements: IECC 102.1.1 & 102.1.1.1

- Insulation
  - R-value must be visible on all insulation or a certification of the R-value(s) by the insulation installer
  - Blown or Sprayed Walls
    - Certification of installed density and R-value
  - Blown or Sprayed Roof/Ceiling
    - Certification of initial installed thickness, settled thickness, coverage area and # of bags installed
    - Insulation depth markers every 300 ft^2

This Attic Has Been Insulated To

INSULATION CONTRACTORS ICAA ASSOCIATION OF AMERICA

R- ☐

By A Professional Insulation Contractor

The insulation in this attic was installed by a qualified professional Contractor to the R-value stated above

CIMA

Energy EPA DOE INSULATION

INSULATE TODAY SAVE TOMORROW

Certificate of Insulation

BUILDING ADDRESS:

_____

_____

_____

Installation Date: _____

CONTRACTOR:

_____

_____

_____

License #: _____

Area Insulated	R-Value	Installed Thickness	Settled Thickness	Installed Density	No. Bags	Sq. Ft.
Attic						
Walls						
Floors						

I, _____, (print name) certify that this residence/building has been insulated to the stated R-value and that the installation is in conformance with all applicable codes, standards, regulations and specifications.

Authorized Signature: _____ Date:_____

Misc. Building Envelope Requirements IECC 102.2.1

- Foundation wall and slab-on-grade floor perimeter insulation **MUST** be protected if exposed
- Protection to be rigid, opaque and weather-resistant covering
- Protection **MUST** extend $\geq$ 6” below grade

Default Values for Fenestration, Doors and SHGC IECC Table 102.1.3

TABLE 102.1.3(1)
DEFAULT GLAZED FENESTRATION *U*-FACTOR

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			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 102.1.3(2)
DEFAULT DOOR *U*-FACTORS

DOOR TYPE	*U*-FACTOR
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

TABLE 102.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC

SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
Clear	Tinted	Clear	Tinted	
0.8	0.7	0.7	0.6	0.6

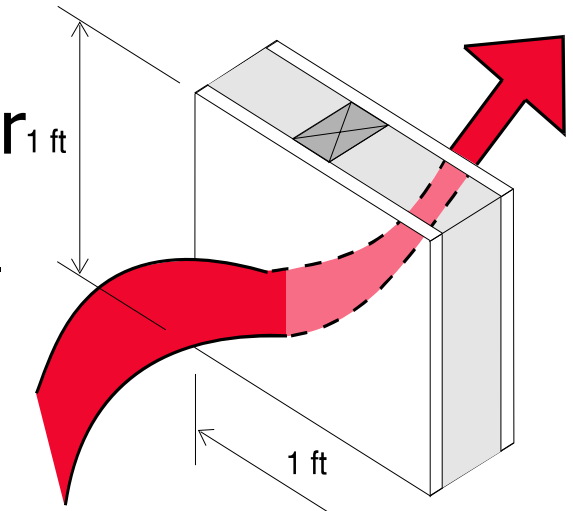
R-Values

- Thermal resistance to heat flow
- The larger the number the better
- The R-value associated with layers in a building component (ie. roof, wall, etc.) can be added together

- **NEVER** Average R-Values

U-Factors

- The amount of heat in Btu (British thermal units) that flows each hour through one square foot, when there is a 1ºF temperature difference across the surface
- The smaller the number the better
- Averaging U-Factors is acceptable



U-Value is the rate of heat flow in Btu/h through one ft^2 area when one side is 1° F warmer

Relationship Between R-Values and U-Factors

U-Factor = 1/Total R-Value

Example: The U-Factor for R-20 is:

U-Factor = 1/20 = 0.05

Basis of R-Values & U-Factors In Prescriptive IECC Options:

- Each building component (ie. roof, wall, window, basement wall, etc) must meet the **prescribed** criteria as defined
  - Min. U-factor for multi-family ceiling/roof in Brown County (Zone 6) is R-value $\geq$ 49
  - Assume building has two different assemblies
    - R-1, 1,000 sf R-value = 45
    - R-2, 1,000 sf R-value = 53
  - Design would **FAIL** to meet IECC prescribed criteria--- R1 (R-45) < minimum R-49

IECC Offers Multiple Building Envelope Compliance Options For:

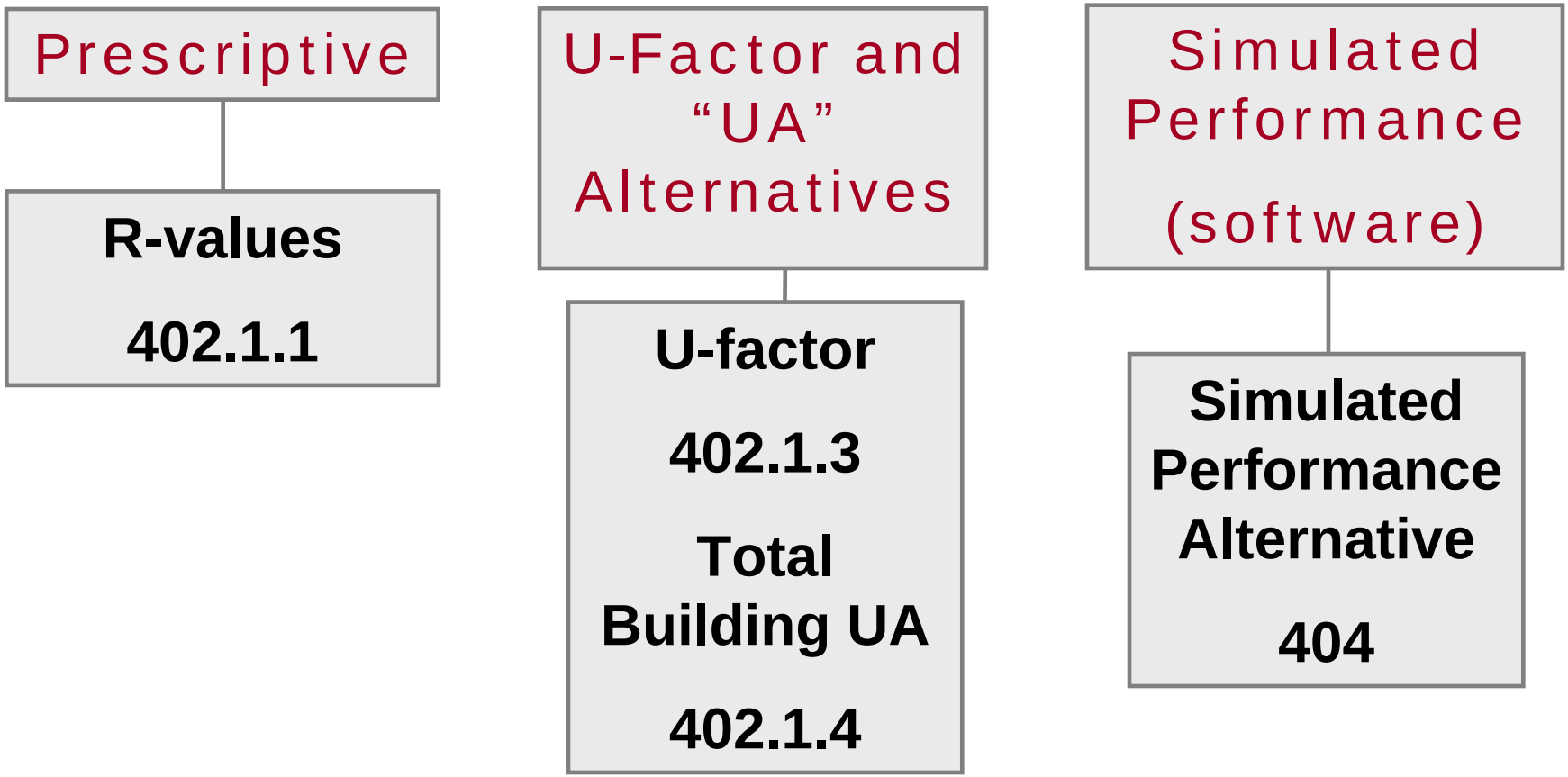
- Ch. 4 Low Rise Residential Buildings (≤ 3 stories) (**Non-Transient--Do NOT use with for Hotels, Motels, etc.**)

- Ch. 5 Commercial (Any Height) and High Rise Residential Buildings (≥ 4 Stories)

Ch. 4 Low Rise Residential Buildings (≤ 3 Stories)

- Compliance Options Include:
  - Building Thermal Envelope requirements in Table 402.1.1 (Prescriptive)
  - UA Alternatives (Prescriptive--Weight Averaged as allowed)
  - ***Rescheck*** computer program per Comm 63.0404) (Performance)
  - Simulated Performance Alternative 404.1 (Performance)

IECC Ch. 4 Code Compliance– Low Rise Residential -- 3 Options



IECC Ch. 4 Code Compliance Tools– Low Rise Residential --

Prescriptive

None Needed

Total Building "UA" Trade Off

RES*check* Software

(Web-based & Desktop)

Energy Analysis

Software

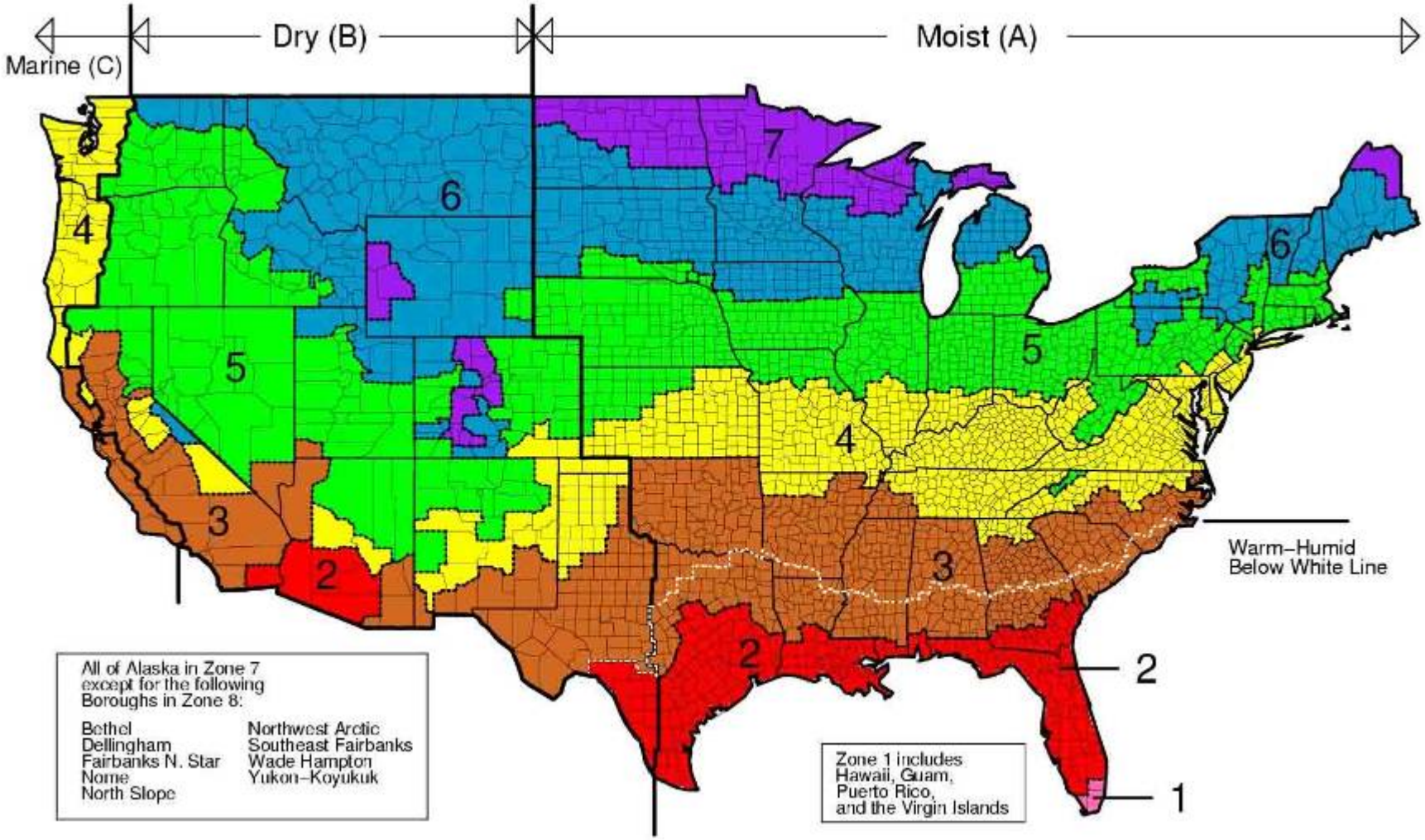
For example:

