Shedding Light on Glazing Safety and Performance

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Provider #60114115

AIA Course #PHRCWEB416

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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Description

- Understanding glazing concepts can help determine how well a product will keep a home cool in the summer and warm in the winter. By recognizing proper fenestration design principles, industry professionals and consumers can reliably compare products and make informed decisions about the windows and doors they purchase, install, and inspect. This webinar will explore glazing characteristics such as U-Factor, Solar Heat Gain Coefficient (SHGC), Visible Transmittance (VT), Air Leakage (AL), and how they relate to the overall performance of the assembly. This webinar will also analyze the impact that provisions of the 2009 IRC dealing with safety have on glazing selection and installation.

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Objectives

- The learning objectives for this program are:
  - Comprehend the scope of the 2009 IRC requirements related to glazing safety and the impact they have on builders and occupants.
  - Analyze the various products that are on the market which aim to ensure a greater level of occupant safety in homes.
  - Understand the characteristics of glazing systems and how they impact occupant comfort, energy efficiency, and overall durability.
  - Examine 2009 IRC requirements related to glazing performance and discuss the impacts these requirements have on the residential construction industry.

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Overview

- Role of Fenestration in Residential Construction
- Occupant Safety
  - Emergency Escape
  - Protection against Falls
  - Safety Glazing
- Building Envelope
  - Natural Light
  - Natural Ventilation
  - Glazing Performance

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Code Definition

- IRC Definition
  - **FENESTRATION.** Skylights, roof windows, vertical windows (whether fixed or moveable); opaque doors; glazed doors; glass block; and combination opaque/glazed doors.

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2009 IRC Chapter 2

What is the Role of Fenestration?

- Occupant Safety
- The Building Envelope

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Occupant Safety

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Occupant Safety

- Emergency Escape
  - IRC Section 310
- Protection against Falls
  - IRC Section 612
- Safety Glazing
  - IRC Section 308

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Emergency Escape

- **R310.1 Emergency escape and rescue required.** *Basements*, habitable attics and every sleeping room shall have at least one operable emergency escape and rescue opening. Where *basements* contain one or more sleeping rooms, emergency egress and rescue openings shall be required in each sleeping room. Where emergency escape and rescue openings are provided they shall have a sill height of not more than 44 inches (1118 mm) above the floor. Where a door opening having a threshold below the adjacent ground elevation serves as an emergency escape and rescue opening and is provided with a bulkhead enclosure, the bulkhead enclosure shall comply with Section R310.3. The net clear opening dimensions required by this section shall be obtained by the normal operation of the emergency escape and rescue opening from the inside. Emergency escape and rescue openings with a finished sill height below the adjacent ground elevation shall be provided with a window well in accordance with Section R310.2. Emergency escape and rescue openings shall open directly into a public way, or to a *yard* or court that opens to a public way.

17 2009 IRC R310.1

Emergency Escape

- **Exception:** *Basements* used only to house mechanical *equipment* and not exceeding total floor area of 200 square feet (18.58 m^2).

18 2009 IRC R310.1

Net Clear Opening

- **R310.1.1 Minimum opening area.** All emergency escape and rescue openings shall have a minimum net clear opening of 5.7 square feet (0.530 m^2).

19 2009 IRC R310.1.1

Net Clear Opening

– **Exception:** *Grade* floor openings shall have a minimum net clear opening of 5 square feet (0.465 m^2).

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2009 IRC R310.1.1

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Net Clear Opening

- **R310.1.2 Minimum opening height.** The minimum net clear opening height shall be 24 inches (610 mm).
- **R310.1.3 Minimum opening width.** The minimum net clear opening width shall be 20 inches (508 mm).

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2009 IRC R310.1.2-3

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Operations of an Egress Window

- **R310.1.4 Operational constraints.** Emergency escape and rescue openings shall be operational from the inside of the room without the use of keys, tools or special knowledge.

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2009 IRC R310.1.4

Emergency Escape under Decks

- **R310.5 Emergency escape windows under decks and porches.** Emergency escape windows are allowed to be installed under decks and porches provided the location of the deck allows the emergency escape window to be fully opened and provides a path not less than 36 inches (914 mm) in height to a *yard* or court.

