BUILDING ENVELOPE REQUIREMENTS

CHAPTER 5

COMMERCIAL ENERGY EFFICIENCY

2011 New York City Energy Conservation Code

Effective December 28, 2010

Acknowledgements

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Welcome to the New York City Department of Buildings Energy Code Training Modules!

This **ENVELOPE** Module addresses:

- Technical issues and strategies related to the 2011 NYCECC;
- Applicability of the 2011 NYCECC;
- NYC DOB Energy Code Submission Requirements; and
- NYC DOB Progress Inspection Requirements.

This module addresses envelope criteria related to all commercial building types, including Group R Buildings as follows: R-1 uses (any height); R-2 and R-3 residential uses when over 3 stories.

Envelope criteria related to low-rise residential buildings are covered under the NYC DOB Residential Training Module.

Training Module Organization

- The **ENVELOPE** Module has been divided into a number of smaller sub-topics. These can be accessed either in-sequence or out-of-sequence through links in the main “Menu” slide.
- Each sub-topic begins with a brief overview of the issues to be reviewed, and many end with a set of summary questions or exercises.
- Many of the sub-topics are organized in a Q & A format. Code-related questions are posed at the top of a slide, with answers provided below, or in the following sequence of slides.

Slide Navigation Guide

Look for the Following Icons:

The **NYC Buildings** logo takes you to the NYCECC 2011 Training Modules home page.

The **Menu** icon takes you to the main menu page within each module.

The **Attention** icon brings up Callouts with key points and additional information.

The **Links** icon takes you to related DOB web pages or other resources.

The **Documentation** icon addresses DOB documentation issues and requirements.

The **Inspection** icon addresses DOB Progress Inspection issues and requirements.

The **Code Reference** icon refers to relevant Code sections.

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The **Documentation** icon add

The slides are enhanced with special icons that will help to focus on key points, or serve as links to external resources. The Attention icon brings up Callouts (like this one) with key points and additional information.

The **Inspection** icon addresses DOB Progress Inspection issues and requirements.

The **Code Reference** icon refers to relevant Code sections.

Envelope Module Menu

Slide Navigation

Click on a Sub-Module to Navigate Directly to Corresponding Slides

Envelope Module Menu

Slide Navigation

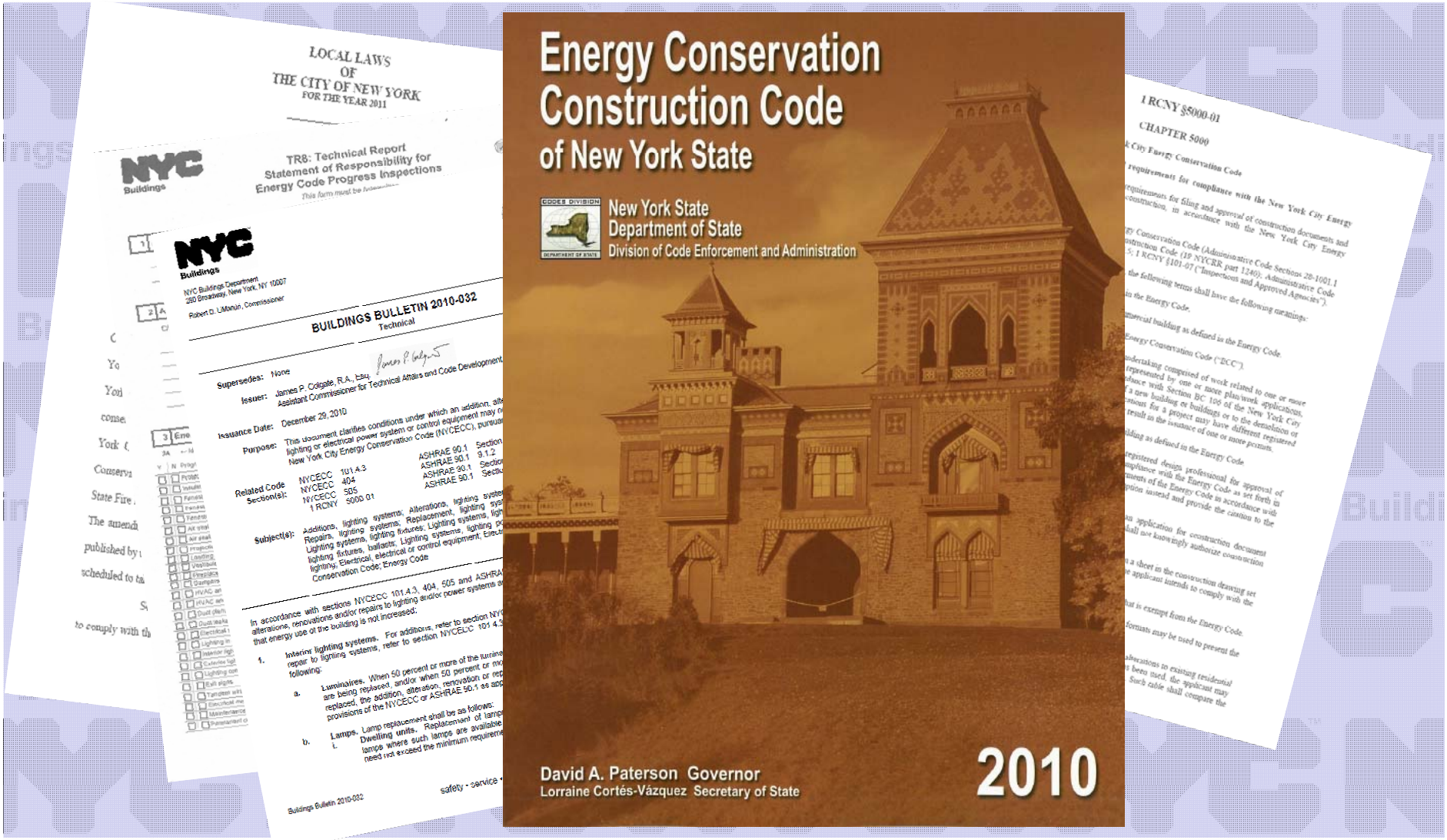
Click on a Sub-Module to Navigate Directly to Corresponding Slides

The main menu slide is interactive; clicking on each line item will take you to the respective sub-module. Use this feature to navigate throughout the presentation. The menu icon at the bottom right corner of each slide will always bring the you back to the main menu slide.

Building Envelope

Slides 8 to 13

1. What's New in the 2011 NYCECC



1. What's New in the NYCECC

Sub-Module Overview

In this section you will learn about:

- Key changes and additions in the 2011 NYCECC related to building envelope; and
- Current local laws, rules, & bulletins affecting envelope compliance.

Key Updates for the 2011 NYCECC

? **What are the Major Changes to the Envelope Section in the New Code?**

Simplified, Streamlined & More Comprehensive:

- All new buildings, renovations, alterations & repairs are required to comply
- Climate zone classifications are simplified
  - Single zone for all NYC boroughs, both residential & commercial (Zone 4A)
- Commercial building definition (Group R) expanded
  - Now includes Group R-3 over 3 stories
- Section by section compliance no longer allowed
  - All NYCECC Chapter 5 - OR - All ASHRAE 90.1-2007
  - Chapters 1, 2, 3, & 6 of the NYCECC still apply in either scenario

What are the Major Changes to the Envelope Section in the New Code?

Simplified, Streamlined & More Comprehensive:

- Performance requirements include U-Factor alternative
  - Offers Trade-offs within envelope assemblies without energy modeling
- Fenestration requirements are revised
  - Eliminates fenestration-to-wall area % factors, except the overall 40% threshold for prescriptive or envelope trade-off path (commercial only)
  - Includes options for frame types (commercial only)
  - Envelope & glazing tables fit in 1 page instead of 14
- Air leakage requirements are expanded
  - Limitations for opaque elements & fenestration
  - Requirements for air impermeable insulation
  - Continuous air barriers
  - Lighting fixtures recessed in thermal envelope

Simplified, Streamlined & More Comprehensive

- Siding attachment requirements added for foam sheathing
- Vapor retarders & moisture control requirements are not mandated for NYC boroughs
  - Mandatory requirements apply to NYS Climate Zones 5 & 6, but not 4
  - See also NYC Building Code about vapor barriers

Local Laws, Rules & Bulletins

? What NYCECC-Related Local Laws, Rules, or Bulletins Affect the Envelope?

Local Laws

- LL1 – Established the current 2011 NYCECC

Rules

- 1 RCNY §5000-01
  - Defines Energy Code submission procedures, including requirements to include progress inspections in drawings
- 1 RCNY §101-07
  - Defines qualification requirements for individuals performing progress inspections

Bulletins

- Buildings Bulletin 2011–015
  - Provides interpretations of Energy Code applicability to envelope additions, alterations, renovations, or repairs
  - Additional details are provided in the Code applicability section of this module

Building Envelope

Slides 14 to 23

2. Code Applicability

Photo: Comstock / Jupiter Images

2. Code Applicability

Sub-Module Overview

In this section you will learn about:

- DOB terminology related to NYCECC applicability;
- Differences in applicability for New Construction, Additions, Alterations, Renovations, and Repairs; and
- Allowable Exemptions and Exceptions related to Building Envelope.

General Terminology - 1

? What is the Terminology Used by DOB Related to Code Applicability?

The Code:

- The NYCECC is law.
- It applies to all buildings, new and existing, unless explicitly stated otherwise.

Rules:

- Rules are prepared by the DOB to implement the Code.
- Rules must go through a formal administrative public comment process.
- Rules have the force of law.

Bulletins:

- Bulletins are issued by the DOB, in part to clarify interpretations of the codes.
- They may change more frequently than laws or rules.

The DOB website is always updated to reflect all changes to laws, rules and bulletins. Check the website frequently.

General Terminology - 2

? What is the Terminology Used by DOB Related to Code Applicability?

Exemptions:

- Exemptions define specific building types or building elements that are not required to meet the Code, and are addressed in the PW1 form when they constitute the entire application.
- The following are the **only** allowed exemptions to the NYCECC:
  - Historic buildings (per §ECC 101.4.2, 1 RCNY §5000-01)
    - » National or State designated historic buildings
    - » Buildings certified as contributing buildings within a National or State historic district
    - » Buildings certified as eligible for the designations above
    - » City level certification does not qualify for exemptions
  - The envelopes of low-energy buildings (buildings with peak design rate of energy use <3.4 Btu/h/SF, or unconditioned buildings) or spaces
  - Temporary buildings under Administrative Code §28-111 and §BC 3203
  - The following work types, which are categorized as not affecting energy use:
    - » FA (fire alarm), FP (fire suppression in a range hood), SD (standpipe), SP (sprinklers), FS (fuel storage), EQ (construction equipment), CC (curb cut), OT/BPP (Builder's Pavement Plan), OT/FPP (Fire Protection Plan)

Historic Buildings: NYCECC: 101.4.3, LL 01 of 2011, §5000-1; Low Energy Buildings: NYCECC 101.5.2

General Terminology - 3

? **What are Exceptions?**

Exceptions:

- Exceptions are conditions under which specific provisions of the Code may not be required.

- Exceptions to Section NYCECC 101.4.3, Alterations, apply only if they do not result in increased energy use of the building.
  - There are 8 exceptions in this section; 6 of these exceptions apply to envelope.

§NYCECC 101.4.3

? What are the Potential Envelope Exceptions or Relief in Alterations/Renovations?

Per NYCECC 101.4.3:

- Work that creates:
  - Unsafe or hazardous conditions
  - Overloading of existing building systems
- DOB Interpretation(per Bulletin 2011-015)
  - Insulation of existing walls or portions of existing walls may be omitted if the applicant can demonstrate that the installation of insulation would create conditions such as freeze-thaw and cracking of the element, or mold in or around the element.

Exceptions and other conditions relieved from compliance by Section NYCECC 101.4.3 must be identified in the applicant's energy analysis, with citations to Code, 1 RCNY §5000-01 and/or Bulletins provided.

§NYCECC 101.4.3

? What are the Potential Envelope Exceptions or Relief in Alterations/Renovations?

Per NYCECC 101.4.3:

- Storm windows installed over existing fenestration
- Glass-only replacements in an existing sash and frame
  - U-Factor and SHGC must be equal to or lower than existing glass
  - Per Bulletin: Exception includes glass-only replacements within curtain wall panels to remain
- Alterations of roof/ceiling, wall or floor cavity, if they are already filled to full depth with insulation of R-3/inch or more
- Alterations/renovations/repairs to walls and floors where the existing structure is without framing cavities, and no new cavities are created

§NYCECC 101.4.3

? What are the Potential Envelope Exceptions or Relief in Alterations/Renovations?

Per NYCECC 101.4.3:

- Re-roofing where neither sheathing nor insulation is exposed
- Replacement of existing exterior doors does not require installation of revolving doors or vestibules, but existing vestibules must not be removed.

Per Buildings Bulletin 2011–015:

- Additional interpretations are provided for:
  - Curtain wall panel replacements
  - Roofs, including roof setbacks
  - Ceilings under unconditioned roof attics
  - Below grade walls
  - Slabs-on-grade
  - Interior renovations
  - Sunrooms and greenhouses
  - Rainscreens
  - Sealing
  - Zoning and property line conflicts
  - Trade-offs

Applicability for Different Scopes of Work

New Buildings

- All must comply via Prescriptive or Performance-Based Approaches (see topic 3 of this module)
- Only exemption is for envelope in low-energy/unconditioned buildings

Additions

- Must comply either:
  - As a stand-alone addition, or
  - Along with the existing building as a single entity

Alterations / Renovations

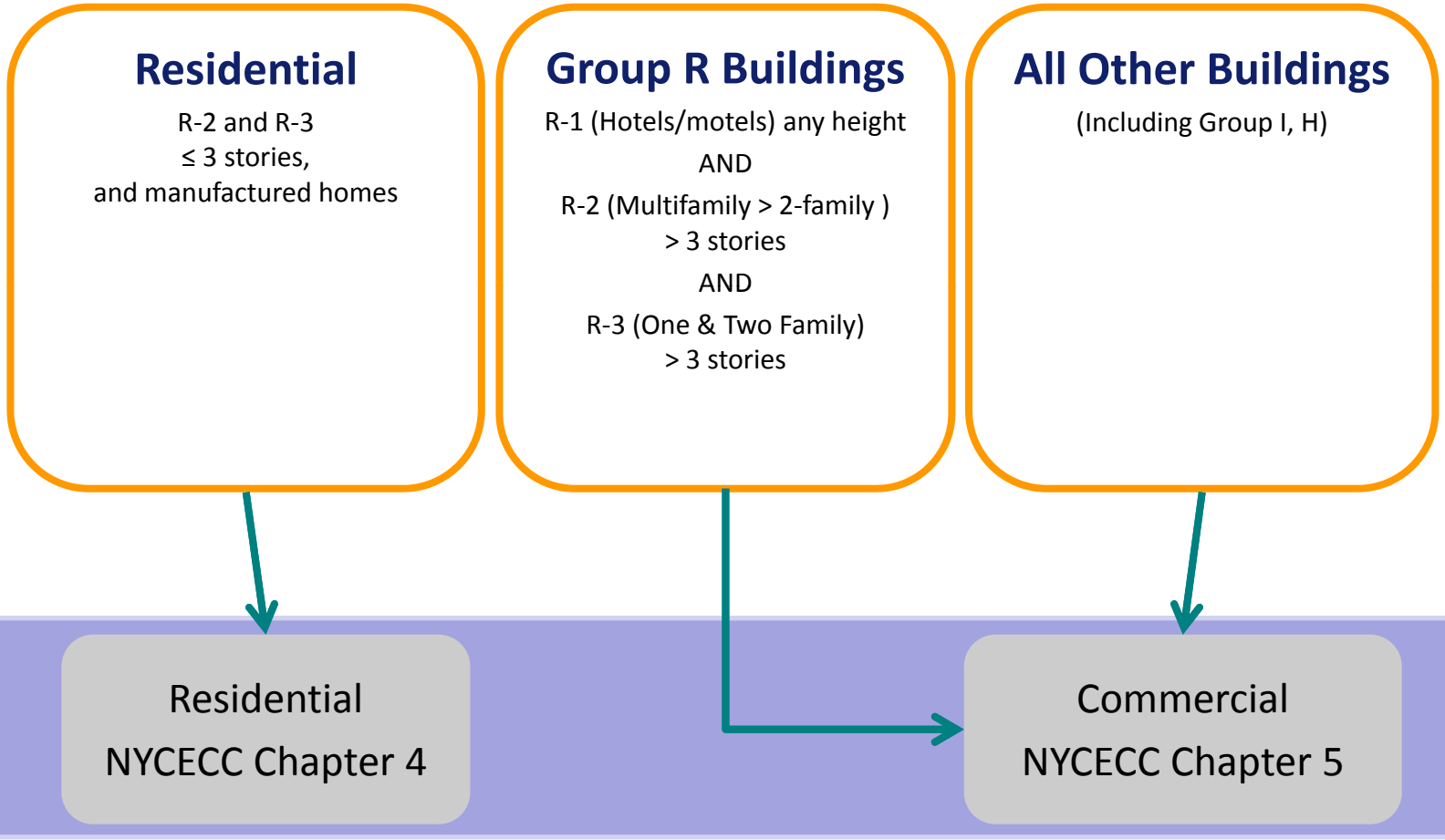
- Only applies to scope of alteration work; unaltered portions are not required to comply
- Some exceptions may apply (see NYCECC 101.4.3 and per Bulletin 2011-015)

Repairs

- Technically applies even if a permit is not required (e.g., window or roof replacements or repairs)

Applicability by Building Type

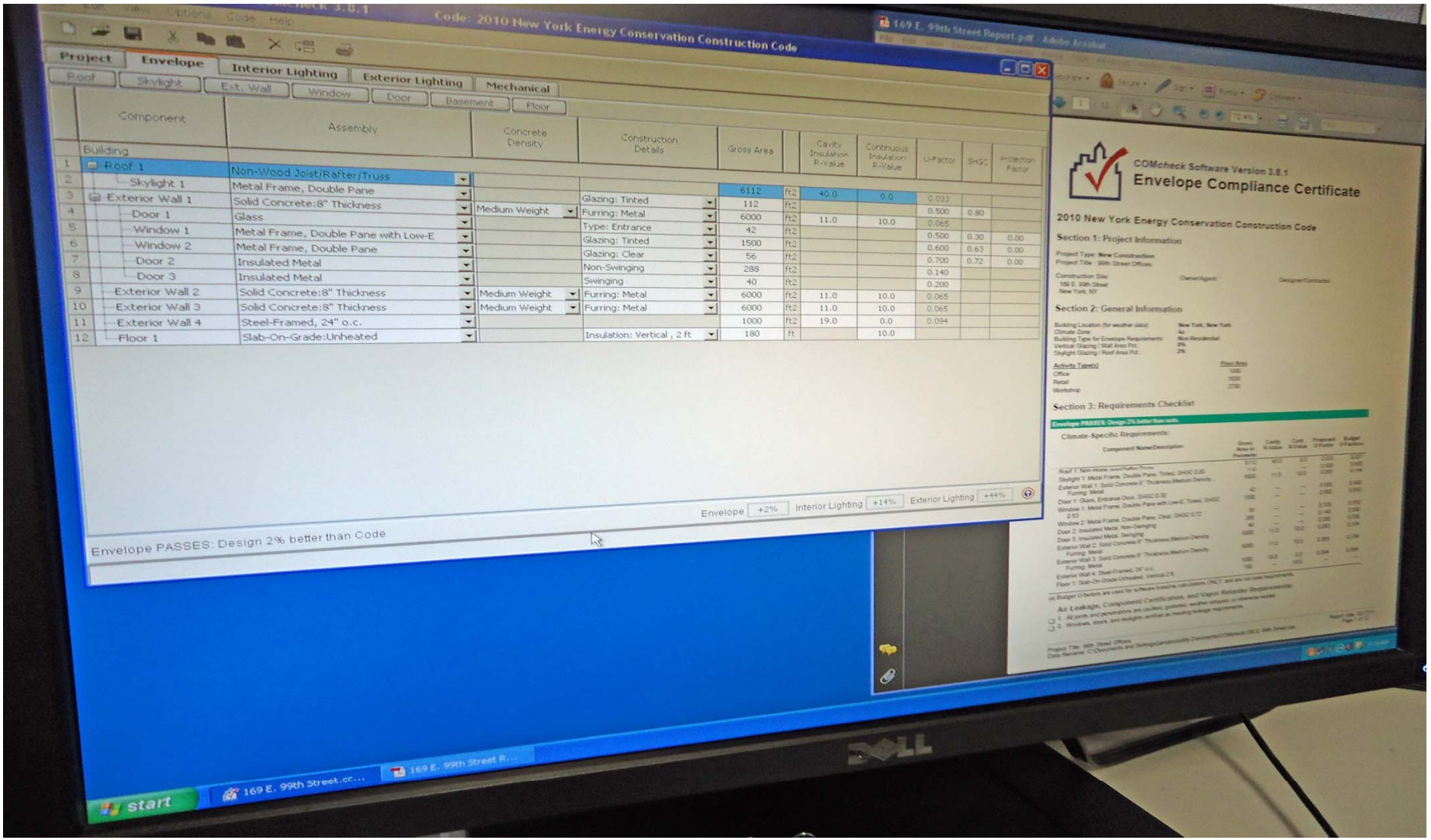
? Which Chapters of the Code Apply to Different Building Types?



Building Envelope

Slides 24 to 39

3. Methods of Compliance



3. Methods of Compliance

Sub-Module Overview

In this section you will learn about:

- Mandatory Provisions of the NYCECC related to Envelope design;
- Prescriptive versus Performance-based Compliance Paths; and
- Using the ANSI/ASHRAE/IESNA Standard 90.1-2007 instead of the NYCECC.

Code Structure

3. Methods of Compliance

Mandatory Requirements

May include
design features &
construction practices

NOT subject to Trade-offs

+

Prescriptive or Performance Targets

Minimum criteria apply
at the component, system,
or whole building level

Trade-offs allowed, depending on compliance path

Requirements common to all Compliance Paths

Compliance Paths:

Prescriptive / Trade-off / Performance-based

Code Structure

3. Methods of Compliance

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It is important to understand the basic structure of the Energy Code.

Mandatory requirements are defined throughout Chapters 4 and 5 of the NYCECC, and are not subject to any type of Trade-off.

Additional NYCECC provisions can be satisfied through Prescriptive compliance, Trade-offs, or a Performance-based approach.

The following slides describe each type of NYCECC provision in more detail.

? **What are the Mandatory Provision Categories for Envelope Design?**

Air Leakage:

- Includes provisions for:
  - Maximum allowable leakage of window, storefront, curtainwall, and door assemblies
  - Continuous Air Barriers
  - Outdoor Air Intakes and Exhaust Openings
  - Loading Dock Weatherseals
  - Vestibules
  - Recessed Lighting within the thermal envelope
  - See Topic 9 of this Module for further review of Air Leakage Requirements

Vapor Retarders:

- Vapor retarder requirements do **NOT** apply to NYC (Climate Zone 4a)

Even though the NYCECC does not require vapor retarders, the NYC Building Code does generally require them (with the noted exceptions).

Per NYC Building Code, section BC 1403 - Performance requirements for Exterior Walls:

1403.2 Weather protection. Protection against condensation in the exterior wall assembly shall be provided in accordance with the NYCECC.

1403.3 Vapor Retarder. An approved vapor retarder shall be provided.

Exceptions:

1. Where other approved means to avoid condensation and leakage of moisture are provided.
2. Plain and reinforced concrete or masonry exterior walls designed and constructed in accordance with Chaps. 19 and 21, as applicable.

Compliance Paths

Options:

- 2011 NYCECC offers three compliance methods for envelope:

  1. **Prescriptive**
     - » Through Opaque Assembly and Fenestration Tables

  2. **Trade-off**
     - » Through U-Factor approach and COMCheck

  3. **Performance-based**
     - » Through energy modeling

- Code also allows use of the ANSI/ASHRAE/IESNA 90.1-2007 standard ("ASHRAE 90.1") as an alternative compliance method
  - ASHRAE 90.1 also offers Prescriptive, Trade-off & Performance Paths

Path 1: Prescriptive

Level of effort: Simplest

- Prerequisites:
  - WWR (Window Wall Ratio): Must be ≤ 40%
  - SRR (Skylight-Roof Ratio): Must be ≤ 3%
- Each assembly must meet or exceed the prescribed thermal properties
  - R-Values of insulation for Walls, Roofs, Slabs
  - U Factors for doors and fenestration
  - SHGC for fenestration

Energy Analysis documentation will typically be through a Tabular Analysis or through COMCheck. See topic 10 of this module for details.

NYC BOROUGHS (Climate Zone 4A) Prescriptive R-Value Table		All Other Commercial	Group R, >3 Stories
Roofs			
	Insulation entirely above deck	R-20ci	R-20ci
	Metal buildings	R-13 + R13	R-19
	Attic & Other	R-38	R-38
Walls, Above Grade			
	Mass	R-9.5ci	R-11.4ci
	Metal building	R-19	R-19
	Metal framed	R-13 + R-7.5ci	R-13 + R-7.5ci
	Wood frame and other	R-13	R-13 + R-3.8ci
Below - Grade Walls		NR	R-7.5ci
Floors			
	Mass Floor	R-10ci	R-10ci
	Joist / Framing / Steel / Wood Floor	R-30	R-30
Slabs			
	Unheated Slab	NR	R-10 for 24 in Below
	Heated Slab	R-15 for 24in Below	R-15 for 24in Below
Opaque Doors			
	Swinging Door	U-0.70	U-0.70
	Roll-Up Sliding Door	U-0.50	U-0.50

NYCECC Table 502.2.(1)

Path 2: Trade-Off

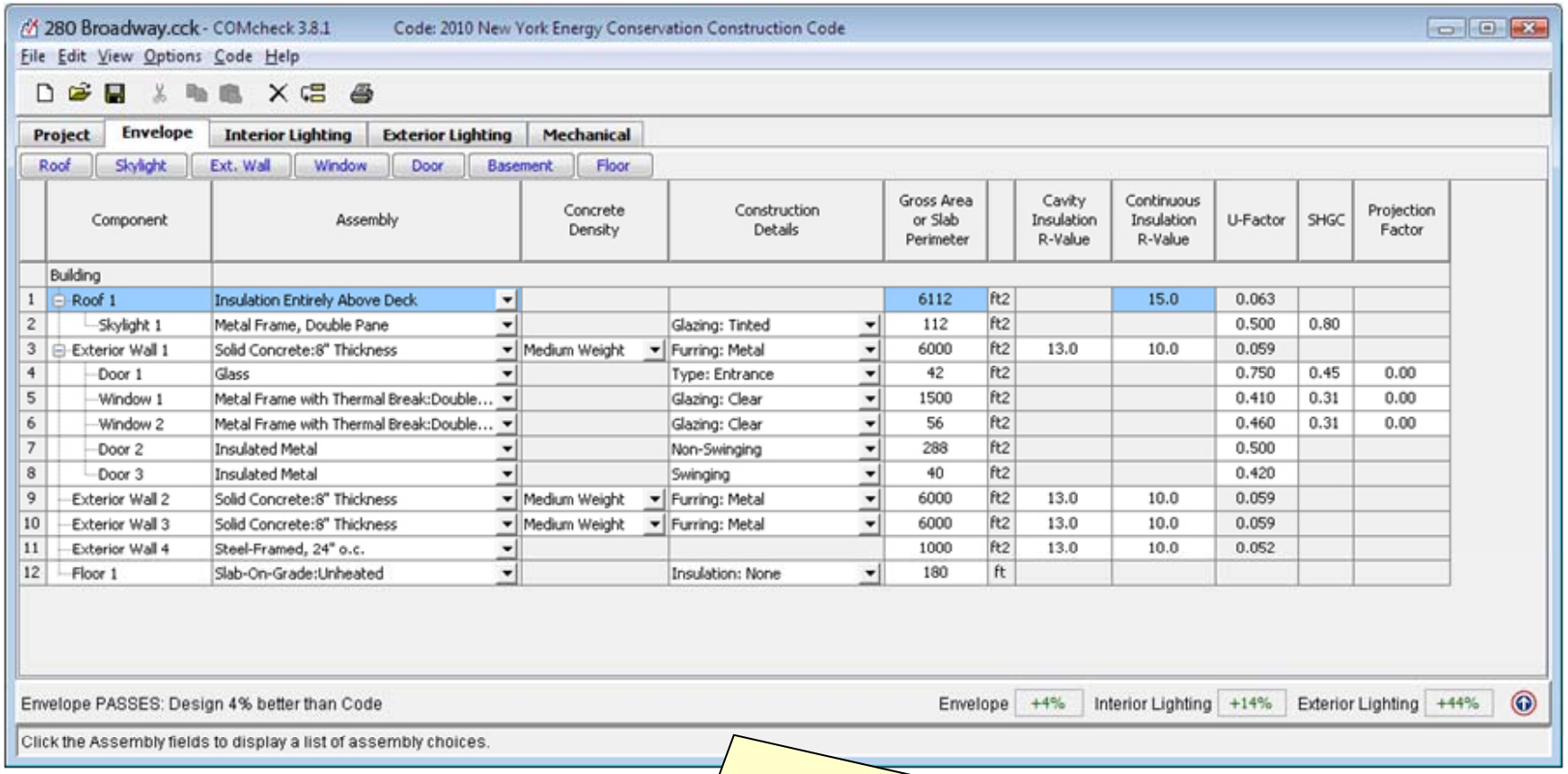
Level of Effort: Simple to Moderate

- Prerequisites:
  - WWR ≤ 40%
  - SRR ≤ 3%
- Compliance is demonstrated through U-Factor Alternative approach
  - Based on U–Factor / C-Factor / F-Factor Tables
- Weighted average value per component type is allowed
  - Example: Non-compliance in one roof assembly can be compensated for by using more insulation in another roof assembly
- If COMcheck is used, Trade-offs can be performed among different envelope components (roofs, walls, fenestration)

NYC BOROUGHS (Climate Zone 4A) U-Factor Alternative Table		All Other Commercial	Group R, >3 Stories
Roofs			
	Insulation entirely above deck	U - 0.048	U - 0.048
	Metal buildings	U - 0.055	U - 0.055
	Attic & Other	U - 0.027	U - 0.027
Walls, Above Grade			
	Mass	U - 0.104	U - 0.09
	Metal building	U - 0.084	U - 0.084
	Metal framed	U - 0.064	U - 0.064
	Wood frame and other	U - 0.089	U - 0.064
Below - Grade Walls		C - 1.14	C - 0.119
Floors			
	Mass Floor	U - 0.087	U - 0.074
	Joist / Framing / Steel / Wood Floor	U - 0.033	U - 0.033
Slabs			
	Unheated Slab	F - 0.73	F - 0.54
	Heated Slab	F - 0.86	F - 0.86

Path 2: Trade-Off – COMcheck Example

3. Methods of Compliance



	Component	Assembly	Concrete Density	Construction Details	Gross Area or Slab Perimeter		Cavity Insulation R-Value	Continuous Insulation R-Value	U-Factor	SHGC	Projection Factor
	Building										
1	Roof 1	Insulation Entirely Above Deck			6112	ft2		15.0	0.063		
2	Skylight 1	Metal Frame, Double Pane		Glazing: Tinted	112	ft2			0.500	0.80	
3	Exterior Wall 1	Solid Concrete:8" Thickness	Medium Weight	Furring: Metal	6000	ft2	13.0	10.0	0.059		
4	Door 1	Glass		Type: Entrance	42	ft2			0.750	0.45	0.00
5	Window 1	Metal Frame with Thermal Break:Double...		Glazing: Clear	1500	ft2			0.410	0.31	0.00
6	Window 2	Metal Frame with Thermal Break:Double...		Glazing: Clear	56	ft2			0.460	0.31	0.00
7	Door 2	Insulated Metal		Non-Swinging	288	ft2			0.500		
8	Door 3	Insulated Metal		Swinging	40	ft2			0.420		
9	Exterior Wall 2	Solid Concrete:8" Thickness	Medium Weight	Furring: Metal	6000	ft2	13.0	10.0	0.059		
10	Exterior Wall 3	Solid Concrete:8" Thickness	Medium Weight	Furring: Metal	6000	ft2	13.0	10.0	0.059		
11	Exterior Wall 4	Steel-Framed, 24" o.c.			1000	ft2	13.0	10.0	0.052		
12	Floor 1	Slab-On-Grade:Unheated		Insulation: None	180	ft					

In this non-residential COMcheck example, the roof insulation R-value is below the prescriptive requirement of R-20; however overall envelope compliance has been achieved through improved performance of the exterior walls, windows, and doors.