REM/Design

REM/Rate

EnergyGauge

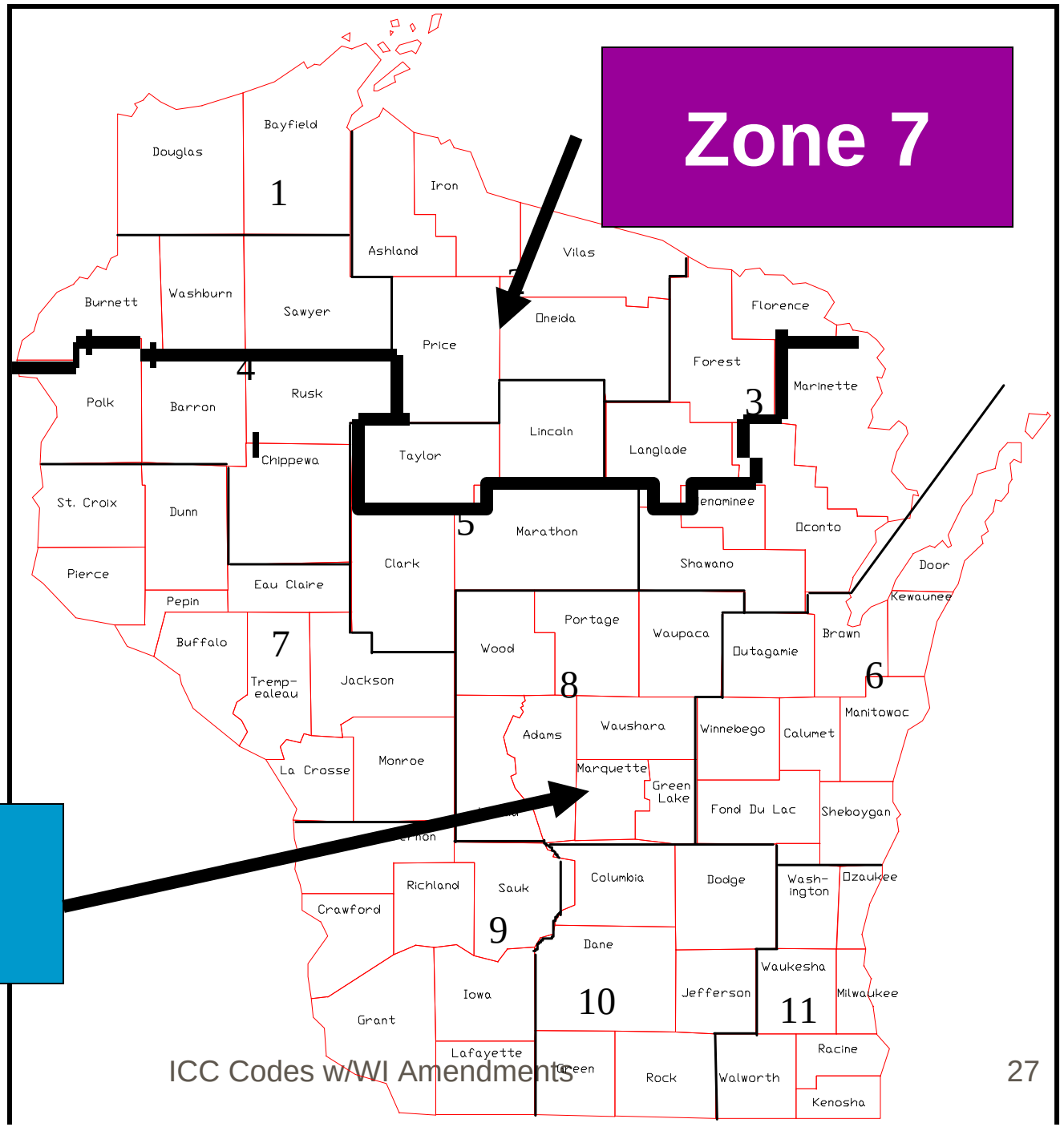
Climate Zones—2006 IECC



To Apply Prescriptive Req'ts-- Determine Climate Zone

IECC Table 301.1

- Review Table 301.1 to determine which Climate Zone (either 6 or 7) your building is located in as based on county


Zone 7
Zone 6
Douglas
Bayfield
1
Iron
Ashland
Vilas
Burnett
Washburn
Sawyer
Price
Oneida
Florence
Forest
Marinette
Polk
Barron
Rusk
4
3
Chippewa
Taylor
Lincoln
Langlade
St. Croix
Dunn
5
Marathon
enaminee
Oconto
Pierce
Clark
Shawano
Door
Eau Claire
Pepin
Kewaunee
Portage
Waupaca
Brawn
Buffalo
7
Wood
Outagamie
6
Tremp-
ealeau
Jackson
8
Manitowac
Adams
Waushara
Winnebego
Calumet
La Crosse
Monroe
Marquette
Green
Lake
Fond Du Lac
Sheboygan
Richland
Sauk
Columbia
Dodge
Wash-
ington
Ozaukee
Crawford
9
Dane
Waukesha
Iowa
10
Jefferson
11
Milwaukee
Grant
Lafayette
Racine
Rock
Walworth
Kenosha

Apply the Prescriptive Req'ts

IECC Table 402.1.1

Table 402.1.1
Insulation and Fenestration Requirements by Component

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	GLAZED FENESTRATION SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB R-VALUE & DEPTH	CRAWL SPACE WALL R-VALUE
1	1.20	0.75	0.40	30	13	3	13	0	0	0
2	0.75	0.75	0.40	30	13	4	13	0	0	0
3	0.65	0.65	0.40	30	13	5	19	0	0	5 / 13
4 except Marine	0.40	0.60	NR	38	13	5	19	10 / 13	10, 2ft	10 / 13
5 and Marine 4	0.35	0.60	NR	38	19 or 13+5	13	30	10 / 13	10, 2 ft	10 / 13
6	0.35	0.60	NR	49	19 or 13+5	15	30	10 / 13	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	19	30	10 / 13	10, 4 ft	10 / 13

Building Envelope R-Value

IECC 402.1.2

- **What Counts Towards R-Value?**
  - **Add:**
    - **Insulation Layers**
    - **Insulation between Framing**
    - **Insulation over Framing**
  - **<u>DON'T</u> Add:**
    - **Non Insulation Products**
    - **Sheathing < R-2, Air Films & Air spaces**
  - **Framing Spacing (or amount) Doesn't Matter**
  - ***R-value must compensate for conductivity per Comm 63.0102***

Apply the Prescriptive Req'ts

IECC Table 402.1.1

- "Fenestration" includes BOTH windows & doors
- Add R-5 to the minimum insulation required for HEATED "Slabs on Grade"
- Side note: Exterior wall wrap is NOT required, however, the requirements of IBC Ch. 14 MUST be met
- Basement & Crawl Space Walls have double listing—1st is for continuous exterior insulation, 2nd listing is for framing cavity insulation inside the bldg— either installation meets the requirement

U-Factor

IECC Table 402.1.3

Table 402.1.3
Equivalent U-Factors

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	CEILING U-FACTOR	FRAME WALL U-FACTOR	MASS WALL U-FACTOR	FLOOR U-FACTOR	BASEMENT WALL U-FACTOR	CRAWL SPACE WALL U-FACTOR
1	1.20	0.75	0.035	0.082	0.197	0.064	0.360	0.477
2	0.75	0.75	0.035	0.082	0.165	0.064	0.360	0.477
3	0.65	0.65	0.035	0.082	0.141	0.047	0.360	0.136
4 except Marine	0.40	0.60	0.030	0.082	0.141	0.047	0.059	0.065
5 and Marine 4	0.35	0.60	0.030	0.060	0.082	0.033	0.059	0.065
6	0.35	0.60	0.026	0.060	0.06	0.033	0.059	0.065
7 and 8	0.35	0.60	0.026	0.057	0.057	0.033	0.059	0.065

U-Factor & Total UA (REScheck Approach) IECC Table 402.1.3

- U-factor Alternative
  - Similar to Prescriptive but uses U-factors instead of R-values
- An assembly with a U-factor $\leq$ than that specified in Table 402.1.3 shall be permitted as an alternative to the R-value in Table 402.1.1

Total UA (REScheck Approach)

IECC 402.1.4

- Same as U-factor alternative but allows trade-offs across all envelope components (same as REScheck Software)
- If "Total Bldg Thermal Envelope UA" (sum of U-factor times assembly areas) $\leq$ to the "Total UA resulting from using the U-Factors in Table 402.1.3" (multiplied by the same assemblies area as the in the proposed building), the building is considered to be in compliance with Table 402.1.1
- Material Conductivity MUST be addressed (ie. metal/masonry)

Total UA (REScheck Approach)

IECC 402.1.4

- Per Proposed Bldg
  - $U_{wall} \times A_{wall}$
  - $U_{roof} \times A_{roof}$
  - $U_{door} \times A_{door}$
  - $U_{window} \times A_{window}$
  - $U_{skylight} \times A_{skylight}$
  - Etc.

- Per Table 402.1.1
  - $U_{wall} \times A_{wall}$
  - $U_{roof} \times A_{roof}$
  - $U_{door} \times A_{door}$
  - $U_{window} \times A_{window}$
  - $U_{skylight} \times A_{skylight}$
  - Etc.

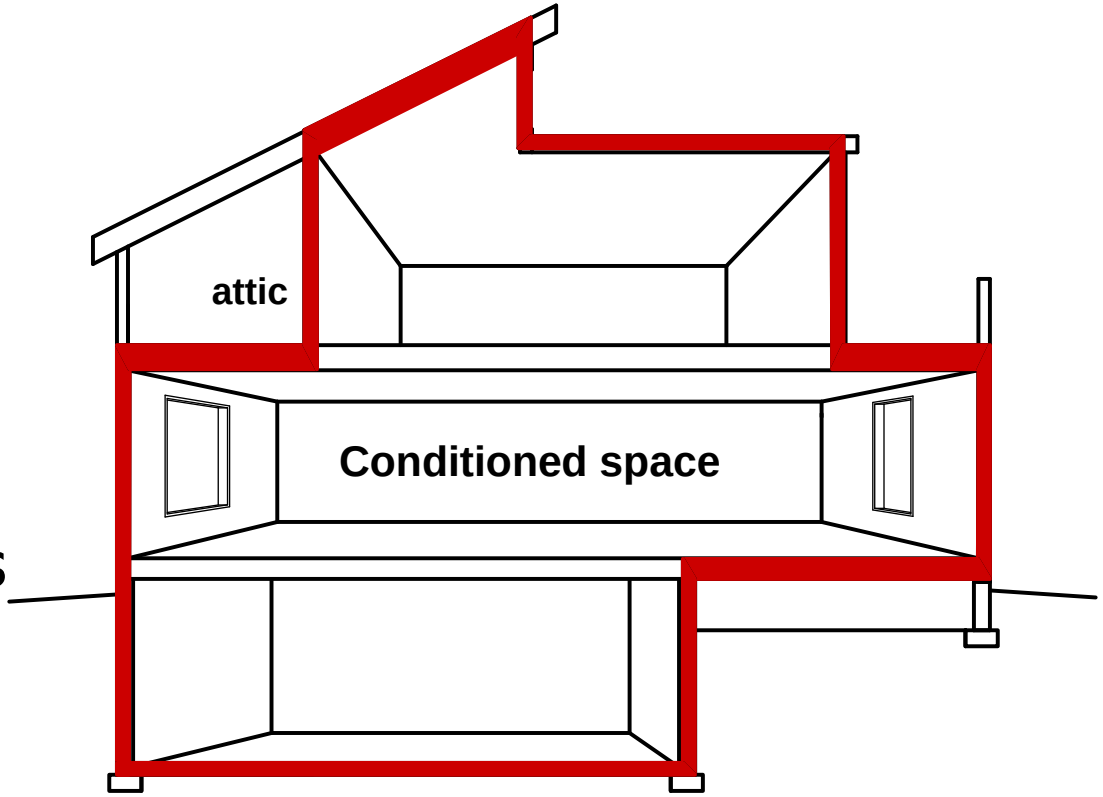
Total $U_{Proposed} \times A_{Proposed} \leq$ Total $U_{Allowed} \times A_{Allowed}$