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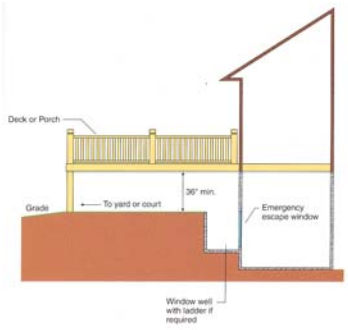
2009 IRC R310.5

Emergency Escape under Decks



Protection Against Falls

- **R612.2 Window sills.** In *dwelling* units, where the opening of an operable window is located more than 72 inches (1829 mm) above the finished *grade* or surface below, the lowest part of the clear opening of the window shall be a minimum of 24 inches (610 mm) above the finished floor of the room in which the window is located. Operable sections of windows shall not permit openings that allow passage of a 4 inch (102 mm) diameter sphere where such openings are located within 24 inches (610 mm) of the finished floor.

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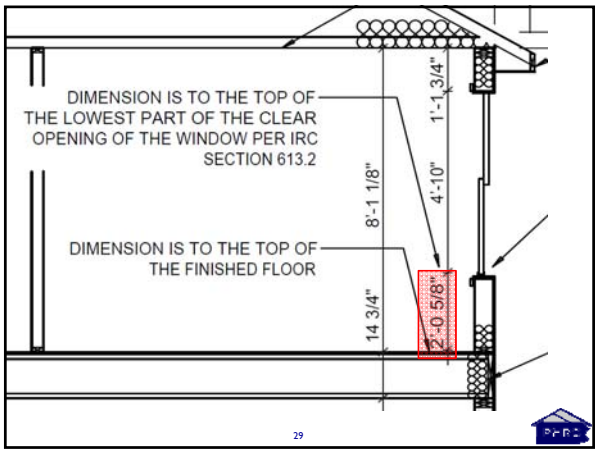
2009 IRC R612.2


DIMENSION IS TO THE TOP OF THE LOWEST PART OF THE CLEAR OPENING OF THE WINDOW PER IRC SECTION 613.2
DIMENSION IS TO THE TOP OF THE FINISHED FLOOR
1'-1 3/4"
4'-10"
8'-1 1/8"
2'-0 5/8"
14 3/4"
29


24" Min.
30


Greater than 72" from window to grade
Tyvek
31

Protection Against Falls

– **Exceptions:**
  1. Windows whose openings will not allow a 4-inch diameter (102 mm) sphere to pass through the opening when the opening is in its largest opened position.
  2. Openings that are provided with window fall prevention devices that comply with Section R612.3.
  3. Openings that are provided with fall prevention devices that comply with ASTM F 2090.
  4. Windows that are provided with opening limiting devices that comply with Section R612.4.

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2009 IRC R612.2

Limiting Devices

- **R612.4 Window opening limiting devices.** When required elsewhere in this code, window opening limiting devices shall comply with the provisions of this section.

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2009 IRC R612.4

Fall Prevention Devices

- **R612.3 Window fall prevention devices.** Window fall prevention devices and window guards, where provided, shall comply with the requirements of ASTM F 2090.

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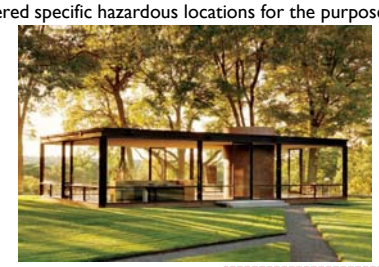
2009 IRC R612.3

Safety Glazing

- **R308.4 Hazardous locations.** The following shall be considered specific hazardous locations for the purposes of glazing:



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2009 IRC R308.4

Safety Glazing (R308.4 Hazardous locations)

1. Glazing in all fixed and operable panels of swinging, sliding and bifold doors.

Exceptions:

1. Glazed openings of a size through which a 3-inch diameter (76 mm) sphere is unable to pass.
2. Decorative glazing.

2009 IRC R308.4

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Safety Glazing (R308.4 Hazardous locations)

2. Glazing in an individual fixed or operable panel adjacent to a door where the nearest vertical edge is within a 24-inch (610 mm) arc of the door in a closed position and whose bottom edge is less than 60 inches (1524 mm) above the floor or walking surface.

