2016 Energy Standards – Residential Envelope

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QUESTIONS...

• Please feel free to ask at anytime:
  ➢ During class
  ➢ During break
  ➢ @ the end of/after class
Goals for this Training

• Review over and clarify the residential envelope requirements in the 2016 Energy Standards for:
  ➢ Low-rise residential buildings (in sequential order of §)
  ➢ Newly constructed buildings, additions, and alterations

• Simplify compliance and enforcement of the Energy Standards during the:
  ➢ Plan review process
  ➢ Field inspection process
A Little CEC History

• Section 25402 of the Public Resources Code (known as the Warren Alquist Act)

• The act created the Energy Commission in 1974 and gave it authority to develop and maintain Building Energy Efficiency Standards

• Requires the Standards and new requirements to be cost effective over the economic life of the structure

• Requires the Energy Commission to update the Standards periodically (about every 3 years)
Let’s start with some Energy Standards Basics - 101
2016 Building Energy Efficiency Standards

• Effective on Jan. 1, 2017
  ➢ Building permit applications submitted on or after this date

• Master plans for tract homes affected:
  ➢ Need to resubmit if permits pulled on or after effective date
2016 Documents

- Building Energy Efficiency Standards
- Residential Compliance Manual
- Reference Appendices
- ALL available online

www.energy.ca.gov/title24/2016standards
Navigating The Energy Standards

TITLE 24 - THE CALIFORNIA BUILDING STANDARDS CODE

• Part 1 (Administrative Code)
  ➢ Chapter 10: the administrative requirements

• Part 6 (Energy Code)
  ➢ Subchapters 1 through 9
  ➢ Mostly referred to by Section #’s
  ➢ These are the technical requirements
Part 1 Section #'s

- 10-101 – Scope
- 10-102 – Definitions
- 10-103 – Requirements for Designers, Enforcement...
- 10-103.1 – Lighting ATTCP
- 10-103.2 – Mech. ATTCP
- 10-104 – Exceptional Designs
- 10-105 – CEC Enforcement
- 10-106 – Local Standards
- 10-107 – Interpretations
- 10-108 – Exemption
- 10-109 – Software & Registries
- 10-110 – Application Procedures
- 10-111 – Fenestration
- 10-112 – Default Tables
- 10-113 – Roofing Products
- 10-114 – Out. Lighting Zones
Part 6 Section #s for Res

- §110.0 – 110.10 as applicable
  - Cover both res and nonres

- §150.0 for res mandatory measures

- §150.1 for **ALL** prescriptive requirements
  - Newly constructed buildings

- §150.2 for additions and alterations
Low-Rise Residential

- Single family dwellings (any # of stories)
- Duplexes (any # of stories)
- Multi-family occupancies in any building 3 habitable stories or less
Requirements

• Mandatory measures
  - Minimum efficiency levels and requirements that must always be met
  - Can never trade off

• Prescriptive Measures
  - Set of predefined efficiency levels and requirements that comprise the Prescriptive Approach
  - Usually supersede mandatory measures
  - Different requirements for newly constructed buildings, additions, and alterations
Compliance Approaches

• Prescriptive Approach
  - Simplest approach, but less flexible (by-hand forms)
  - Establishes baseline for Standard home/budget under Performance Approach
  - Mostly used for alterations

• Performance Approach
  - Most flexible approach, allows for trade-offs
  - Requires the use of Energy Commission approved software
  - Mostly used for newly constructed homes and additions
## Compliance Documents (Forms)

<table>
<thead>
<tr>
<th>Certificate of Compliance</th>
<th>Residential</th>
<th>Nonresidential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificate of Compliance</td>
<td>CF1R</td>
<td>NRCC</td>
</tr>
<tr>
<td>Certificate of Installation</td>
<td>CF2R</td>
<td>NRCI</td>
</tr>
<tr>
<td>Certificate of Verification</td>
<td>CF3R</td>
<td>NRCV</td>
</tr>
<tr>
<td>Certificate of Acceptance</td>
<td>-</td>
<td>NRCA</td>
</tr>
</tbody>
</table>
Where can I find the forms?

Appendix A of the 2016 Residential Compliance Manual

http://www.energy.ca.gov/2015publications/CEC-400-2015-032/appendices/forms/
Project Status Report (PSR)

- Summarizes status of ALL forms
- Available for any project in HERS registry
- “Overall” and “HERS” should be marked Complete
  - Can access directly in registry
  - Can request as a hard copy in lieu of a stack of forms
Let’s talk about the Envelope
Mandatory Measures
Envelope Big Picture
Fenestration Definitions

Fenestration – a transparent or translucent material plus any sash, frame, mullions and dividers

U-factor – a measure of the heat transmission through the fenestration

Solar Heat Gain Coefficient (SHGC) – the fraction of solar radiation entering the space through the fenestration which is released as heat into the space
Fenestration Definitions cont.