U-Factor When Applying the Prescriptive Requirements of the Code IECC 402.3.3 & 402.3.4

- Up to 15 sf of glazed fenestration per dwelling unit shall be permitted to be exempt from U-factor and SHGC requirements in Section 402.1.1 when demonstrating compliance "Prescriptively"
- One (1) opaque door assembly is exempted from the U-factor requirements in 402.1.1

Building Envelope Specific Requirements

- Building Envelope consists of:
  - Fenestration
  - Ceilings
  - Walls
    - Above grade
    - Below grade
    - Mass/Steel walls
  - Floors
  - Slab
  - Crawl space



Fenestration

IECC 402.3 & 402.4.2

- An area weighted average of fenestration can be used to satisfy the U-factor & SHGC requirements
  - Area-weighted average U-factor and SHGC are subject to "hard limits", even in trade-offs.
  - Windows to be NFRC rated & certified if default not used
- Fenestration to meet the U-factor requirements in all zones

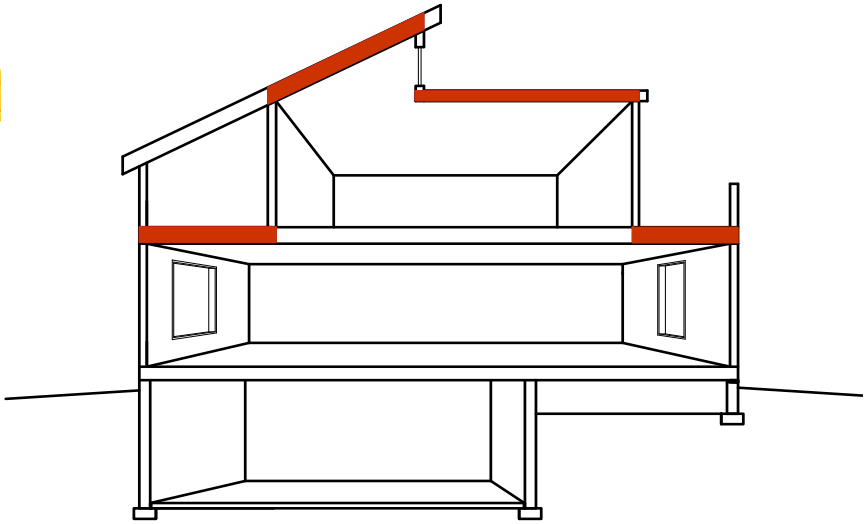
NFRC 100 Rating for U-factor or Default IECC Table 102.1.3(1)

TABLE 102.1.3(1)
DEFAULT GLAZED FENESTRATION *U*-FACTOR

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			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			

Ceilings
IECC 402.2.1 & 402.2.2

- Requirements based on:
  - Assembly type
  - Continuous insulation
  - Insulation between framing
- Meet or exceed listed R-values

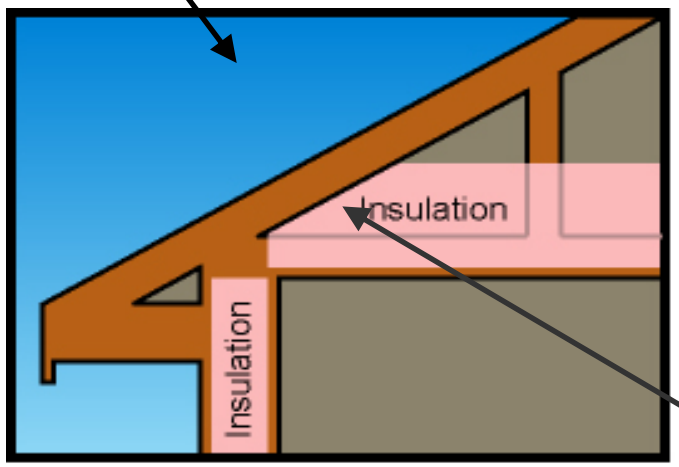


Example of Poorly Installed / Non-Code Compliant Insulation

Standard Roof Truss

IECC 402.2.1 & 402.2.2

Possibility of ice dam formations



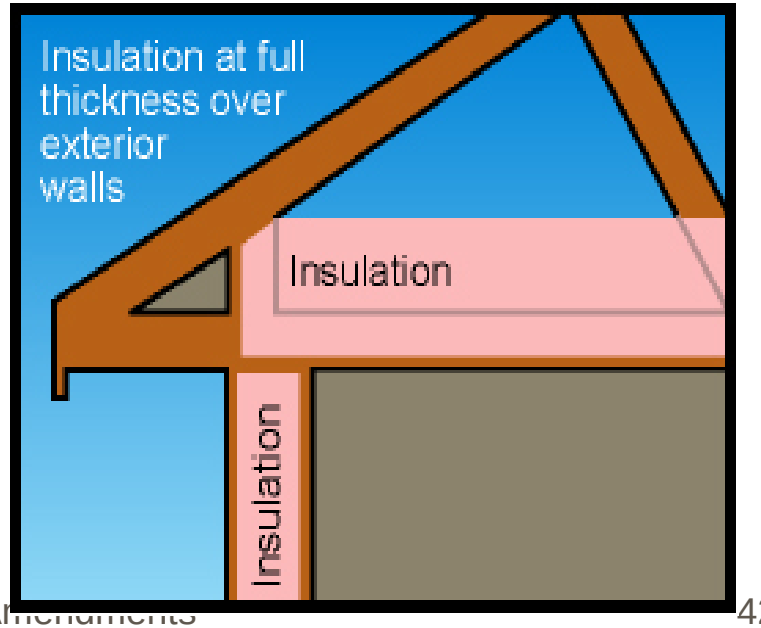
- Ceiling insulation code requirements assume standard truss systems

Cold corners contribute to condensation and mold growth

Raised Heel Truss

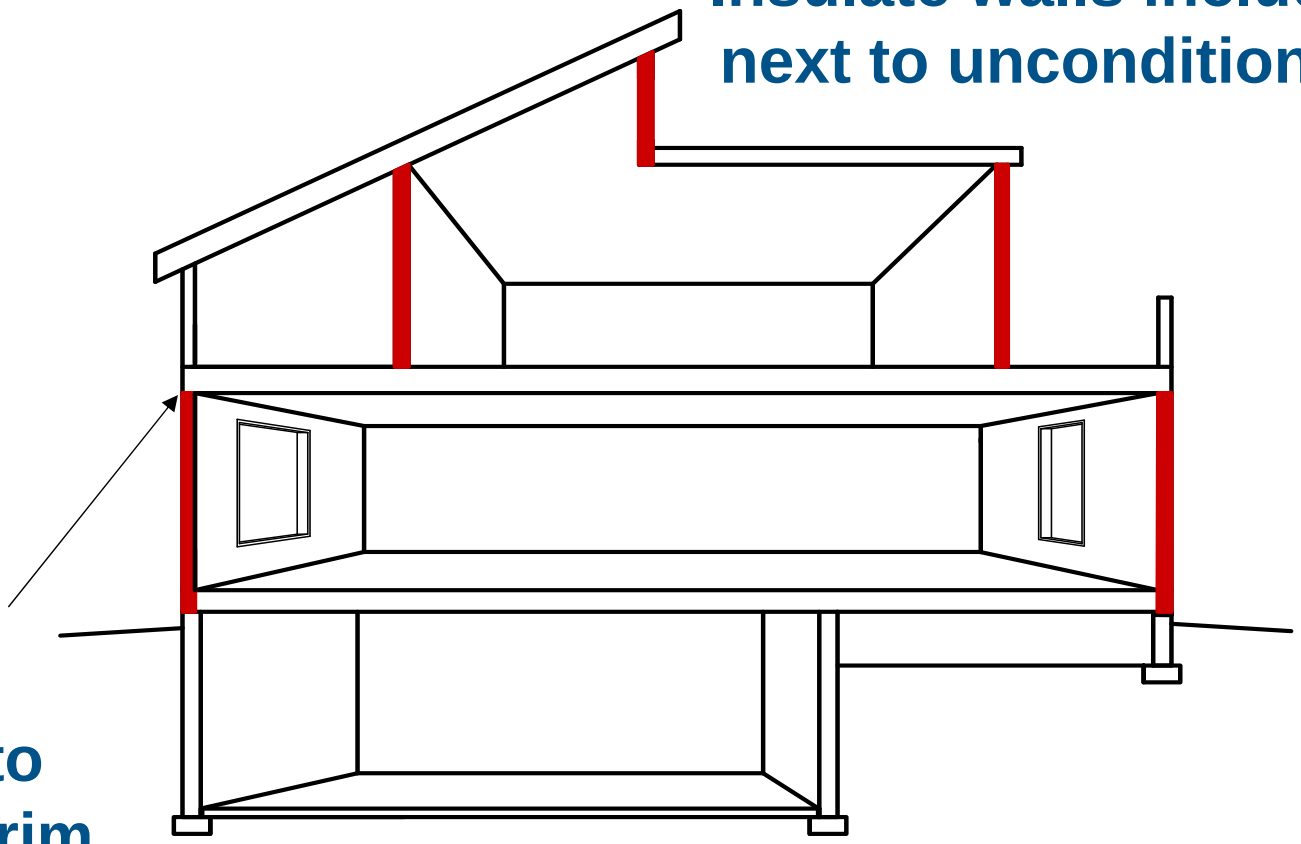
IECC 402.2.1 & 402.2.2

- Raised Heel/Energy Truss credit if insulation is full height over exterior wall
  - R-38 instead of R-49