Exceptions:

1. Decorative glazing.
2. When there is an intervening wall or other permanent barrier between the door and the glazing.
3. Glazing in walls on the latch side of and perpendicular to the plane of the door in a closed position.
4. Glazing adjacent to a door where access through the door is to a closet or storage area 3 feet (914 mm) or less in depth.
5. Glazing that is adjacent to the fixed panel of patio doors.

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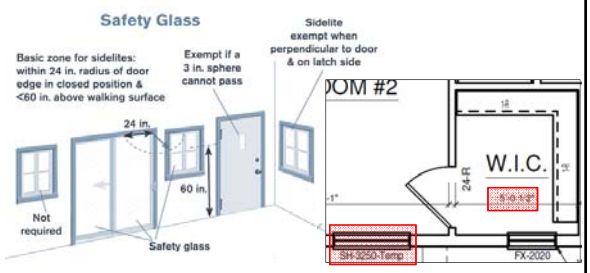
2009 IRC R308.4

Safety Glazing (R308.4 Hazardous locations)



2009 IRC R308.4

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Safety Glazing (R308.4 Hazardous locations)

3. Glazing in an individual fixed or operable panel that meets all of the following conditions:
   - 3.1. The exposed area of an individual pane is larger than 9 square feet (0.836 m^2);
   - **and**
   - 3.2. The bottom edge of the glazing is less than 18 inches (457 mm) above the floor;
   - **and**
   - 3.3. The top edge of the glazing is more than 36 inches (914 mm) above the floor;
   - **and**
   - 3.4. One or more walking surfaces are within 36 inches (914 mm), measured horizontally and in a straight line, of the glazing.

- Refer to Section R308.4 for Exceptions

2009 IRC R308.4

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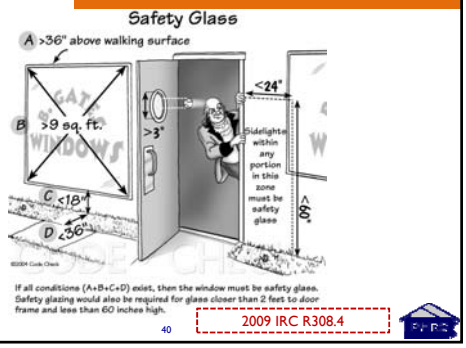
Safety Glazing (R308.4 Hazardous locations)



2009 IRC R308.4

40

Safety Glazing (R308.4 Hazardous locations)

4. All glazing in railings regardless of area or height above a walking surface. Included are structural baluster panels and nonstructural infill panels.

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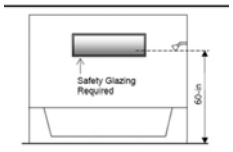
2009 IRC R308.4

Safety Glazing (R308.4 Hazardous locations)

5. Glazing in enclosures for or walls facing hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) measured vertically above any standing or walking surface.



GLASS WITHIN SHOWER WALLS

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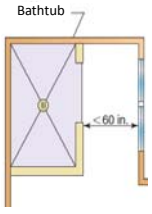
2009 IRC R308.4

Safety Glazing (R308.4 Hazardous locations)

Exception: Glazing that is more than 60 inches (1524 mm), measured horizontally and in a straight line, from the waters edge of a hot tub, whirlpool or bathtub.



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2009 IRC R308.4

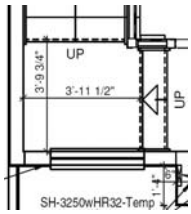
Safety Glazing (R308.4 Hazardous locations)

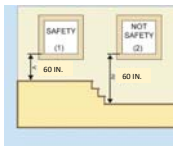
6. Glazing in walls and fences adjacent to indoor and outdoor swimming pools, hot tubs and spas where the bottom edge of the glazing is less than 60 inches (1524 mm) above a walking surface and within 60 inches (1524 mm), measured horizontally and in a straight line, of the water's edge. This shall apply to single glazing and all panes in multiple glazing.