Path 3: Total Building Performance

Level of Effort: High

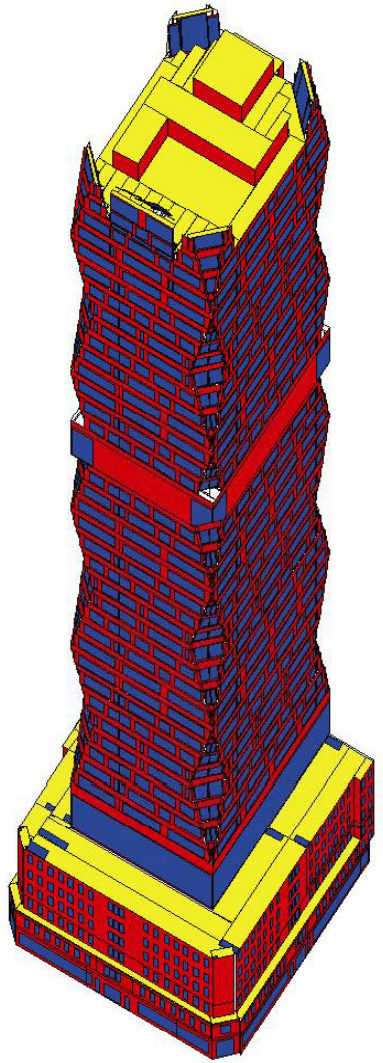
- Energy Modeling, per Section NYCECC 506 or using the Energy Cost Budget Method from ASHRAE 90.1, is used to demonstrate that:

Total Annual Energy Cost of the Proposed Building Design

is less than or equal to

Total Annual Energy Cost of the Budget Building Design

- Budget Building Design:
  - Meets mandatory & prescriptive Code requirements
- Proposed Building Design:
  - Meets mandatory requirements, but non-compliant parts (usually glass façade, sometimes lighting) are offset by high-performance parts (e.g., lighting, HVAC, central plant, cogeneration)



Path 3: Total Building Performance

? When Would a Project Pursue the Total Building Performance Approach?

Envelope–related Scenarios:

- Fenestration Area exceeds 40% of wall or 3% of roof
- Fenestration does not meet SHGC of 0.40
  - Example: Lower-performing low-e coating on clear glass
- Difficult or costly to insulate existing exterior walls to meet prescriptive R-Values or U-Factors

Other Potential Reasons:

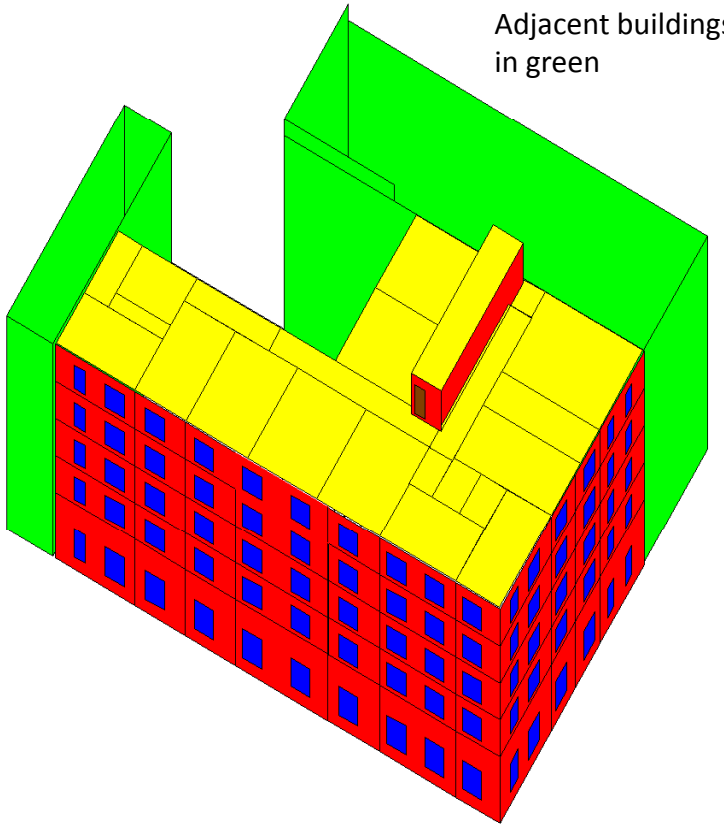
- Project exceeds prescriptive interior Lighting Power Densities
- Project is pursuing a LEED rating, and requires energy modeling
- Project is pursuing energy-efficiency incentives (e.g., NYSERDA, Con Edison), and requires energy modeling
- Project uses Trade-offs among disciplines

Energy Modeling Example -1

Multi-Story Residential Building

Residential Scenario:

- Modeling is used to assess the effects of varying:
  - (WWR)
  - Glazing Wall insulation values
  - Glazing areas U-Factor
  - Glazing Solar Heat Gain Coefficient
  - Lighting Power (owner-installed)
  - Equipment Efficiencies (boilers)

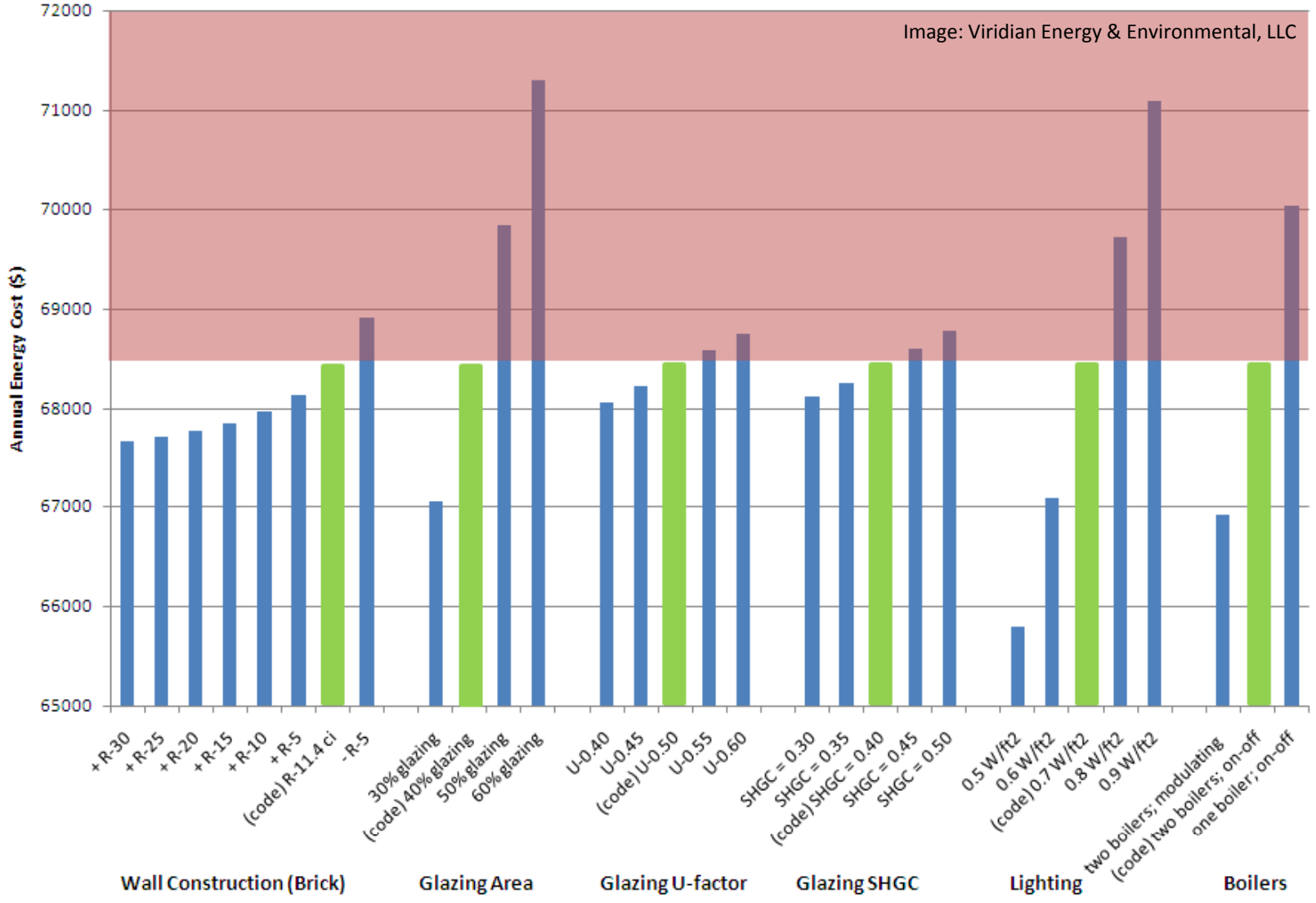


Sample Multi-story Residential Building
Analysis Using DOE-2 Software

Energy Modeling Example - 2

3. Methods of Compliance

Multi-Story Residential Building



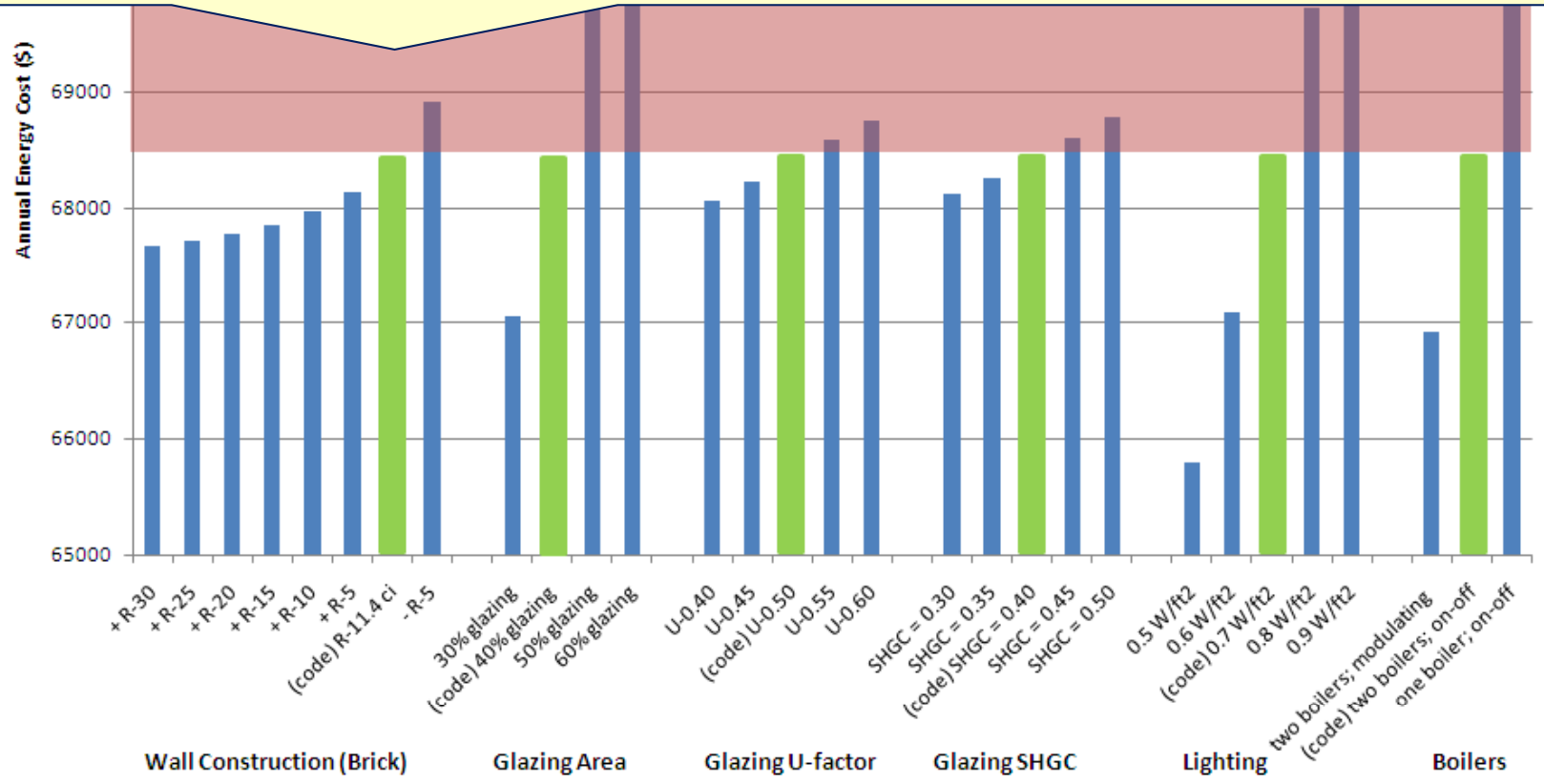
Energy Modeling Example - 2

This chart shows the energy use impact of different building components, as calculated through energy modeling of a sample multi-story residential building.

Different building systems (wall construction, glazing area, etc.) are shown in the six groups below. Within each group, the bar shaded in green represents the minimum prescriptive NYCECC requirement. Measures to the left of the green bar perform better than the Code minimum, while measures to the right perform worse. Any bars crossing into the red shaded portion of the graph perform worse than Code requirements.

The chart shows how certain design decisions, such as increasing the building's glazing area above 40% WWR, correspondingly increase the building's energy use. To achieve NYCECC compliance, the building must employ one or more counter-measures, such as reducing lighting power densities, utilizing modulating boilers, or improving the glazing U-Factor and SHGC.

Energy modeling is often used to assess these Trade-offs and define a path to overall NYCECC compliance.



ANSI/ASHRAE/IESNA 90.1 - 2007

? When would ASHRAE 90.1 be used to demonstrate compliance?

Applicability:

- ASHRAE 90.1 is an approved alternative to the NYCECC
- If used, **ASHRAE 90.1 must be followed and applied for the entire project**
  - Applicants cannot mix compliance of one discipline in the NYCECC with another discipline in ASHRAE-90.1
- Prescriptive, Trade-off, or Performance-based paths can be used

Potential Reasons to Use ASHRAE:

- WWR > 40%, SRR> 3%
- Programs such as LEED, NYSERDA rebates, and Federal Tax credits are based on ASHRAE 90.1
- A few envelope measures are less stringent
  - Example: Up to 5% SRR allowed in prescriptive path
- Space-by-space lighting approach is allowed

? **What are the difficulties of using ASHRAE vs. the NYCECC?**

More Extensive Mandatory Provisions:

- Power, Section 8.4, has maximum voltage drop requirements for main feeders (2%) and branch circuits (3%)

Although this item is not related to envelope, it is important to realize that pursuing compliance via ASHRAE 90.1 may have other repercussions that affect the applicant's design.

Review Questions - 1

Q: A proposed office building has a 60% WWR on the front façade, shared party walls on the two sides with no windows, and a 10% WWF on the rear façade (which is equal in area to the front façade). Can the prescriptive path be used to show compliance?

Review Questions - 1

Q: A proposed office building has a 60% WWR on the front façade, shared party walls on the two sides with no windows, and a 10% WWF on the rear façade (which is equal in area to the front façade). Can the prescriptive path be used to show compliance?

A: **Yes**

The vertical glazing area of the **entire building** does not exceed 40% of the total wall area, so the prescriptive method can be used.

Building Envelope

Slides 40 to 55

4. Key Thermal Properties

4. Key Thermal Properties

Sub-Module Overview

In this section you will learn about:

- Key terminology used in describing the thermal properties of materials and assemblies, including:
  - R-Value, U-Factor, C-Factor, and F-Factor
- The R-Values of typical insulation materials, and how to verify R-Values in the field;
- The differences between continuous and cavity insulation; and
- How thermal bridging impacts the effectiveness of insulations and assemblies.

Opaque Envelope, Thermal Properties

? Which Thermal Property Applies to Which Envelope Component?

R-Value

- Thermal Resistance
- Applies to all material components
- Unit: **hr • ft² • °F / Btu**

U-Factor

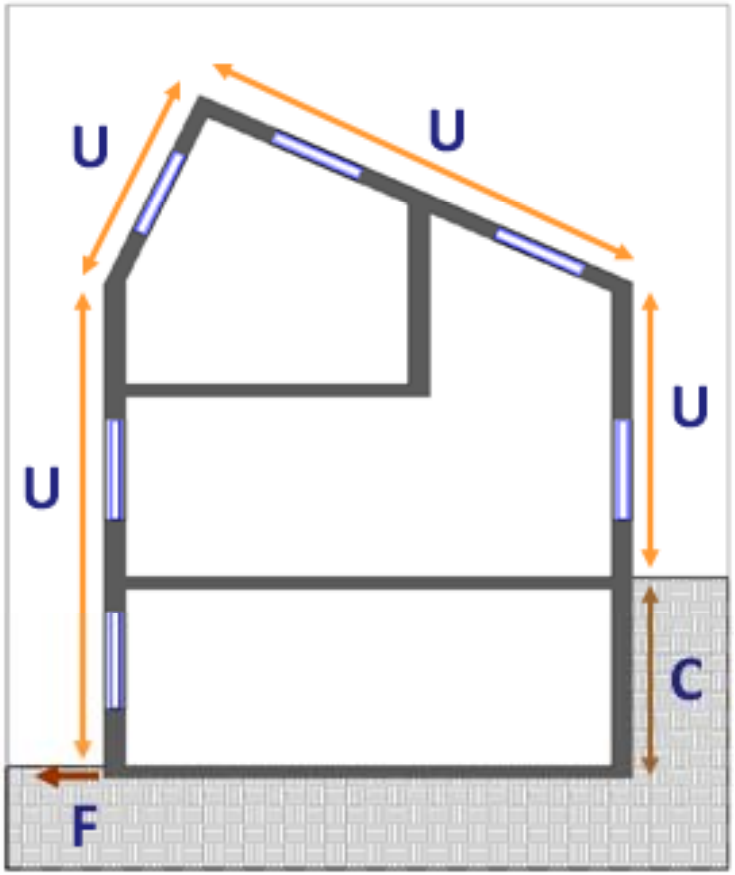
- Thermal Transmittance
- Applies to all assemblies except below grade walls and slabs on grade
- Includes exterior and interior air films
- Unit: **Btu / hr • ft2 • °F**

C-Factor

- Thermal Conductance
- Applies to below-grade wall assemblies
- Unit: **Btu / hr • ft2 • °F**

F-Factor

- Perimeter Heat Loss Factor
- Applies to Slabs on grade
- Unit: **Btu / hr • ft • °F**



Insulation Property: R-Value

R-Value (Resistance Value):

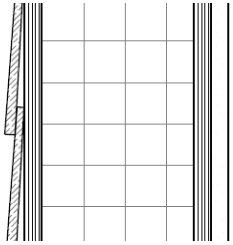
- Measures an individual material's thermal resistance to heat flow

☑ **Higher R-Value is Better**

- R-Values can be added, but:
  - Only if materials are in series, and assuming there are no thermal bridging effects

- R-Values of insulation materials are used to show compliance using the Prescriptive Method

Calculating the R-Value of a Simple Assembly (Structural Insulated Panel)



Material	R-Value
Outside Air Film	0.17
Wood Shingles	0.87
Air infiltration barrier	--
5/8" Exterior Plywood Sheathing	0.85
5 ½" thick EPS Board Insulation	22
5/8" Interior Plywood Sheathing	0.85
5/8" Gypsum Wallboard	0.57
Inside Air Film	0.68
TOTAL for Assembly: ("R-effective")	**25.99**

R-Value Naming Convention

? What is the Difference Between R and Rci?

R:

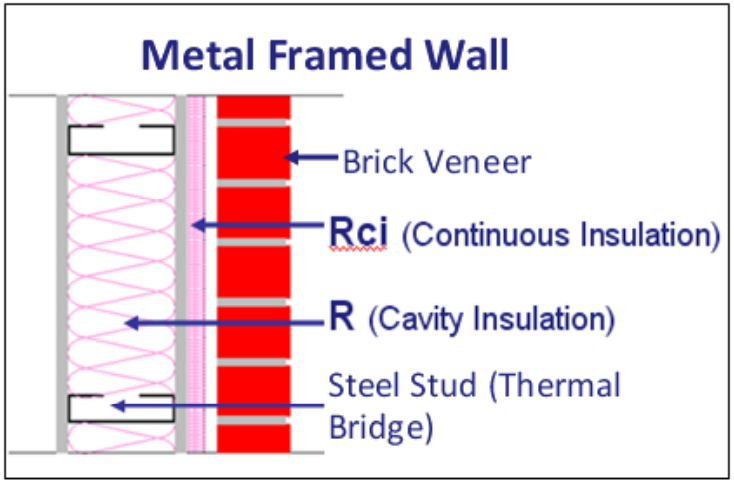
- Insulation installed within the cavity between framing members

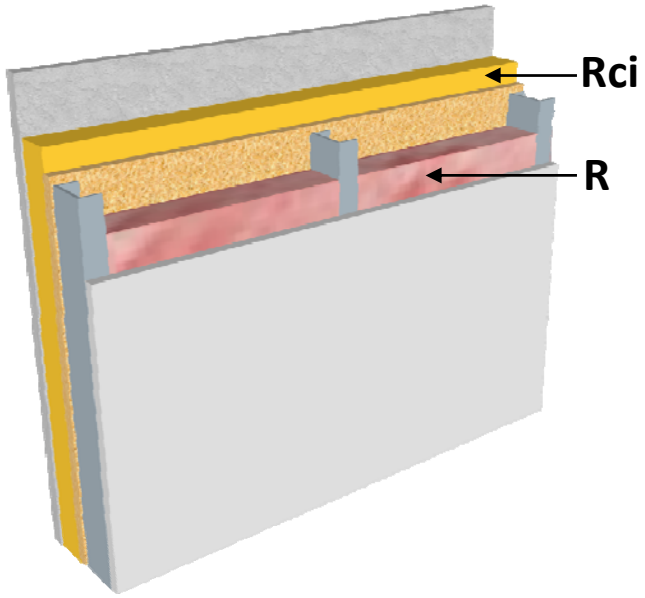
Rci:

- Continuous insulation uninterrupted by framing, most commonly installed exterior to framing in climate zone 4
- Typically required in assemblies subject to thermal bridging

Code Requirement Examples:

- Roof (attic) - R-38: cavity only requirement
- Roof (metal buildings) - R-13&R-13: 2 layers of R-13 cavity type.
- Walls (mass) - R-9.5ci: continuous only requirement
- Walls (metal-framed) - R-13&R-7.5ci: continuous + cavity





R-Value: Prescriptive Method

? **How are R-Values Used to Determine Compliance in the Prescriptive Method?**

Step 1: Determine Climate Zone:

- Zone 4A for all NYC Boroughs

Step 2: Confirm vertical fenestration & skylight area are below limits

- Vertical fenestration: (WWR ≤ 40%)
- Skylights: (SRR ≤ 3%)
  - ☒ If one of the above limits is exceeded, the Prescriptive method cannot be used

Step 3: Determine Minimum R + Rci Values

- Table 502.2(1): Based on Building Classification & Component type
- Each component must individually comply with the R-Value requirements

NYC BOROUGHS (Climate Zone 4A) Prescriptive R-Value Table		All Other Commercial	Group R, >3 Stories
Roofs			
	Insulation entirely above deck	R-20ci	R-20ci
	Metal buildings	R-13 + R13	R-19
	Attic & Other	R-38	R-38
Walls, Above Grade			
	Mass	R-9.5ci	R-11.4ci
	Metal building	R-19	R-19
	Metal framed	R-13 + R-7.5ci	R-13 + R-7.5ci
	Wood frame and other	R-13	R-13 + R-3.8ci
Below - Grade Walls		NR	R-7.5ci
Floors			
	Mass Floor	R-10ci	R-10ci
	Joist / Framing / Steel / Wood Floor	R-30	R-30
Slabs			
	Unheated Slab	NR	R-10 for 24 in Below
	Heated Slab	R-15 for 24in Below	R-15 for 24in Below
Opaque Doors			
	Swinging Door	U-0.70	U-0.70
	Roll-Up Sliding Door	U-0.50	U-0.50

Insulation Materials - 1

4. Thermal Properties

? What are the Most Common Types of Insulation Materials Used?

Batt Insulation	
Fiberglass Batts	R-3.1 to R-4.3 / inch
Rock Wool Batts	R-3.2 to R-3.9 / inch
Cotton Batts	R-3.7 / inch

Rigid Foam Boards	
Expanded Polystyrene	R-3.9 to R-4.2 / inch
Extruded Polystyrene	R-5.0 / inch
Polyisocynurate	R-5.6 to R-7.0 / inch
Polyurethane	R-5.6 to R-7.0 / inch

Insulation Materials - 2

4. Thermal Properties

? What are the Most Common Types of Insulation Materials Used?

Loose-Fill (Blown In)	
Cellulose	R-3.1 to R-3.7 / inch
Fiberglass	R-2.2 to R-2.9 / inch
Fiberglass (Dense-Pack)	R-3.4 to R-4.2 / inch
Mineral Wool	R-2.2 to R-2.9 / inch


Photo: Courtesy of DOE/NREL

Spray-In Place	
Polyurethane Foam	R-5.6 to R-6.2 / inch
Low Density Urethane Foam	R-3.6 to R-4.3 / inch
Magnesium Silicate Foam	R-3.9 / inch
Wet-Spray Cellulose	R-2.9 to R-3.4 / inch
Spray-in Fiberglass	R-3.7 to R-3.8 / inch

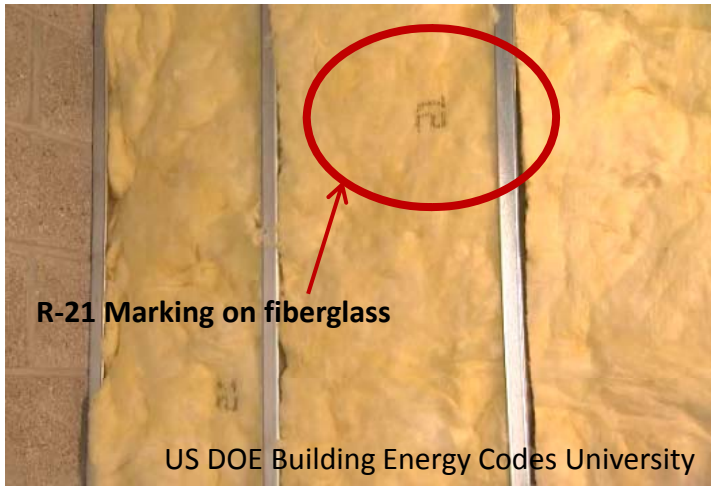

Photo: Courtesy of DOE/NREL

Identifying R-values in the Field

? **How are R-Values Verified Through Progress Inspections?**

Progress Inspection requirements for insulation placement and R-Values:

- Visual inspection required for installed insulation for each component of the conditioned space envelope, and junctions between components.
- Confirm that:
  - R-Values are marked
  - R-Values conform to those identified in the construction documents
  - The insulation is properly installed.
- Certifications for unmarked insulation shall be similarly visually inspected.



U-Factor – Thermal Transmittance

- Conductance of a Total Assembly (Btu/H.ft^2.F)
- Inverse of an assembly's R-Value

☑ **Lower U-Factor is Better**

- Offers Flexibility for Trade-off Calculations:

  (Weighted-average Method)

$$U = \frac{(U_1 \bullet A_1) + (U_2 \bullet A_2) + \ldots}{A_1 + A_2 + \ldots}$$

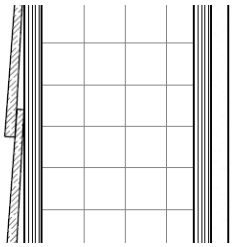
  - » U: U-Factor of material or assembly
  - » A: Surface Area of the material or assembly

☒ Cannot be added in series
(i.e., by layer of material)

- Accounts for thermal bridging

  (see later slides in this module)

Calculating the U-Factor
of a Simple Assembly
(Structural Insulated Panel)



Material	R-Value
Outside Air Film	0.17
Wood Shingles	0.87
Air Infiltration Barrier	--
5/8" Exterior Plywood Sheathing	0.85
5 ½" Thick EPS Board Insulation	22
5/8" Interior Plywood Sheathing	0.85
5/8" Gypsum Wallboard	0.57
Inside Air Film	0.68
TOTAL R-Value for Assembly:	**25.99**
U-Factor for Assembly (1/R)	**0.0385**

U-Factor - 2

? **What is U-Factor? When do You Use it Instead of R-Value?**

Common Mistake:

Averaging R-Values of different assemblies instead of U-Factors

- Example for Exterior Wall:
  - 50% of wall area has R-Value of 22 (opaque walls)
  - 50% of wall area has R-Value of 2.0 (fenestration)

What is the Weighted Average Thermal Resistance?

☒ If you average R-Values: **R-12**

☑ If you average U-Factors: U = 0.273, or **R-3.67**

U-Factor - 2

? **What is U-Factor? When do You Use it Instead of R-Value?**

Common Mistake:

Averaging R-Values of different assemblies i

- Example for Exterior Wall:
  - 50% of wall area has R-Value of 22 (opaque walls)
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What is the Weighted Average Thermal Res

☒ If you average R-Values: **R-12**

☑ If you average U-Factors: U = 0.273, or **R-3.67**

Heat travels through the path of least resistance. As shown in this example, the windows in a vertical wall assembly (which have a much lower R-value than the opaque wall areas) transmit heat at a much higher rate than the walls. When determining the overall wall performance, the U-Factors (which represent thermal transmittance) must be averaged. As shown in the example, averaging R-values will result in an exaggerated and incorrect value.

In this simple example, it can also be demonstrated that increasing the insulation levels in the opaque walls will result in little improvement overall, so long as the window values remain the same. Try increasing the wall R-value to 50 versus changing the window R-value to 3.0 – which has the greater impact? In buildings where the % of glazing is high, windows will dominate the overall heat loss performance of the wall.

C-Factor and F-Factor

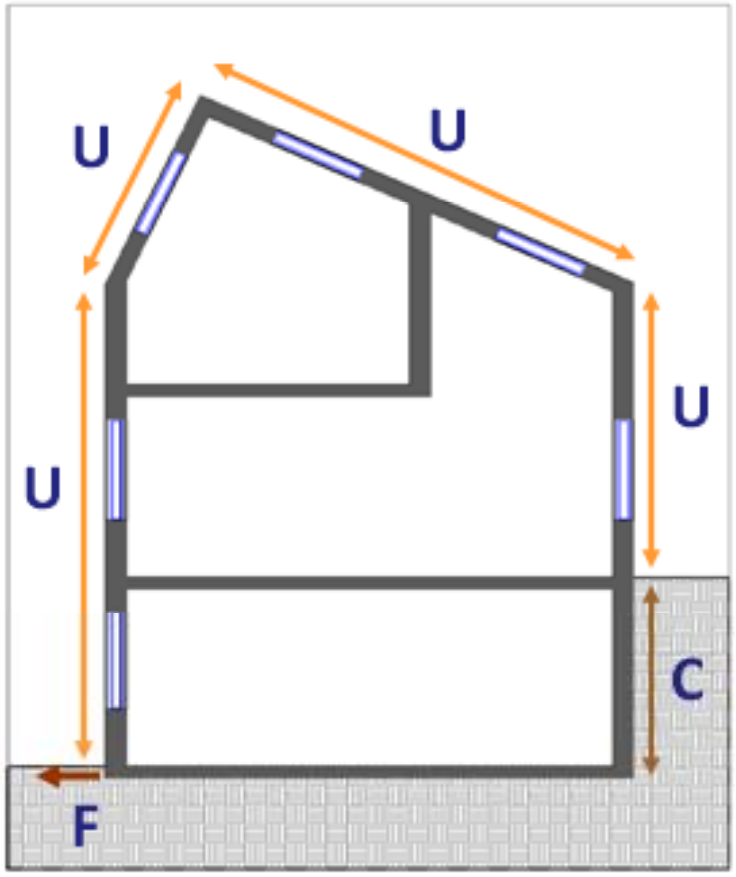
? How do C-Factors and F-Factors Differ from U-Factors?

C-Factor

- Only used for below-grade assemblies
  - Similar to U-Factor, but calculations omit exterior & interior air films and values for soil

F-Factor

- Only used for slabs-on-grade
  - Heat transfer is defined per linear foot, based on slab edge perimeter



? **How are U-Factors, C-Factors, and F-Factors Determined or Calculated?**

ASHRAE 90.1-2007 Look-Up Tables

- Appendix A
  - Typical construction assemblies shown with U-Factor, C-Factor and F-Factor values

Software Programs

- COMcheck
- HVAC Load analysis programs
- LBL THERM (2-dimensional Heat Flow analysis)

Manual Calculations

- Refer to ASHRAE Fundamentals
  - Various methods defined based on type of assembly
    - » e.g., Series Method, Parallel Path Method, Isothermal Method

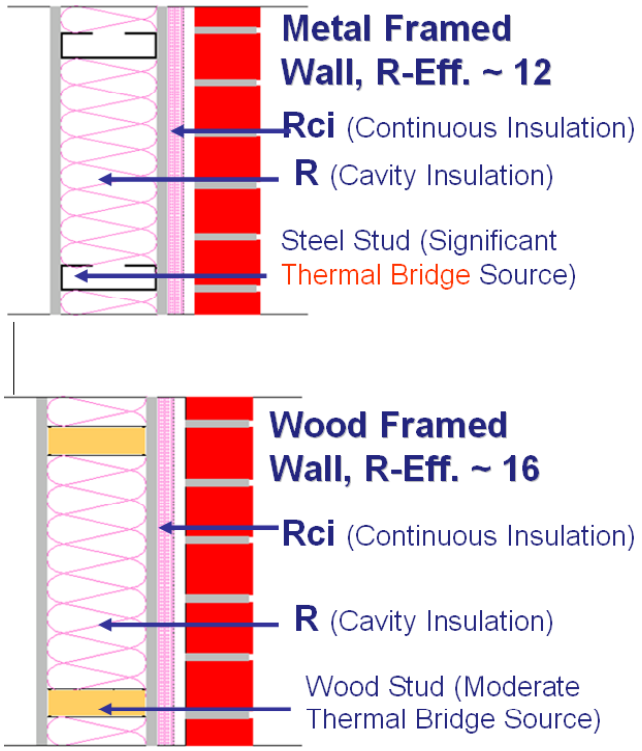
For most users, the ASHRAE look-up tables will be the easiest way to determine U-Factor, C-Factor, or F-Factor values. If an applicant is submitting an energy analysis using these factors, be sure to cite the ASHRAE table or the calculation method used.