Manufactured – preassembled glazing and frame
- Typical window or skylight

Site-Built – plant-fabricated and field-assembled
- Storefront or curtain wall system
- Referred to as knock-down

Field-Fabricated – field-made
- Custom made at site for a specific application
§110.6: Fenestration Labels

- Temporary labels are required for all fenestration
  - NFRC label (manufactured)
  - NFRC certificate (site-built)
  - Default values label (manufactured, site-built, field fabricated)

- Labels specify U-Factor, SHGC, and air leakage values
  - Used to determine/verify efficiency

- Most residential fenestration is manufactured, and must have NFRC label
## Temporary Labels

### World's Best Window Co.

**Millennium 2000+**
- Vinyl-Clad Wood Frame
- Double Glazing • Argon Fill • Low E
- Product Type: **Vertical Slider**

### ENERGY PERFORMANCE RATINGS

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>U-Factor (U.S./I-P)</td>
<td>0.30</td>
</tr>
<tr>
<td>Solar Heat Gain Coefficient</td>
<td>0.30</td>
</tr>
</tbody>
</table>

### ADDITIONAL PERFORMANCE RATINGS

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible Transmittance</td>
<td>0.51</td>
</tr>
<tr>
<td>Air Leakage (U.S./I-P)</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer’s literature for other product performance information. [www.nfrc.org](http://www.nfrc.org)

### 2016 California Energy Commission Default Label

**XYZ Manufacturing Co.**

<table>
<thead>
<tr>
<th>Key Features</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>□ Doors</td>
<td>□ Double-Pane</td>
</tr>
<tr>
<td>□ Skylight</td>
<td>□ Glass Block</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frame Type</th>
<th>Product Type</th>
<th>Product Glazing Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Metal</td>
<td>□ Operable</td>
<td>□ Clear</td>
</tr>
<tr>
<td>□ Non-Metal</td>
<td>□ Fixed</td>
<td>□ Tinted</td>
</tr>
<tr>
<td>□ Metal, Thermal Break</td>
<td>□ Greenhouse/Garden Window</td>
<td>□ Single-Pane</td>
</tr>
<tr>
<td>□ Air space 7/16 in. or greater</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ With built-in curb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Meets Thermal-Break Default Criteria</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>California Energy Commission</th>
<th>California Energy Commission</th>
<th>California Energy Commission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default U-factor =</td>
<td>Default SHGC =</td>
<td>Calculated VT =</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To calculate VT see NA6</td>
</tr>
</tbody>
</table>

Product meets the air infiltration requirements of §110.6(a)1, U-factor criteria of §110.6(a)2, SHGC criteria of §110.6(a)3 and VT criteria of §110.6(a)4 of the 2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings.
Air Leakage Definitions

**Infiltration** - uncontrolled air leakage from outside to inside, through cracks, joints, windows, doors, partitions or penetrations

**Exfiltration** - uncontrolled air leakage from inside to outside, through cracks, joints, windows, doors, partitions or penetrations
§110.7: Air leakage

- Must seal building envelope to limit infiltration and exfiltration

  - Where: Joints, penetrations, openings
    - Prefabricated items (like windows) need to be sealed into the envelope
    - Includes things like pipes penetrating a ceiling/attic or garage wall (unconditioned space)
  
  - How: Sealant/caulking, weather-stripping, or gasket
§110.8(g): Heated Slab Insulation

- Heated slab edge insulation requirements:
  - Install insulation per TABLE 110.8-A
  - Protect exposed material to wind, equipment, moisture, & UV
  - Terminate insulation to block insects from access to structure above foundation
§110.8(i): Roofing (Cool Roof)

- When a cool roof is required:
  - Product must be certified and labeled by the CRRC
    - Label specifies solar reflectance (SR) and thermal emittance (TE) efficiency values
  - Solar reflectance index (SRI) may be used as alternative which trades off between rated SR and TE values
  - Default values can be used for non-certified products
  - Liquid-applied roof coatings must meet TABLE 110.8-C
§110.8(j): Radiant barrier

- When a radiant barrier is required, the product must:
  - Have an emittance of 0.05 or less; and
  - Be tested per ASTM; and
  - Be certified to CA Department of Consumer Affairs
Insulation Definitions