44 2009 IRC R308.4

Safety Glazing (R308.4 Hazardous locations)

7. Glazing adjacent to stairways, landings and ramps within 36 inches (914 mm) horizontally of a walking surface when the exposed surface of the glazing is less than 60 inches (1524 mm) above the plane of the adjacent walking surface.





45 2009 IRC R308.4

Safety Glazing (R308.4 Hazardous locations)

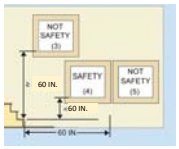
Exceptions:

1. When a rail is installed on the accessible side(s) of the glazing 34 to 38 inches (864 to 965 mm) above the walking surface. The rail shall be capable of withstanding a horizontal load of 50 pounds per linear foot (730 N/m) without contacting the glass and be a minimum of $1\frac{1}{2}$ inches (38 mm) in cross sectional height.
2. The side of the stairway has a guardrail or handrail, including balusters or in-fill panels, complying with Sections R311.7.7 and R312 and the plane of the glazing is more than 18 inches (457 mm) from the railing; or
3. When a solid wall or panel extends from the plane of the adjacent walking surface to 34 inches (863 mm) to 36 inches (914 mm) above the walking surface and the construction at the top of that wall or panel is capable of withstanding the same horizontal load as a *guard*.

46 2009 IRC R308.4

Safety Glazing (R308.4 Hazardous locations)

8. Glazing adjacent to stairways within 60 inches (1524 mm) horizontally of the bottom tread of a stairway in any direction when the exposed surface of the glazing is less than 60 inches (1524 mm) above the nose of the tread.



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2009 IRC R308.4

Safety Glazing (R308.4 Hazardous locations)

Exceptions:

1. The side of the stairway has a guardrail or handrail, including balusters or in-fill panels, complying with Sections R311.7.7 and R312 and the plane of the glass is more than 18 inches (457 mm) from the railing; or

2. When a solid wall or panel extends from the plane of the adjacent walking surface to 34 inches (864 mm) to 36 inches (914 mm) above the walking surface and the construction at the top of that wall or panel is capable of withstanding the same horizontal load as a guard.

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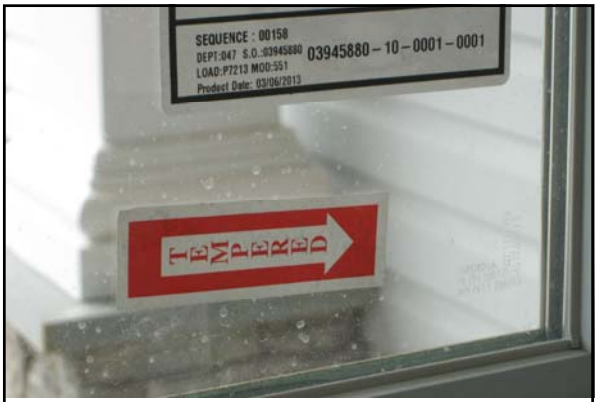
2009 IRC R308.4



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Occupant Safety Questions?

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The Building Envelope

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Building Envelope

- Natural Light
- Natural Ventilation
- Glazing Performance
  - U-Factor
  - Solar Heat Gain Coefficient
  - Visible Transmittance
  - Gas Fillings
  - Low-E Coatings
- Flashing (*beyond the scope of this presentation*)

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Natural Light

- IRC Section R303 (Light, Ventilation, and Heating)
  - **R303.1. Habitable rooms.** All habitable rooms shall have an aggregate glazing area of not less than 8 percent of the floor area of such rooms. Natural ventilation shall be through windows, doors, louvers or other approved openings to the outdoor air. Such openings shall be provided with ready access or shall otherwise be readily controllable by the building occupants. The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated.
  - Alternative: Artificial lighting.

54 2009 IRC R303.1

Definition: Habitable Rooms

- **HABITABLE SPACE**. A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered *habitable spaces*.