Above Grade Walls

Insulate walls including those next to unconditioned spaces

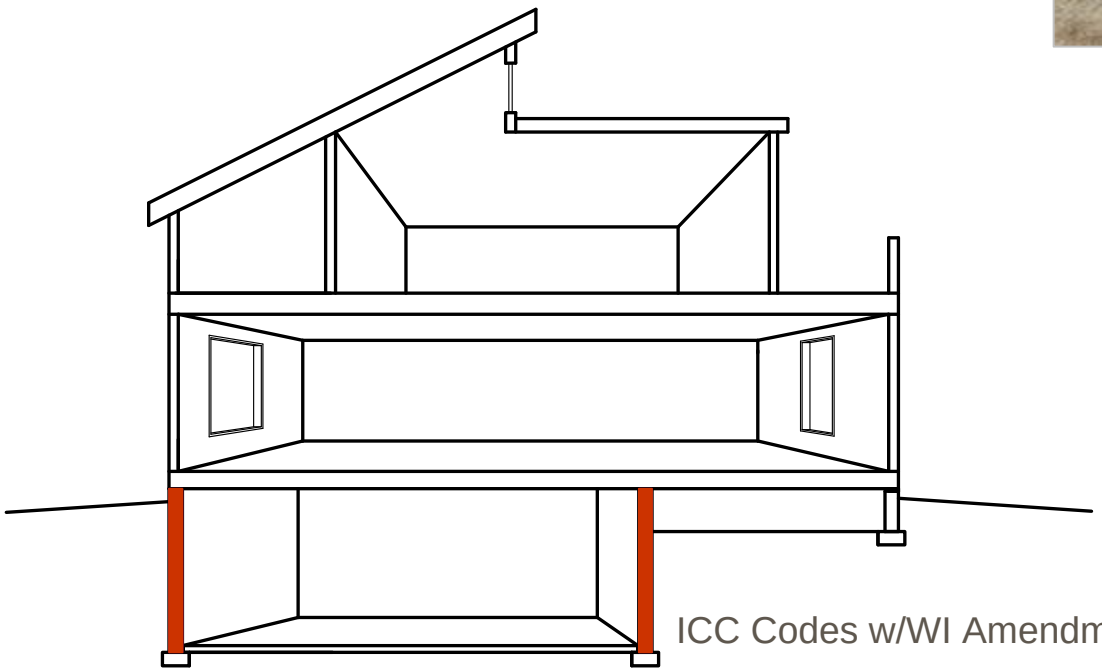


Don’t forget to insulate rim joists

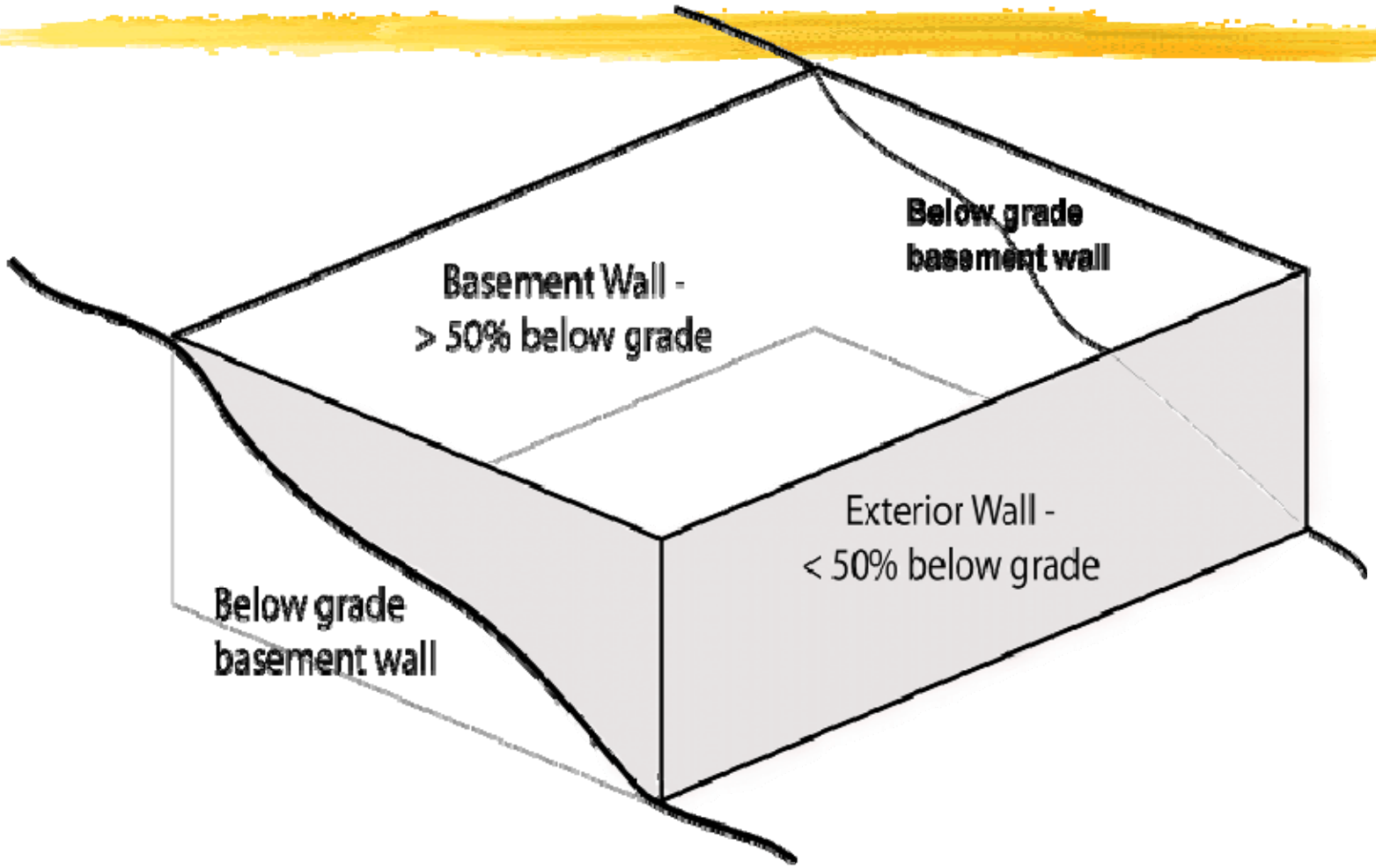
Below-Grade Walls

IECC 402.2.6

- > 50% below grade
- Zones 6 & 7
  - R-10 Exterior insulation
  - R-13 Interior insulation



Defining Below-Grade Walls IECC 402.2.6



Mass Walls (Above Grade ONLY)

IECC 402.2.3

- What type
  - Concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth, & solid timber/logs
- Provisions
  - At least 50% of the required R-value must be on the **exterior** or integral to the wall
  - If insulation placement cannot be met, provisions for wood frame wall insulation requirements apply

Steel-Framed Ceilings, Walls & Floors

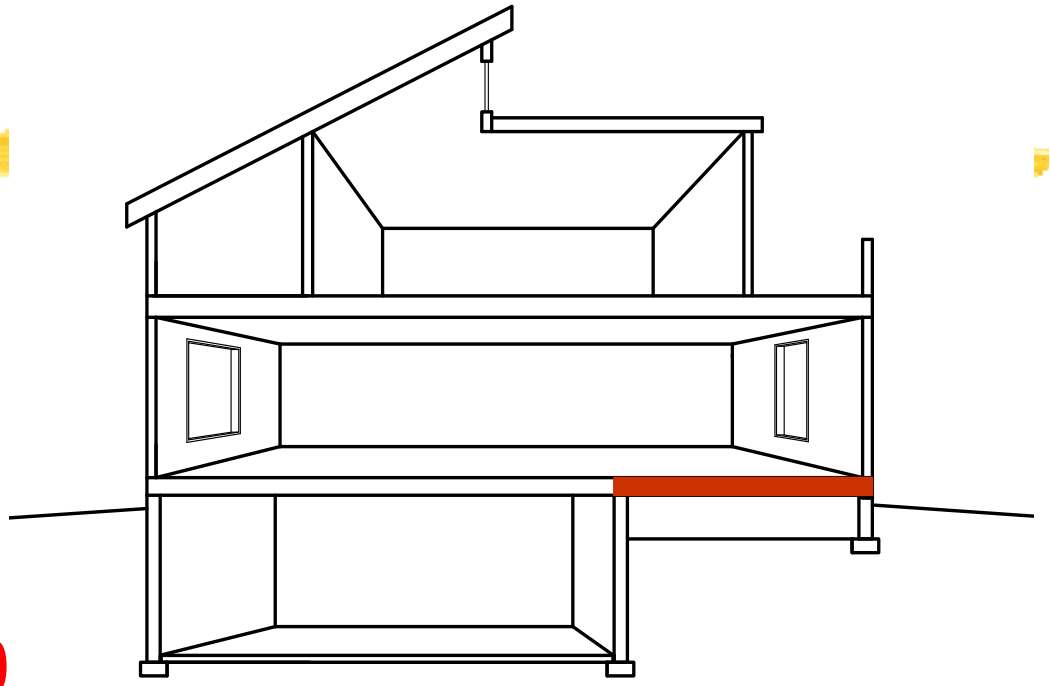
IECC 402.2.4

- Req'd to meet insulation requirements of Table 402.2.4
- Calculation of the U-factor for a steel-frame envelope assembly to use a series-parallel path calculation method

TABLE 402.2.4
STEEL-FRAME CEILING, WALL AND FLOOR INSULATION (*R*-VALUE)

WOOD FRAME *R*-VALUE REQUIREMENT	COLD-FORMED STEEL 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 Framed Wall	
R-13	R - 13 + 5 or R - 15 + 4 or R - 21 + 3
R-19	R - 13 + 9 or R - 19 + 8 or R - 25 + 7
R-21	R - 13 + 10 or R - 19 + 9 or R - 25 + 8
Steel Joist Floor	
R-13	R - 19 in 2×6 R - 19 + 6 in 2×8 or 2×10
R-19	R - 19 + 6 in 2×6 R - 19 + 12 in 2×8 or 2×10

Floors over Unconditioned Space IECC 402.2.5



- Space can be unheated basement, crawlspace, or outdoor air

Zones 6 & 7: Min. R-30

- Insulation must maintain permanent contact with underside of subfloor

Slab Edge Insulation

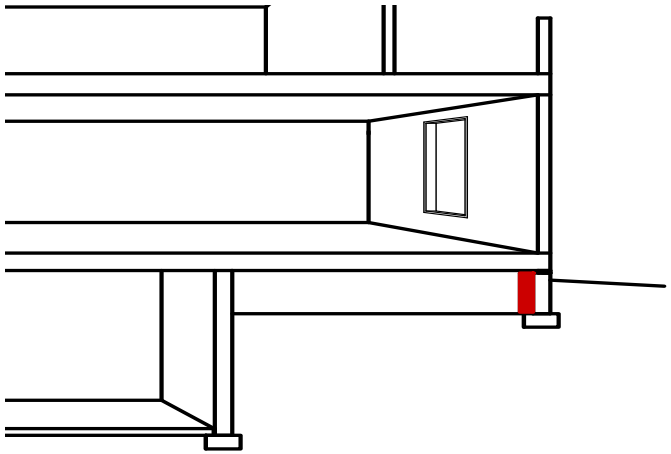
IECC 402.1.1 footnote d, 402.2.6

- R-10 (typically 2 inches) insulation
- R-15 for heated slabs
- Downward from top of slab a minimum of **48”** Insulation can be vertical or extend horizontally under the slab or out from the building (must be under minimum of 10” of soil)

Crawlspace Wall Insulation

IECC 402.2.8

When crawlspace walls are insulated, the space should be mechanically vented or conditioned. See Section R408 of the IRC.



Sunrooms IECC 402.3.5

Less stringent insulation
R-value & glazing
U-factor requirements

Sunroom definition:

- Glazing area > 40% glazing of gross exterior wall and roof area
- Separate heating or cooling system or zone
- Must be thermally isolated (closeable doors or windows to the rest of the residence)

Sunroom Requirements

IECC 402.3.5

- Ceiling Insulation $\geq$ R-24
- Wall Insulation $\geq$ R-13
- Fenestration U-Factor $\leq$ 0.50
- Skylight U-Factor $\leq$ 0.75

Ch. 5 Commercial Bldgs (Any Height) & High Rise Residential Buildings (≥ 4 Stories) IECC 501 & Comm 63.0501

- ASHRAE 90.1-2004 may be used in place of the 2006 IECC requirements for satisfying the following topics on an individual basis:
  - IECC 502 Building Envelope
  - IECC 503 Building Mechanical Systems
  - IECC 504 Service Water Heating
  - IECC 505 Lighting --on individual basis
- Designer's may NOT mix & match—ie. lighting controls from ASHRAE, lighting allowances from IECC. The design must be COMPLETELY based on either the IECC or ASHRAE for that 1 topic. Designer to clearly designate on plans.

Ch. 5 Commercial Bldgs (Any Height) & High Rise Residential Buildings (≥ 4 Stories) IECC 501 & Comm 63.0501

- **ALL** of the following rules shall apply regardless of whether the IECC ch. 5 or ASHRAE 90. 1 Standard is used to determine compliance:
  - Comm 63.0503 (1) relating to design loads
  - Comm 63.0503 (7) & (8) relating to economizers
  - Comm 63.0505 relating to lighting systems
  - IECC 505.2.2.1 relating to duel switching

Ch. 5 Commercial Bldgs (Any Height) & High Rise Residential Buildings (≥ 4 Stories)

- Building Thermal Envelope requirements in Tables 502.2(1), 502.2(2) & 502.3 for ≤ 40% window/wall ratio & ≤ 3% skylights (Prescriptive)
- ***Comcheck-EZ*** computer program per 501.1 or 501.2
- Total Building Performance 506
- ASHRAE 90.1 Criteria per 501.1 or 501.2 for > 40% window wall ratio & > 3% skylights

Ch. 5 Commercial Bldgs (Any Height) & High Rise Residential Buildings (≥ 4 Stories) IECC 502.2.2.1 & 502.2.3

- Above Grade Walls
  - Walls on the exterior of the building & completely above grade, OR walls that are more than 15% above grade.
  - R-value of integral insulation installed in CMU shall not be used in determining compliance with Table 502.2(1)

Ch. 5 Commercial Bldgs (Any Height) & High Rise Residential Buildings (≥ 4 Stories) IECC 502.2.2.2 & 502.2.4

- Below Grade Walls
  - Walls which are basement or first story walls associated with the exterior of the building that are at least 85% below grade.
  - Minimum R-value of insulating material installed in, or on wall, shall extend to the lesser of 10 ft below outside finish ground level, or to the level of the floor.