R-value – capacity of an insulating material to resist heat flow

U-factor – a measure of the heat transmission through a wall, roof, floor, or a given thickness of a material
§150.0(a),(c): Ceiling/Roof & Wall Insulation

• Ceilings/Roof assemblies
  ➢ Minimum R-22 insulation between wood frame; or maximum average assembly U-factor of 0.043

• Wall assemblies
  ➢ Minimum R-13 insulation in 2x4 wood frame; or maximum average assembly U-factor of 0.102
  ➢ Minimum R-19 insulation in 2x6 & greater wood frame; or maximum average assembly U-factor of 0.074
§150.0(d),(f): Raised Floor & Slab Edge Insulation

- Raised floor assemblies
  - Minimum R-19 insulation between wood frame; or maximum average assembly U-factor of 0.037

- Slab edge insulation
  - When required, material must meet minimum specifications:
    - Water absorption
    - Water vapor permeance
    - Protection from UV & physical damage
§150.0(g): Vapor Retarder

• Climate Zones 14 & 16 only, a Class I or II vapor retarder is required on conditioned side of insulation in:
  - Exterior wall
  - Vented attics
  - Unvented attics having air-permeable insulation

• All Climate Zones, a Class I or II vapor retarder is required on grade for unvented spaces (and controlled vent spaces)

• What’s a *Class I, II, or III*?
  - I = perm ≤ 0.1
  - II = perm > 0.1 and ≤ 1.0
  - III = perm < 1.0 and ≤ 10.0
§150.0(q): Fenestration U-Factor

- Fenestration (including skylights & glass doors) must:
  - Have a U-factor of 0.58 or less; or
  - The weighted average of all fenestration cannot exceed 0.58 U-factor (meaning some can be higher if some are lower)
    - Should not be an issue for most homes with manufactured NFRC rated windows/skylights
    - Keep an eye out for custom windows (especially stained glass/decorative windows)
QUESTIONS...

About the mandatory measures?
Let’s talk about the Envelope
Prescriptive Measures
(New construction)
§150.1(c)1A: Ceiling/Roof Insulation Summary

• Introduction of “high performance attics” requirements

• 3 options available

• Insulation required at ceiling and roof depending on option and Climate Zone

• Radiant barrier and duct location/insulation requirements also depend on option and Climate Zone
§150.1(c)1Ai: Ceiling/Roof Insulation cont.

- **Option A**
  - Per TABLE 150.1-A
    - Continuous insulation required above roof rafters in some Climate Zones
    - Ceiling insulation required
    - Radiant barrier required in Climate Zones 2 through 15
    - Vented attic space
§150.1(c)1Aii: Ceiling/Roof Insulation cont.

- Option B

- Per TABLE 150.1-A
  - Insulation required below roof deck in some Climate Zones
  - Ceiling insulation required
  - Radiant barrier required in Climate Zones 2, 3 and 5 through 7
  - Vented attic space
§150.1(c)1Aiii: Ceiling/Roof Insulation *cont.*

- **Option C**
  - Per TABLE 150.1-A
    - Ceiling insulation required
    - Radiant barrier required in Climate Zones 2 through 15
    - Ducts must be located in conditioned space (HERS verified)
    - Vented attic space
§150.1(c)1B: Wall Insulation

- “High performance walls” requirements introduced
- Per TABLE 150.1-A:
  - Maximum U-factor specified
  - Required value lowered (more stringent)
  - Provides for greater design flexibility
  - Requirements for below grade walls
§150.1(c)1C,D: Raised Floors & Slab Perimeter Insulation

• Raised floors
  ➢ Minimum R-19 insulation between wood frame; or maximum average assembly U-factor of 0.037 (same as mandatory)
  ➢ Requirements for raised concrete slab in TABLE 150.1-A

• Slab perimeter
  ➢ Climate Zone 16 only
    ▪ Minimum R-7 continuous insulation; or maximum average assembly U-factor of 0.58
§150.1(c)2: Radiant Barrier

- Radiant barrier required per HPA Options A, B, or C:
  - Must be installed according to Reference Residential Appendix RA4.2.1
    - Including on gable ends
    - Usually installed laminated (which is perforated) to OSB board for new construction
  - Attic space must meet free ventilation area requirements
§150.1(c)3,4: Fenestration