Thermal Bridging - 1

? **How does Thermal Bridging Impact the Effective R-Value?**

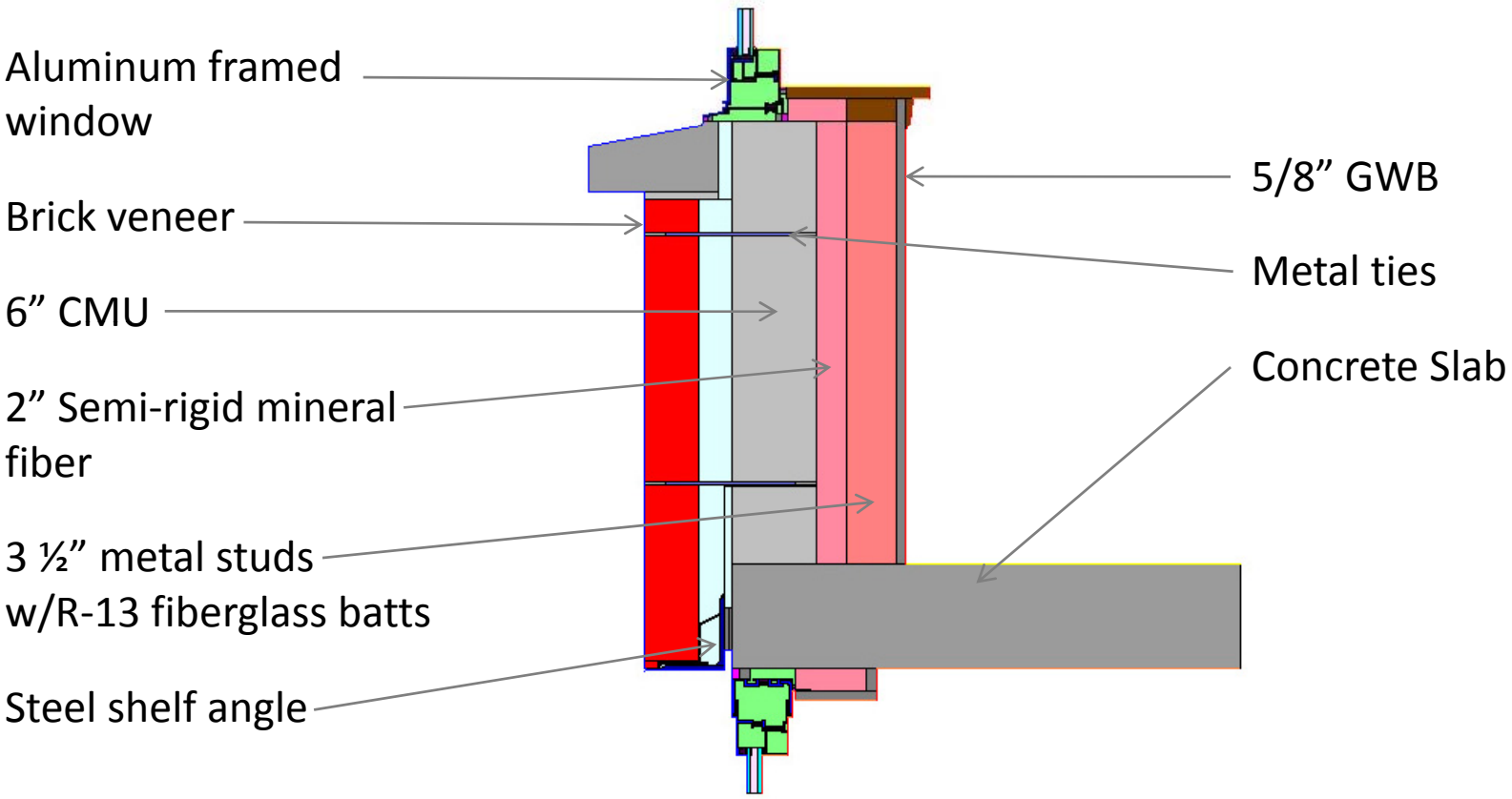
Thermal bridging is caused by heat transfer through highly-conductive materials

- Typically steel or aluminum framing members are of most concern, but other materials can also create thermal short circuits
- Examples @ Cavity Wall assembly:
  - 3.5" Fiber glass insulation: R-13
  - + 1" Rigid XPS: Rci-3.8
  - + Other layers, R-2 approx.
    (Brick + Air Gap + Drywall + Air Films)
  - Total (Nominal) = **R-18.8**
  - In a Metal Framed Wall, the effective value is **R-12**
    (R-13 in cavity provides benefit of about R-7)
  - In a Wood Framed Wall, the effective value is **R-16**
    (R-13 in cavity provides benefit of R-10)



Thermal Bridging - 2

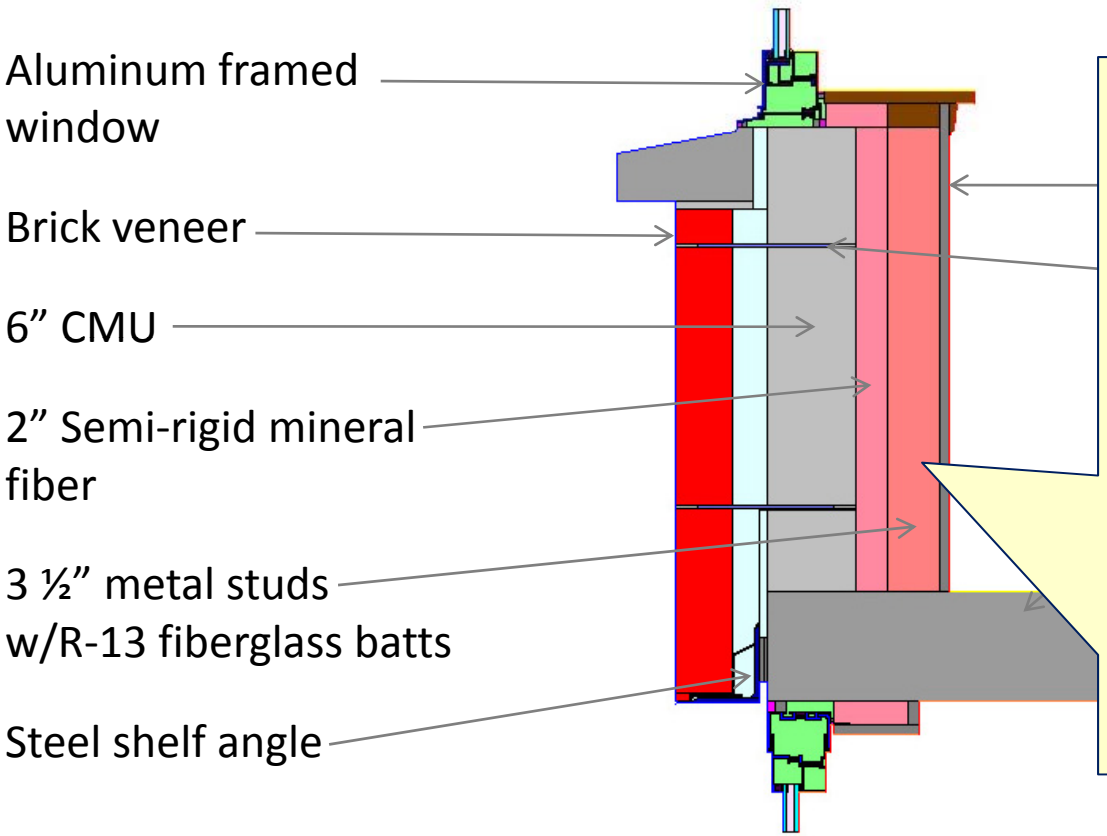
Masonry Wall / Concrete Slab Example



Nominal R-Value = 22

Thermal Bridging - 2

Masonry Wall / Concrete Slab Example



Thermal bridging occurs through many types of building assemblies. This example shows a vertical section through a masonry cavity wall at a concrete floor slab. Aluminum-framed windows are also shown above the wall and below the slab.

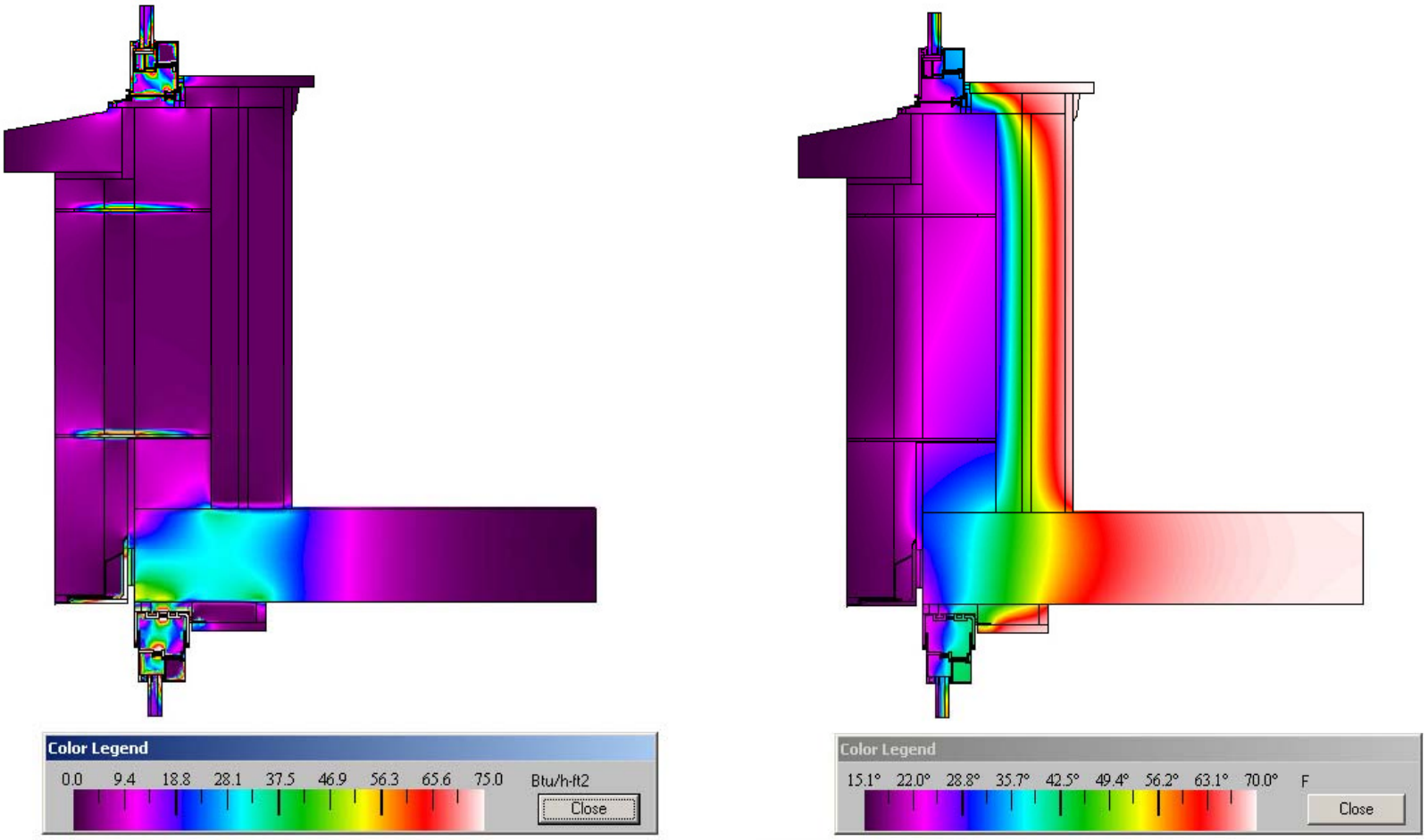
In this assembly, R-13 batt insulation is used within the cavities of an interior metal stud wall. In addition, a 2” thick semi-rigid mineral fiber batt is attached directly to the inside surface of the c.m.u. wall.

Without accounting for thermal bridging, this assembly would have a nominal R-Value of 22.

Nominal R-Value = 22

Thermal Bridging - 3

Analysis Performed Using 2-Dimensional Heat Flow Software



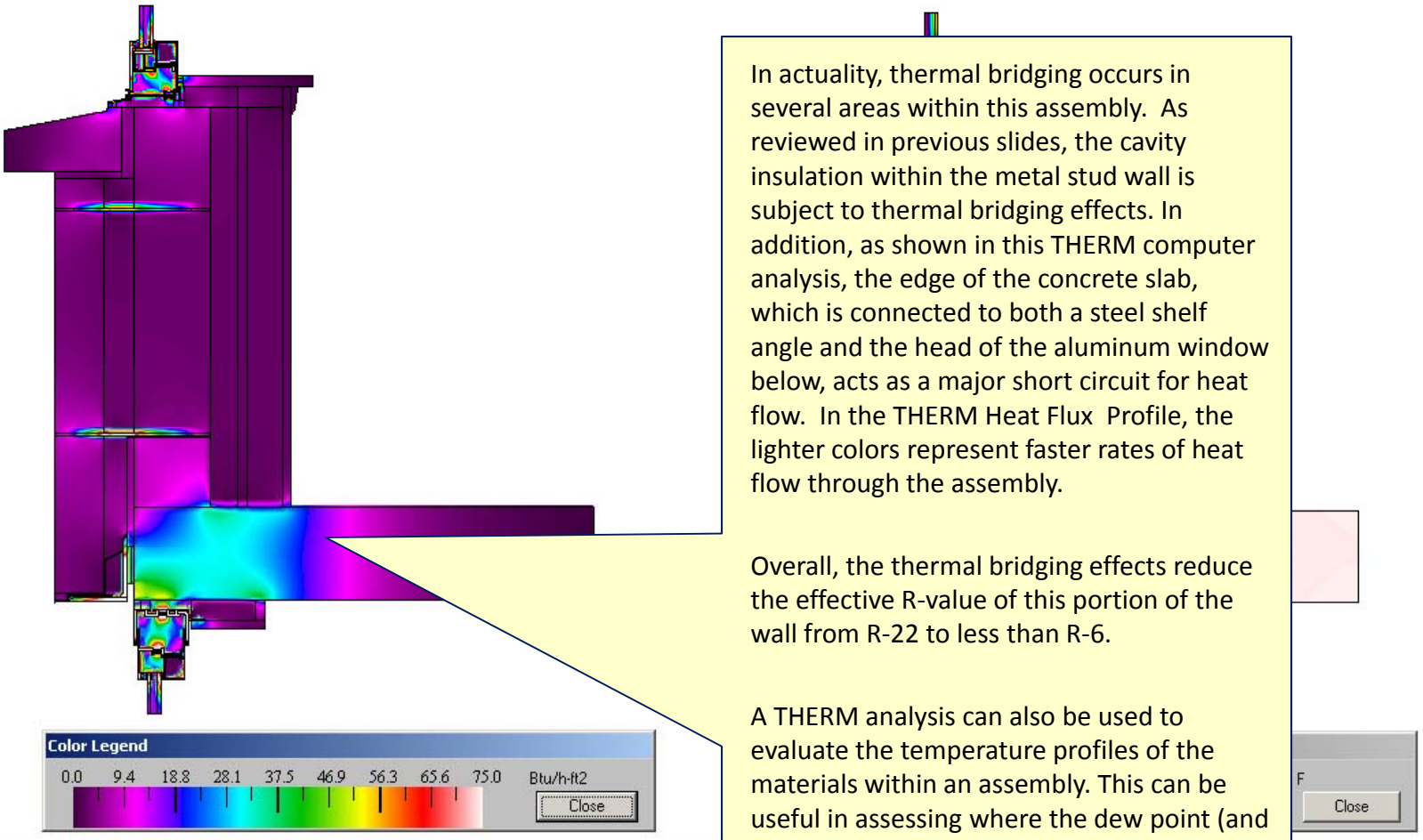
Heat Flux Profile

Temperature Profile

Calculated R-Value = 5.6

Thermal Bridging - 3

Analysis Performed Using 2-Dimensional Heat Flow Software



Heat Flux Profile

In actuality, thermal bridging occurs in several areas within this assembly. As reviewed in previous slides, the cavity insulation within the metal stud wall is subject to thermal bridging effects. In addition, as shown in this THERM computer analysis, the edge of the concrete slab, which is connected to both a steel shelf angle and the head of the aluminum window below, acts as a major short circuit for heat flow. In the THERM Heat Flux Profile, the lighter colors represent faster rates of heat flow through the assembly.

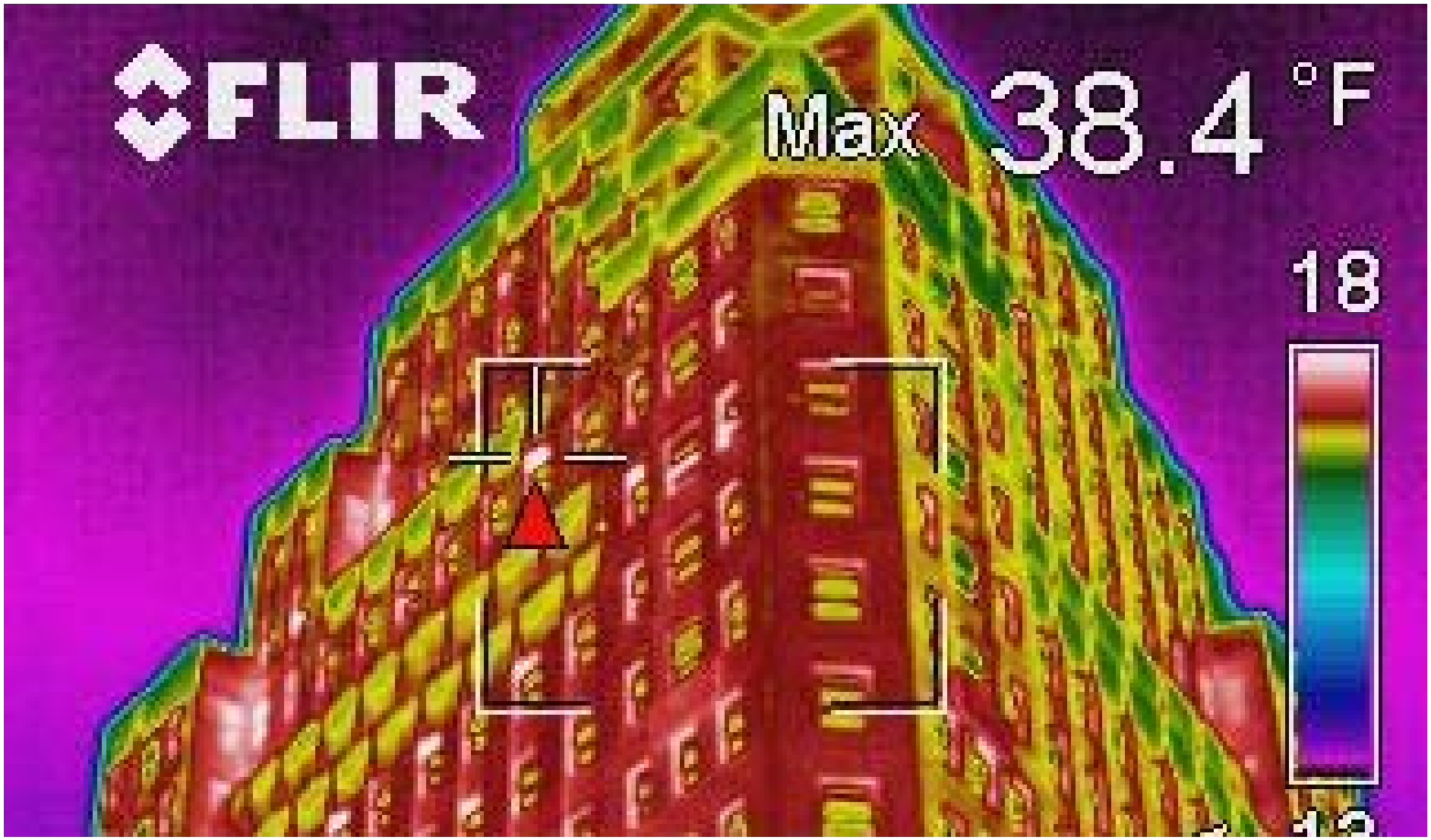
Overall, the thermal bridging effects reduce the effective R-value of this portion of the wall from R-22 to less than R-6.

A THERM analysis can also be used to evaluate the temperature profiles of the materials within an assembly. This can be useful in assessing where the dew point (and therefore condensation) may occur.

Calculated R-Value = 5.6

Slides 56 to 73

5. Above-Grade Walls



5. Above Grade Walls

Sub-Module Overview

In this section you will learn about:

- Compliance criteria related to different wall types, including:
  - Mass Walls;
  - Metal Framed Walls;
  - Metal Building Walls;
  - Wood Framed Walls;
  - Structural Insulated Panels;
  - Insulated Concrete Forms; and
  - Opaque areas of Curtain Walls.

Wall Types

5. Above-Grade Walls

What are the Major Types of Above-Grade Walls?

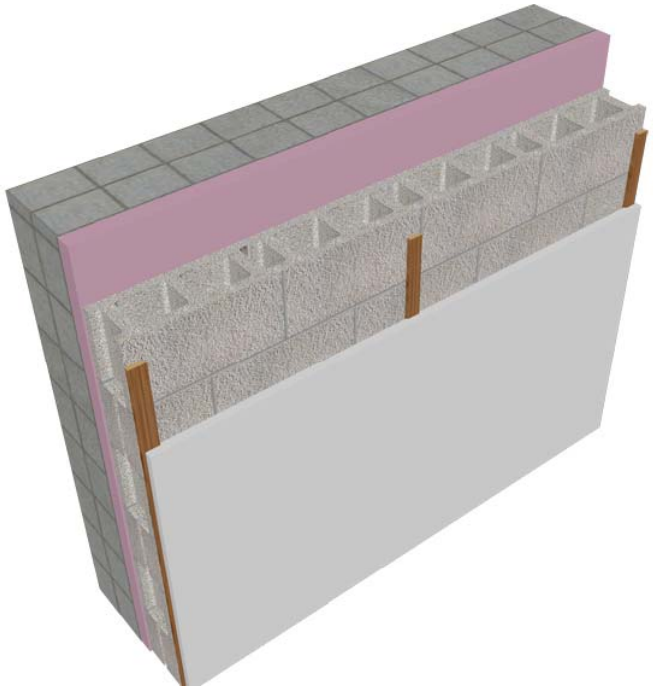
Type	Mass Wall	Metal Framed Wall	Metal Building Wall	Wood Framed Wall
Typical Construction	**Brick / Brick-CMU / CMU / Concrete walls**	**Steel Stud walls**	**Steel Structural Member (Z-girt) walls**	**Wood Stud walls**
Prescriptive Insulation R-Values	Others: R-9.5ci Group R: R-11.4ci	All building types: R-13 + R-7.5ci	All building types: R-19 + Thermal Spacer	Others: R-13 Group R: R-13 + R-3.8ci

Mass Wall - Qualification

? What Qualifies as a Mass Wall?

Mass Wall Descriptions

- Load-bearing Brick
- Concrete Masonry Unit (CMU) backup with brick or other finish
- Poured Concrete
- Face Brick with Stud Backup, if the Face Brick is higher density
- Weight criteria for mass wall classification
  - $\geq$ 35 Lbs / ft^2 of surface area or
  - $\geq$ 25 Lbs / ft^2 of surface area & $\leq$ 120 Lbs / ft^3 of Volume



Mass Wall – Examples

? **What Qualifies as a Mass Wall?**

Q: Which of the following can qualify as Mass Walls?

- ☑ Solid Concrete (145 pcf): 3” thick or more: **Yes**
- ☑ 5-5/8” thick CMU wall, no grout – minimum 125 pcf: **Yes**
- ☑ 3-5/8” Solid-Face Brick (minimum 120 pcf – typical density varies between 70 to 140 pcf) with stud backing: **Potentially**
- ☒ 1” Face brick with stud backing: **No**
- ☒ 3” thick Fly ash concrete wall: **No**
- ☒ Plastered EIFS walls with metal stud Framing: **No**

Mass Wall - Insulation

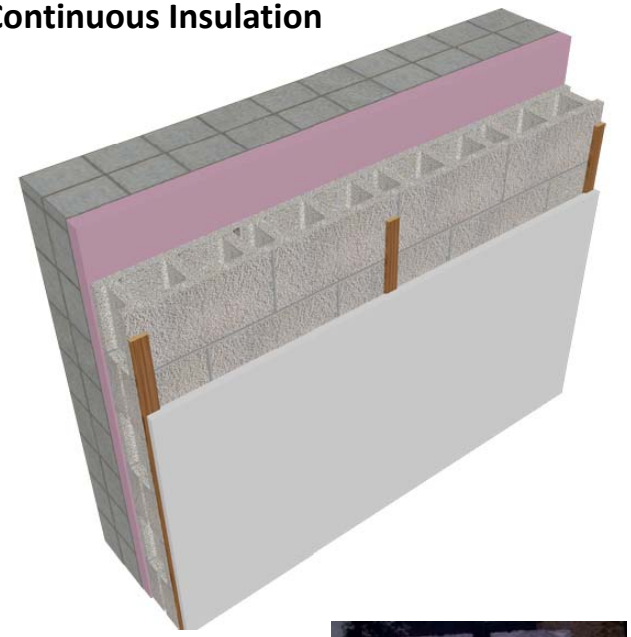
? What are the Insulation Requirements for Mass Walls?

Mass Wall Insulation Requirements:

NYC BOROUGHS (Climate Zone 4A)	All Other Commercial	Group R, >3 Stories
Mass Walls, Above Grade		
Prescriptive Insulation R-value	R-9.5ci	R-11.4ci
Alternative U-Factor	U - 0.104	U - 0.09
Effective Assembly R-value	R-9.6	R-11.1

- Continuous insulation is placed to the exterior of the mass wall
- Use U-Factor table if:
  - Insulation inserts or fill (e.g., perlite) used within CMUs
  - Continuous insulation used on the winter-warm surface of the mass wall
  - Cavity wall insulation used on the winter-warm surface of the mass wall
- For Retrofits:
  - No insulation required if walls are not rebuilt and no cavity exists

Double Wythe Concrete Masonry Unit Wall with Continuous Insulation



Insulation inserts within CMUs - No Credit allowed in R-Value Method (Use U-Factor Alternative)

Metal Framed Walls

? What are the Requirements for Metal Framed Walls?

Steel Studs Walls

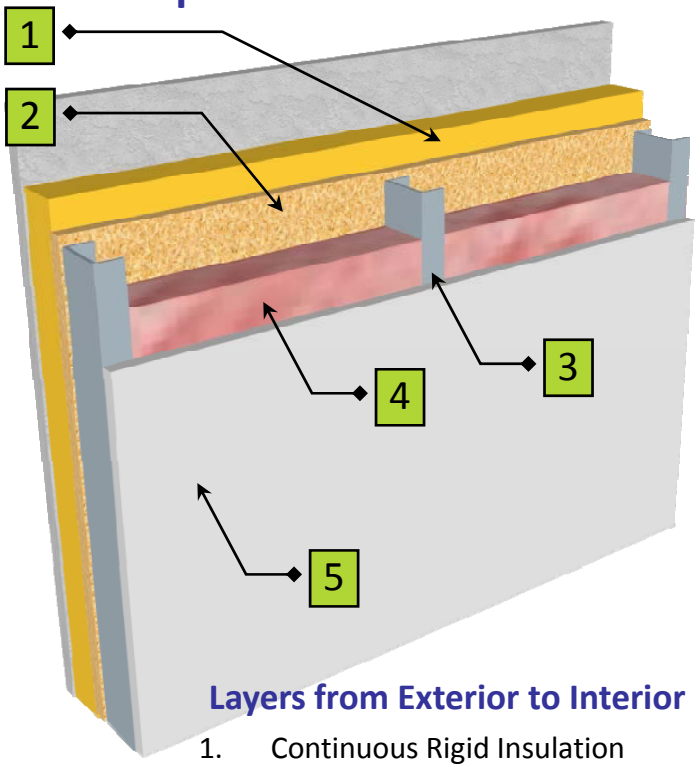
- Typical walls are 4” or 6” steel studs, at 16” or 24” spacing

Insulation Requirements

NYC BOROUGHS (Climate Zone 4A)	All Other Commercial	Group R, >3 Stories
Metal Framed Walls, Above Grade		
Prescriptive Insulation R-value	R-13 + R-7.5ci	R-13 + R-7.5ci
Alternative U-Factor	U - 0.064	U - 0.064
Effective Assembly R-value	R-15.625	R-15.625

- Insulation is both exterior and continuous (to mitigate thermal bridging)
- Cavity insulation can be removed if continuous insulation is increased and U-Factor method is used
- NYCECC Tables 502.2.8.1 & 502.2.8.2 define siding attachments over foam sheathing

Sample Metal Framed Wall



Layers from Exterior to Interior

1. Continuous Rigid Insulation
2. Structural Sheathing
3. Steel studs
4. Cavity Insulation
5. Gypsum Wall Board

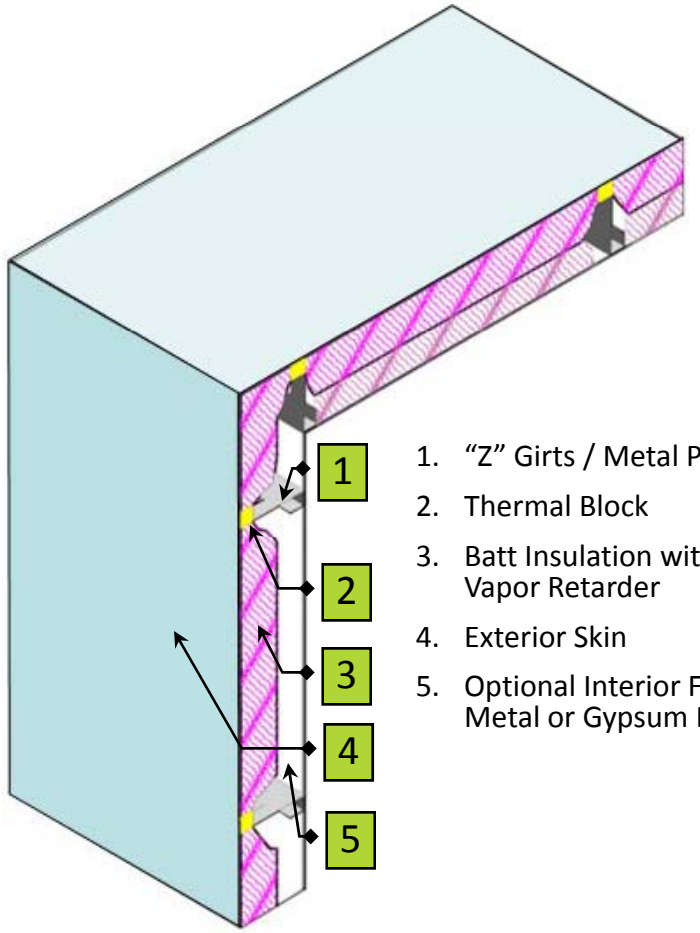
Metal Building Wall

? How are Metal Walls Typically Constructed?

Wall Type Description

- Typically pre-fabricated
- Exterior metal skin attached to horizontal metal purlins that span between vertical building supports
- Insulation is draped over supports & compressed at the supports as exterior panels are fixed
- Rigid thermal blocks used at supports to mitigate thermal bridging

Typical Metal Wall Construction



1. "Z" Girts / Metal Purlins
2. Thermal Block
3. Batt Insulation with Vapor Retarder
4. Exterior Skin
5. Optional Interior Finish, Metal or Gypsum Board

Metal Building Wall

? What are the Insulation Requirements for Metal Building Walls?

Insulation Requirements

NYC BOROUGHS (Climate Zone 4A)		All Other Commercial	Group R, >3 Stories
Metal Building Walls, Above Grade			
	Prescriptive Insulation R-value	R-19 + R-5 (Thermal Block)	R-19 + R-5 (Thermal Block)
	Alternative U-Factor	U - 0.084	U - 0.084
	Effective Assembly R-value	R-11.9	R-11.9

- Constructions described in Table 502.2(2)
- U-Factors calculated in ASHRAE 90.1 Table A3.2
- Methods for computing U-Factor for custom types
  1. Manufacturer's ratings
  2. Two dimensional heat flow modeling
  3. Three dimensional heat transfer modeling (more accurate)
  4. Laboratory testing of mock wall

Wood Framed Wall

? What are the Prescriptive Requirements for Wood Framed Walls?

Wood Stud Walls

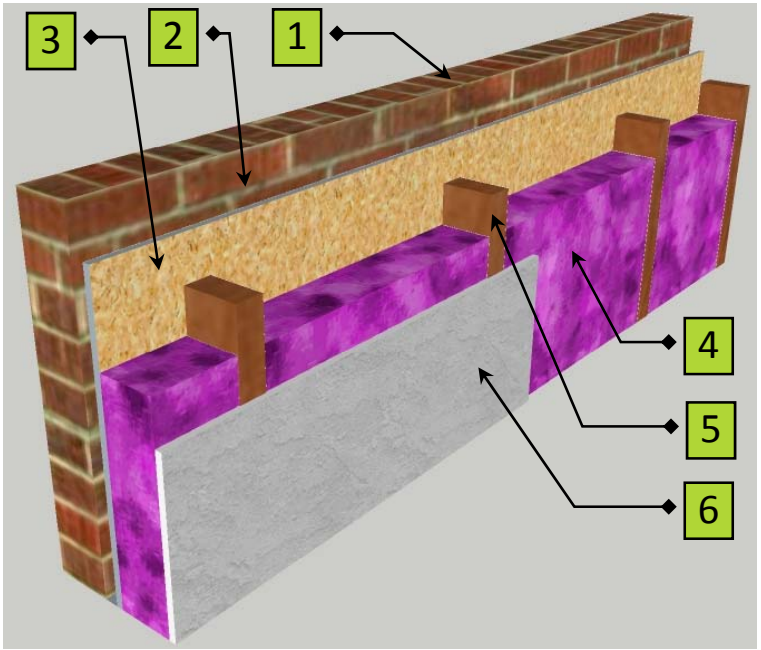
- Typical walls are 3.5” or 5.5” wood studs, at 16” or 24” o.c.