Ch. 5 Commercial Bldgs (Any Height) & High Rise Residential Buildings (≥ 4 Stories)

TABLE 502.2(1)
BUILDING ENVELOPE REQUIREMENTS – OPAQUE ASSEMBLIES

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine 4	6	7	8
Roofs								
Insulation entirely above deck	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-20 ci	R-20 ci	R-25 ci	R-25 ci
Metal buildings (with R-5 thermal blocks[a])[b]	R-19 + R-10	R-19	R-19	R-19	R-19	R-19	R-19 + R-10	R-19 + R-10
Attic and other	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38
Walls, Above Grade								
Mass	NR	NR	R-5.7 ci[c, e]	R-5.7 ci[c]	R-7.6 ci	R-9.5 ci	R-11.4 ci	R-13.3 ci
Metal building[b]	R-13	R-13	R-13	R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13
Metal framed	R-13	R-13	R-13	R-13	R-13 + R-3.8 ci	R-13 + R-3.8 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13 + R-7.5 ci
Walls, Below Grade								
Below grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5 ci	R-7.5 ci
Floors								
Mass	NR	R-5 ci	R-5 ci	R-10 ci	R-10 ci	R-10 ci	R-15 ci	R-15 ci
Joist/Framing	NR	R-19	R-19	R-19	R-19	R-30	R-30	R-30
Slab-on-Grade Floors								

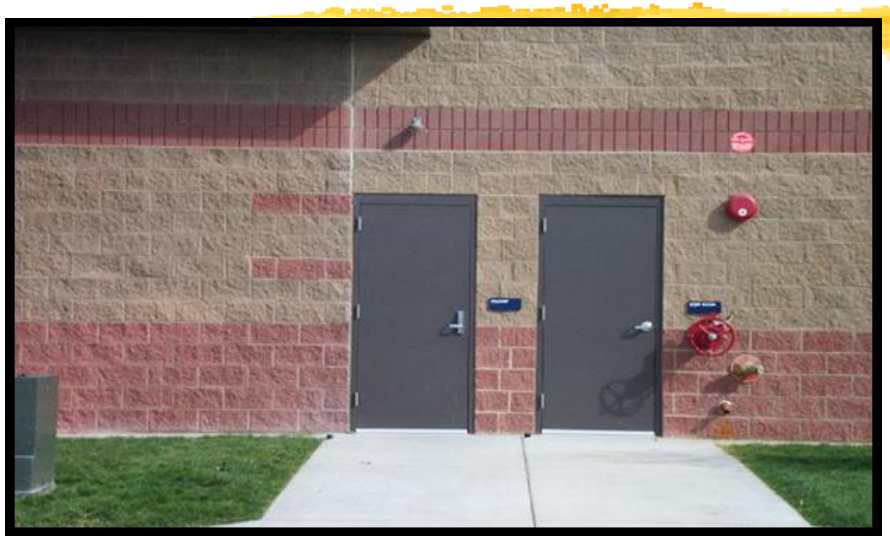
Prescriptive Requirements

IECC 502.1.1, Table 502.3

- For buildings ≤ 40% glazing to gross wall area; and skylight area ≤ 3% of the roof area
- Minimal calculations

Opaque Doors

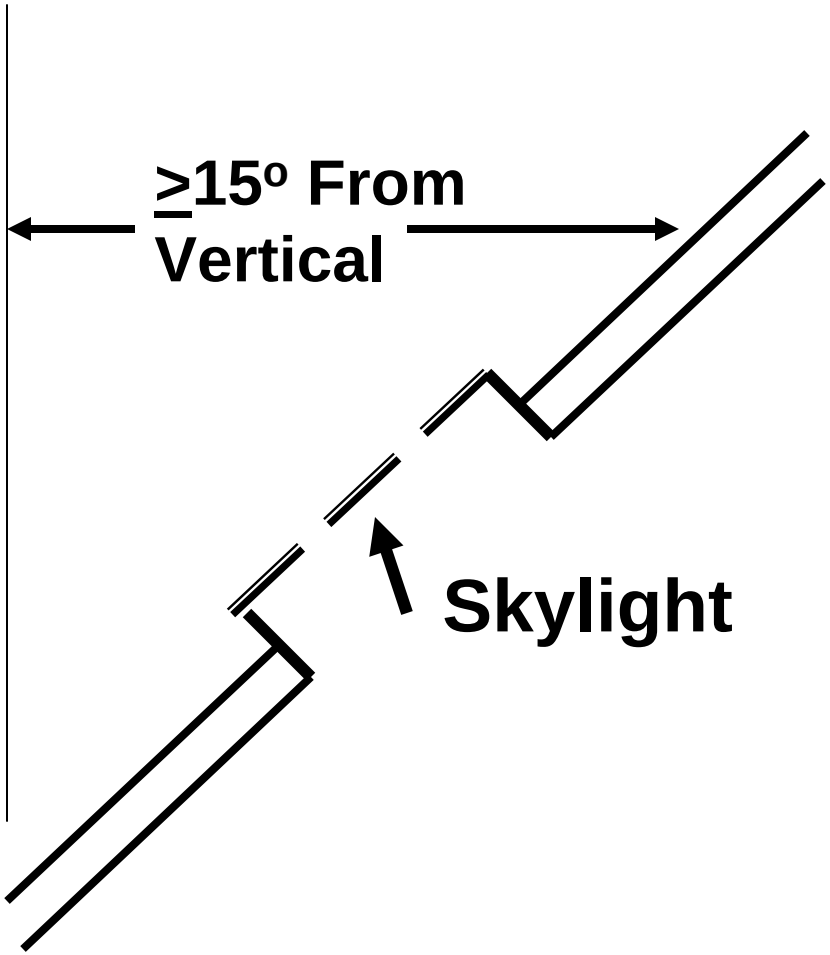
IECC 502.2.7



- Doors having < 50% glass area
- Swinging doors
  - Meet U-factor requirement
- Roll-up or sliding doors
  - Climate Zones 6/7: Minimum R = 2.0

Skylight U-factor

IECC 502.3.2



What is a Skylight?

- Glass or other transparent or translucent glazing material installed at a slope of ≥ 15° from vertical

Computerized Compliance Tools

Comm 63.0404, Comm 63.0506, & IECC 501.1/ASHRAE 90.1

- Use **"2006 IECC"** or **"90.1 (2004 ASHRAE) Std"** as the *code criteria* for both computer programs

Select Code & Location:

Code: 2006 IECC or 90.1 (2004) Standard

State: Wisconsin

City: As located (or closest listed municipality)

Computerized Compliance Application (Code Criteria)

Computerized Compliance Application

- If REScheck or COMcheck compliance is used in conjunction with lighting & HVAC equipment efficiencies, the information associated with the compliance **SHALL be part of the building plan set, appropriately indexed on the bldg plans, and NOT be addressed ONLY in calculations**
- Failure to include the information requires:
  - Reviewer to "Hold" building plans
  - Designer to pay $150 ($50 for revision + $100 submittal fee)
  - Plans to remain on "Hold" until plans have appropriate change in index & information for the field

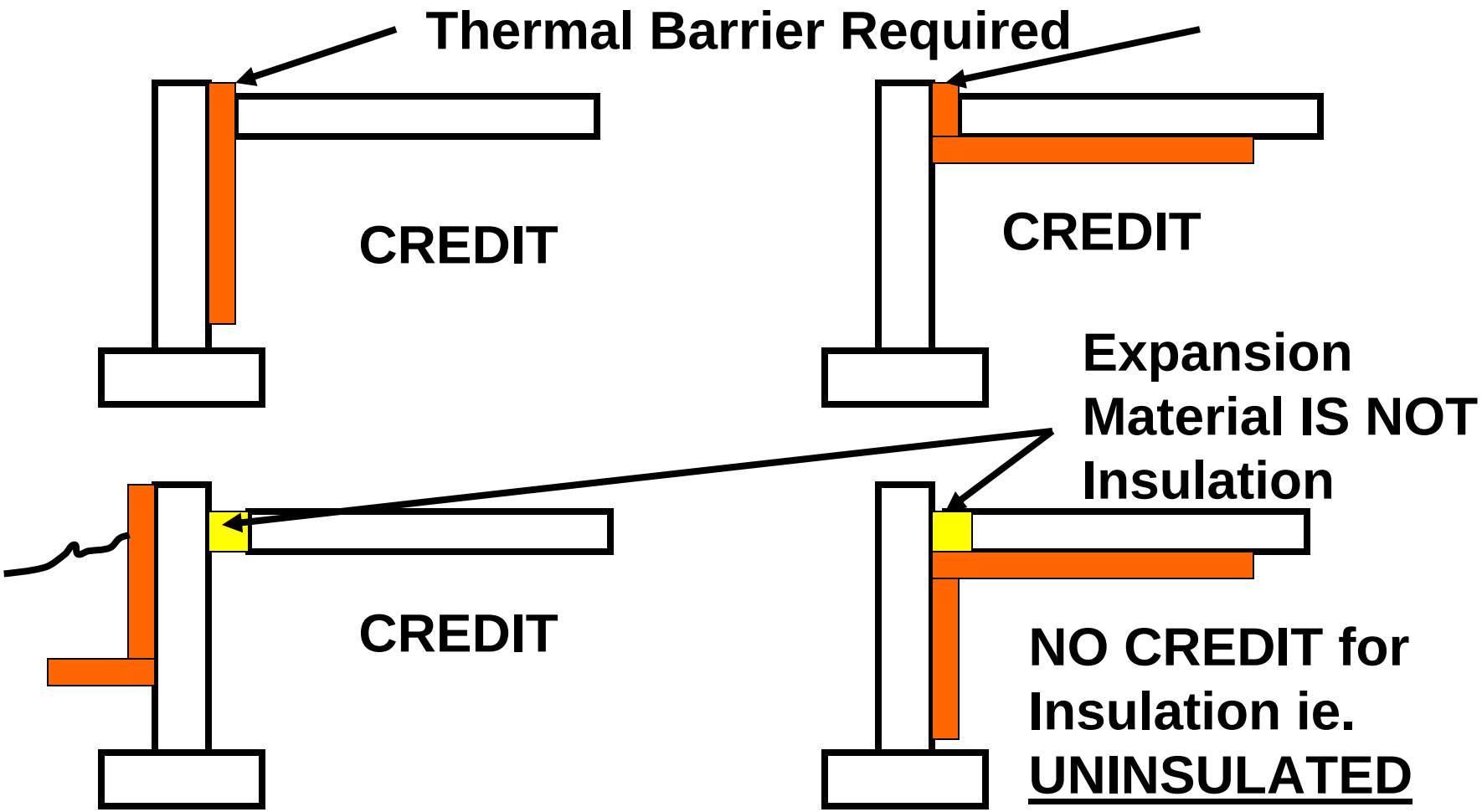
Building Envelope Calculations Must be Submitted with Building Plans

COMM 61.31(2)(e)

- Signed Printout from ***COMcheck,*** *or*
- Signed Printout from ***REScheck*** for Residential Buildings (≤ 3 stories), or
- Signed comparison of R-values, U-Factors, or UA Totals.
- **Ensure that calculations PASS**
- ***Professional Stamp Req'd if bldg is > 50,000 cubic ft (Architectural or Professional Engineer ONLY)***

Computerized Compliance Tools
Slab Edge Insulation Credit

Comm 63.0404, Comm 63.0506, & IECC 501.1/ASHRAE 90.1



Unique Building Designs can still meet the Energy Code

- This building passed by using low-U glazing, and extra insulation on the Roof, Side and Back Walls

Misc. Building Envelope Requirements

IECC 402.4.1, IECC 502.4.3

- Leakage areas shall be caulked, closed with gasketing systems, taped OR covered with moisture vapor-permeable house-wrap, OR properly addressed
- Includes sealing around tubs and showers, at the attic or crawl space panels, at recessed lights and around plumbing & electrical penetrations

Areas for Air Leakage

Infiltration Controls

Loading Dock Weather Seals

IECC 502.4.5

- Cargo doors & loading dock doors shall be equipped with weather seals to restrict infiltration when vehicles are parked in the doorway.