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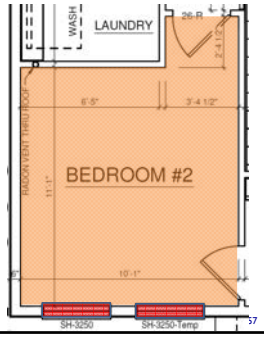
Example: Natural Light Calculation



- Bedroom = Habitable space
- Floor area = 120 SF
- Required glazing area = (120 SF) x (0.08) = **9.6 SF**

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Natural Ventilation

- IRC Section R303 (Light, Ventilation, and Heating)
  - **R303.1. Habitable rooms.** All habitable rooms shall have an aggregate glazing area of not less than 8 percent of the floor area of such rooms. Natural ventilation shall be through windows, doors, louvers or other approved openings to the outdoor air. Such openings shall be provided with ready access or shall otherwise be readily controllable by the building occupants. The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated.
  - Alternative: Mechanical ventilation.

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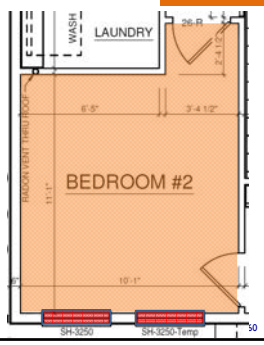
2009 IRC R303.1

Example: Natural Ventilation Calculation



- Bedroom = Habitable space
- Floor area = 120 SF
- Required openable area = (120 SF) x (0.04) = **4.8 SF**

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Glazing Performance

- Measures of performance
  - U-Factor
  - Solar Heat Gain Coefficient
  - Visible Transmittance
  - Air Leakage

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U-Factor

- Thermal Transmittance (U-Factor)
  - Rate at which a glazing unit transmits non-solar heat flow
  - Includes heat transfer by conduction, convection, and radiation
  - Area-weighted average (including glazing, frame, edge of glazing), not just center of glass

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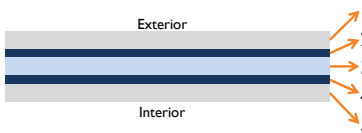
U-Factor for Double Glazing



1. Outside Air Film
2. Glass
3. Air space / gas filling
4. Glass
5. Inside Air Film

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Solar Heat Gain Coefficient (SHGC)

- Solar Heat Gain Coefficient (SHGC)
  - Ratio of solar heat passing through glass to solar heat falling on the glass at 90° angle
  - Fraction of solar radiation admitted through the unit and released as heat within the structure
    - Windows with high SHGC's allow more solar heat gain during the winter months (can be desirable in heating climates)
- Impact: Solar heat gained through windows can account for up to 40% of the heat removed through summer air conditioning
  - *Source: Residential Energy (Krigger)*

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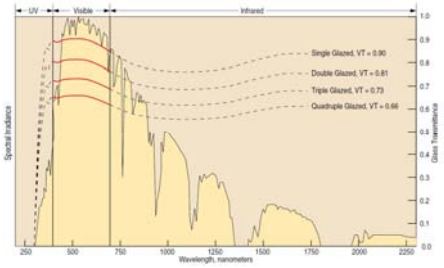
Visible Transmittance (VT)

- Visible Transmittance = fraction of the visible spectrum of light transmitted through a glazing unit



How Can Windows Be More Efficient?

- Strategies to Reduce U-Factor (Increase R-Value)
  1. Multiple panes
  2. Gas fillings
  3. Special coatings

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Gas Fillings

- Certain gases, such as argon, can improve the efficiency of windows when used as a filling in multiple-pane units
  - An argon filled layer between glass panes can have a higher R-Value than still air
  - Argon weighs more than air, thus reducing the impact of convection within the space

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Low-E Coatings

- Emissivity (e) = relative ability of a surface to emit radiant energy
  - Opposite of emissivity = reflectivity, or the ability of a surface to reflect or reject radiant energy
- Low-E, in the context of windows, refers to a metallic coating on one of the glazed surfaces (facing the air space) that is used to increase the energy efficiency of windows
  - In heating dominated climates, low-e coatings are used to lower U-factor
  - In cooling dominated climates, low-e coatings are used to lower SHGC

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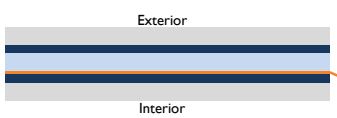
Low-E Coatings in Heating Climates



1. Outside Air Film
2. Glass
3. Air space / gas filling
4. Low-E coating
5. Glass
6. Inside Air Film

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What Does a Low-E Coating Do?