Insulation Requirements

NYC BOROUGHS (Climate Zone 4A)	All Other Commercial	Group R, >3 Stories
Wood Frame & Other Walls, Above Grade		
Prescriptive Insulation R-value	R-13	R-13 + R-3.8ci
Alternative U-Factor	U - 0.089	U - 0.064
Effective Assembly R-value	R-11.2	R-15.625

- Thermal bridging is not as significant as for steel stud walls, but:
  - ► For some building types, such as apartment buildings, wood studs and headers can account for 30-40% of the opaque wall area.
  - ► The fraction of wood is a consideration only when complying via U-Factor for assembly.
- NYCECC Tables 502.2.8.1 & 502.2.8.2 define siding attachments over foam sheathing

Brick Cavity Wall



Layers from Exterior to Interior

1. Brick Wall – 4” to 12” thick
2. 1” Air space minimum
3. Structural Sheathing
4. Framing – Wood or Steel Studs
5. Cavity Insulation
6. Gypsum Wall Board

Other Wall Types

? How do you Address Unconventional Wall Systems?

Structural Insulated Panels (SIPS)

- Also known as Stress Skin Panels
  - Rigid insulation sandwiched between shear panels (typically plywood or OSB)
  - Use U-Factor Method to demonstrate compliance
  - Manufacturers typically furnish assembly U-Factor data

Insulated Concrete Forms (ICF)

- Specially shaped insulation provides form work for concrete
  - Very good insulation values, but insulation needs to be protected on outside (stucco or other materials) and inside (GWB)
  - Use U-Factor Method to demonstrate compliance
  - Manufacturers typically furnish assembly U-Factor data


Photo: Courtesy of DOE/NREL

SIPS


Photo: Courtesy of DOE/NREL


Photo: Courtesy of DOE/NREL

ICF

Opaque Sections of Curtain Walls

? **How are the Opaque Areas of Curtain Walls and Window Walls Addressed?**

Code Insulation Requirements

- Use values for metal framed walls (Max. U = 0.064)

Curtain Walls

- Entirely in front of structure

Window Walls

- Rest on each floor, so slab edge is often exposed or covered, but not insulated

How are these U-Factors determined?

- From factory testing (uncommon)
- Through calculations
  - From NFRC calculations using two-dimensional heat flow modeling (typically THERM software)
  - From three-dimensional heat flow modeling (more accurate than 2D)

Progress Inspections

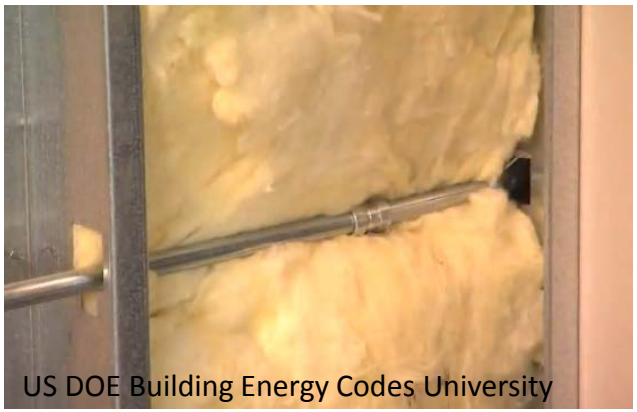
5. Above-Grade Walls

? What are the Applicable Progress Inspections for Above Grade Walls?

Inspection / Test	Frequency
Insulation Placement and R-Values Installed insulation for each component of the conditioned space envelope and at junctions between components shall be **visually inspected to ensure that the R-Values are marked**, that such R-Values conform to the R-Values identified in the construction documents and that **the insulation is properly installed**. Certifications for unmarked insulation shall be similarly visually inspected.	As required to verify continuous enclosure while walls, ceilings and floors are open
Sealing Openings and penetrations in the building envelope, including site-built fenestration and doors, shall be **visually inspected to verify that a continuous air barrier around the envelope forms and air-tight enclosure**. The Progress Inspector shall visually inspect to verify that materials and/or assemblies have been tested and meet the requirements of the respective standards, or that the building is tested and meets the requirements of the standard, in accordance with the standard(s) cited in the approved plans.	As required during construction

Key inspections for Above-Grade Opaque Walls

- Confirm R-Values of all installed insulation types
  - Verify values compared to approved drawings
- Check for continuity of the insulation at:
  - Corners
  - Window or door headers
  - Rim joists at floor framing
  - Junctions between different wall systems
  - Interior walls separating conditioned/ unconditioned spaces



US DOE Building Energy Codes University

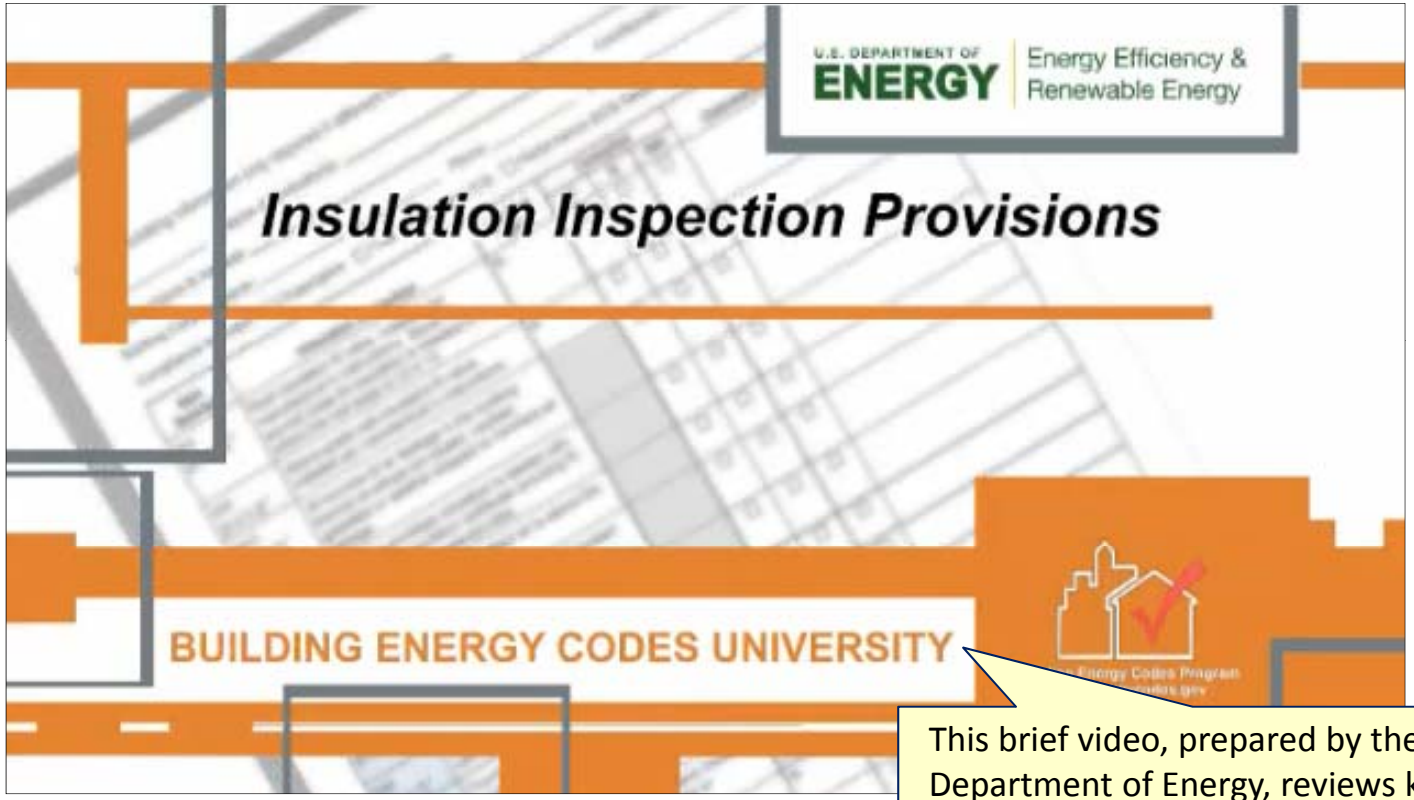
- Confirm proper installation of the insulation
  - Cavity insulation should fill the full width of the stud cavity
  - Batts should not be compressed behind piping, conduit, receptacles, etc.
  - Insulation should be replaced if severely ripped by piping, conduit, etc.

Key inspections for Above Grade Opaque Walls

- Confirm proper installation of the insulation (continued)
  - Blown-in, sprayed-in, or foamed-in place insulations should fill all cavity voids – check behind framing, piping, receptacles, etc.
  - Continuous insulation boards should fit tightly together – no gaps
  - Fasteners for siding over foam sheathing should match NYCECC criteria
- Confirm proper documentation has been provided
  - Blown-in, sprayed-in, or foamed-in-place insulations should have R-Values verified through installer's certificates
- Confirm joint sealing and the installation of a continuous air barrier system
  - See Air Leakage section of this module

US DOE Building Inspection Video

5. Above-Grade Walls



Insulation Inspection Provisions
(Length - 3:41)

This brief video, prepared by the U.S. Department of Energy, reviews key inspection issues related to insulation installation. Progress Inspectors may find useful tips in the video, even though it is not specific to the NYCECC.

Wall Renovation – Scenario 1

5. Above-Grade Walls

Q: A renovation involves the replacement of the interior wallboard along existing 6" deep steel stud exterior walls. The existing walls have 3.5" of fiberglass batt insulation (R-13). Does this insulation need to be improved?

A: Yes.

If the structure is unaltered, then insulation must be installed to full depth in wall cavity at a minimum.

If the structure is also fully rebuilt, Code mandates the assembly be brought to a U-Factor of 0.064 or lower.

R-7.5ci needs to be added to the wall if compliance is via R-value table 502.2(1)

Exception: Unaltered portions are not required to comply with NYCECC.

Exception: Alterations, renovations or repairs to wall which are insulated to full depth with insulation having a minimal nominal value of R-3.0/inch

Wall Renovation – Scenario 2

5. Above-Grade Walls

Q: A renovation involves the replacement of the interior wallboard along existing 3 1/2" deep steel stud exterior walls. The existing walls have 3.5" of fiberglass batt insulation (R-13). Does this insulation need to be improved?

A: No.

Allowed Exception.
Existing Insulation is at full depth and greater than R-3/inch.

Exception: Alterations, renovations or repairs to wall which are insulated to full depth with insulation having a minimal nominal value of R-3.0/inch

Building Envelope

Slides 74 to 87

6. Roofs

6. Roofs

Sub-Module Overview

In this section you will learn about:

- Compliance criteria related to different roof / insulation assemblies, including:
  - Roofs with Insulation entirely above the Deck;
  - Roofs of Metal buildings (using thermal blocks at purlins); and
  - Roofs with Attics.

Roof / Insulation Categories

What are the Roof /Insulation Categories Addressed in the NYCECC?

Type	Insulation above Deck	Metal Building Roof	Attic & Other
Typical Construction	**Structural decks (concrete or steel)**	**Metal roofs of pre-fabricated metal buildings**	**Attics with insulation within the attic floor, Sloped roofs with insulation within the rafter framing, Flat roofs with insulation underneath the deck**
Prescriptive Insulation R-values	All building types: R-20ci	Others: R-13+R-13 (with R-5 Thermal Block) Group R: R-19 (with R-5 Thermal Block)	All building types: R-38

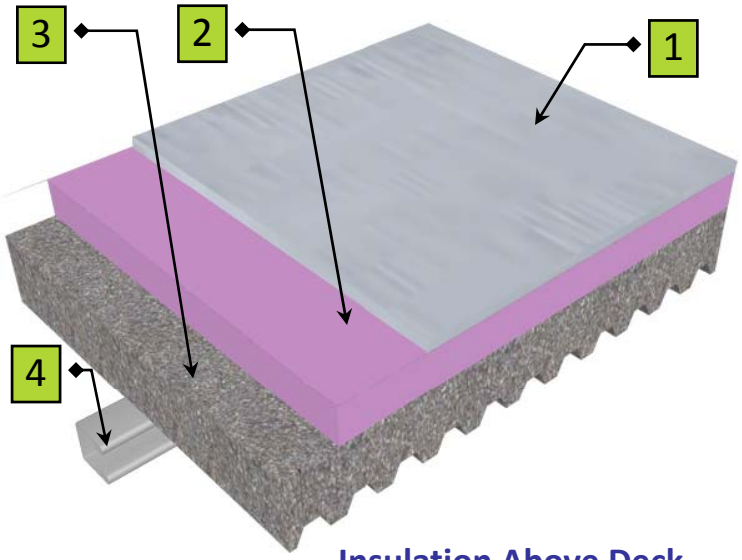
Insulation Above Deck

Roof Assembly Description

- Waterproof membrane + layer of Continuous Rigid insulation is attached on top of Concrete / Metal / Wood Deck

Insulation

- Commercial or Group-R: R-20ci
- U-0.48 or lower
- If the Insulation is tapered for Drainage
  - The average area-weighted U-factor of the roof assembly with the varying insulation thicknesses must be equivalent to the same assembly with the NYCECC prescriptive R-value (R-20)
- Recommended Practice (beyond Code):
  - Joints between insulation sheets should be vertically staggered



Insulation Above Deck

1. Roof Membrane
2. Rigid Insulation
3. Metal Deck with Concrete
4. Structural Framing

Metal Building Roof

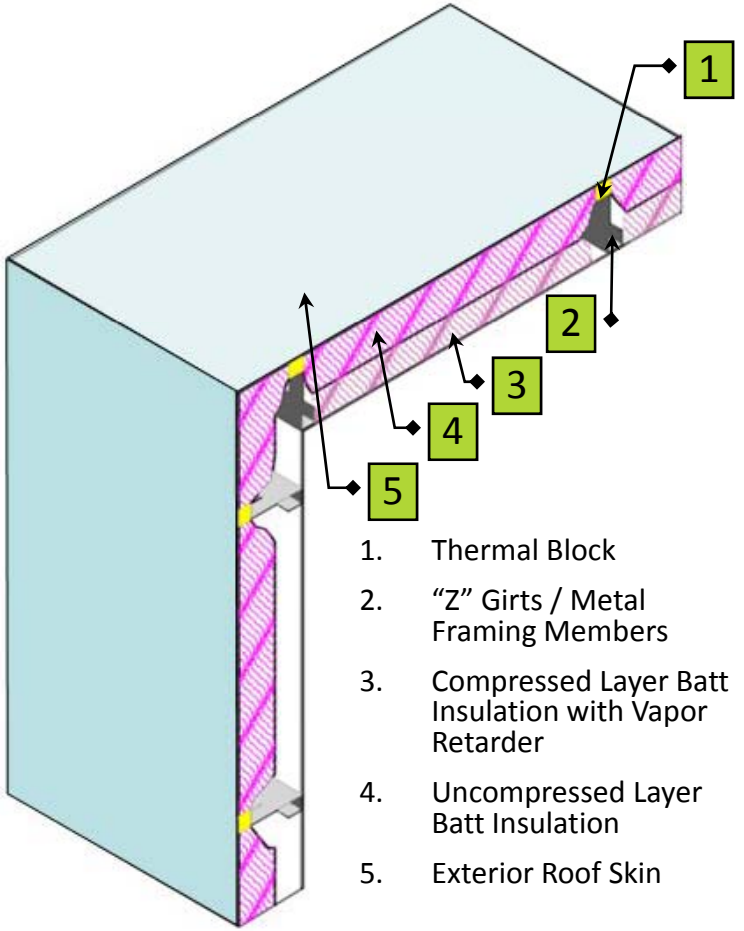
Roof Assembly Description

- Metal skin exterior with metal purlin or joists support (typically every 4')

Insulation

- Other Commercial: R13 + R13 (2 layers)
- Group R Buildings: R19 (1 layer)
- Assembly U-0.55 or lower
  - Thermal insulation block (R-5) is required to be installed between support purlin and exterior skin to reduce thermal bridging
  - First layer of insulation draped between thermal block & support – may get compressed at junctions
  - Second layer of insulation is required to be installed without any compression

Typical Metal Roof Construction

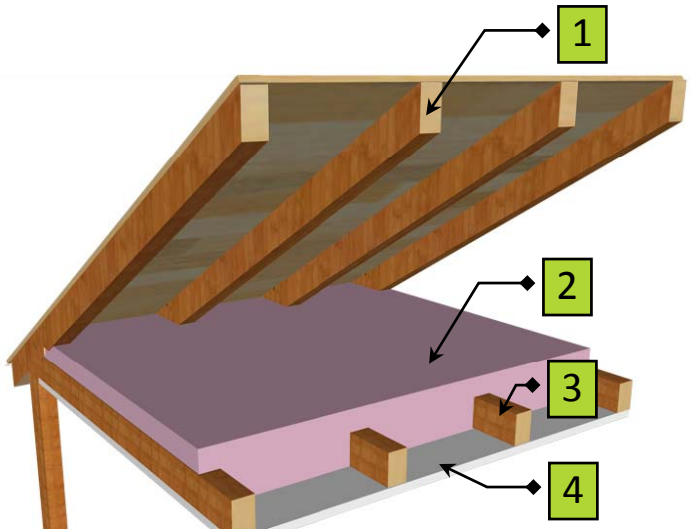


1. Thermal Block
2. "Z" Girts / Metal Framing Members
3. Compressed Layer Batt Insulation with Vapor Retarder
4. Uncompressed Layer Batt Insulation
5. Exterior Roof Skin

Roof Assembly Description:

All roof assemblies that:

- Do not have CONTINUOUS insulation above deck
- Are not metal building roofs
- Examples:
  - Roofs with attic
    - » Ventilated attics with insulation installed over ceiling
    - » Unventilated attics with insulation installed along slopes
  - Insulation between rafters of sloped roofs (cathedral ceilings)
  - Insulation above the deck of sloped roofs, interrupted by furring members which support the roofing
  - Insulation below flat decks (e.g., pin-impelled) - may NOT be placed above removable ceiling tiles.



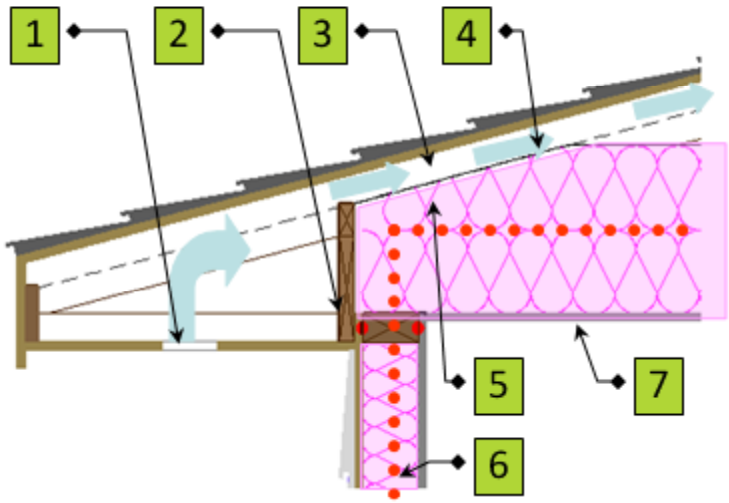
Attic Roof

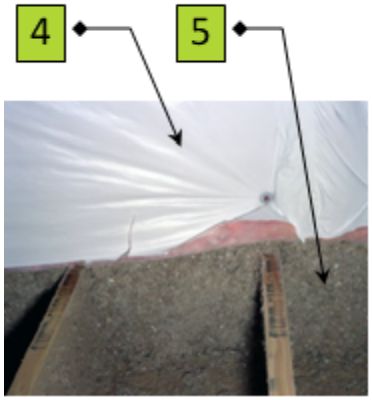
1. Roof Deck & Rafters
2. Insulation Layer
3. Purlins
4. Air Tight Ceiling

Insulation

- Commercial or Group R: R-38
- Assembly U-0.027 or lower
- Air barrier details are critical

Vented Attic – Insulation Details





Insulation Details

1. Soffit Vent
2. Vertical support for insulation
3. 2" clear air space for air flow
4. Polyethylene Baffle Membrane
5. R-38 Insulation required (Compression occurs at top plate & eaves)
6. Thermal Boundary
7. Air tight ceiling

Additional Roof Insulation Requirements

- Insulation installed over suspended ceilings that have removable panels cannot be counted for R-Value or U-Factor compliance.
- Loose-fill insulation is not permitted to be used in attic roof spaces when the slope of the ceiling is more than three in twelve.
- Air Barrier Control: Attic eave vents must have baffling to deflect the incoming air above the surface of the insulation.
- Lighting fixtures, HVAC, and other equipment should not be recessed in ceilings in such a manner that they might affect the insulation thickness.

Progress Inspections

6. Roofs

? What are the Applicable Progress Inspections for Roofs?

Inspection / Test	Frequency
Insulation Placement and R-Values Installed insulation for each component of the conditioned space envelope and at junctions between components shall be **visually inspected to ensure that the R-Values are marked**, that such R-Values conform to the R-Values identified in the construction documents and that **the insulation is properly installed**. Certifications for unmarked insulation shall be similarly visually inspected.	As required to verify continuous enclosure while walls, ceilings and floors are open
Sealing Openings and penetrations in the building envelope, including site-built fenestration and doors, shall be **visually inspected to verify that a continuous air barrier around the envelope forms and air-tight enclosure**. The progress inspector shall visually inspect to verify that materials and/or assemblies have been tested and meet the requirements of the respective standards, or that the building is tested and meets the requirements of the standard, in accordance with the standard(s) cited in the approved plans.	As required during construction

Key inspections for Opaque Roofs

- Confirm R-Values of all installed insulation types
  - Verify values compared to approved drawings
  - If above deck tapered insulation is used, verify that pitching and thickness of insulation match or equal approved drawings
  - At metal buildings, confirm R-Value of thermal blocks
  - For loose fill or blown-in place insulation, confirm that R-Value depth markers have been installed

- Check for continuity of the insulation at:
  - Wall/ Roof connection at Eaves
  - Parapet walls
  - Skylight wells
  - Dunnage or other penetrations

Key inspections for Opaque Roofs

- Confirm proper installation of the insulation
  - Cavity insulation must fill the full width of the rafter or ceiling joist cavity.
  - Batts should not be compressed at roof eaves (pitched roofs).
  - Batts should not be compressed at ductwork, lighting fixtures, or other equipment.
  - Blown-in, sprayed-in, or foamed-in place insulations should fill all cavity voids.
  - Above deck insulation boards should fit tightly together – no gaps.
  - Where shown in drawings, rigid insulation should be provided at eaves or parapets.
  - Recessed light fixtures in the thermal envelope should have IC rating.
  - No insulation installed over removable ceiling tiles may be substituted for other insulation as shown on the drawings. (It does not count toward NYCECC compliance).

Key inspections for Opaque Roofs

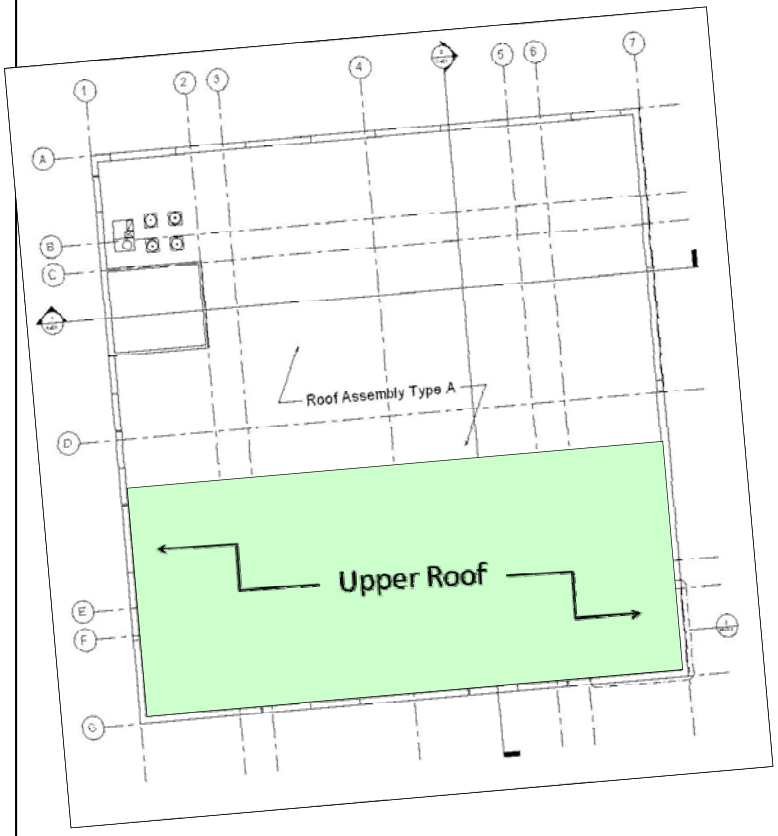
- Confirm proper documentation has been provided
  - Blown-in, sprayed-in, or foamed-in-place insulations should have R-Values verified through installer's certificates
- Confirm joint sealing and the installation of a continuous air barrier system
  - See Air Leakage section of this module

Review Question

Q: Partial Re-Roofing Scenario

This commercial building's upper low-sloped roof (defined by the green shading) has an existing BUR membrane with negligible insulation. The roofing replacement project will require stripping the existing roofing down to the structural deck. The upper roof currently has only a 6" high parapet/ curb. No renovation of the interior ceiling below the roof area is planned.

Is NYCECC-compliant insulation required?



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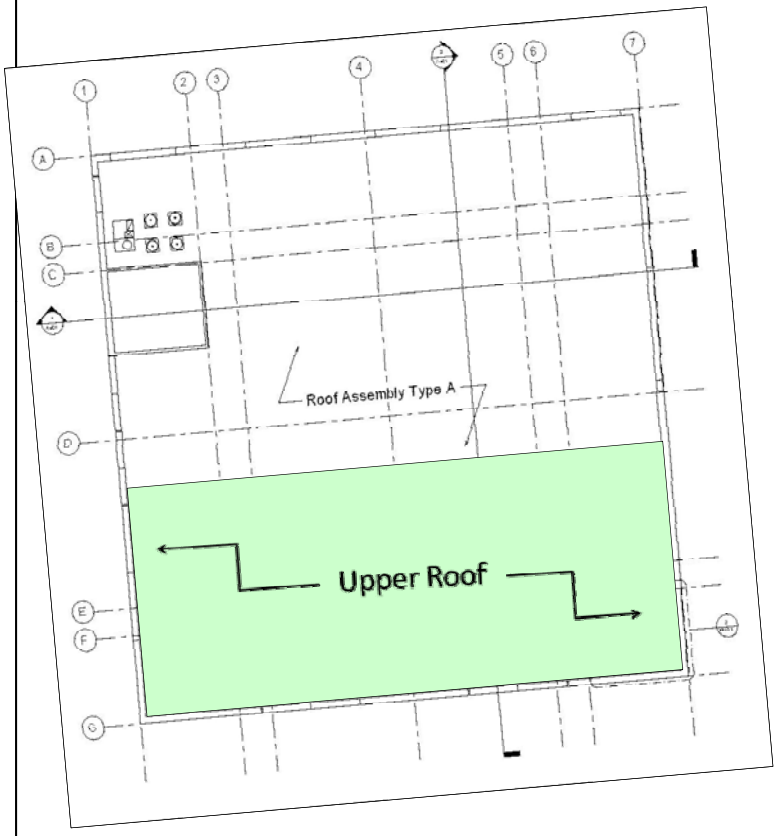
Is NYCECC-compliant insulation required?

A: YES.

Since the roofing is being stripped to the sheathing level, new insulation meeting NYCECC criteria must be added.

The Owner would need to determine if the preferred approach would entail exterior insulation (which could require raising the roof curb and possible adjustments at the bulkheads) or insulating from below.

See also Building Bulletin 2011-015.



Slides 87 to 96

7. Other Opaque Assemblies

7. Other Opaque Assemblies

In this section you will learn about:

- Compliance criteria related to different opaque assemblies, including:
  - Below Grade Walls;
  - Slab on Grade Floors;
  - Floor Systems; and
  - Opaque Doors.

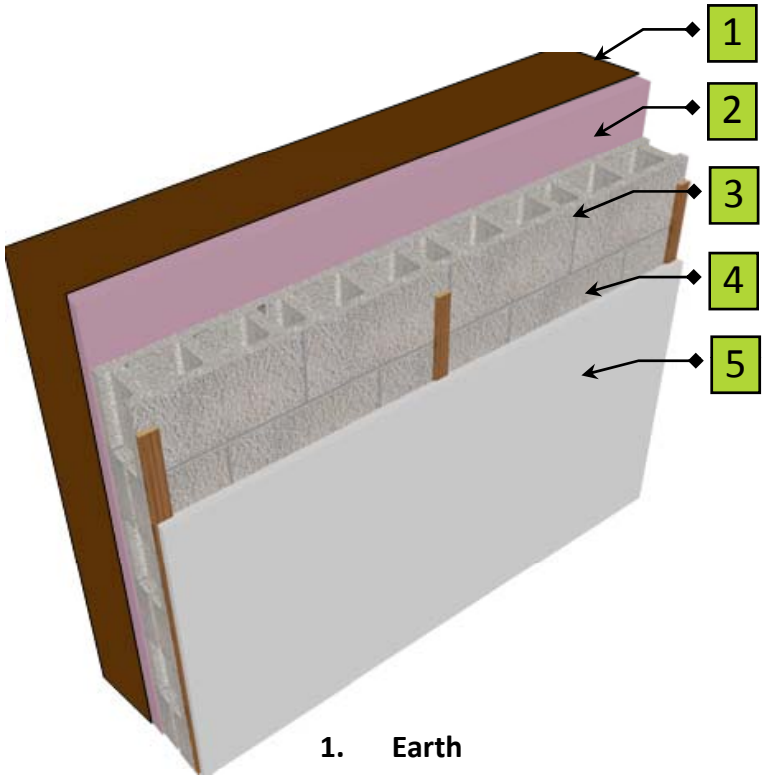
Below Grade Walls

Coverage

- ≥ 85% of the wall must be below grade to qualify

Insulation

- No requirement for non-Group R occupancy
- R-7.5ci required for Group-R occupancy
- Insulation to extend from top of wall to bottom of floor or to 10’ below grade, whichever is less
- C-Factor is used instead of U-Factor
- Protective coverings required for exposed exterior insulation



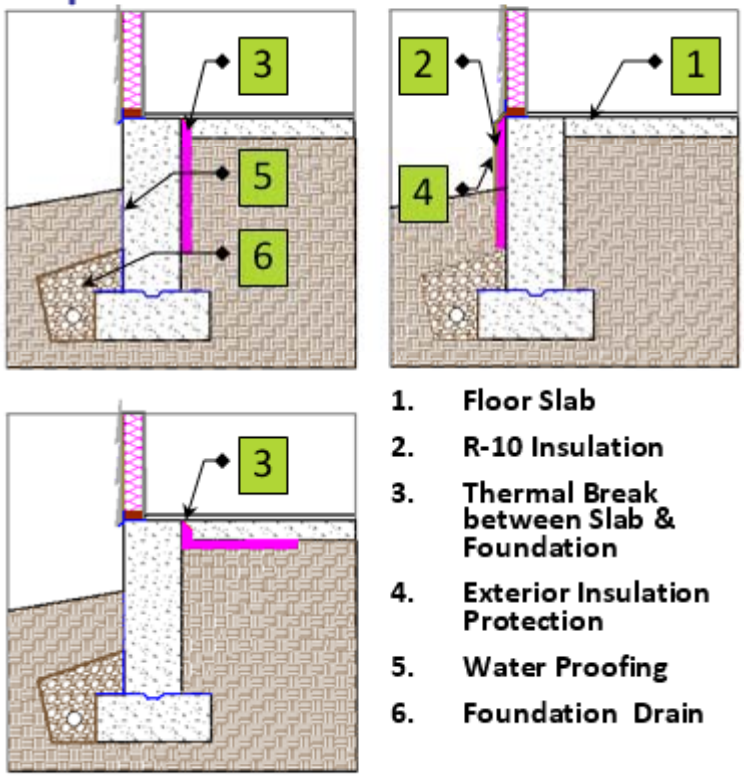
1. **Earth**
2. **R-7.2ci Exterior Insulation (Group-R requirement)**
3. **CMU**
4. **Furring Space**
5. **Gypsum Wall Board**

Slab On Grade Floors

Insulation (Prescriptive)

- Heated Slab (Radiant Heating)
  - R-15 for 24” Below grade for Group R only
- Unheated Slab
  - No Requirement for commercial occupancy
  - R-10 for 24” below grade for Group R occupancy
- F-Factor Alternative
  - Heated Slab: Max. allowed F-0.860
    - » Examples from ASHRAE 90.1-2007:
      - R-10 for 36” (F-0.84)
      - R-7.5 for 48” (F-0.85)
  - Unheated: F-0.730
  - Unheated (Group R): F-0.540
    - » Examples from ASHRAE 90.1-2007:
      - R-10 for 24” (F-0.54)
      - R-5 for 48” (F-0.54)

Options for Insulation Placement



1. Floor Slab
2. R-10 Insulation
3. Thermal Break between Slab & Foundation
4. Exterior Insulation Protection
5. Water Proofing
6. Foundation Drain

Floors over Unconditioned Spaces

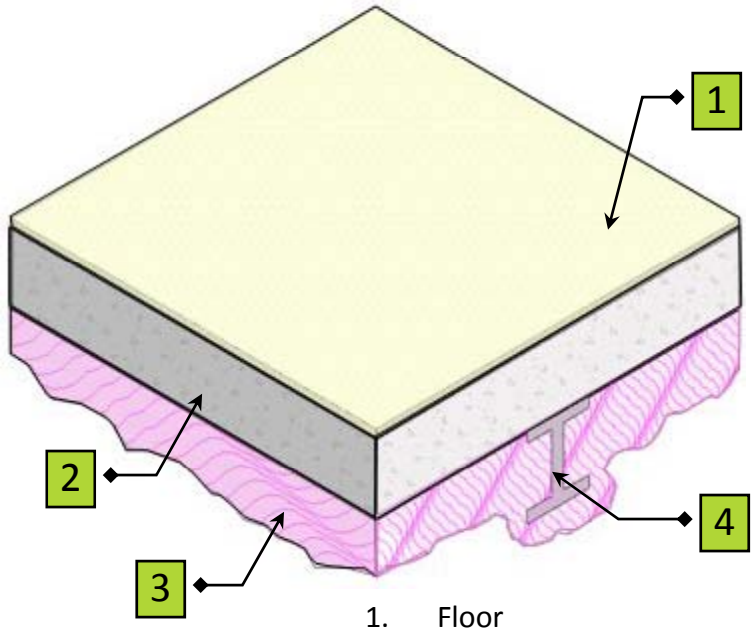
Coverage

- Any floor over unconditioned space
- 2 classes:
  1. Mass Floor
     - » Must weigh 35#/SF of floor surface area, or
     - » 25#/SF of floor surface area if material weight is not more than 120 pcf
  2. Floors with framing members
     - » Joist/Framing, Steel or Wood

Insulation

- Mass Floors:
  - ▸ R-10ci for non-Group R
  - ▸ R-10.4ci for Group R
- Floors with framing members
  - ▸ R-30

Typical Floor Insulation



1. Floor
2. Concrete Slab
3. Spray Insulation
4. Metal Beam

Opaque Doors

Door Classification

- Doors with less than 50% glass are considered opaque envelope
- Doors with 50% or more glass are regulated as Fenestration

U-Factors for Opaque Doors

- Swinging Doors: U-0.70 or less
- Roll up or Sliding: U-0.50 or less

Examples

- Steel or fiberglass doors with insulated cores
  - Fiberglass/Mineral Wool
  - Polystyrene
  - Polyurethane
- Many (but not all) wood doors

Be sure to obtain the manufacturer's U-Factor for the full door assembly, not just the core insulation material. For example, a polystyrene core may have a U-Factor of 0.091, but the U-Factor of the overall steel door would be closer to 0.4.