Always think ahead…….. It's easier than dealing with difficulties after the fact…..

Vestibules

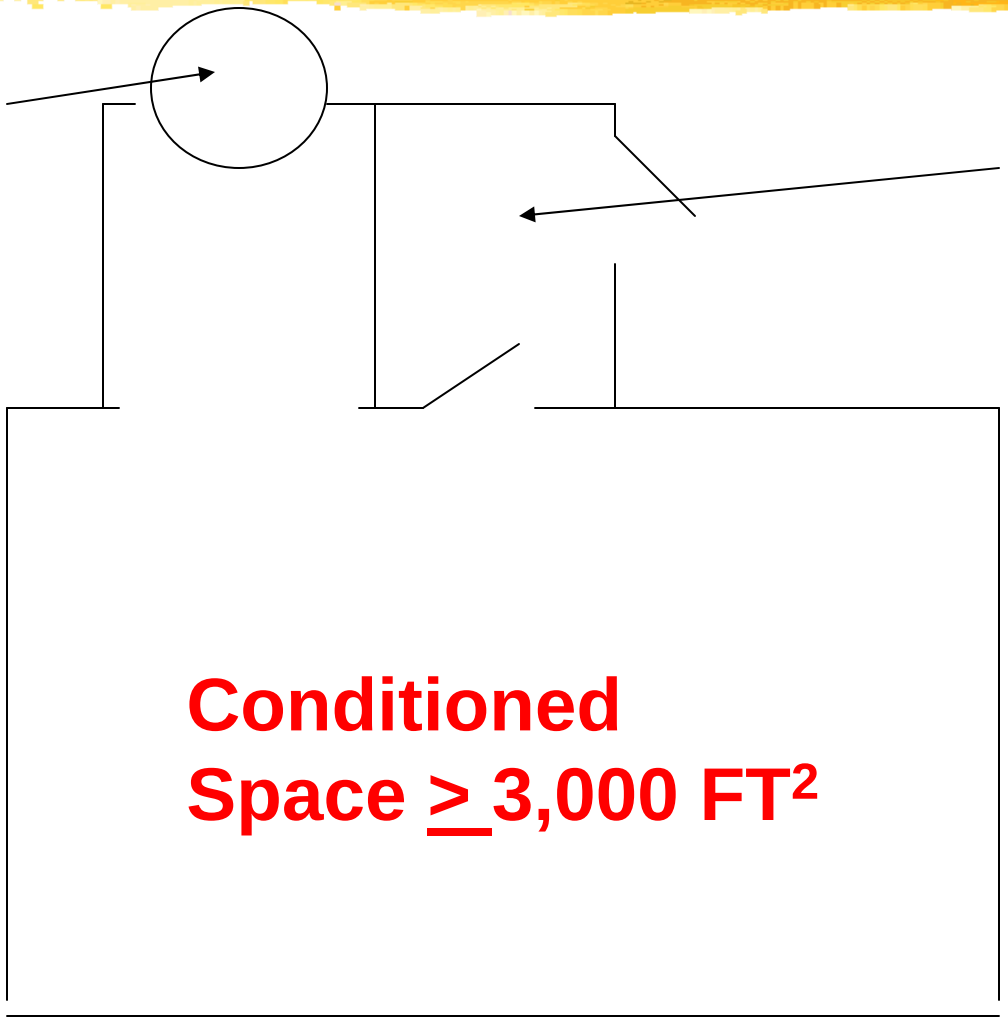
IECC 502.4.6

Vestibules on Entrance Doors

- Req'd to reduce infiltration into spaces
- Req'd on entrance doors leading into spaces ≥ 3,000 ft^2
- Doors **MUST** have self-closing devices
- Some Exceptions (not all listed)
  - Doors from a guest room or dwelling unit
  - Doors used primarily for vehicular movement, materials handling & adjacent personnel doors

Vestibules

IECC 502.4.6



HVAC System Controls

IECC 403.1, 503.2.4

- Commercial & high rise residential buildings require set-back controls
  - Exceptions
- 5º F deadband capability requirements
  - Exceptions
- Req'rs capability of 7 daily schedules, time setting for a power loss of ≥ 10 hrs, & a manual override of up to 2 hrs, or other listed means
- Residential buildings (≤ 3 Stories) ***Do Not*** require setback controls

HVAC System Controls

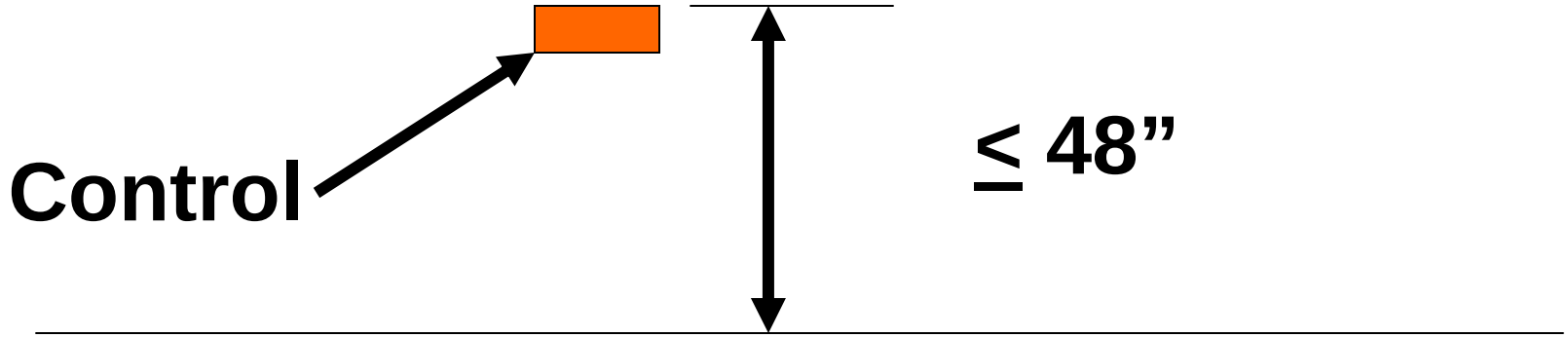
IECC 503.4.1.1

- Heat pumps, with electric resistance heat, to have controls to prevent supplementary heat operations when the heat pump can meet the heating load—
- Exception: during defrost modes

HVAC System Controls

COMM 62.1101.2 ICC A117.1 308.1 & 2

- HVAC system controls (thermostat, humidistat) to be located ≤ 48" above the finished floor for accessibility purposes.
- Measurement is taken from "TOP" of the control



Outdoor Intake, Exhaust Dampers & Vents Integral to the Bldg Envelope

Comm 63.0403(3), IECC 503.2.4.4/Comm 63.0503(5)

- Motorized dampers required on all outdoor air **supply** & **exhaust** ducts that will automatically shut when the system or a space is not used, & to permit gravity dampers only under certain conditions.
- Gravity (barometric) dampers may be utilized in outside air or exhaust airflows of 300 cfm or less.

Outdoor Intake, Exhaust Dampers & Vents Integral to the Bldg Envelope

IECC 502.4.4

If a motorized damper is required to be installed, the damper shall meet:

- **AMCA test 500D for a Class 1 motorized leakage-rated damper**
  - **Maximum leakage rate ≤ 4 cfm /ft^2 @ 1.0 inch w.g.**

Pool Covers

IECC 504.7.3

- Heated pools required to have a pool cover
  - Pool cover must be vapor retardant
- Pools heated to over 90°F require minimum R-12 cover-Exception

Pool Requirements

IECC 504.7

- Pool heaters to have on/off switch. Heaters using natural gas shall NOT have continuously burning pilot lights.
- Time switches req'd that can be used on heaters and pumps to turn equipment on/off based on a preset schedule—Exceptions

Mechanical Equipment Efficiencies

IECC 503.2.2.3 (1) through (11), Table 504.2

- Minimum efficiencies for air conditioners & heat pumps, furnaces, boilers, condensing units, centrifugal chillers, heat rejection equipment, & water heaters must be met
- Efficiencies are based on AFUE, HSPF, SEER, EER, COP, IPLV, etc.
- NOTE: Any "new" equipment placed in a commercial building must meet these minimum requirements

Recessed Lighting Fixtures Through Envelope IECC 402.4.3 & 502.4.7

- Type IC rated & labeled in a sealed or gasketed enclosure to prevent air leakage
- Type IC rated and labeled as meeting ASTM E 283 with no more than 2.0 cfm of air movement
- Located inside an airtight box with clearances of at least 0.5” from combustible material & 3” from insulation

Example of IC Label

IECC 402.4.3 & 502.4.7

Energy Recovery Ventilation

IECC 503.2.6

Requirement reduces energy usage by:

- Preheating cool outdoor air in space heating systems
- Precooling hot outdoor air in space cooling systems
- Dehumidify moist outdoor air during periods of cooling

Energy Recovery Ventilation

IECC 503.2.6

- Required to be installed for individual fan systems (ie. based on a per zone basis) w/supply air ≥ 5,000 cfm **AND** minimum outside air supply ≥ 70% are required to have an energy recovery system.
- Exceptions
- **NOTE**—Use of a energy recovery system will NOT be recognized as having met the Economizer requirements of the code.

Duct Insulation Requirements

Comm 63.0403(2), Comm 63.0503(5), IECC 503.2.7

- Ducts outside the building envelope, or within the bldg envelope, shall be insulated to minimum R-8 (includes underground)
- Minimum R-4 allowed for ducts in floor trusses (Low Rise Residential Bldgs ONLY)
- All supply ducts located in plenums within the building envelope to be insulated to ≥ R-4 (Commercial Bldgs & High Rise Residential Bldgs ONLY)
- Building framing cavities shall not be used as supply ducts

Duct Insulation Requirements

IECC 104.2, IMC 604.7

- MUST have R-value, installed thickness, flame spread & smoke development index every $\leq$ 36”

Duct Sealing

IECC 403.2.2 & Int'l Residential Code 1601 (Low Rise Residential)

- Connections to flanges of air system equipment or sheet metal fittings shall be mechanically flattened, crimp joints for round ducts shall have a contact lap of a least 1.5" & shall be mechanically fastened by means of at least 3 metal screws or rivets equally spaced around the joint.
- Note: Tape alone cannot be substituted for mechanical fasteners.

Duct Sealing

IECC 403.2.2 & Int'l Residential Code 1601

- Rigid Fibrous glass ducts to have closure which complies with with UL 181A, and shall be marked 181A-P for pressure sensitive tape, 181A-M for mastic or 181A-H for heat sensitive tape.
- Flexible air ducts & connectors to have closure which complies with UL 181B, and shall be marked 181B-FX for pressure sensitive tape or 181B-M for mastic.
- **Note: Unlisted duct tape is <u>NOT</u> permitted as a sealant on any duct**

Duct Sealing

IECC 503.2.7 (Commercial bldgs & residential > 3 stories)

- Labeling for approved mastics and tapes

Sealant/ Duct Connection Type	**UL Listing**
Pressure Sensitive Tape	181A-P
Mastic	181A-M
Heat Sensitive Tape	181A-H
Flexible Air Ducts - Pressure Sensitive Tape	181B-FX
Flexible Air Ducts - Mastic	181B-M

Duct Sealing

IECC 503.2.7 (Commercial bldgs & residential > 3 stories)

- Connections to flanges of air system equipment or sheet metal fittings shall be sealed and mechanically fastened.
- Mechanical fasteners for use with flexible nonmetallic air ducts to comply w/UL 181B and shall be marked 181B-C
- **Note: Unlisted duct tape is <u>NOT</u> permitted as a sealant on any duct**
- Note: Tape alone cannot be substituted for mechanical fasteners.