- Fenestration must meet requirements per TABLE 150.1-A:
  - Maximum U-factor of 0.32
  - Maximum SHGC of 0.25
    - Climate Zones 2, 4, 6–16
  - Maximum total fenestration area of 20%
  - Maximum total west-facing area of 5%
    - Climate Zones 2, 4, 6–16
Roofing Definitions

Low-sloped – rise to run 2:12 or lower
Steep-sloped – rise to run higher than 2:12

Solar Reflectance (SR) - ability to reflect solar energy from the sun back into the atmosphere

Thermal Emittance (TE) - the ability to release heat that has been absorbed

Solar Reflectance Index (SRI) - combines SR three year *aged* value and TE in an equation
§150.1(c)11: Cool Roofs

- Roofing product must meet requirements per TABLE 150.1-A:
  
  ➢ Steep-sloped roofs:
    - Climate Zones 10 – 15
      ✓ Minimum aged solar reflectance of 0.20; and
      ✓ Minimum thermal emittance 0.75
      ✓ **OR**, minimum solar reflectance index (SRI) of 16
  
  ➢ Low-sloped roofs:
    - Climate Zones 13 and 15
      ✓ Minimum aged solar reflectance of 0.63; and
      ✓ Minimum thermal emittance of 0.75
      ✓ **OR**, minimum SRI of 75
QUESTIONS...

About the prescriptive requirements?
Performance Approach

• Can trade off between prescriptive requirements
  ➢ Including with other envelope measures and/or HVAC, water heating, HERS testing/verification, etc.

• Envelope HERS compliance credits
  ➢ Quality Insulation Installation (QII)
  ➢ Envelope leakage (blower door test)
Envelope Plan Review

- Verify efficiencies on CF1R form match plans (schedules, architectural/structural, etc.):
  - Assembly R-Values and insulation type
  - Fenestration U-Factor, SHGC, and areas
  - Radiant barrier
  - Cool roof solar reflectance and thermal emittance (or SRI)
  - HERS testing/verification

- Can require mandatory measures summary
Envelope Field Inspection

- Verify efficiencies and installation during respective stage of construction:
  
  ➢ Foundation Inspection
    - Slab edge insulation R-value and installation
  
  ➢ Rough Frame Inspection
    - NFRC labels on fenestration
    - CRRC label for cool roof
    - Radiant barrier in attic, including on gable ends
  
  ➢ Insulation Inspection
    - Walls, ceiling/attic, and raised floor insulation R-values (and sealing)
  
  ➢ Final Inspection
    - All ENV CF2R and CF3R forms are completed and registered when required (use PSR)
Let’s talk about Additions & Alterations (Prescriptive Approach)
§150.2(a): Additions

- Additions ≤ 700 ft² have less stringent requirements:
  - Meet mandatory ceiling insulation R-22
  - Extension of wood frame walls allowed to be same dimensions
  - Cool roof not required for additions ≤ 300 ft²
  - Climate Zones 2, 4, and 6–16
    - Allowed 60 ft² of west facing fenestration
    - For additions ≤ 700 ft² and > 400 ft², total allowed fenestration is greater of: 120 ft² or 25% of CFA
    - For additions ≤ 400 ft², total allowed fenestration is greater of: 75 ft² or 30% of CFA
§150.2(b)1A: Fenestration Alterations

- **When adding** fenestration, must meet same efficiency and area requirements as new construction
  - Exempt from area requirements when:
    - Add fenestration area ≤ 75 ft\(^2\)
    - Add skylight area ≤ 16 ft\(^2\), with 0.55 U-factor & 0.30 SHGC

- **When replacing** fenestration, must meet same efficiency requirements as new construction
  - Exemptions to efficiency requirements:
    - Replacement fenestration area ≤ 75 ft\(^2\) with 0.40 U-factor & 0.35 SHGC
    - Skylights with 0.55 U-factor & 0.30 SHGC
§150.2(b)1H: Re-Roofs

- When replacing > 50% of the roof:
  - Product must meet same cool roof requirements for new construction
  - Only the altered roofing area need comply
  - There are several exceptions for both steep-sloped roofs and low-sloped roofs

* See new Cool Roof Brochures!
Alterations and Additions Forms

• Available online
• Interactive instructions
• Dynamic
  ➢ Scope specific
  ➢ Add and delete table rows
  ➢ Simple logic
Alterations and Additions
Forms Exception §10-103

• For alterations, and additions < 300 ft² that do not require HERS testing:
  ➢ Building Department has the discretion to exempt CF1R and CF2R form requirements, or create simplified versions

• Does not exempt applicant from complying with code

• Can include requirements on permit application