Progress Inspections

? What are the Applicable Progress Inspections?

Inspection / Test	Frequency
Protection of exposed foundation insulation **Insulation shall be visually inspected** to verify proper protection where applied to the exterior of basement or cellar walls, crawl-space walls and/or the perimeter of slab-on-grade floors.	As required during foundation work and prior to backfill
Insulation Placement and R-Values Installed insulation for each component of the conditioned space envelope and at junctions between components shall be **visually inspected to ensure that the R-Values area marked**, that such R-Values conform to the R-Values identified in the construction documents and that the **insulation is properly installed**. Certifications for unmarked insulation shall be similarly visually inspected..	As required to verify continuous enclosure while walls, ceilings and floors are open
Sealing Openings and penetrations in the building envelope, including site-built fenestration and doors, shall be **visually inspected to verify that a continuous air barrier around the envelope forms and air-tight enclosure**. The progress inspector shall visually inspect to verify that materials and/or assemblies have been tested and meet the requirements of the respective standards, or that the building is tested and meets the requirements of the standard, in accordance with the standard(s) cited in the approved plans.	As required during construction

Additional requirements for doors are included under the Fenestration section of this module.

Key inspections for Below Grade Walls, Floors, & Opaque Doors

- Confirm R-Values of all installed insulation types
  - Verify values compared to submitted drawings
- Check for continuity of the insulation at:
  - Rim joists @ floor framing
  - Junctions between below grade walls and the floor structure above
  - Slab/Foundation wall connection
- Confirm proper installation of the insulation
  - Cavity insulation must fill the full width of the joist cavity
  - Batts in floor framing should be installed using wire supports or other means to keep them permanently in place

Key inspections for Below Grade Walls, FlooValues Opaque Doors

- Confirm proper installation of the insulation (continued)
  - Blown-in, sprayed-in, or foamed-in place insulations should fill all cavity voids – check behind piping, receptacles, etc.
  - Rigid insulation boards should fit tightly together – no significant gaps
  - Exposed exterior insulation board at foundation wall or slab is covered with a protective coating that extends 6” or more below grade

- Confirm proper documentation has been provided
  - Blown-in, sprayed-in, or foamed-in-place insulations should have R-Values verified through installer’s certificates
  - U-Factors of full door assembly
  - Air leakage rating for manufactured door/frame assemblies

Key inspections for Below Grade Walls, Floors, & Opaque Doors

- Confirm joint sealing and the installation of a continuous air barrier system
  - See Air Leakage section of this module

Building Envelope

Slides 98 to 118

8. Fenestration

8. Fenestration

In this section you will learn about:

- Thermal & solar properties related to fenestration;
- Key dimensional metrics used in determining fenestration compliance; and
- Compliance criteria related to different fenestration types, including:
  - Unitary Windows;
  - Storefronts / Curtain Walls;
  - Skylights; and
  - Entrance Doors.

Importance of Fenestration

? **Why is Fenestration so Important to Building Energy Use?**

Heat Loss

- Fenestration assemblies typically have much higher rates of heat loss vs. opaque walls
  - Example: Allowable metal framed wall U-Factor = **0.064**
    Allowable metal framed window U-Factor = **0.55**
    8.6 x Higher
- Low surface temperatures of glazings can reduce occupant comfort
- Extensive glazing often requires perimeter radiation systems

Solar Heat Gain

- Solar heat gain through glazings can add substantially to the building cooling load
- High glazing-related peak loads can lead to larger AC system sizing

Importance of Fenestration

? **Why is Fenestration so Important to Building Energy Use?**

Daylighting

- Well-designed Fenestration systems can substantially reduce electric lighting loads through daylighting (often via automated dimming systems)

Air Leakage

- Fenestration systems (particularly operable windows and doors) and joints between Fenestration and walls are often the highest areas of air leakage in building assemblies

Thermal & Solar Properties

? What are the Key Thermal and Solar Properties for Fenestration?

U – Factor:

- Heat transmission coefficient
- Lower is better
- Verified through the NFRC 100 Standard

SHGC - Solar Heat Gain Coefficient:

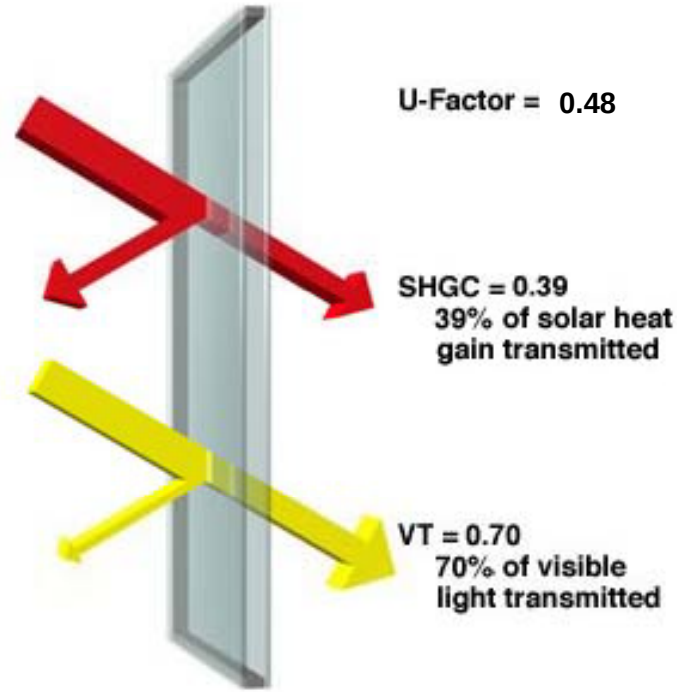
- Ratio of Solar Heat gain entering the space to the total solar radiation incident on the fenestration unit.
- Lower is better
- Verified through the NFRC 200 Standard

Shading Coefficient (SC):

- Older metric based on relative scale to single pane glass
- SC x 0.87 = SHGC

Visible Light Transmittance (VLT):

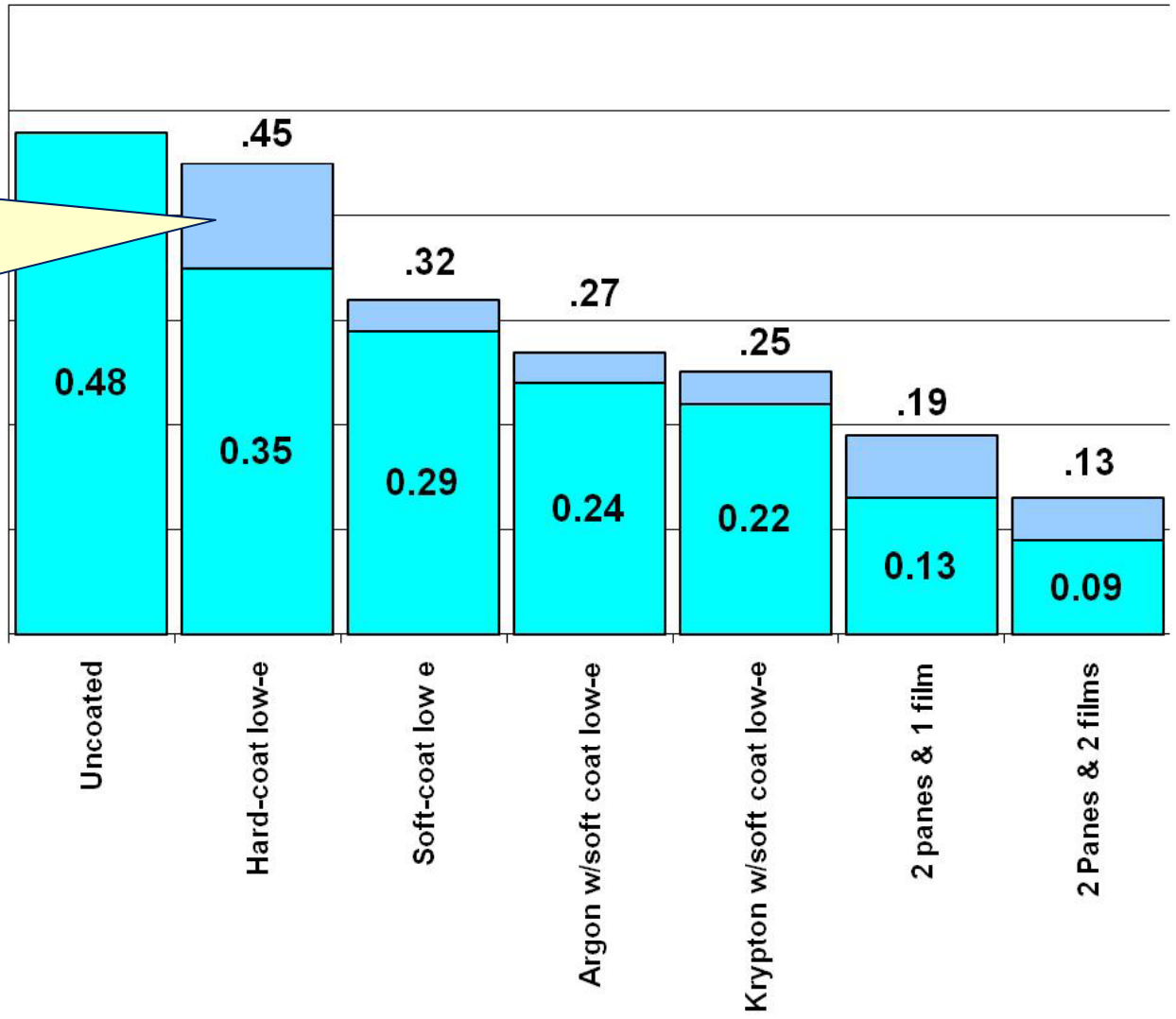
- The fraction of the visible light spectrum that is allowed to pass through the window assembly



Center of Glass U-Factors

? What are the Typical Ranges of Insulated Glazing Unit Performance?

The 2 different shades of blue in the bar graph represent the typical range of U-Factor values per glazing type.

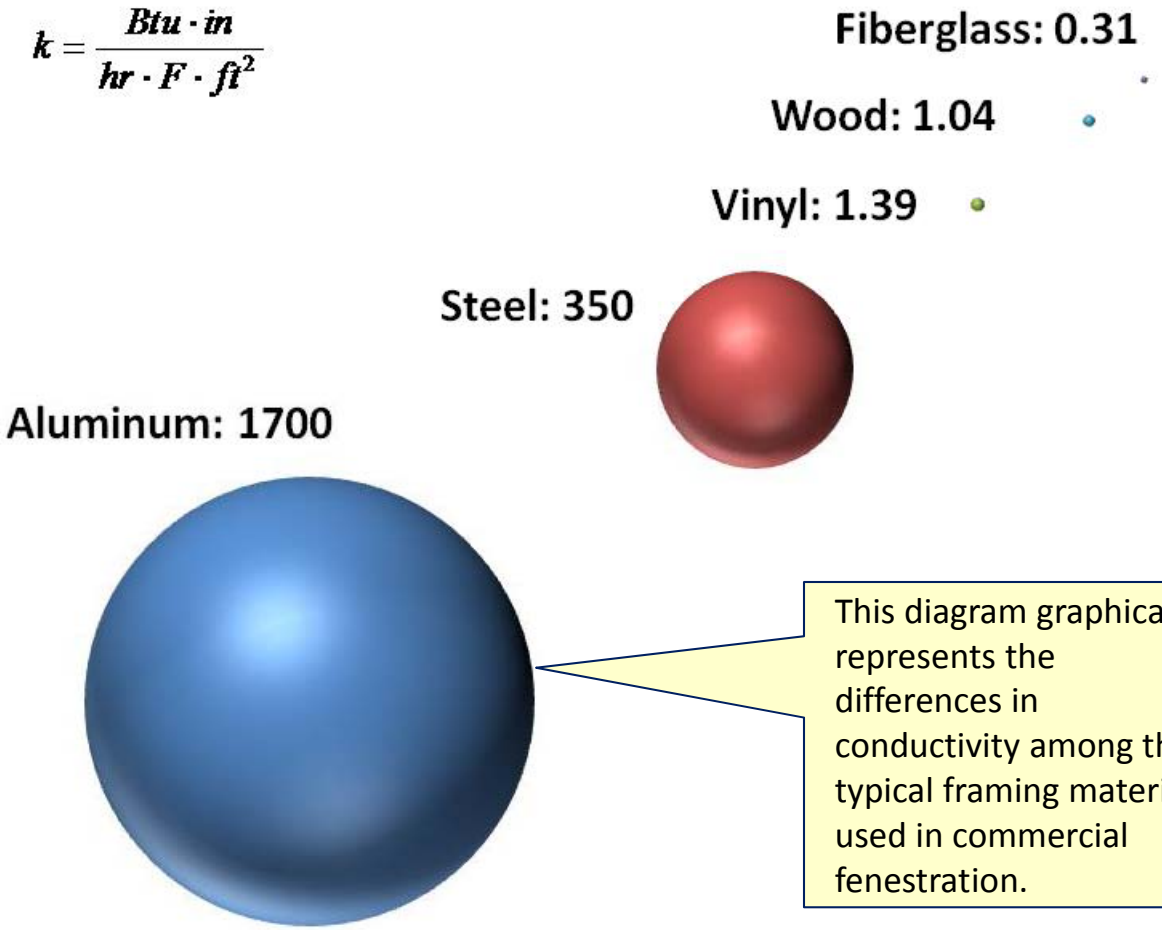


Conductivity (k) of Frame Materials

? Why Does the Frame Material Significantly Impact Thermal Performance?

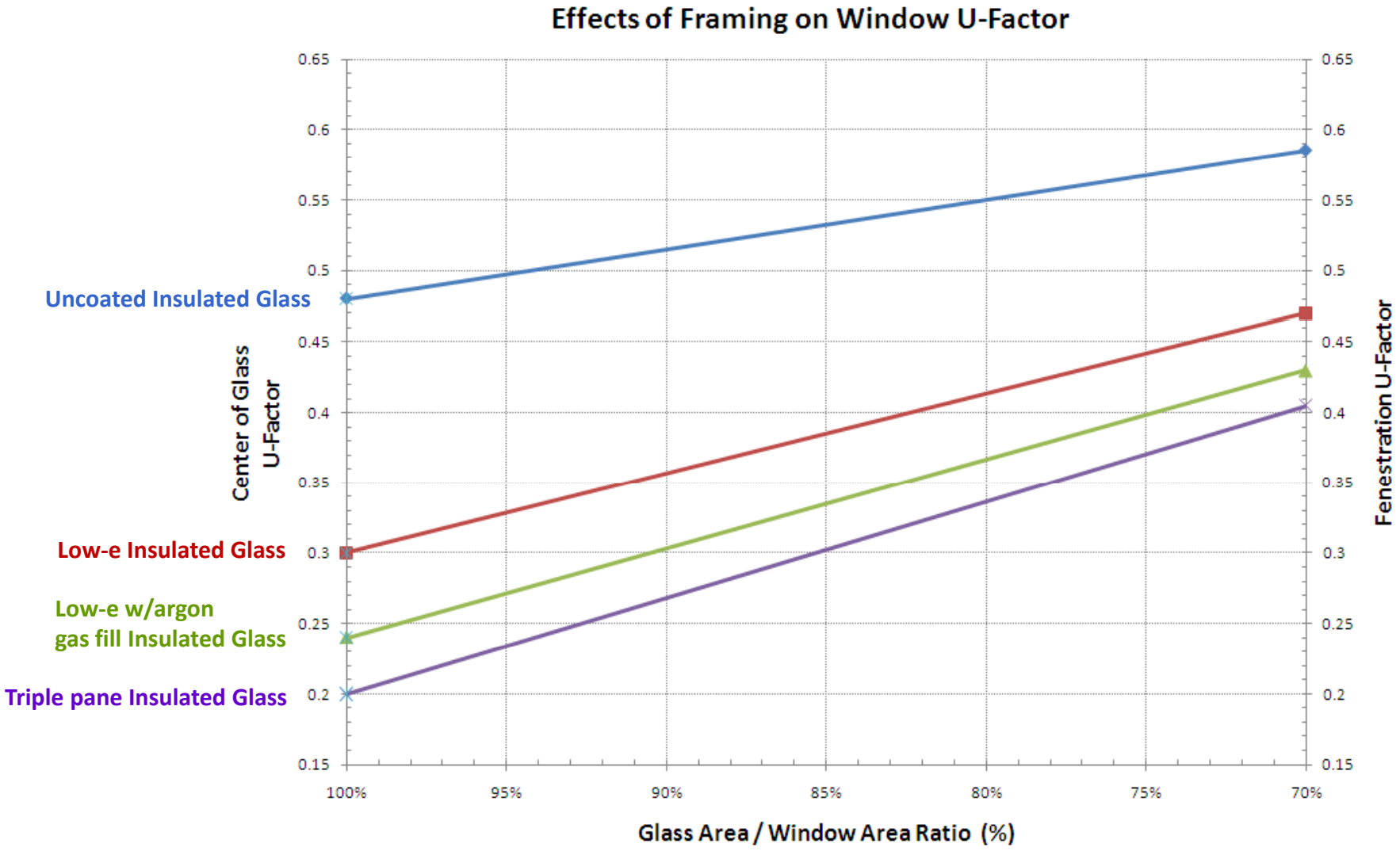
The conductivity of different frame materials varies enormously. Even though the frame typically makes up only 10-30% of a fenestration assembly, the most conductive frame types (aluminum and steel) will significantly reduce the overall U-Factor.

$$k = \frac{Btu \cdot in}{hr \cdot F \cdot ft^2}$$



This diagram graphically represents the differences in conductivity among the typical framing materials used in commercial fenestration.

System U-Factor vs. % of Glass Area

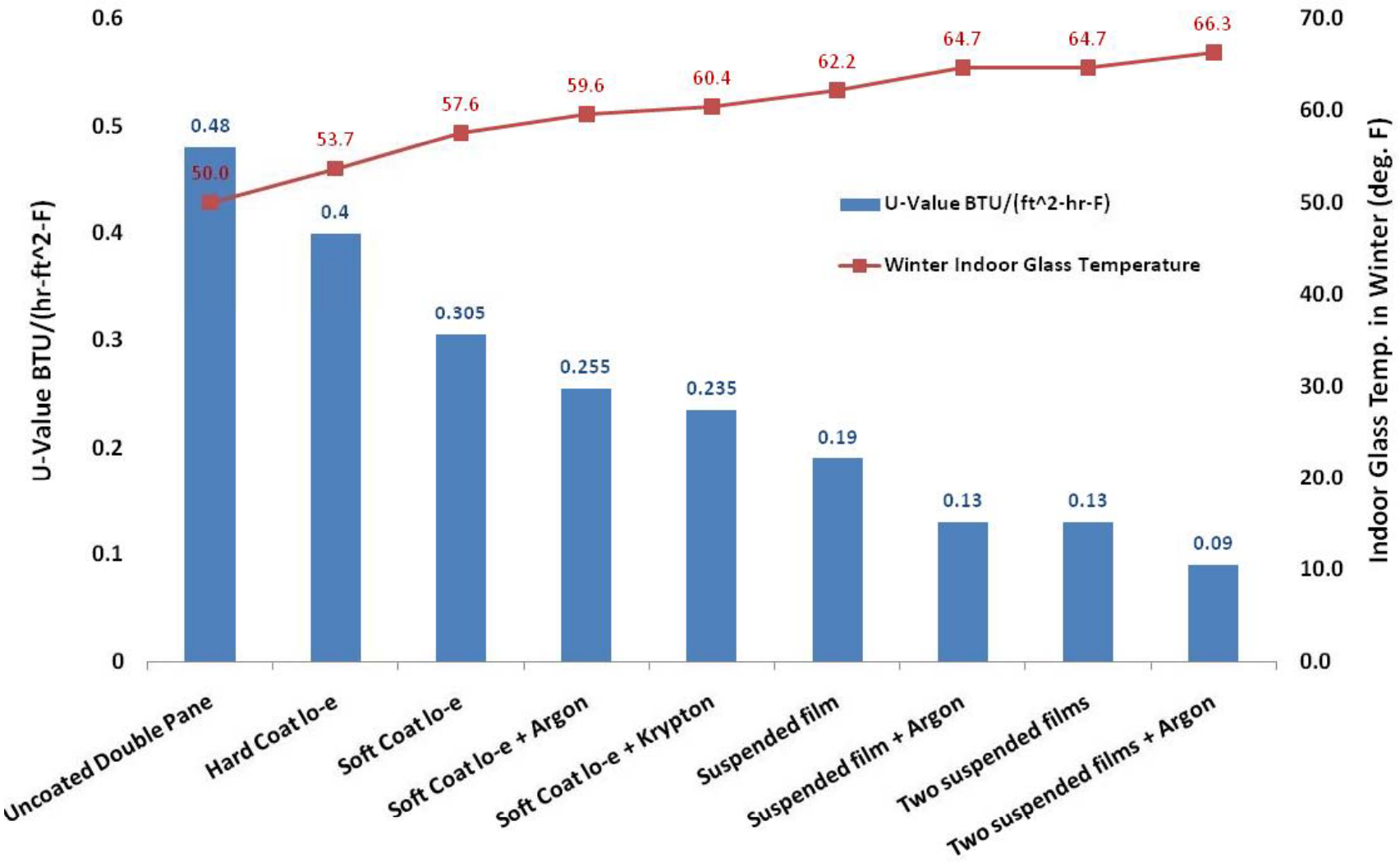


System U-Factor vs. % of Glass Area

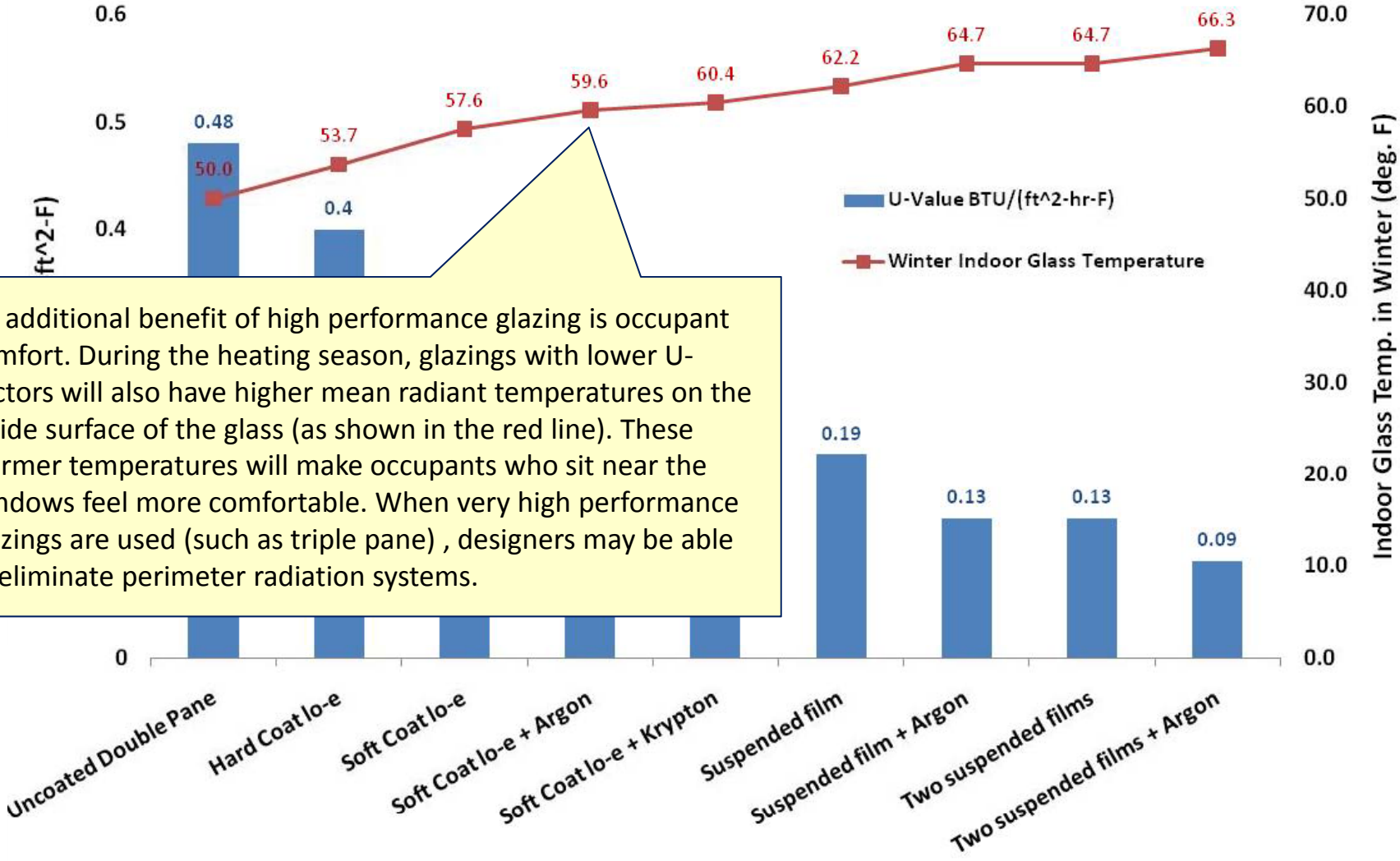
This graph illustrates the relationships between glazing type and frame area (expressed as the glass area to window area ratio). This example is for aluminum framed windows (thermally-broken).

Glass U-Factors & Indoor Glass Temperatures

8. Fenestration



Glass U-Factors & Indoor Glass Temperatures



An additional benefit of high performance glazing is occupant comfort. During the heating season, glazings with lower U-Factors will also have higher mean radiant temperatures on the inside surface of the glass (as shown in the red line). These warmer temperatures will make occupants who sit near the windows feel more comfortable. When very high performance glazings are used (such as triple pane) , designers may be able to eliminate perimeter radiation systems.

Solar Heat Gain Control

Options to Control Solar Gain

- Design Concept:
  - Building massing, Façade Orientation
  - Shading from adjacent buildings, vegetation, etc.
- Exterior Overhangs, Louvers, Shading Devices
- Glazing Options:
  - Low-e Coatings
  - Tinted Glass
  - Ceramic Fritting Patterns

Light to Solar Heat Gain Ratio (LSG)

- Visible Light Transmittance (VLT) / Solar Heat Gain Coefficient (SHGC)
- Higher is better

Examples of LSG Values

Glass Type	VLT	SHGC	LSG
Uncoated Clear IGU	0.79	0.70	1.13
Good Low-e coating, clear glass	0.70	0.38	1.84
Low-e coating + green tint	0.60	0.31	1.94
Low-e coating + 50% frit, clear glass	0.44	0.26	1.69
Superior Low-e coating, low-iron glass	0.64	0.27	2.37

NYCECC Fenestration Coverage

? What Types of Fenestration are Covered in the NYCECC?

Coverage:

- Vertical Windows - Fixed & Operable
- Curtain Walls (Vision Panels)
- Storefront Systems
- Skylights & Roof Windows
- Doors (> 50% glazing)
- Glass Block Walls and Panels

Exceptions:

- Storm Windows installed over existing fenestration
- Glass only replacements in existing sash and frames

Dimensional Properties

? **What are the Key Fenestration Dimensional Properties Addressed in the NYCECC?**

Fenestration Area:

- Includes gross area covering outer boundaries of the frame, typically measured at rough opening

Window to Wall Ratio (WWR):

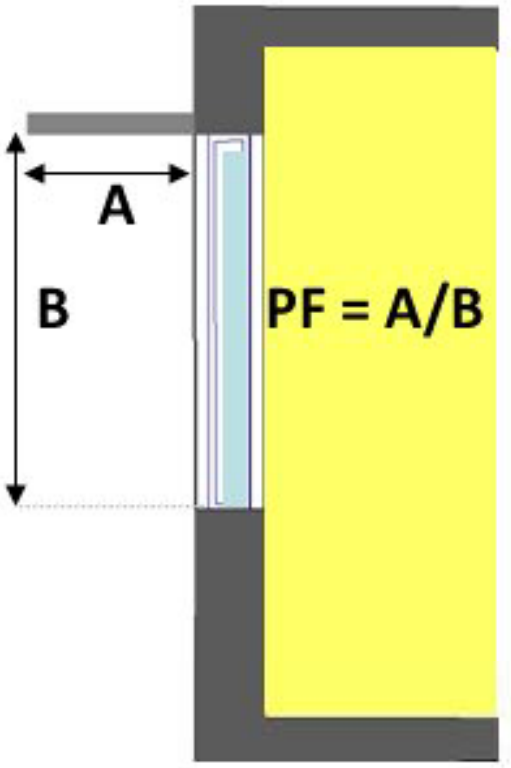
- Ratio of vertical fenestration to gross exterior above-grade wall area
- For Prescriptive method WWR ≤ 40%

Skylight to Roof Ratio (SRR):

- Ratio of horizontal fenestration to gross roof area
- For Prescriptive method SRR ≤ 3%

PF - Projection Factor:

- Ratio of horizontal projection of shading device to the vertical height from sill level of fenestration
- PF = A / B



Prescriptive Compliance Approach

? **What are the Steps in Complying Via the Prescriptive Approach?**

Process

- Determine type of vertical fenestration
  - Curtain Wall / Storefront
  - Entrance Door
  - All Other (Operable or Fixed Windows, Non-Entrance Doors)
- Determine Frame Type
  - **Non-Metal Framing**
    - » Wood / Vinyl / Fiberglass
    - » Metal Clad Wood or similar hybrids
  - **Metal Framing (with or without Thermal Break)**
- Determine Shading Projection Factor
- Use NYCECC Table 502.3 for maximum allowed assembly U-Factor & SHGC

Window Requirements

Vertical Fenestration Type	U Factor	SHGC, PF<0.25	SHGC, PF>0.25
Non Metal Frame	0.40	0.4	NR
Metal Framed - Curtain Wall / Store Front	0.50		
Metal Framed Window / All Other	0.55		
Metal Framed Entrance Door	0.85		

U-Factor & SHGC Verification

8. Fenestration

? What Documentation Verifies Typical Window/Door/Storefront Performance?

The U-Factor and SHGC of window, storefront, and door assemblies is typically provided by the manufacturer in their product literature, based on NFRC 100 (U-Factor) and NFRC 200 (SHGC) testing protocols. During Progress Inspections, NFRC labels should be affixed to fenestration products, and should be used to verify the approved performance values.