Sealing Examples

Duct Sealing

IECC 503.2.7.1

- Low (≤ 2″ w.g.), Medium (> 2″ but < 3″ w.g.), and High pressure (≥ 3″ w.g.) duct systems require:
  - ALL longitudinal & transverse joints, seams and connections of supply and return ducts to be securely fastened & sealed
  - **Designation to be on the HVAC Plans as to the pressure classification of the duct system**

Duct Sealing

IECC 503.2.7.1.3

- Ducts designed to operate at static pressures ≥ 3 in. wg to be leak tested in accordance with SMACNA HVAC Air Duct Leakage Test Manual
  - **Air leakage rate < 6.0 (See equation in code)**
- Must test ≥ 25% of duct area & meet the requirements

- **Large House in a Country Setting -- $1,000,000;**
- **3 Sports Cars -- $150,000;**
- **Forgetting to shut your water off prior to leaving Wisconsin for the winter --*Priceless***

Piping Insulation Requirements

IECC 403.3 & 403.4

- Low-Rise Residential Pipe Insulation required for:
  - Mechanical system piping carrying fluids above 105°F or below 55°F to be insulated to R ≥ 2.0
  - All circulating service hot water piping to be insulated to R ≥ 2.0

Piping Insulation

IECC 503.2.8

Table redone with R-values = (1/k value) x minimum pipe insulation thickness (inches)

Commercial: All piping serving heating or cooling system must be insulated in accordance with Table 503.2.8 shown

MINIMUM PIPE INSULATION[a]
(thickness in inches)

FLUID	NOMINAL PIPE DIAMETER	
	≤1.5"	> 1.5"
Steam	R- 5.5	R-11
Hot water	R- 3.7	R- 7.4
Chilled water, brine or refrigerant	R- 3.7	R- 5.5

Piping Insulation Requirements

IECC 503.2.8

- Pipe Insulation required except when:
  - Factory installed & included w/ratings
  - Fluid temperature is $\geq$ 55°F & $\leq$ 105°F
  - Piping conveys fluids which have not used fossil fuels or electric power
  - Runout piping $\leq$ 4 ft length & $\leq$ 1" diam. between the control valve & HVAC coil
- Note: Pool piping is not considered a "plumbing system"

Piping Insulation Requirements

IECC 504.5

- Commercial/High Rise Residential Pipe Insulation required for:
  - Recirculating hot water system to be insulated to a R ≥ 3.7
  - Non-recirculating hot water systems for the first 8 ft served by equipment without integral heat traps to be insulated to R ≥ 1.85

Economizers

IECC/COMM Table 63.0503

- Unless a listed exception is met, Economizers are required for
  - Split systems & water source heat pumps **≥ 54,000 Btu/h**
    - Split Systems (furnace & condensor similar to those found in homes, small businesses)
  - All other systems **≥ 33,000 Btu/h**
    - Rooftop units, built-up VAV reheat/single fan dual duct, etc.

Economizers

IEBC 302.5, 607, 711, & 808, IECC/COMM Table 63.0503

- Rooftop fan systems that replace existing fan systems shall be provided with economizers that comply with Ch. 63 requirements for new construction (per International Existing Building Code)
- **NOTE**—Use of an energy recovery system will NOT be recognized as having met the Economizer requirements of the code.

Variable Air Volume Fan Control

IECC 503.4.5 (Complex System-Multi-zoned)

- Reheating, recooling or mixing not allowed unless 1 of the following is met:
  - System airflow is 30% of the max. supply air to each zone
  - System airflow is < 300 cfm where the max. flow rate is 10% of the total system supply airflow rate
  - The minimum ventilation requirements of the IMC Ch. 4 are met (includes BOTH minimum outside air and air-change requirements) which must be met at all times people are present)

First Hot Water Heater in Space?

Photo: Chris Brown, Florida HomePro, Jacksonville, Fla.

Not only did the homeowners install the water heater on its side, but they replaced the TPR valve with a large pressure gauge. Fortunately, the building was vacant and the heater not pressurized at time of inspection.

Hydronic Systems Controls

IECC 503.4.3

- Multiple-staged boilers require automatic controls capable of sequencing operation.
- Systems comprised of a single boiler >500,000 Btu/h input design capacity shall include either a multi-staged or modulating burner.

Hydronic Systems Controls-- Part Load Controls IECC 503.4.3.4

- Hydronic systems ≥ 300,000 btu/hr in design output capacity supplying heated/chilled water to have special controls.
  - Temperature to be capable of being reset, by 25% of the design supply-to-return water temperature difference.
  - Capable of reducing system pump flow by 50% of design flow utilizing adjustable speed drives on pumps where 1/3 of total horsepower is automatically turned off or modulated

Hydronic Systems-Heat Rejection Equipment Fan Speed Control

IECC 503.4.4

- Each fan ≥ 7.5 hp to have the capability to operate that fan at 2/3 of full speed or less & shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature pressure of that heat rejection device
- **Exception**- Factory installed heat rejection devices.

Hot Water System Controls

IECC 504.6

- Ability to turn off circulating hot water pumps & heat trace tape when the system is not in operation
  - Automatically or manually


CITGO
CITGO
CITGO
WAUNAKEE QUICK STOP
COLD BEER PIZZA SODA SNACKS TOBACCO
1.70
1.79
1.88

Lighting Code Application

IECC Ch. 4, IBC 1006 & 1011, IMC 306.3.1

- There are NO lighting requirements, as relating to limiting lighting use, to be met on Low-Rise Residential Buildings
- All exit signage, means of egress illumination, access & service lighting, etc. are still required to met.

Lighting Code Application

IECC 505

- 1) *Determine Power Allowance* in watts for interior and exterior use (add **5%** for exterior allowance per IECC 505.6.2)
- 2) *Determine Actual Lighting Installation* (inclusive of ballasts) in watts for the interior and exterior of the building
- 3) *Compare*--Actual installation wattage to be ≤ Power allowance as applicable to interior and exterior use
- 4) *Determine Required Controls*

Exterior Lighting Power Allowance IECC 505.6.2 & Table 505.6.2

- Table defines lighting power densities in Watts/Square Foot
- Is the sum of the individual lighting power allowances per Table each application plus an additional unrestricted allowance of **5%** of the sum
  - Example: Allowance from Table x 1.05 = Total Exterior Lighting Power Allowance
  - 10,000 W/sf x 1.05 = 10,500 W/SF Total ELPA

Exterior Lighting Power Allowance IECC 505.6.2

- **Lighting that can be exempted:**
  - Specialized signal/directional/marker lights for transportation
  - Advertising/directional signage
  - Integral equipment installed by manufacturer
  - Theatrical purposes
  - Athletic playing areas
  - Temporary lighting
  - Industrial production/storage areas
  - Theme elements in theme/amusement parks
  - Lighting for public monuments/landmarks, et al

Exterior Lighting Controls

IECC 505.2.4

- Automatic shut-off controls such the following are to be installed.
  - Photosensor which turns off lighting when there is sufficient daylight.
  - An astronomical time switch with the capability of retaining programming for $\geq$ 10 hrs if a power loss should occur.
  - Exceptions

Interior Lighting Power Allowance

IECC Table 505.2

- Table defines lighting power densities in Watts/Square Foot
  - Footnote a: Where both a general building area type & a more specific bldg area is listed, the more specific shall apply.
  - Footnote b: Additional wattage will be allowed for in retail areas in the amounts listed, and for the specific products listed.

Interior Lighting Accounting Rules

IECC 505.5.1, Comm 63.0505

- The wattage for track & busway line voltage lighting to be the volt-ampere rating of the branch circuit feeding the luminaries, or an integral current limiter controlling the luminaires, or the higher of the minimum relamping rated wattage of the all luminaries included in the system, or 30 W/linear ft.

Interior Lighting Accounting Rules

IECC 505.5.1

- Low voltage systems (track, cable, conductor, trail conductor, etc.) accountable for wattage of transformer supplying system

Interior Lighting Power Allowance IECC 505.5.1

- **What Lighting Can I Exempt From the Proposed Lighting Power Allowance Calculation?**
  - **Specialized medical, dental & research lighting**
  - **Professional sports arena playing field lighting**
  - **Display lighting for exhibits in galleries, museums & monuments**
  - **Sleeping unit lighting in hotels, motels, boarding house or similar buildings**
  - **Emergency lighting automatically off during normal building operation**

Interior Lighting Power Allowance IECC 505.5.1/Comm 63.0505(3)

- **Additional exceptions:**
  - Theatrical lighting
  - Photographic process
  - Lighting integral to equipment installed by manufacturer
  - Task lighting for plant growth
  - Advertising/directional signage
  - Lighting equipment for sale
  - Lighting demonstration equipment for school
  - Lighting for safety/emergency (inclusive of "EXIT" lights

Interior Lighting Controls

IECC 505.2.1

- General **Interior Lighting Control** req'rs minimum of 1 manual control unless exception is met
  - Exceptions:
    - Areas designated as security or emergency areas that must be continuously lighted.
    - Lighting in stairways or corridors that are elements of the means of egress.

Interior Lighting Control Requirements IECC 505.2.1

- **Independent Lighting Control**
  - **Req'd for each space surrounded by floor to ceiling participations**
  - **To be located in the space served, or**
  - **Switched from a remote location**
    - **Req'rs indicator that identifies the lights served & their status (off/on)**
  - **Exemptions**
    - **Areas continuously lit for security or emergency**
    - **Lighting in stairways or corridors that are means of egress**

Interior Lighting Control Requirements IECC 505.2.2.1

- **Light Reduction Controls** required to reduce lighting by at least 50% in reasonable uniform pattern
  - **Exemptions**
    - **Areas with only 1 luminaire**
    - **Areas controlled by occupancy sensor(s)**
    - **Corridors, storerooms, restrooms, public lobbies, sleeping units, spaces with < 0.6 w/ft^2**

Interior Lighting Controls

Comm 63.0505

- **<u>Daylighting Controls</u>** required to reduce lighting by at least 50% in reasonable uniform pattern for windows & skylights:
  - Exceptions
    - Enclosed space is < 250 sf
    - Lighting density is **<u>≤</u> 0.8** watts
    - Only 1 luminaire in daylight area
    - Etc.

Interior Lighting Controls

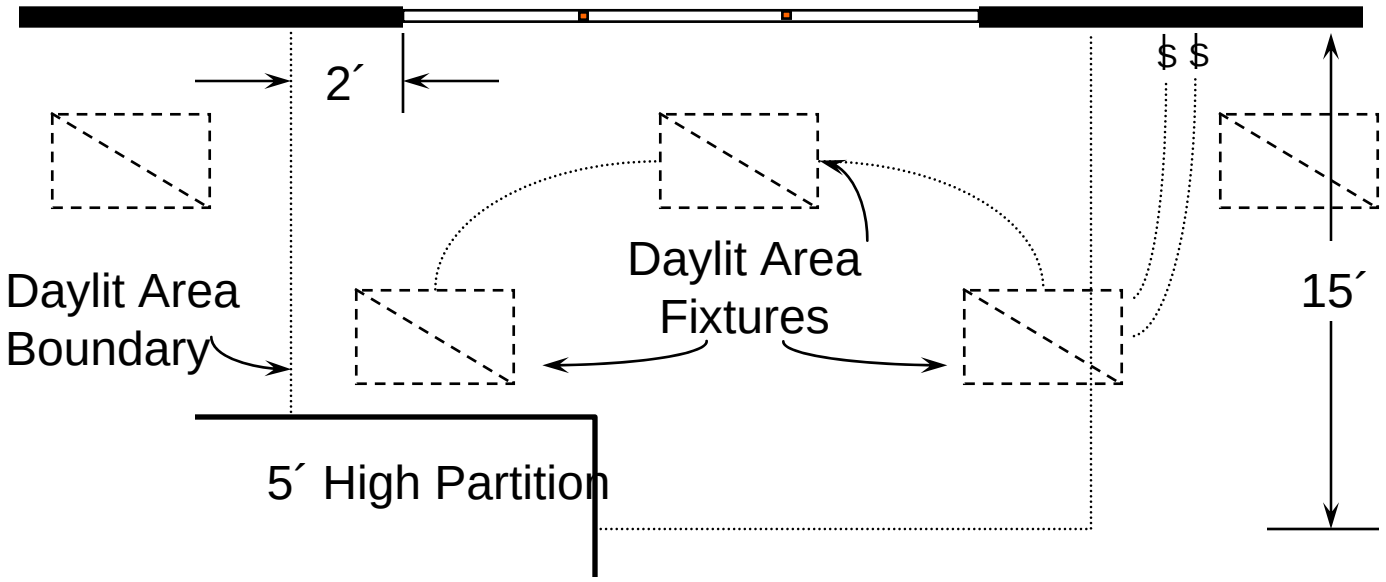
Comm 63.0505

- **Daylit area behind windows**:
  - 15 ft behind vertical glazing, 2 ft on either side, or up to partitions ≥ 60" tall
- **Daylit area under skylights**:
  - Area of skylight plus the lesser of 70% of the floor-to-ceiling height, the distance to the nearest 60" or high permanent partition, or ½ the horizontal distance to the edge of the closest skylight or vertical glazing