- A large portion of winter heat loss (in heating climates) through windows is through infrared radiation
  - Interior glass pane absorbs radiant heat
  - Low-E coating resists reradiation of heat through air space (and to the exterior)

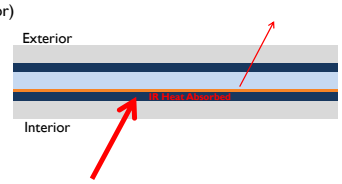

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TABLE N1102.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[k]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE AND DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	1.2	0.75	0.35[j]	30	13	3/4	13	0	0	0
2	0.65[j]	0.75	0.35[j]	30	13	4/6	13	0	0	0
3	0.50[j]	0.65	0.35[j]	30	13	5/8	19	5/13[f]	0	5/13
4 except Marine	0.35	0.60	NR	38	13	5/10	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	20 or 13 + 5[h]	13/17	30[g]	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	20 or 13 + 5[h]	15/19	30[g]	10/13	10, 4 ft	10/13
7 and 8	0.35	0.60	NR	49	21	19/21	30[g]	10/13	10, 4 ft	10/13

a. *R*-values are minimums. *U*-factors and solar heat gain coefficient (SHGC) are maximums. R-19 batts compressed in to nominal 2 × 6 framing cavity such that the *R*-value is reduced by R-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.
b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
c. The first *R*-value applies to continuous insulation, the second to framing cavity insulation; either insulation meets the requirement.
d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less, in zones 1 through 3 for heated slabs.
e. There are no SHGC requirements in the Marine Zone.
f. Basement wall insulation is not required in warm-humid locations as defined by Figure N1101.2 and Table N1101.2.
g. Or insulation sufficient to fill the framing cavity, R-19 minimum.
h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25% or less of the exterior, R-5 sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.
i. For impact-rated fenestration complying with Section R301.2.1.2, the maximum *U*-factor shall be 0.75 in zone 2 and 0.65 in zone 3.
j. For impact-resistant fenestration complying with Section R301.2.1.2 of the *International Residential Code*, the maximum SHGC shall be 0.40.
k. The second *R*-value applies when more than half the insulation is on the interior.

2009 IRC Table N1102.1

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SHGC in Climate Zones 4-6

- Why is the requirement for SHGC listed as "NR" for climate zones 4, 5, and 6? (all of PA)
  - PA is a heating dominated climate
  - Heat gained through solar radiation can reduce overall heating loads
    - Depends on orientation, size of glazing, materials, etc.

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Fenestration Exemption

- **N1102.3.3 Glazed fenestration exemption.** Up to 15 square feet (1.4 m2) of glazed fenestration per dwelling unit shall be permitted to be exempt from U-factor and SHGC requirements in Section N1102.1. This exemption shall not apply to the U-factor alternative approach in Section N1102.1.2 and the Total UA alternative in Section N1102.1.3.

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2009 IRC N1102.3.3

Fenestration Air Leakage

- **N1102.4.4 Fenestration air leakage.** Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cubic foot per minute per square foot [1.5(L/s)/m^2], and swinging doors no more than 0.5 cubic foot per minute per square foot [2.5(L/s)/m^2], when tested according to NFRC400 or AAMA / WDMA / CSA101 / I.S.2 / A440 by an accredited, independent laboratory, and listed and labeled by the manufacturer.
  - Exception: Site-built windows, skylights and doors.

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2009 IRC N1102.4.4

Glazing Performance Questions?

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Overall Summary

- Fenestration systems and units (windows) serve multiple purposes in residential construction
  - Occupant Safety
  - The Building Envelope
- Specification of fenestration systems are driven by code requirements and is based on:
  - Climate
  - Architectural placement
  - Energy efficiency goals

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References

- International Code Council (ICC). (2008). 2009 International Energy Conservation Code, Country Club Hill, Ill.
- International Code Council (ICC). (2008). 2009 International Residential Code, Country Club Hill, Ill.

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Evaluations / Certificate / Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

Link to Certificate:

http://www.cvent.com/d/lfq4z8/4W

Join us next month on Tuesday, May 10th at 1pm for the webinar titled
"Residential Deck Design and Construction"
Presenter: Chris Hine (PHRC)

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