Curtain Walls & Window Walls

? **How are Curtain Walls and Window Walls Addressed?**

Curtain Walls

- Entirely in front of structure
- Typically, U=0.42-0.48 for thermally improved or thermally broken assemblies

Window Walls

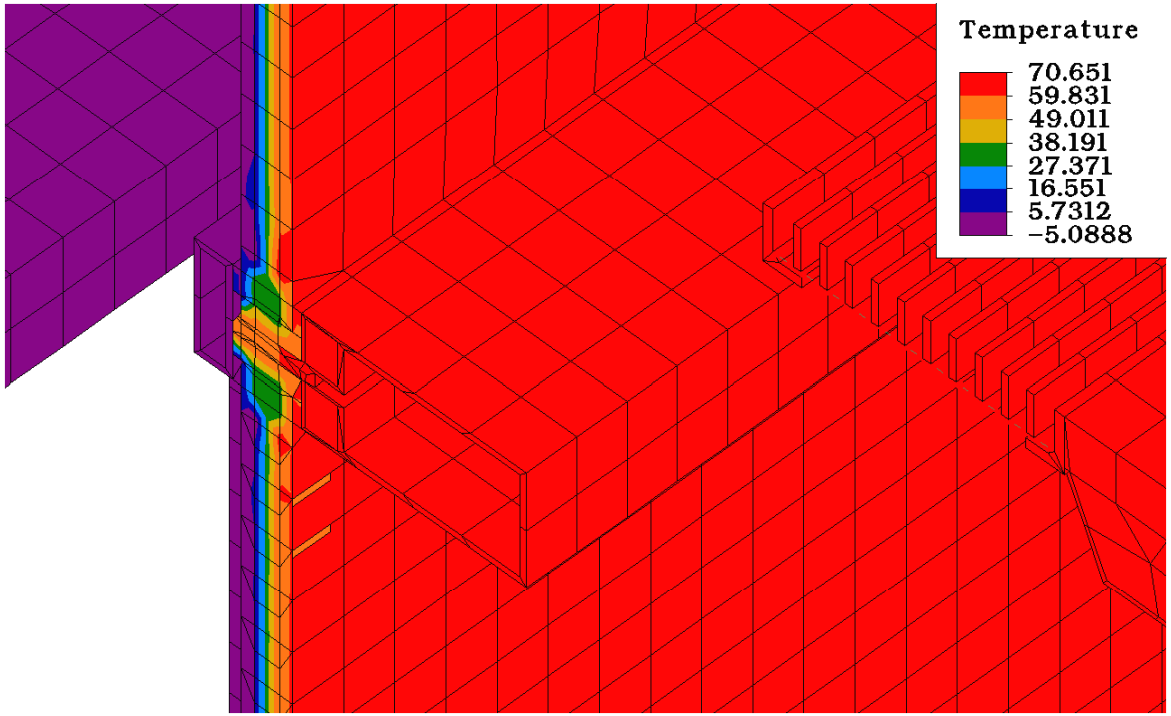
- Rest on each floor, so slab edge is often exposed, or covered but not insulated
- Typically, U=0.48-0.50 (thermally broken), excusive of slab edge

How are these U-Factors determined?

- From factory testing (uncommon)
- Through calculations
  - From NFRC calculations using two-dimensional heat flow modeling (typically THERM software)
  - From three-dimensional heat flow modeling (more accurate than 2D)

U-Factor & SHGC Verification

? What Documentation Verifies Custom Curtainwall Performance?



COMPONENT U-Factor

#	COMPONENTS	U-Value [Btu/(hft²F)]	A [ft²]	UxA [Btu/hF]
WWT/GASKET TYPICAL VISION				
1	WWT Mullion Left	1.25	1.57	1.96
3	Gasket Mullion Right	0.92	1.17	1.08
5	WWT Mullion Left Edge	0.33	1.96	0.65
7	Gasket Mullion Right Edge	0.27	1.96	0.53
9	Gutter Bottom Side	2.01	0.8	1.61
10	Intermediate Top Side	1.8	0.54	0.97
11	Gutter Bottom Edge	0.31	0.89	0.28
12	Intermediate Top Edge	0.3	0.89	0.27
13	Vision Glass	0.29	37.28	10.81
		Totals =	47.06	18.15
			U-Factor = 0.386	Btu/(hft²F)

The U-Factor of custom curtainwall assemblies is typically provided by the manufacturer using 2 or 3-dimensional heat flow analysis software, and following the protocols of NFRC 100. Applicants should have reports available as back-up if an audit is conducted.

Skylights

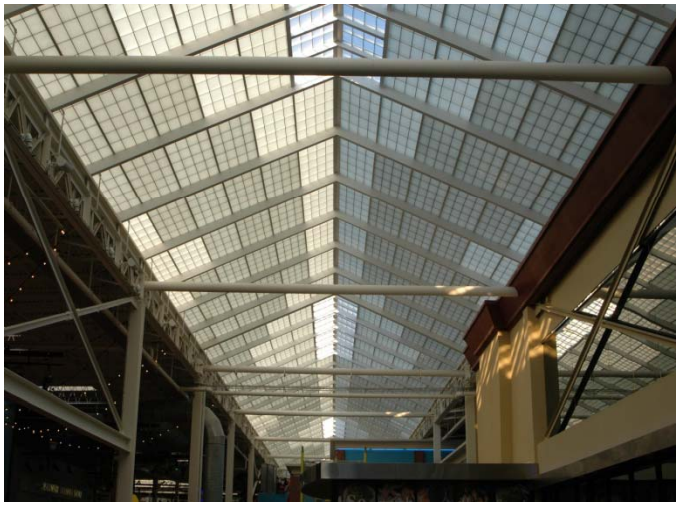
? What are the Prescriptive Requirements for Skylights?

Coverage:

- Glazing on horizontal or within 60° from horizontal are covered under skylights
- Glass or Polymer glazings

Requirements:

- For Prescriptive Method:
  - Skylight to Roof Ratio (SRR) must be less than or equal to 3%
- Assembly U-Factor: 0.60 maximum
- Assembly SHGC: 0.40 maximum
- Values verified through NFRC 100 and 200



Unlabeled Fenestration

- Default values must be used from NYCECC Section 303.1.3 (and be included in the Energy Analysis)
- Since the default values do NOT meet prescriptive criteria, Trade-off or performance-based compliance must be pursued

TABLE 303.1.3(1)
DEFAULT GLAZED FENESTRATION *U*-FACTORS

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			

Progress Inspections

8. Fenestration

? **What are the Applicable Progress Inspections for Fenestration?**

Inspection / Test	Frequency
Fenestration thermal values and product ratings **U-Factors and SHGC values of installed fenestration shall be visually inspected** for conformance with the U-Factors and SHGC values identified in the construction drawings by verifying the manufacturer's NFRC labels or, where not labeled, using the ratings in NYCECC Tables 303.1.3(1), (2) and (3). Where ASHRAE 90.1 is used, visible light transmittance values shall also be verified.	As required during installation
Fenestration and door assembly product ratings for air leakage Windows and sliding or swinging door assemblies, except site-built windows and/or doors, shall be **visually inspected to verify that installed assemblies are labeled by the manufacturer to the referenced standard**. For curtain wall, storefront glazing, commercial entrance doors and revolving doors, the testing reports shall be reviewed to verify that the installed assembly complies with the standard cited in the approved plans.	As required during installation; prior to final construction inspection
Sealing Openings and penetrations in the building envelope, including site-built fenestration and doors, shall be **visually inspected to verify that a continuous air barrier around the envelope forms an air-tight enclosure**. The progress inspector shall visually inspect to verify that materials and/or assemblies have been tested and meet the requirements of the respective standards, or that the building is tested and meets the requirements of the standard, in accordance with the standard(s) cited in the approved plans.	As required during construction

Progress Inspections

8. Fenestration

? **What are the Applicable Progress Inspections for Fenestration?**

Inspection / Test	Frequency
Fenestration areas Dimensions of windows, doors and skylights shall be **verified by visual inspection**.	Prior to final construction inspection
Projection factors Where the energy analysis utilized a projection factor > 0, the projection dimensions of overhangs, eaves or permanently attached shading devices **shall be verified against approved plans by visual inspection.**	Prior to final construction inspection

Key inspections for Fenestration

- Confirm areas of fenestration have not increased from approved drawings
- Confirm U-Factor, SHGC, & Air Leakage of all installed fenestration types
  - Verify values compared to submitted drawings
- Confirm Projection Factors of overhangs or shading devices match approved drawings
- Confirm joint sealing at the fenestration and integration with the continuous air barrier system
  - See Air Leakage section of this module
- Confirm proper documentation has been provided
  - Look for NFRC Labels or Test Results

9. Air Leakage Control

9. Air Leakage Control

Learning Objectives

In this section you will learn about:

- Concepts & terminology related to Air Leakage;
- Air leakage control requirements mandated in the NYCECC; and
- Air Barrier Systems.

Air Leakage:

- Includes provisions for:
  - Maximum allowable leakage of window, storefront, curtainwall, and door assemblies
  - Continuous Air Barriers
  - Outdoor Air Intakes and Exhaust Openings
  - Loading Dock Weatherseals
  - Vestibules
  - Recessed Lighting

Vapor Retarders:

- NYCECC requirements do **NOT** apply to NYC (all Boroughs are Climate Zone 4A)

Per NYC Building Code, section BC §1403 - Performance requirements for Exterior Walls:

§1403.2 Weather protection. Protection against condensation in the exterior wall assembly shall be provided in accordance with the ECCCNYS.

§1403.3 Vapor Retarder. An approved vapor retarder shall be provided.

Exceptions:

1. Where other approved means to avoid condensation and leakage of moisture are provided.
2. Plain and reinforced concrete or masonry exterior walls designed and constructed in accordance with Chapters. 19 and 21, as applicable.

Air Leakage Rates:

- Amount of air that can leak through an assembly at specific pressure differential

- CFM / SF @ PSF
  - CFM: Cubic Feet per Minute
  - SF: Surface Area in Square feet
  - PSF: Pressure in Pounds per Square Foot

- Compliance can be demonstrated for individual materials, assemblies, or whole buildings

Air Leakage Control: Fenestration

Air Leakage Limits for Fenestration

- Windows: 0.3 cfm/SF
  Doors: 0.5 cfm/SF
  - Tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, or
  - Certified & labeled following NFRC 400

- Curtainwalls & Storefront Glazing:
  0.3 cfm/SF @ 1.57 psf (75 Pa)
  - Tested in accordance with ASTM E 283

- Glazed Entrance Doors (swinging & revolving):
  1.00 cfm/SF @ 1.57 psf (75 Pa)
  - Tested in accordance with ASTM E 283

NFRC Labels must be reviewed as part of the Progress Inspections

Air Barrier:

- Required to prevent uncontrolled leakage of air through the envelope
  - Common problems due to air leakage:
    - » Comfort issues,
    - » Over-worked HVAC systems,
    - » Degradation of insulation,
    - » Moisture damage, mold growth, risk to structural integrity of envelope

Continuous Air Barriers

Air Barrier:

- NYCECC Requirements:
  - A continuous system throughout the envelope
  - Typically involves multiple materials working in concert, such as:
    - » Seam sealers between foundations and structural framing
    - » Elastomeric or liquid-applied membrane systems (typically used over masonry)
    - » “House wrap” permeable air infiltration barriers
    - » T&G or taped exterior gwb sheathing
    - » Caulked and sealed joints and penetrations
    - » Metal or membrane flashings
    - » Expandable foam sealants at wall penetrations and fenestration/door openings
    - » Rigid or spray applied foam insulations (rigid insulation boards must have joints taped)
    - » Roofing paper or membranes

Measuring Air Barrier Compliance

Individual Materials:

- **0.004 cfm/SF @ 0.3 in. water gauge**
  - ASTM E 2178: Air Permeance of Materials
  - Typical: Use manufacturer's tested values
    - » Air Barrier Association of America, Inc. (ABAA) has directory of tested products

Assemblies:

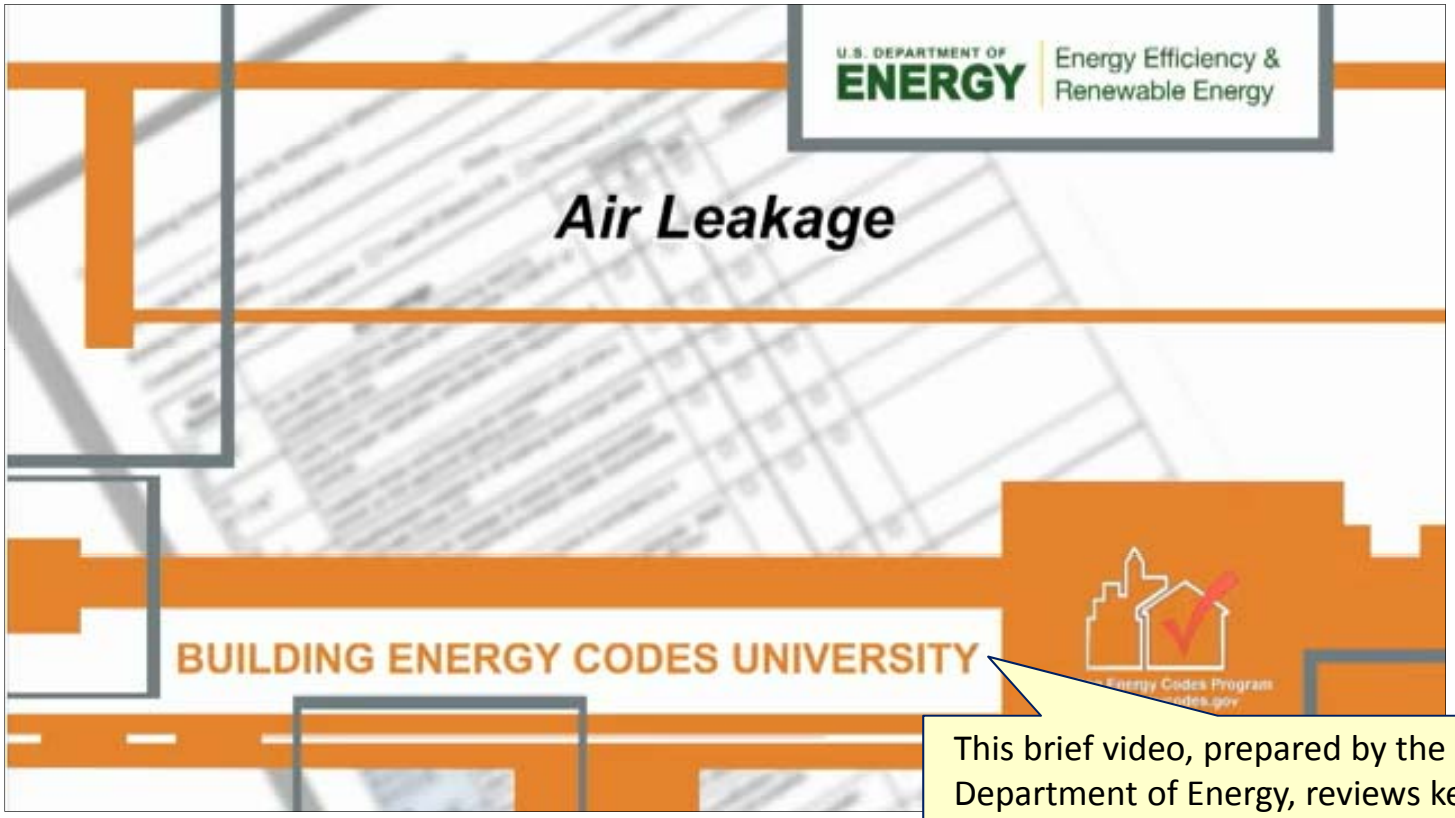
- **0.04 cfm/ft^2 @ 0.3 in. water gauge**
  - ASTM E 2357: Air Leakage of Air Barrier Assemblies, or
  - ASTM E 1677: Air Retarder (AR) Material or System for Systems Low-Rise Framed Building Walls
  - Typical: Use manufacturer's tested value or test mock up assemblies of 8'x8' sizes

Whole Buildings:

- **0.4 cfm/ft^2 @ 0.3 in. water gauge**
  - ASTM E 779: Air Leakage Rate by Fan Pressurization
  - Best practice: Blower Door tests with infrared imaging during construction for detecting and correcting for leaks

US DOE Building Inspection Video

9. Air Leakage Control



This brief video, prepared by the U.S. Department of Energy, reviews key inspection issues related to air sealing. Progress Inspectors may find useful tips in the video, even though it is not specific to the NYCECC.

Air Leakage Inspection Issues
(Length - 0:52)

Additional Mandatory Features

9. Air Leakage Control

Vestibules:

- Required for Main Entrance Doors opening into a conditioned space over 3,000 SF
- Exceptions include:
  - Doors not used for entrances
  - Doors opening directly from Sleeping units or Dwellings unit
  - Revolving doors
  - Service doors

DOE Vestibule Inspection Video

Loading Dock Weatherseals:

- Required at cargo or loading dock doors

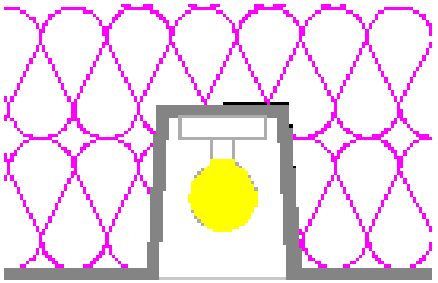
DOE Loading Dock Inspection Video

Outdoor Air Intakes & Exhaust Openings:

- Class I motorized leakage-rated dampers are required at:
  - Stair & Elevator shafts
  - Other OA intakes & exhaust openings integral to the envelope
  - Maximum leakage rate 4 cfm/SF @ 1.0 in water gauge (1250 Pa)
- Exceptions:
  - In buildings less than 3 stories in height, non-motorized gravity dampers are allowed

Recessed Lighting:

- If installed in thermal envelope, must be sealed, gasketed, or caulked @ interior finish
- Must be IC- Rated (Insulation Contact Rated) and labeled as meeting ASTM E 283
  - Maximum 2.0 cfm at 1.57 psf pressure difference



"IC" Rated Luminaire

Progress Inspections

? What are the Applicable Progress Inspections for Air Leakage?

Inspection / Test	Frequency
Fenestration and door assembly product ratings for air leakage Windows and sliding or swinging door assemblies, except site-built windows and/or doors, shall be **visually inspected to verify that installed assemblies are labeled by the manufacturer to the referenced standard**. For curtain wall, storefront glazing, commercial entrance doors and revolving doors, the testing reports shall be reviewed to verify that the installed assembly complies with the standard cited in the approved plans.	As required during installation; prior to final construction inspection
Sealing of Openings and Penetrations Openings and penetrations in the building envelope, including site-built fenestration and doors, shall be **visually inspected to verify that a continuous air barrier around the envelope forms an air-tight enclosure**. The Progress Inspector shall visually inspect to verify that materials and/or assemblies have been tested and meet the requirements of the respective standards, or that the building is tested and meets the requirements of the standard, in accordance with the standard(s) cited in the approved plans.	As required during construction

9. Air Leakage Control

Key inspections for Air Leakage Control

- Confirm the use of sill sealers, gaskets, caulking and other means where framing, masonry, or prefabricated wall panels meet a foundation wall or slab
- Confirm the main type(s) of air barrier materials used for the above-grade walls
  - Confirm the air permeance of the air barrier material or assembly
- Confirm the air leakage rate of all fenestration
  - Look for NFRC Labels for Windows, Doors
  - Obtain test results for Curtainwalls

Key inspections for Air Leakage Control

- Confirm the use of flashing, window dams, expandable foam sealant, and caulking at rough opening/fenestration joints to create a continuous air barrier with the surrounding wall system

- Confirm the use of gaskets, backer rods, caulking and other means at all expansion joints, utility penetrations, roof/wall connections, and other similar conditions

Key inspections for Air Leakage Control

- Confirm IC rating recessed lighting fixtures in insulated ceilings, and sealing of fixtures against the finish ceiling
- Confirm vestibules are built per approved drawings
  - Confirm self-closers on doors
- Confirm loading dock weather seals are installed where applicable
- Confirm the use of motorized, leakage-rated dampers at applicable stairwells, elevator shafts, and other locations
- Confirm results of blower door testing, if utilized

Slides 135 to 164

10. Submissions & Inspections

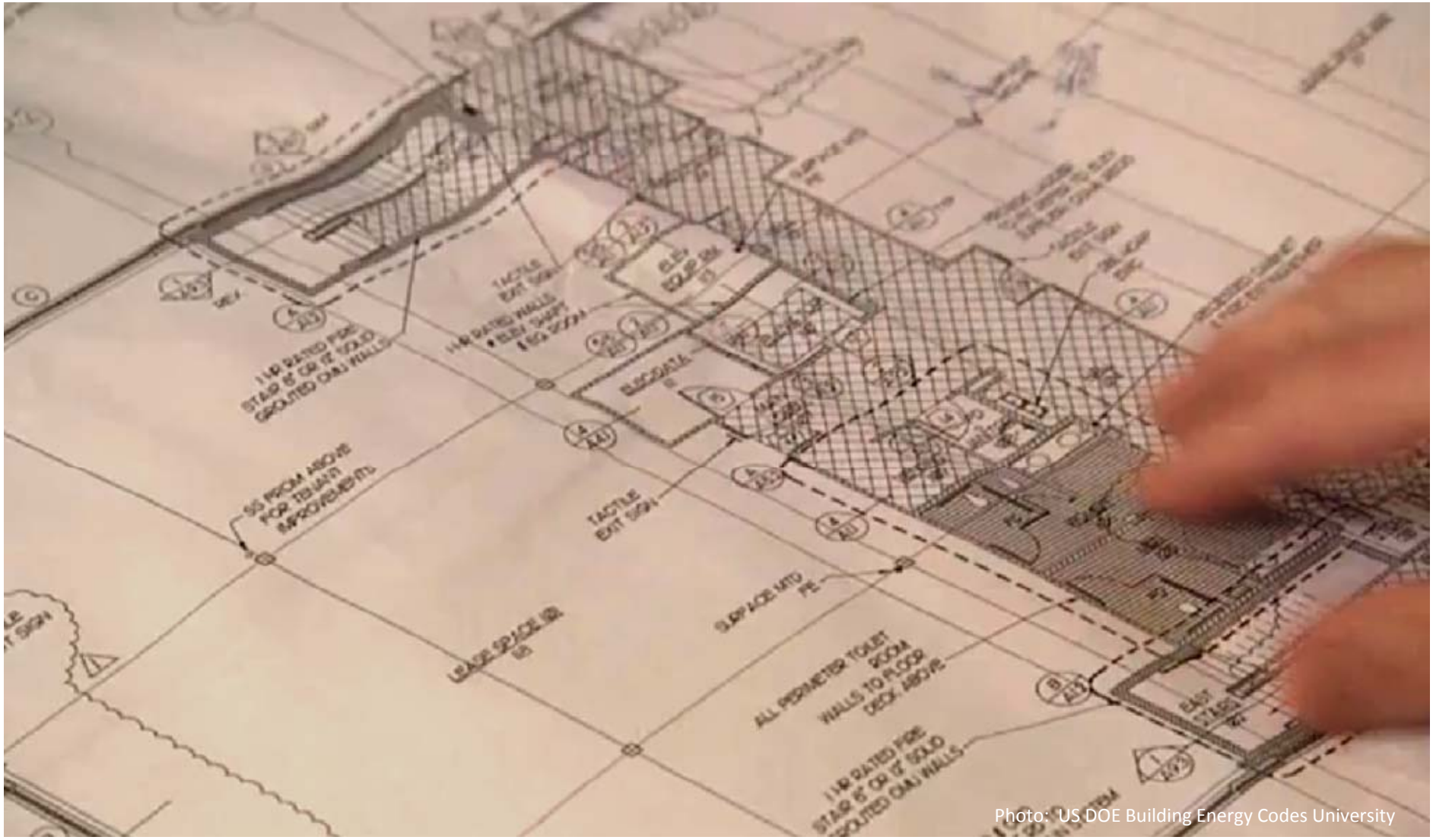


Photo: US DOE Building Energy Codes University

10. Submissions & Inspections

Learning Objectives

In this section you will learn about:

- Envelope-related requirements for NYCECC Submissions, including:
  - Energy Analysis, and
  - Supporting Documentation; and
- Applicable Progress Inspections associated with building envelope

? What are the Application Requirements Related to the NYCECC?

Per 1 RCNY §5000-01:

- A Professional Statement
- An Owner Statement
- An Energy Analysis
- Supporting Documentation, including required Progress Inspections descriptions in drawings

This Envelope Module addresses only Energy Analysis, Supporting Documentation, and Progress Inspection issues. A full overview of the required submission documents, including Professional and Owner Statements, is included under the NYCECC Administrative Overview module in this series.

Energy Analysis

? What Types of Energy Analysis are Allowed?

Per 1 RCNY §5000-01:

- Tabular Analysis
- COMcheck software
- Energy Modeling
- Alternative Formats

Option 1: Tabular Analysis

- The Tabular Analysis compares proposed values of each ECC-regulated item in the scope of work with the respective prescriptive values required by the Code.
  - Applicable to New Buildings, Additions, or Alterations
  - Demonstrates Prescriptive Compliance
  - Can be used with either NYCECC or ASHRAE 90.1

Envelope documentation should be sure to include:

- **ALL** assemblies related to the scope of work (roofs, above grade walls, fenestration, below grade walls, floors over unconditioned space, etc.)
- **ALL** significant variations of envelope assemblies (different wall assemblies, glazing types, roof assemblies, door types, etc.)

Sample Tabular Analysis - 1

 Examples of Notes for Commercial Alterations / Renovations

ITEM DESCRIPTION	PROPOSED DESIGN VALUE	CODE PRESCRIPTIVE VALUE AND CITATION	SUPPORTING DOCUMENTATION
BUILDING ENVELOPE			
Replace roof membrane and add insulation SRR = 2.2%	Roof Type 1: 4" XPS (R -20) continuous insulation above deck	Minimum R-20 continuous insulation NYCECC Table 502.2(1)	Roof Type 1: A-106 (Roof Plan) A-402 (Wall Sections) 6-8/A-603 (Roof Details)
Replace existing windows w/new aluminum framed windows, Floors 2 - 4 WWR = 32% PF = 0	Window Type A: U = 0.46, SHGC = 0.29, Air leakage ≤ 0.10 cfm/SF Window Types B + C: U = 0.41, SHGC = 0.31, Air leakage ≤ 0.30 cfm/SF Window Type D: U = 0.41, SHGC = 0.23, Air leakage ≤ 0.30 cfm/SF	Window Types A-D: Maximum U-Factor = 0.55 Maximum SHGC = 0.40 NYCECC Table 502.3 Maximum Air Leakage = 0.3 cfm/SF NYCECC 502.4.1	Window Types A-D: A-301-302 (Elevations) A-501 (Schedules)
Renovate interior side of exterior walls around new window openings – repair/replace gwb	N/A - No change proposed to existing 3 ½" metal stud furring walls which are completely filled with fiberglass batts (estimated R-3.1/inch).	NYCECC 101.4.3 Exception 3 – Alterations, renovations, or repairs to roof/ceiling, wall, or floor cavities which are insulated to full depth with insulation having a minimal nominal value of R-3.0/inch.	A-102-104 (Floor Plans) 1-2/A-305 (Interior Elevations)

Sample Tabular Analysis - 1

ITEM DESCRIPTION	PROPOSED DESIGN VALUE	CODE PRESCRIPTIVE VALUE AND CITATION	SUPPORTING DOCUMENTATION
BUILDING ENVELOPE			
Replace roof membrane and add insulation SRR = 2.2%	Roof Type 1: 4" XPS (R -20) continuo insulation above deck		Roof Type 1: A-106 (Roof Plan) A-402 (Wall Sections) 6-8/A-603 (Roof Details)
Replace existing windows w/new aluminum framed windows, Floors 2 - 4 WWR = 32% PF = 0	Window Type A: U = 0.46, SHGC = 0.29, Air leakage ≤ 0.10 cfm/SF Window Types B + C: U = 0.41, SHGC = 0.31, Air leakage ≤ 0.30 cfm/SF Window Type D: U = 0.41, SHGC = 0.23, Air leakage ≤ 0.30 cfm/SF	Maximum SHGC = 0.40 NYCECC Table 502.3 Maximum Air Leakage = 0.3 cfm/SF NYCECC 502.4.1	Window Types A-D: A-301-302 (Elevations) A-501 (Schedules)
Renovate interior side of exterior walls around new window openings – repair/replace gwb	N/A - No change proposed to existing 3 ½" metal stud furring walls which are completely filled with fiberglass batts (estimated R-3.1/inch).	NYCECC 101.4.3 Exception 3 – Alterations, renovations, or repairs to roof/ceiling, wall, or floor cavities which are insulated to full depth with insulation having a minimal nominal value of R-3.0/inch.	A-102-104 (Floor Plans) 1-2/A-305 (Interior Elevations)

Applicants must include reference to the applicable Supporting Documentation for EACH item within the Tabular Analysis.

Sample Tabular Analysis - 2

 Examples of Notes for Commercial Alterations / Renovations

ITEM DESCRIPTION	PROPOSED DESIGN VALUE	CODE PRESCRIPTIVE VALUE AND CITATION	SUPPORTING DOCUMENTATION
BUILDING ENVELOPE			
Add insulation/furring to existing basement walls	Wall Type 2: 1 ½" rigid Extruded Polystyrene continuous insulation (R-7.5) adhered to existing concrete foundation walls	Minimum R-7.5 continuous insulation (Group R) Table 502.2(1)	Wall Type 2: A-100 (Basement Plan) 2/A-603 (Wall Detail)
New metal exterior egress doors in existing metal frames	Door Type 1: Insulated Steel Door U = 0.62	Maximum U-Factor = 0.70 Table 502.2(1)	Door Type 1: A-101 (1st Floor Plan) A-301 (Elevations) A-501 (Schedules)
Air Sealing @ replacement windows	Expandable spray-applied polyurethane foam sealant, continuous @ window rough openings	NYCECC 502.4.3 – Continuous Air Barrier	A-501 (Schedules) – see air sealing notes in Comments column of Window Schedule
New Vestibule at 1st Floor Entry	New 10' deep vestibule @ building entrance. Two sets of swinging doors with self-closers.	NYCECC 502.4.6 - Vestibules	A-101 (1st Floor Plan) A-501 (Schedules) – see door closer notes in Comments column of Door Schedule

Option 2: COMcheck submissions

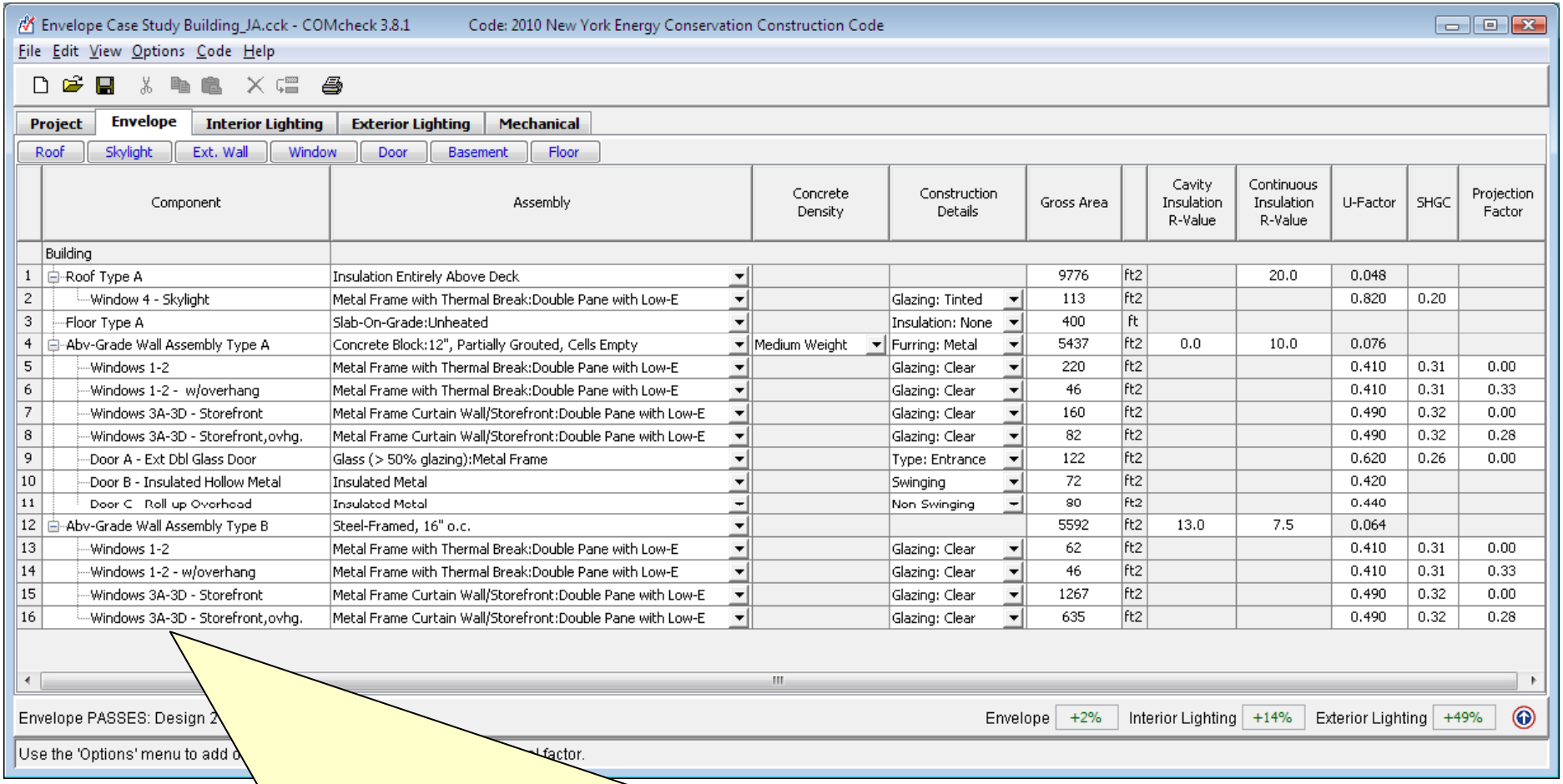
- COMcheck software, available for free from the US Department of Energy, can be used to prepare Energy Code compliance calculations.
  - Demonstrates Prescriptive Compliance, with Trade-offs allowed among different envelope assemblies (roofs, walls, glazings, etc.)
  - Only New York State NYCECC or ASHRAE-90.1 COMcheck forms are permitted (not IECC)
  - Downloads: http://www.energycodes.gov/software.stm

Envelope input in COMcheck should be sure to include:

- **ALL** assemblies related to the scope of work (roofs, above grade walls, fenestration, below grade walls, floors over unconditioned space, etc.)
- **ALL** significant variations of envelope assemblies (different wall assemblies, glazing types, roof assemblies, door types, etc.)