Interior Lighting Controls- Windows

Comm 63.0505

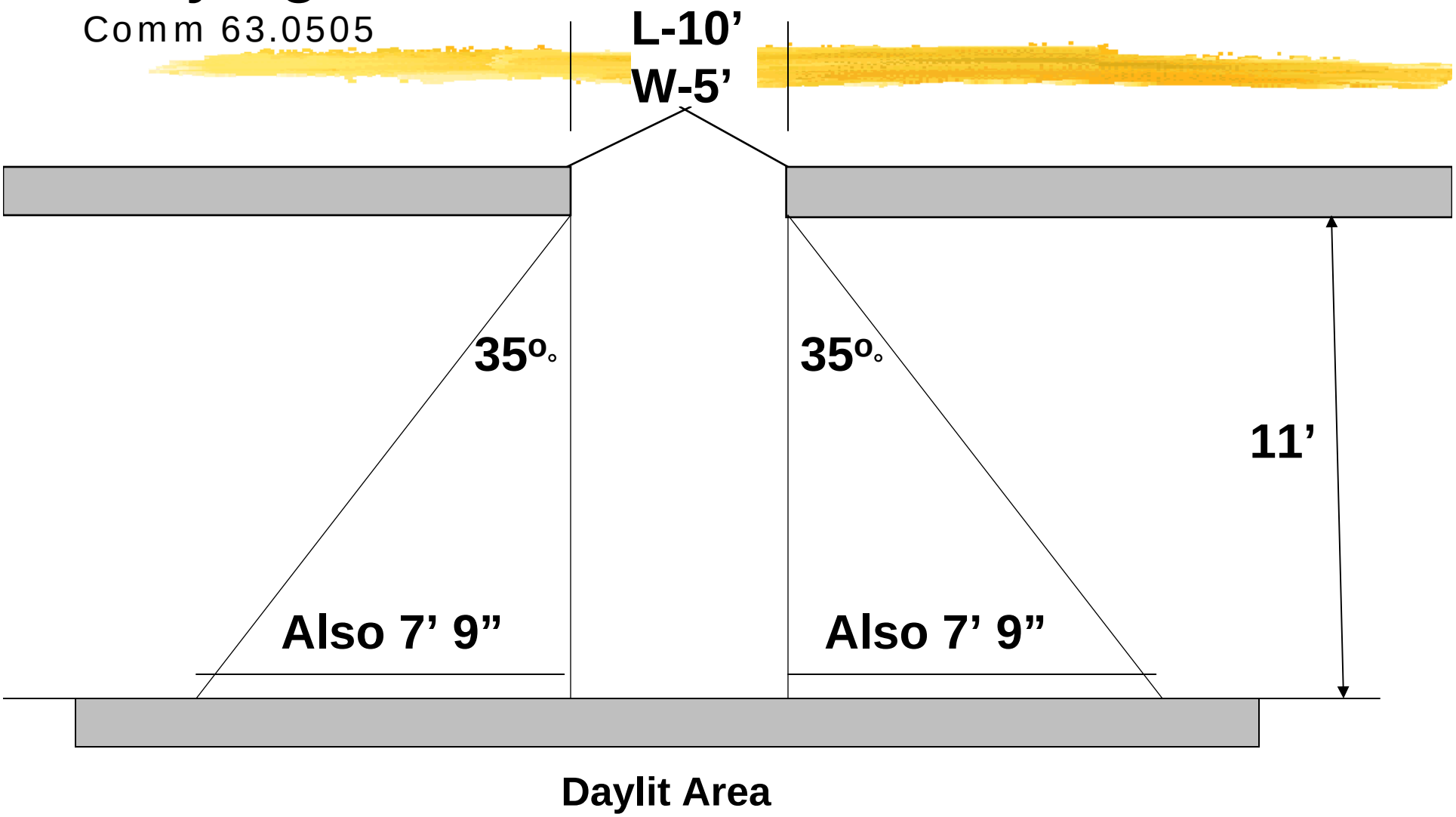
Vertical Glazing (windows):



Lighting Controls

Interior Lighting Controls- Skylights

Comm 63.0505



Interior Lighting Controls

IECC 505.2.2.2

- **Automatic Lighting Shut-off Controls** required for buildings > 5,000 sf:
  - May be addressed via a scheduled bases by controlling areas that do not exceed 25,000 sf & not more than 1 floor.
  - May be addressed with an occupant sensor which turns lighting off in < 30 minutes after the occupant has left the space.
  - May use a signal from another control or alarm that indicates area is unoccupied.

Interior Lighting Controls

IECC 505.2.2.2.1

- **Automatic Lighting Shut-off Controls** to have occupant override which incorporates:
  - Ready accessibility
  - A location so that the person can see the lights or area being lit or so that the area being lit is annunciated.
  - Manual operation
  - An allowance for lighting to remain "on" for ≤ 2 hrs
  - Controls for an area ≤ 5,000 sf---Exceptions

Interior Lighting Controls

IECC 505.2.2.2.1

- Exemptions to Override Requirements
  - Malls & arcades, auditoriums, single-tenant retail space, industrial facilities & arenas using captive key override (override time may exceed 2 hrs)
  - In malls & arcades, auditoriums, single-tenant retail spaces, industrial facilities & arenas, the area controlled may not exceed ≤ 20,000 ft^2

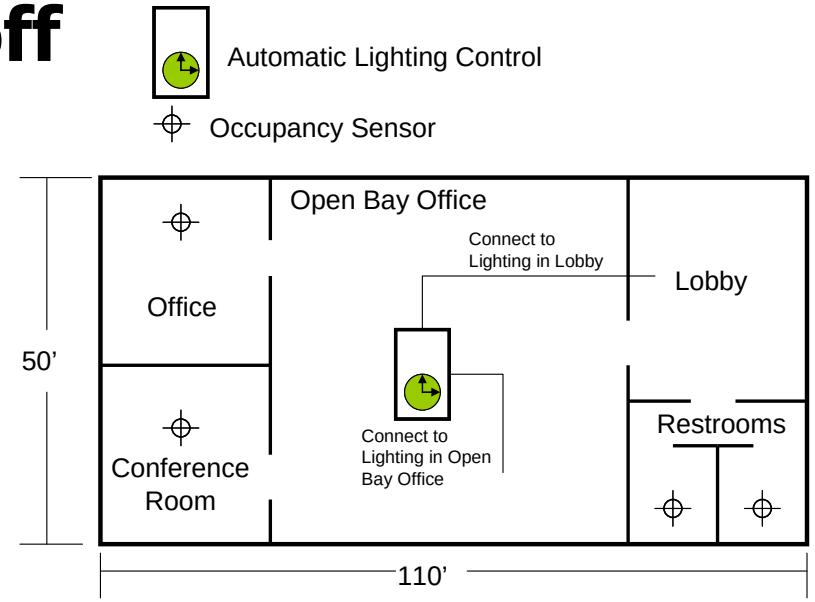
Interior Lighting Controls

IECC 505.2.2.2, 505.2.2.2.2

- **Automatic Lighting Shut-off Controls** that are installed on a scheduled basis per IECC 505.2.2.2 Item 1., are required to incorporate an "**automatic holiday scheduling feature**" that turns off all loads ≥ 24 hrs, then resumes the normally scheduled operation.

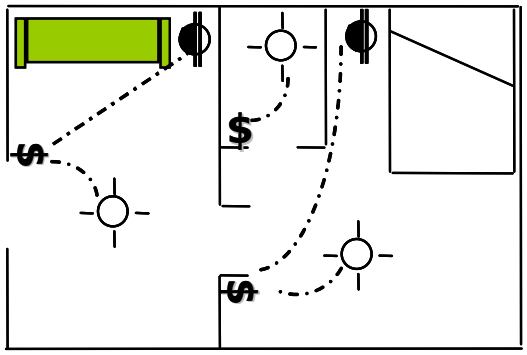
Interior Lighting Control Requirements

- **Automatic Lighting Shutoff**
  - **"Building" Defined**
    - **Building area surrounded by exterior walls & fire walls**
  - **Exempted spaces**
    - **Sleeping units**
    - **Lighting for patient care**
    - **When an automatic shutoff would endanger occupant safety or security**

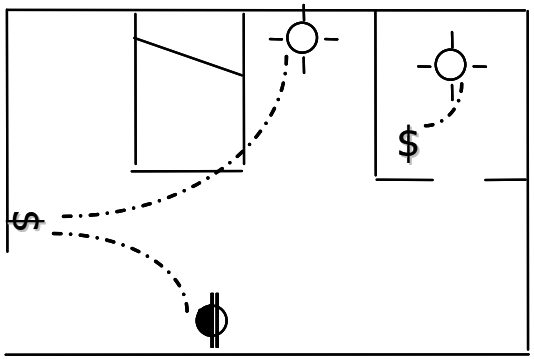


Interior Lighting Control Requirements IECC 505.2.3

- Hotel/Motel Guest Room Switching
  - Master switch required at entry that controls permanently wired fixtures & receptacles
  - Suites to have a control meeting those requirements at the entry to each room or at the primary entry to the suite.



Suite



Standard Room

Tandem Wiring

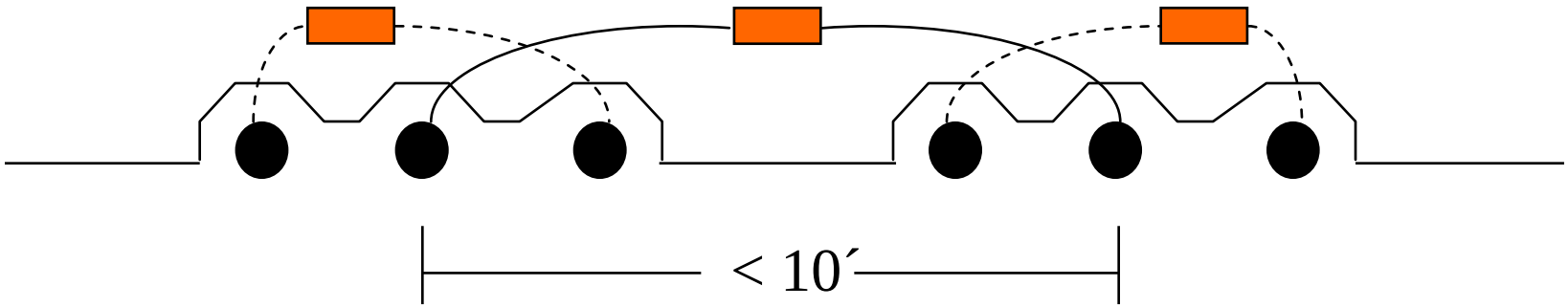
IECC 505.3

- Tandem Wiring required for one-lamp or three-lamp fluorescent fixtures that are:
  - Recess mounted within 10’ center to center of each other;
  - Pendant or surface-mounted within one foot edge-to-edge of each other
  - Exceptions:
    - Usage of electronic ballasts, luminaires on emergency circuits, luminaires with no available pair in same area

Tandem Wiring

IECC 505.3

Tandem Wiring-Recess Mounted



Exit Signs

IECC 505.4

This Sign Uses ¼ Watt!!

- Internally illuminated exit signs shall not exceed ***5 watts.***
  - The code is requiring use of LED assemblies (Energy Star Listed Units)
  - The requirement essentially eliminates fluorescent & incandescent type units.

Questions -----

- ??????????