Sample COMcheck Input

10. Submissions & Inspections



Envelope Case Study Building_JA.cck - COMcheck 3.8.1 Code: 2010 New York Energy Conservation Construction Code

File Edit View Options Code Help

Project | Envelope | Interior Lighting | Exterior Lighting | Mechanical

Roof | Skylight | Ext. Wall | Window | Door | Basement | Floor

	Component	Assembly	Concrete Density	Construction Details	Gross Area		Cavity Insulation R-Value	Continuous Insulation R-Value	U-Factor	SHGC	Projection Factor
	Building										
1	Roof Type A	Insulation Entirely Above Deck			9776	ft2		20.0	0.048		
2	Window 4 - Skylight	Metal Frame with Thermal Break:Double Pane with Low-E		Glazing: Tinted	113	ft2			0.820	0.20	
3	Floor Type A	Slab-On-Grade:Unheated		Insulation: None	400	ft					
4	Abv-Grade Wall Assembly Type A	Concrete Block:12", Partially Grouted, Cells Empty	Medium Weight	Furring: Metal	5437	ft2	0.0	10.0	0.076		
5	Windows 1-2	Metal Frame with Thermal Break:Double Pane with Low-E		Glazing: Clear	220	ft2			0.410	0.31	0.00
6	Windows 1-2 - w/overhang	Metal Frame with Thermal Break:Double Pane with Low-E		Glazing: Clear	46	ft2			0.410	0.31	0.33
7	Windows 3A-3D - Storefront	Metal Frame Curtain Wall/Storefront:Double Pane with Low-E		Glazing: Clear	160	ft2			0.490	0.32	0.00
8	Windows 3A-3D - Storefront,ovhg.	Metal Frame Curtain Wall/Storefront:Double Pane with Low-E		Glazing: Clear	82	ft2			0.490	0.32	0.28
9	Door A - Ext Dbl Glass Door	Glass (> 50% glazing):Metal Frame		Type: Entrance	122	ft2			0.620	0.26	0.00
10	Door B - Insulated Hollow Metal	Insulated Metal		Swinging	72	ft2			0.420		
11	Door C Roll up Overhead	Insulated Metal		Non Swinging	80	ft2			0.440		
12	Abv-Grade Wall Assembly Type B	Steel-Framed, 16" o.c.			5592	ft2	13.0	7.5	0.064		
13	Windows 1-2	Metal Frame with Thermal Break:Double Pane with Low-E		Glazing: Clear	62	ft2			0.410	0.31	0.00
14	Windows 1-2 - w/overhang	Metal Frame with Thermal Break:Double Pane with Low-E		Glazing: Clear	46	ft2			0.410	0.31	0.33
15	Windows 3A-3D - Storefront	Metal Frame Curtain Wall/Storefront:Double Pane with Low-E		Glazing: Clear	1267	ft2			0.490	0.32	0.00
16	Windows 3A-3D - Storefront,ovhg.	Metal Frame Curtain Wall/Storefront:Double Pane with Low-E		Glazing: Clear	635	ft2			0.490	0.32	0.28

Envelope PASSES: Design 2 Envelope +2% Interior Lighting +14% Exterior Lighting +49%

Use the 'Options' menu to add o factor.

All Wall Types, Roof Types, Fenestration Types, Floor Types, and Door Types in the COMcheck analysis should use the same nomenclature as those shown in the Supporting Documentation (Drawings & Schedules).

Option 3: Energy Cost Budget Worksheet

- Either NYCECC Section 506 or the Energy Cost Budget Method of ASHRAE 90.1 can be used to demonstrate compliance.
  - Applicable to New Buildings, Additions, or Alterations
  - Requires computer energy modeling, using software programs approved by the Secretary of State of New York State and the NYC Commissioner of Buildings (e.g., DOE-2.1E, VisualDOE, Energy Plus, eQuest)
  - Compliance is demonstrated using the **EN1** form

Envelope submissions should be sure to address:

- **ALL** assemblies related to the scope of work (roofs, above grade walls, fenestration, below grade walls, floors over unconditioned space, etc.)
- **ALL** significant variations of envelope assemblies (different wall assemblies, glazing types, roof assemblies, door types, etc.) – these will be averaged in the EN1

Sample EN1 – Envelope Input

NYC BUILDINGS

EN1: Energy Cost Budget Worksheet

Must be typewritten.

Do Not Submit Separately.
Must be incorporated in the drawing set.

Energy Model Inputs

NYS approved energy model software: **DOE-2.1E**

Envelope	Proposed Design Input	Budget (Standard Design) Input
Above-grade wall U-factor	0.102 Btu/h-ft2-F	0.124 Btu/h-ft2-F
Below-grade wall U-factor	0.107 Btu/h-ft2-F	0.107 Btu/h-ft2-F
Roof construction U-factor	0.047 Btu/h-ft2-F	0.063 Btu/h-ft2-F
Exterior floor U-factor	0.88	0.88
Slab-on-grade construction (yes/no)	yes	yes
Window-to-gross wall ratio	58.8%	50%
Average fenestration assembly U-factor	0.43 Btu/h-ft2-F typical, 1.1 storefront, 0.453 ave	0.46 Btu/h-ft2-F
Average fenestration assembly SHGC	0.31 typical, 0.73 storefront, 0.325 average	0.39 north, 0.25 other orientations
Fixed shading devices (yes/no)	no	no
Automated movable shading devices (yes/no)	no	no

	0	0
Heating, Ventilating & Air Conditioning		
Refrigeration equipment type	Water-cooled packaged DX units, efficiency ranges from 0.93-1.01 kW/ton	Water cooled, centrifugal chiller, efficiency = 0.576 kW/ton

In the case of an NYCECC-related audit, Applicants may be asked to submit the Energy Modeling report or the calculations used to determine the average U-Factor and SHGC values entered in the EN1.

Sample EN1 – Envelope Input

BUILDINGS

EN1: Energy Cost Budget Worksheet

Do Not Submit Separately. Must be incorporated in the drawing set.

1 Location Information
House No(s)
Borough
Work on Floor(s)
2 Applicant Information
Last Name

Energy Cost Budget Conformance	Proposed Design Output	Budget (Standard Design) Output
Annual Regulated Energy Cost ($)	1,458,109	1,477,272
Annual Regulated Energy Use (BTU/GSF)	44,161	48,006
Annual Regulated Energy Cost Per Sq. Ft. ($/GSF)	2.31	2.34

ergy Model Output Breakdown

nergy Use Breakdown	Proposed Design Output (% BTU/yr)	Budget (Standard Design) Output (% BTU/yr)
Heating	24.2%	32.9
Cooling	13.9%	7.7
Heat rejection	3.9%	2.4%
Fans	8.9%	8.6%
Pumps	1.2%	2.2%
Lighting	19.3%	19.4%
Unregulated loads (e.g., plug loads, elevators, escalators, kitchen, process equipment, exterior lighting)	28.5%	26.9%
Total	100%	100%

The overall regulated annual energy use and annual energy cost of the Proposed and Budget building designs are summarized at the end of the EN1 form, and this is where compliance with the NYCECC is demonstrated.

Supporting Documentation

? **What Type of Supporting Documentation Should be Provided?**

Supporting Documentation should:

- Support the values submitted in the Energy Analysis;
- Verify mandatory requirements of the NYCECC are met; and
- Provide a listing of the applicable progress inspections required based on the scope of work of the project.

Supporting Documentation details for Envelope:

- Building wall sections and details for each unique type of:
  - Roof/ceiling assembly
  - Exterior wall type, and
  - Foundation, slab-on-grade, or basement wall assembly

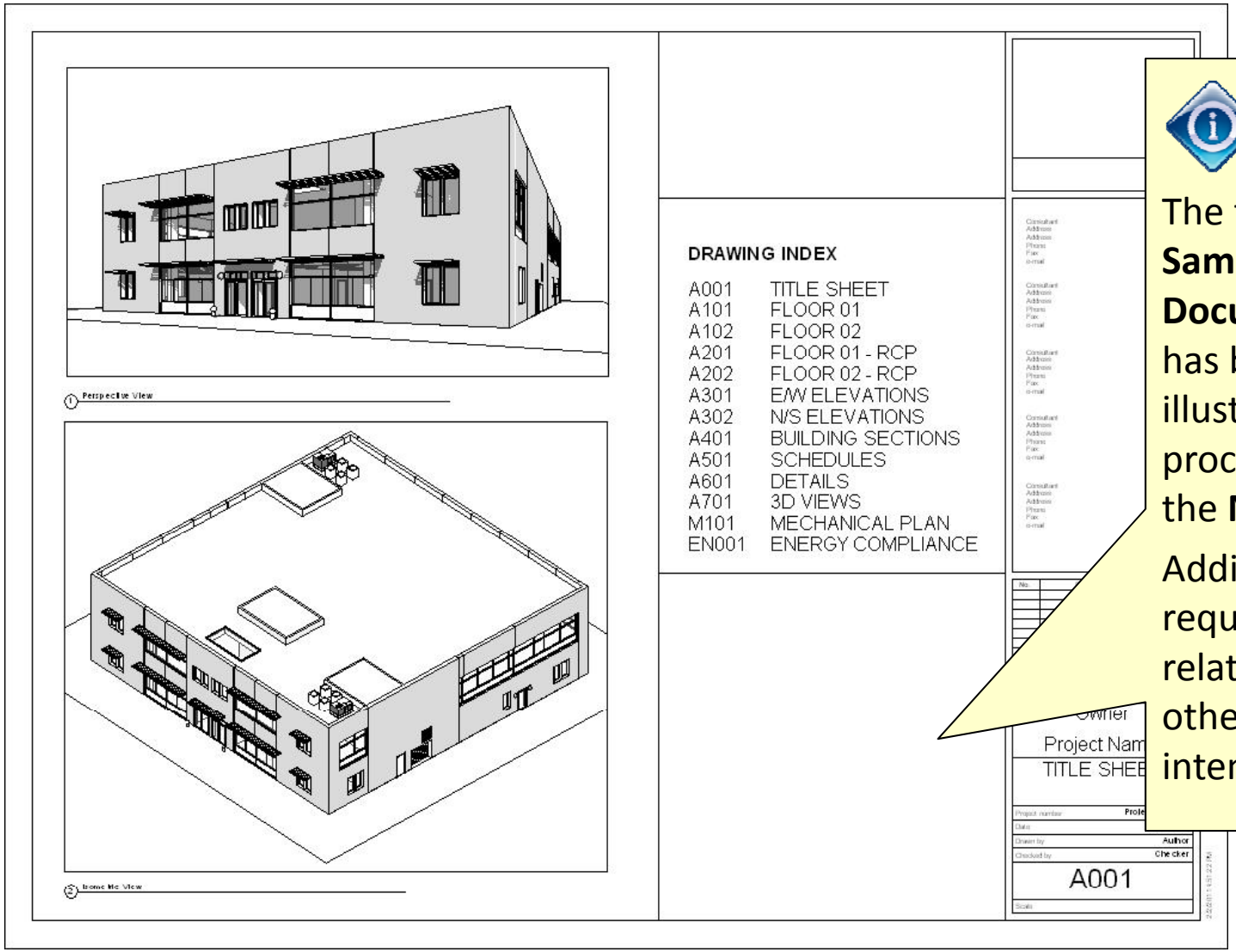
- Building wall sections to show each layer of the assembly, including, but not limited to:
  - Insulation (labeled with R-value), and
  - Moisture control and vapor retarders (where used)

- Door, window and skylight schedules, including columns for U-Factor, SHGC, and VLT where applicable, and Air Leakage for each assembly type

- Details showing mandatory requirements to prevent air and moisture leakage

Sample Supporting Documentation

Sample Building: New Office Facility

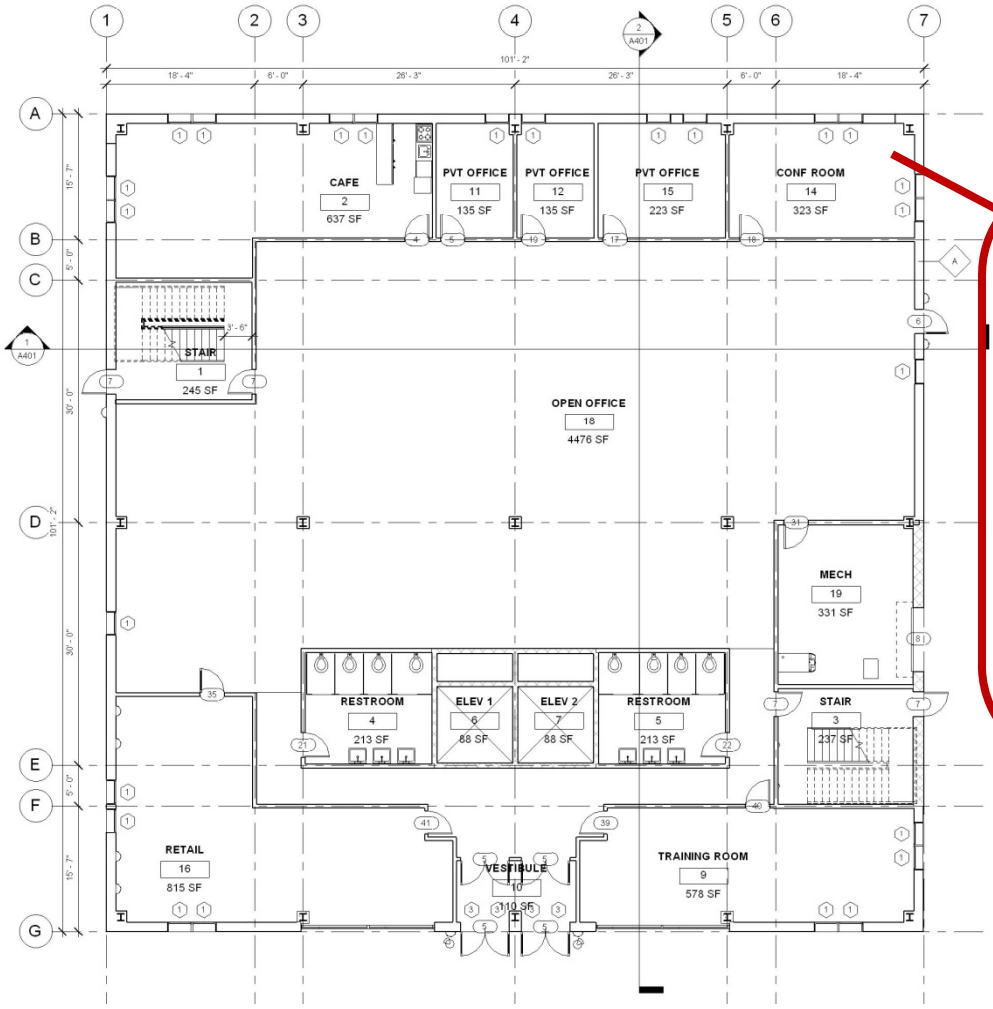


The following **Sample Supporting Documentation** has been developed to illustrate compliance procedures related to the **NYCECC only.**

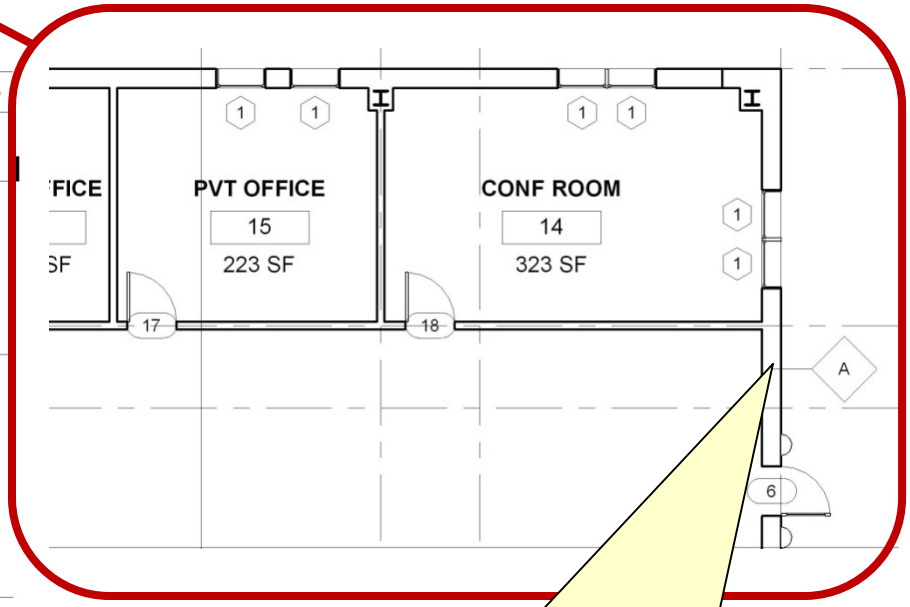
Additional Information required by the DOB related to zoning and other Code provisions is intentionally omitted.

Sample Supporting Documentation

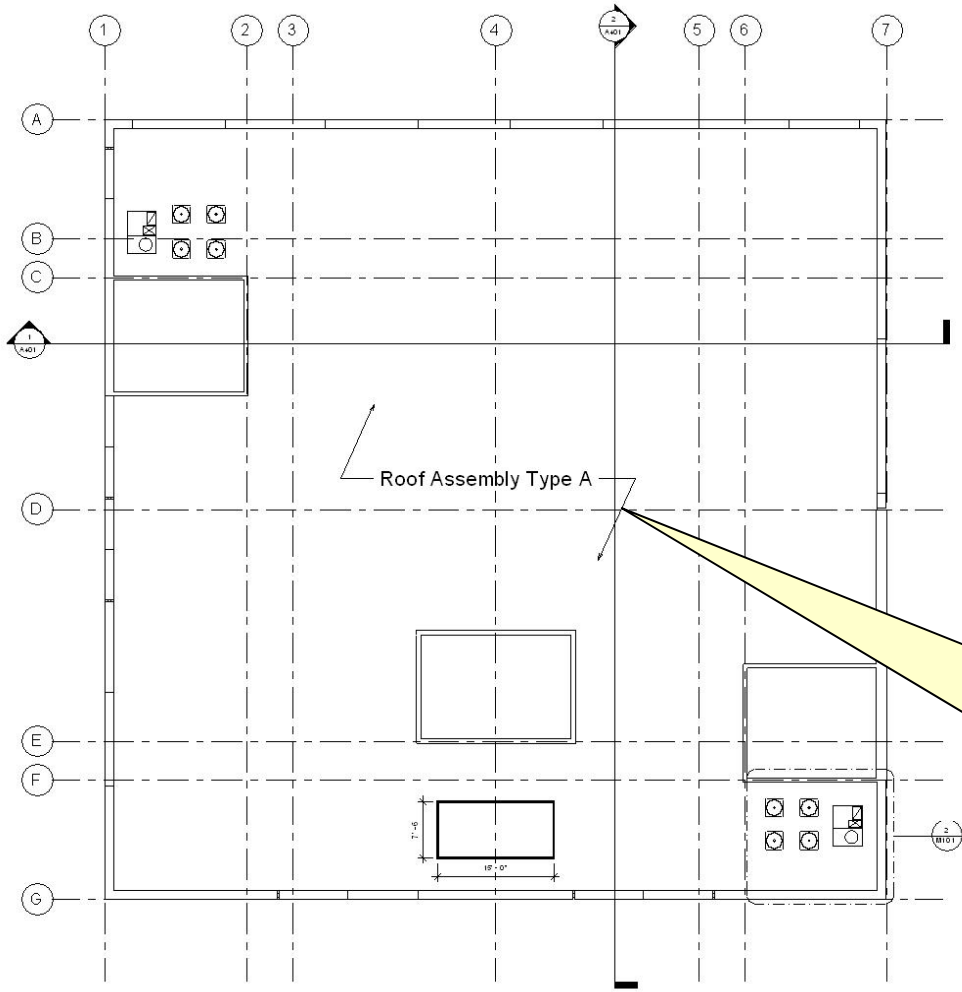
10. Submissions & Inspections



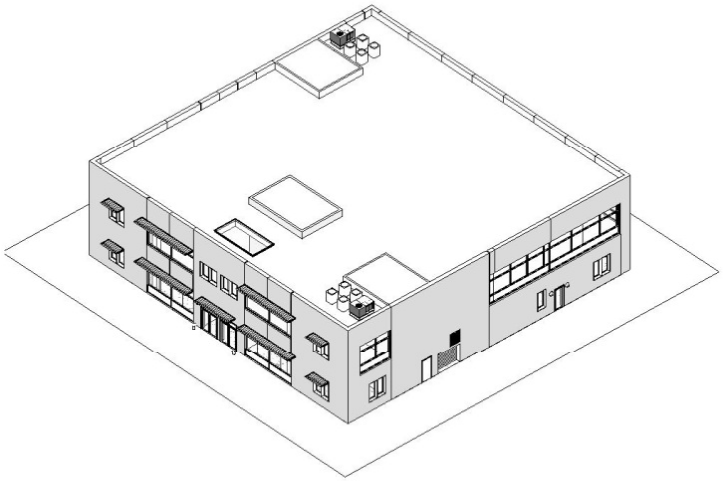
1st FLOOR PLAN



Fenestration types, door types, and exterior wall types should be clearly marked in the plans of the Supporting Documentation.



ROOF PLAN

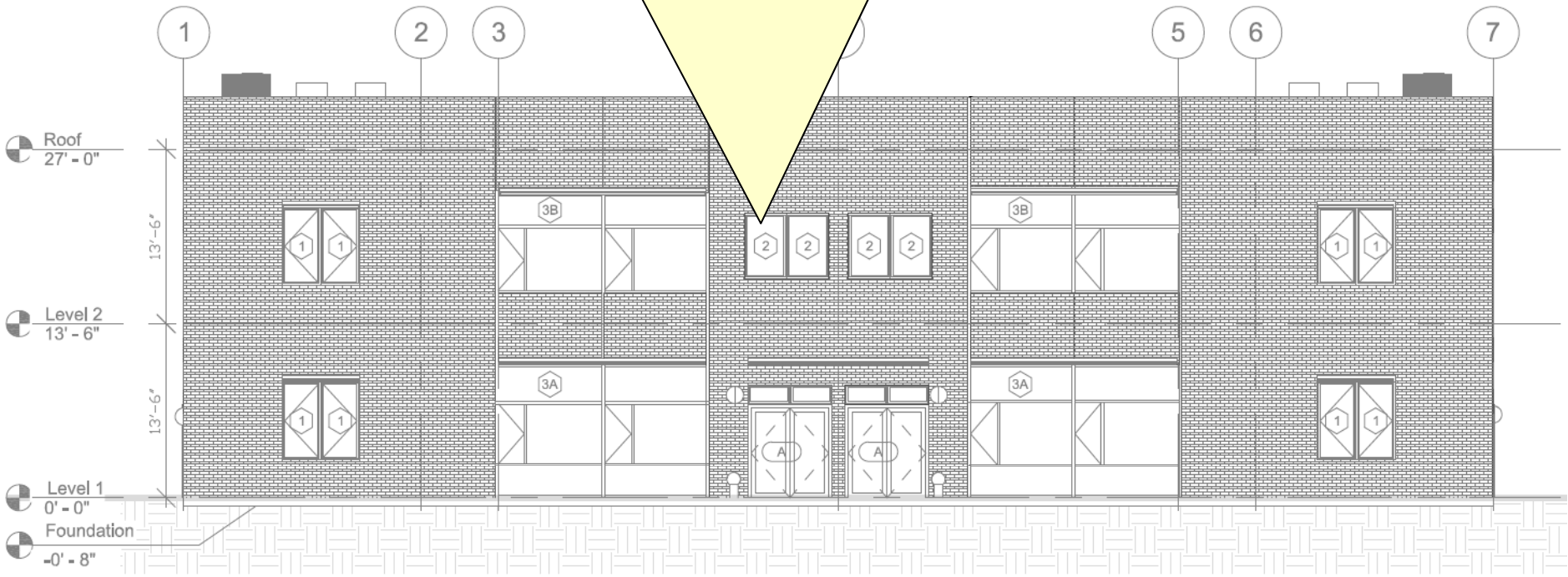


Roof Types should be identified in the Roof Plans of the Supporting Documentation. If more than one type of roof assembly exists, show clear demarcation of the different roof assembly areas.

Sample Supporting Documentation

10. Submissions & Inspections

Fenestration types and door types should be clearly called out on the project elevations in the Supporting Documentation. These should be keyed into the submitted Window/Fenestration and Door Schedules.



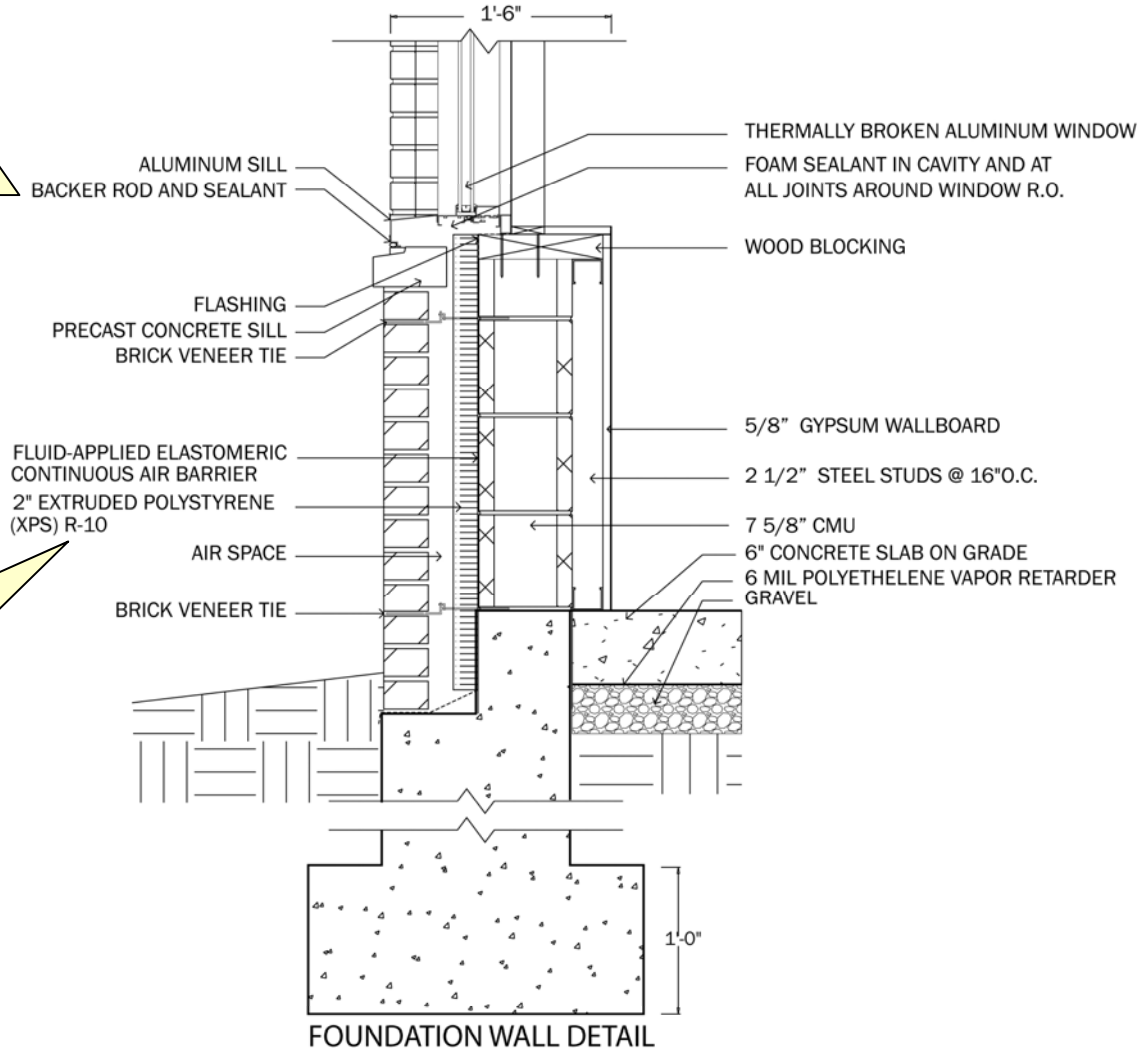
SOUTH ELEVATION

Sample Supporting Documentation

10. Submissions & Inspections

Wall sections and details in the Supporting Documentation should note materials/techniques to meet mandatory NYCECC Air Leakage requirements.

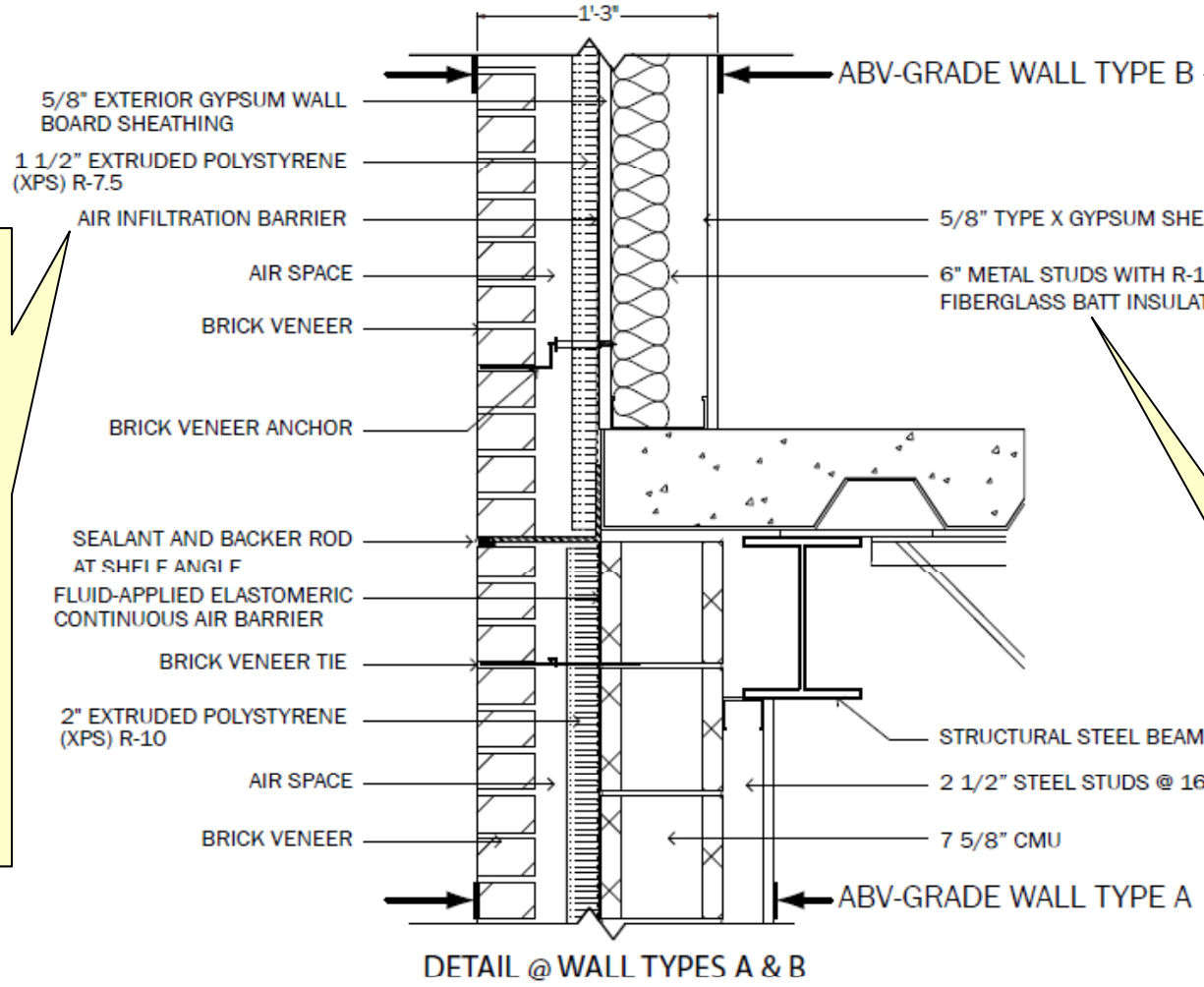
Insulation types should be identified and R-Values stated.



FOUNDATION WALL DETAIL

Sample Supporting Documentation

10. Submissions & Inspections



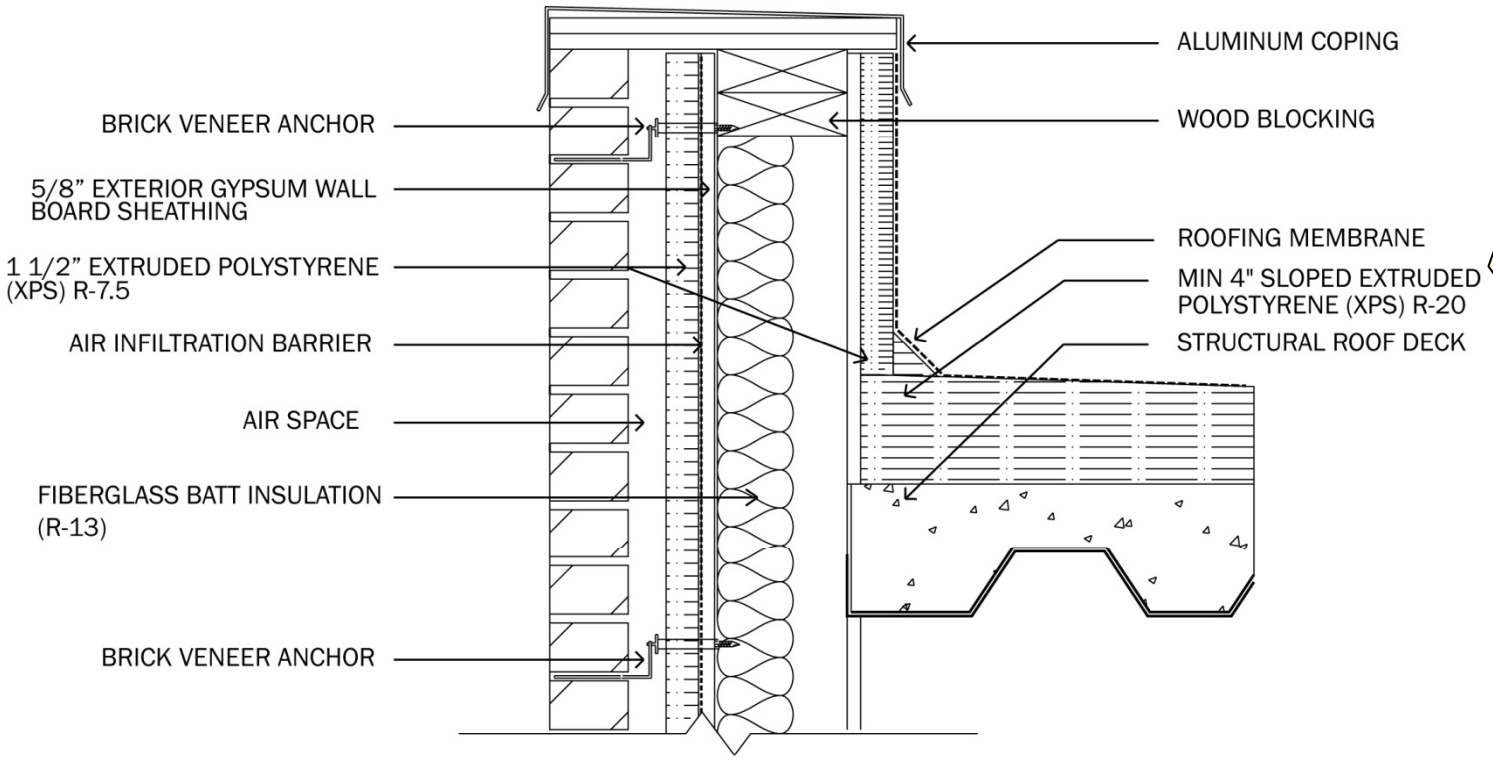
DETAIL @ WALL TYPES A & B

Wall sections and details in the Supporting Documentation should note materials/ techniques to meet mandatory NYCECC Air Leakage requirements.

All Wall Assembly Types should be identified, corresponding to those noted in the Plans.

Insulation types should be identified and R-values stated.

Sample Supporting Documentation



PARAPET DETAIL @ ROOF TYPE A

Wall sections and roof details in the Supporting Documentation should note the insulation type and state the R-Value. Where tapered insulation is used, Applicants should note the minimum and maximum thickness of the insulation.

Roof Assembly Types should be identified, corresponding to those noted in the plans.

Window / Storefront / Skylight Schedule									
Type	Description	R.O. / M.O.	Glass Type	U-Factor	SHGC	Air Leakage	Manufacturer	Catalog #	Notes
1	Alum-Framed Dbl. Casement	3' - 4" x 6' - 8"	IGU, low-e, clear	0.41	0.31	≤ 0.30 cfm/SF	XYZ Inc.	C100-4080	1
2	Alum-Framed Dbl. Casement	3' - 4" x 5' - 4"	IGU, low-e, clear	0.41	0.31	≤ 0.30 cfm/SF	XYZ Inc.	C100-4064	1
3A	Alum-Framed Storefront System	17' - 4" x 11' - 4"	IGU, low-e, clear	0.49	0.32	≤ 0.06 cfm/SF	ABC Inc.	X-100 Series	1, 3, 4
3B	Alum-Framed Storefront System	17' - 4" x 8' - 0"	IGU, low-e, clear	0.49	0.32	≤ 0.06 cfm/SF	ABC Inc.	X-100 Series	1, 3
3C	Alum-Framed Storefront System	12' - 0" x 8' - 0"	IGU, low-e, clear	0.49	0.32	≤ 0.06 cfm/SF	ABC Inc.	X-100 Series	1, 3
3D	Alum-Framed Storefront System	11' - 4" x 8' - 0"	IGU, low-e, clear	0.49	0.32	≤ 0.06 cfm/SF	ABC Inc.	X-100 Series	1, 3
4	Alum-Framed Fixed Skylight	7' - 6" W x 15' - 0" L	IGU, low-e, tinted	0.82	0.20	≤ 0.10 cfm/SF	HLS Inc.	FS400 Series	2, 4

Notes:

1. Air leakage: Provide flashing, window dams, expandable foam sealant, and caulking at rough opening/window frame joints to create a continuous air barrier with surrounding wall system.
2. Air leakage: Provide flashing, expandable foam sealant, and caulking at rough opening/skylight frame joints to create a continuous air barrier with surrounding roof system.
3. See Dwg. A-605 for detailed storefront elevations.
4. Manufacturer's air infiltration rates based on 6.24 psf (300 Pa) static pressure differential, tested per ASTM E 283.

Exterior Door Schedule									
Type	Description	R.O. / M.O.	Glass Type	U-Factor	SHGC	Infiltration Value (cfm/SF)	Manufacturer	Catalog #	Notes
A	Aluminum/Glass Double Door w/Fixed Transom	6' - 4" x 9' - 4"	IGU, low-e, clear	0.62	0.26	≤ 1.00 cfm/SF	HLS Inc.	Y-100 Series	1, 2
B	Insulated Hollow Metal Door	3' - 4" x 7' - 4"	N/A	0.42	N/A	N/A*	EJA Inc.	IHM3684	1
C	Insulated Roll-up Overhead Metal Door	10' - 0" x 8' - 0"	N/A	0.44	N/A	N/A	CJA Inc.	IHM12096	1

Notes:

1. Air leakage: Provide flashing, expandable foam sealant, and caulking at rough opening/door frame joints to create a continuous air barrier with surrounding wall system.
2. See Dwg. A-605 for detailed entry door elevations.

* Doors will be field-fitted with weatherstripping per ECC Section 502.4.1

Sample Supporting Documentation

10. Submissions & Inspections

Schedules must include U-Factor, SHGC, and Air Leakage information and VLT where applicable.

Window / Storefront /

Type	Description	R.O. / M.O.	Glass Type	U-Factor	SHGC	Air Leakage	Manufacturer	Catalog #	Notes
1	Alum-Framed	- 8"	IGU, low-e, clear	0.41	0.31	≤ 0.30 cfm/SF	XYZ Inc.	C100-4080	1
2	Alum-Framed	- 4"	IGU, low-e, clear	0.41	0.31	≤ 0.30 cfm/SF	XYZ Inc.	C100-4064	1
3A	Alum-Framed	' - 4"	IGU, low-e, clear	0.49	0.32	≤ 0.06 cfm/SF	ABC Inc.	X-100 Series	1, 3, 4
3B	Alum-Framed	' - 0"	IGU, low-e, clear	0.49	0.32	≤ 0.06 cfm/SF	ABC Inc.	X-100 Series	1, 3
3C	Alum-Framed	' - 0"	IGU, low-e, clear	0.49	0.32	≤ 0.06 cfm/SF	ABC Inc.	X-100 Series	1, 3
3D	Alum-Framed	' - 0"	IGU, low-e, clear	0.49	0.32	≤ 0.06 cfm/SF	ABC Inc.	100 Series	1, 3
4	Alum-Framed Fixed Skylight	7' - 6" W x 15' - 0" L	IGU, low-e, tinted	0.82	0.20	≤ 0.10 cfm/SF	HLS Inc.	eries	2, 4

Notes:

1. Air leakage: Provide flashing, window dams, expandable foam sealant, and caulking at rough opening/window frame j
2. Air leakage: Provide flashing, expandable foam sealant, and caulking at rough opening/skylight frame joints to create
3. See Dwg. A-605 for detailed storefront elevations.
4. Manufacturer's air infiltration rates based on 6.24 psf (300 Pa) static pressure differential, tested per ASTM E 283.

Manufacturers and Catalog Numbers are optional for the NYCECC submission.

Exterior Door Schedule

Type	Description	R.O. / M.O.	Glass Type	U-Factor	SHGC	Infiltration Value (cfm/SF)	Manufacturer	Catalog #	Notes
A	Aluminum/Glass Double Door w/Fixed Transom	6' - 4" x 9' - 4"	IGU, low-e, clear	0.62	0.26	≤ 1.00 cfm/SF	HLS Inc.	Y-100 Series	1, 2
B	Insulated Hollow Metal Door	3' - 4" x 7' - 4"	N/A	0.42	N/A	N/A*	EJA Inc.	IHM3684	1
C	Insulated Roll-up Overhead Metal Door	10' - 0" x 8' - 0"	N/A	0.44	N/A	N/A	CJA Inc.	IHM12096	1

Notes:

1. Air leakage: Provide flashing, expandable foam sealant, and caulking at rough opening/door frame joints to create a continuous air barrier with surrounding wall system.
2. See Dwg. A-605 for detailed entry door elevations.

* Doors will be field-fitted with weatherstripping per ECC Section 502.4.1

Sample Energy Analysis

10. Submissions & Inspections

COMcheck Report

COMcheck Software Version 3.8.1

Envelope Compliance Certificate

2010 New York Energy Conservation Construction Code

Section 1: Project Information

Project Type: **New Construction**
Project Title :

Construction Site: Owner/Agent: Designer/Contractor:

Section 2: General Information

Building Location (for weather data):	**New York, New York**
Climate Zone:	**4a**
Building Type for Envelope Requirements:	**Non-Residential**
Vertical Glazing / Wall Area Pct.:	**24%**
Skylight Glazing / Roof Area Pct.:	**1%**

Activity Type(s)	Floor Area
Floor 01 (Office)	9322
Floor 02 (Office)	9322
Floor 01 (Dining: Cafeteria/Fast Food)	637
Floor 01 (Retail)	815

Section 3: Requirements Checklist

Envelope PASSES: Design 2% better than code.

Climate-Specific Requirements:

Component Name/Description	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)
Roof Type A: Insulation Entirely Above Deck	9776	---	20.0	0.048	0.048
Window 4 - Skylight: Metal Frame with Thermal Break:Double Pane with Low-E, Tinted, SHGC 0.20	113	---	---	0.820	0.600
Floor Type A: Slab-On-Grade:Unheated	400	---	---	---	---
Abv-Grade Wall Assembly Type A: Concrete Block:12", Partially Grouted, Cells Empty,Medium Density , Furring: Metal	5437	0.0	10.0	0.076	0.104
Windows 1-2: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.31	220	---	---	0.410	0.550
Windows 1-2 - w/overhang: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.31, PF 0.33	46	---	---	0.410	0.550
Windows 3A-3D - Storefront: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.32	160	---	---	0.490	0.500
Windows 3A-3D - Storefront,ovhg.: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.32, PF 0.28	82	---	---	0.490	0.500
Door A - Ext Dbl Glass Door: Glass (> 50% glazing):Metal Frame, Entrance Door, SHGC 0.26	122	---	---	0.620	0.850
Door B - Insulated Hollow Metal: Insulated Metal, Swinging	72	---	---	0.420	0.700
Door C - Roll-up Overhead: Insulated Metal, Non-Swinging	80	---	---	0.440	0.500
Abv-Grade Wall Assembly Type B: Steel-Framed, 16" o.c.	5592	13.0	7.5	0.064	0.064
Windows 1-2: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.31	62	---	---	0.410	0.550

Project Title: Report date: 03/10/11
Data filename: P:\Projects\NYC DOB Energy Code Compliance Study\2C_Training Modules\RWB_VEE_Envelope\Envelope Case Study Building_JA.cck
Page 1 of 2

Windows 1-2 - w/overhang: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.31, PF 0.33	46	---	---	0.410	0.550
Windows 3A-3D - Storefront: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.32	1267	---	---	0.490	0.500
Windows 3A-3D - Storefront,ovhg.: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.32, PF 0.28	635	---	---	0.490	

(a) Budget U-factors are used for software baseline calculations ONLY, and are not code requirements.

Air Leakage, Component Certification, and Vapor Retarder Requirements:

- ☐ 1. All joints and penetrations are caulked, gasketed, weather-stripped, or otherwise sealed.
- ☐ 2. Windows, doors, and skylights certified as meeting leakage requirements.
- ☐ 3. Component R-values & U-factors labeled as certified.

Section 4: Compliance Statement

Compliance Statement: The proposed envelope design represented in this document is consistent with the building plans, specification and other calculations submitted with this permit application. The proposed envelope system has been designed to meet the 2010 New Energy Conservation Construction Code requirements in COMcheck Version 3.8.1 and to comply with the mandatory requirements in th Requirements Checklist.

When a Registered Design Professional has stamped and signed this page, they are attesting that to the best of his/her knowledge, bel professional judgment, such plans or specifications are in compliance with this Code.

Name - Title Signature Date

Project Title: Report date: 03/10/11
Data filename: P:\Projects\NYC DOB Energy Code Compliance Study\2C_Training Modules\RWB_VEE_Envelope\Envelope Case Study Building_JA.cck
Page 2 of 2

Be sure to check-off the applicable Air Leakage & Component Certification Requirements in the COMcheck Summary.

Sign and Seal COMcheck Compliance Certificate if the project team does not use a Lead Professional. If the team uses a Lead Professional, the seal and signature should be at the title block. Also see department guidelines.

Sample Energy Analysis

Detail from COMcheck Report

All Wall Types, Roof Types, Fenestration Types, Door Types, and Floor Types in the COMcheck analysis should use the same nomenclature as those shown in the Supporting Documentation.

Section 3: Requirements Checklist

Envelope PASSES: Design 2% better than code.

Climate-Specific Requirements:

Component Name/Description	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)
Roof Type A: Insulation Entirely Above Deck	9776	---	20.0	0.048	0.048
Window 4 - Skylight: Metal Frame with Thermal Break:Double Pane with Low-E, Tinted, SHGC 0.20	113	---	---	0.820	0.600
Floor Type A: Slab-On-Grade:Unheated	400	---	---	---	---
Abv-Grade Wall Assembly Type A: Concrete Block:12", Partially Grouted, Cells Empty,Medium Density , Furring: Metal	5437	0.0	10.0	0.076	0.104
Windows 1-2: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.31	220	---	---	0.410	0.550
Windows 1-2 - w/overhang: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.31, PF 0.33	46	---	---	0.410	0.550
Windows 3A-3D - Storefront: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.32	160	---	---	0.490	0.500
Windows 3A-3D - Storefront,ovhg.: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.32, PF 0.28	82	---	---	0.490	0.500
Door A - Ext Dbl Glass Door: Glass (> 50% glazing):Metal Frame, Entrance Door, SHGC 0.26	122	---	---	0.620	0.850
Door B - Insulated Hollow Metal: Insulated Metal, Swinging	72	---	---	0.420	0.700
Door C - Roll-up Overhead: Insulated Metal, Non-Swinging	80	---	---	0.440	0.500
Abv-Grade Wall Assembly Type B: Steel-Framed, 16" o.c.	5592	13.0	7.5	0.064	0.064
Windows 1-2: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.31	62	---	---	0.410	0.550

Sample Progress Inspection List

10. Submissions & Inspections

	Inspection/Test	Frequency (minimum)	Reference Standard (See NYCECC Chapter 10) or Other Criteria	NYCECC or Other Citation
IIA	**Envelope Inspections**			
IIA1	**Protection of exposed foundation insulation:** Insulation shall be visually inspected to verify proper protection where applied to the exterior of basement or cellar walls, crawl-space walls and/or the perimeter of slab-on-grade floors.	As required during foundation work and prior to backfill	Approved construction documents	303.2.1
IIA2	**Insulation placement and R-values:** Installed insulation for each component of the conditioned space envelope and at junctions between components shall be visually inspected to ensure that the R-values are marked, that such R-values conform to the R-values identified in the construction documents and that the insulation is properly installed. Certifications for unmarked insulation shall be similarly visually inspected.	As required to verify continuous enclosure while walls, ceilings and floors are open	Approved construction documents	303.1, 303.1.1, 303.1.2, 502.1, 502.2
IIA3	**Fenestration thermal values and product ratings** U-Factors and SHGC values of installed fenestration shall be visually inspected for conformance with the U-Factors and SHGC values identified in the construction drawings by verifying the manufacturer's NFRC labels or, where not labeled, using the ratings in NYCECC Tables 102.1.3(1), (2) and (3). Where ASHRAE 90.1 is used, visible light transmittance values shall also be verified.	As required during installation	Approved construction documents; NFRC 100, NFRC 200	303.1, 303.1.3; 502.3
IIA4	**Fenestration and door assembly product ratings for air leakage:** Windows, skylights and sliding or swinging door assemblies, except site- built windows, skylights and/or doors, shall be visually inspected to verify that installed assemblies are listed and labeled by the manufacturer to the referenced standard. For curtain wall, storefront glazing, commercial entrance doors and revolving doors, the testing reports shall be reviewed to verify that the installed assembly complies with the standard cited in the approved plans.	As required during installation; prior to final construction inspection	NFRC 400, AAMA/WDMA/CSA 101/I.S.2/A440 ASTM E283; ANSI/DASMA 105	502.4
IIA5	**Fenestration areas:** Dimensions of windows, doors and skylights shall b… …tion.	Prior to final inspection	Approved construction documents	502.3
IIA6	**Sealing:** Openings and penetratio… inspected to verify that a continuc… visually inspect to verify that mate… standards, or that the building is t… in the approved plans.			
IIA7	**Projection factors:** Where the ene… permanently attached shading de…			

A Progress Inspections Table must be included in the Supporting Documentation drawings, noting all applicable inspections to be performed based on the scope of work, plus Reference Standards and NYCECC citations.

The design applicant must also include contract language requiring the contractor to identify time in the construction schedule for the progress inspections.

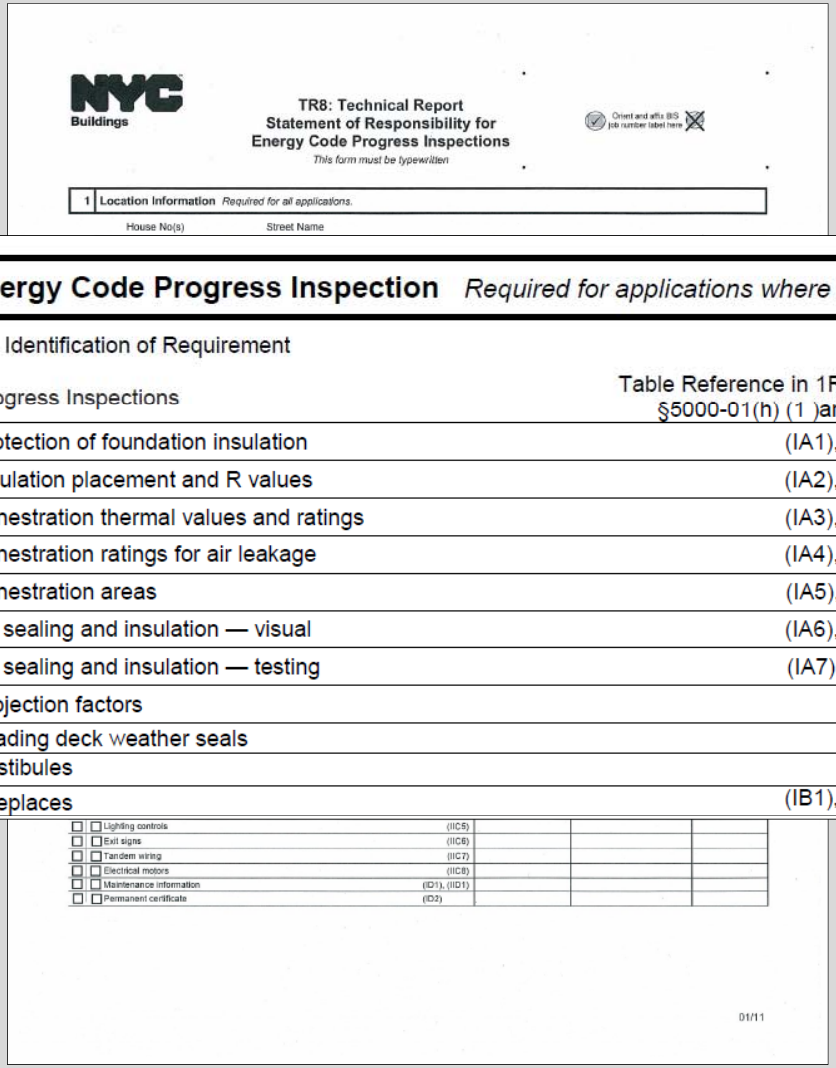
Progress Inspections - Review

? What are the Applicable Progress Inspections for Building Envelope?

Inspection / Test	Frequency
Protection of exposed foundation insulation	As required during foundation work and prior to backfill
Insulation placement and R-values	As required to verify continuous enclosure while walls, ceilings and floors are open
Fenestration thermal values and product ratings	As required during installation
Fenestration and door assembly product ratings for air leakage	As required during installation; prior to final construction inspection
Fenestration areas	Prior to final construction inspection
Sealing (Openings, Penetrations , Air Barrier)	As required during construction
Projection factors	Prior to final construction inspection
Loading dock weatherseals	Prior to final construction inspection
Building entrance vestibules	Prior to final construction inspection

Progress Inspections – TR8 Report

10. Submissions & Inspections



NYC Buildings

TR8: Technical Report
Statement of Responsibility for
Energy Code Progress Inspections
This form must be typewritten

Orient and affix BIS job number label here

1 **Location Information** *Required for all applications.*

House No(s) Street Name

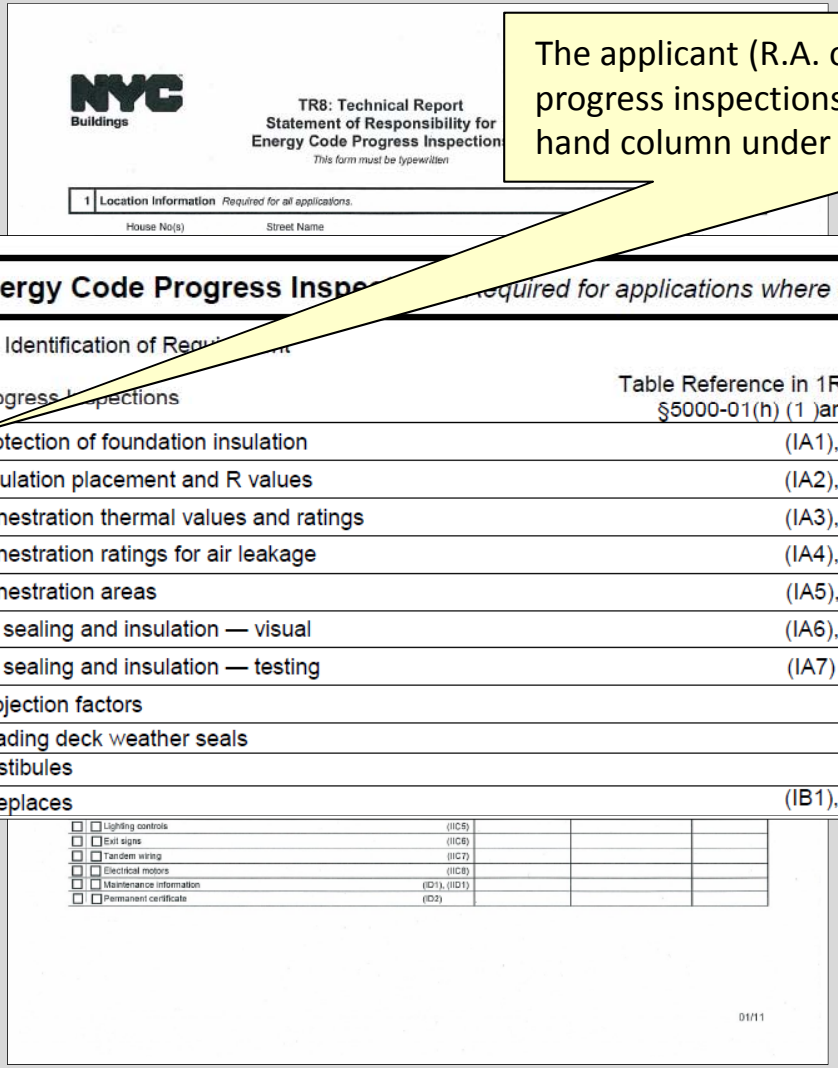
3 Energy Code Progress Inspection *Required for applications where Energy Code Compliance Progress Inspection is marked Yes on TR1*

3A ← Identification of Requirement			3B Identification of Responsibilities	3C Certificate of Complete Inspections / Tests	3D Withdraw Responsibilities
Y	N Progress Inspections	Table Reference in 1RCNY §5000-01(h) (1)and (2)	Initial & Date	Initial & Date	Initial & Date
☐	☐ Protection of foundation insulation	(IA1), (IIA1)			
☐	☐ Insulation placement and R values	(IA2), (IIA2)			
☐	☐ Fenestration thermal values and ratings	(IA3), (IIA3)			
☐	☐ Fenestration ratings for air leakage	(IA4), (IIA4)			
☐	☐ Fenestration areas	(IA5), (IIA5)			
☐	☐ Air sealing and insulation — visual	(IA6), (IIA6)			
☐	☐ Air sealing and insulation — testing	(IA7)			
☐	☐ Projection factors	(IIA7)			
☐	☐ Loading deck weather seals	(IIA8)			
☐	☐ Vestibules	(IIA9)			
☐	☐ Fireplaces	(IB1), (IIB1)			
☐	☐ Lighting controls	(IIC5)			
☐	☐ Exit signs	(IIC6)			
☐	☐ Tandem wiring	(IIC7)			
☐	☐ Electrical motors	(IIC8)			
☐	☐ Maintenance information	(ID1), (IID1)			
☐	☐ Permanent certificate	(ID2)			

01/11

Progress Inspections – TR8 Report

10. Submissions & Inspections



TR8: Technical Report
Statement of Responsibility for
Energy Code Progress Inspection
This form must be typewritten

1 **Location Information** *Required for all applications.*

House No(s) Street Name

3 Energy Code Progress Inspe *equired for applications where Energy Code Compliance Progress Inspection is marked Yes on TR1*

3A ← Identification of Requ			3B Identification of Responsibilities	3C Certificate of Complete Inspections / Tests	3D Withdraw Responsibilities
Y	N	Progress Inspections	Table Reference in 1RCNY §5000-01(h) (1)and (2)	Initial & Date	Initial & Date	Initial & Date
☐	☐	Protection of foundation insulation	(IA1), (IIA1)			
☐	☐	Insulation placement and R values	(IA2), (IIA2)			
☐	☐	Fenestration thermal values and ratings	(IA3), (IIA3)			
☐	☐	Fenestration ratings for air leakage	(IA4), (IIA4)			
☐	☐	Fenestration areas	(IA5), (IIA5)			
☐	☐	Air sealing and insulation — visual	(IA6), (IIA6)			
☐	☐	Air sealing and insulation — testing	(IA7)			
☐	☐	Projection factors	(IIA7)			
☐	☐	Loading deck weather seals	(IIA8)			
☐	☐	Vestibules	(IIA9)			
☐	☐	Fireplaces	(IB1), (IIB1)			

☐ ☐ Lighting controls	(IIC5)			
☐ ☐ Exit signs	(IIC6)			
☐ ☐ Tandem wiring	(IIC7)			
☐ ☐ Electrical motors	(IIC8)			
☐ ☐ Maintenance information	(ID1), (IID1)			
☐ ☐ Permanent certificate	(ID2)			

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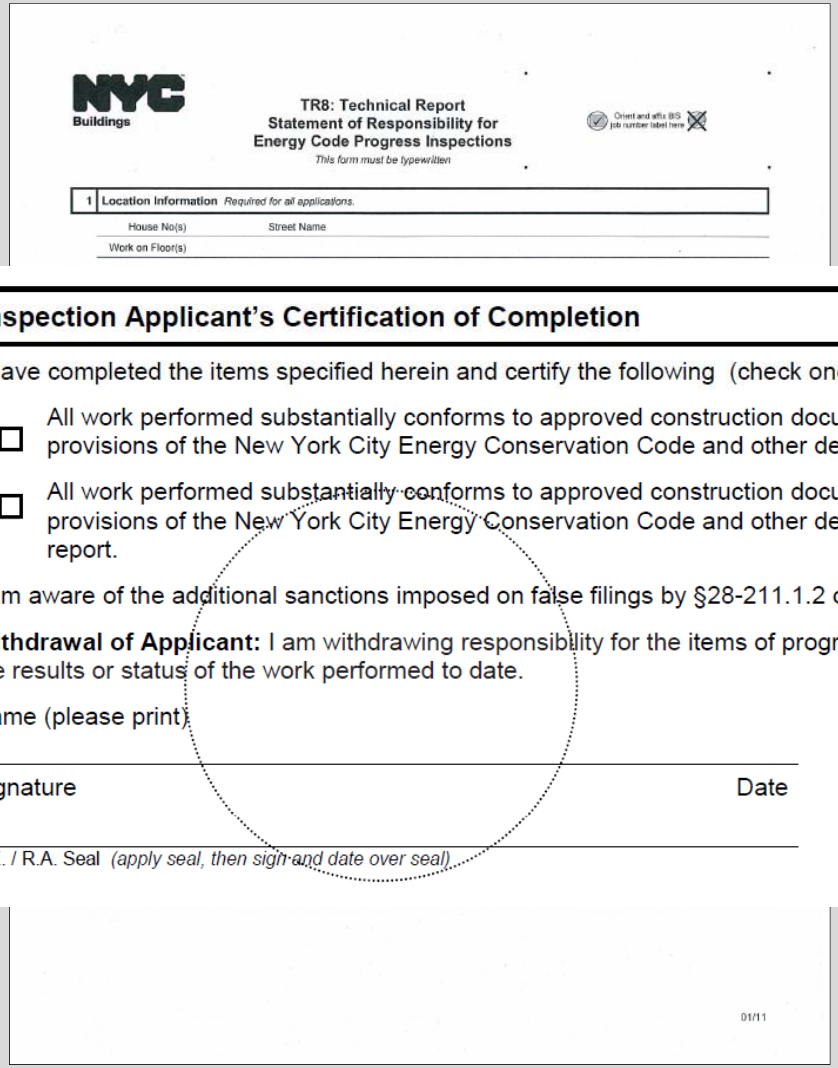
The applicant (R.A. or P.E.) defines the required progress inspections by checking "Y" or "N" in the left-hand column under section 3 of the TR8 form.

Prior to Permit, the designated Progress Inspector must initial and date each inspection they will be responsible for, and sign/seal under section 5 of the TR8 form. If multiple Progress Inspectors are involved in a project, each one must submit a signed/sealed TR8 for their scope of inspection services.

Progress Inspections – TR8 Report

10. Submissions & Inspections



NYC Buildings

TR8: Technical Report
Statement of Responsibility for
Energy Code Progress Inspections
This form must be typewritten

Orient and affix BIS job number label here

1 Location Information *Required for all applications.*

House No(s) Street Name

Work on Floor(s)

6 Inspection Applicant's Certification of Completion

☐ I have completed the items specified herein and certify the following (check one only):

☐ All work performed substantially conforms to approved construction documents and has been performed in accordance with applicable provisions of the New York City Energy Conservation Code and other designated rules and regulations.

☐ All work performed substantially conforms to approved construction documents and has been performed in accordance with applicable provisions of the New York City Energy Conservation Code and other designated rules and regulations, except as indicated in the attached report.

I am aware of the additional sanctions imposed on false filings by §28-211.1.2 of the Administrative Code.

☐ **Withdrawal of Applicant:** I am withdrawing responsibility for the items of progress inspections and/or tests indicated herein and herewith submit the results or status of the work performed to date.

Name (please print)

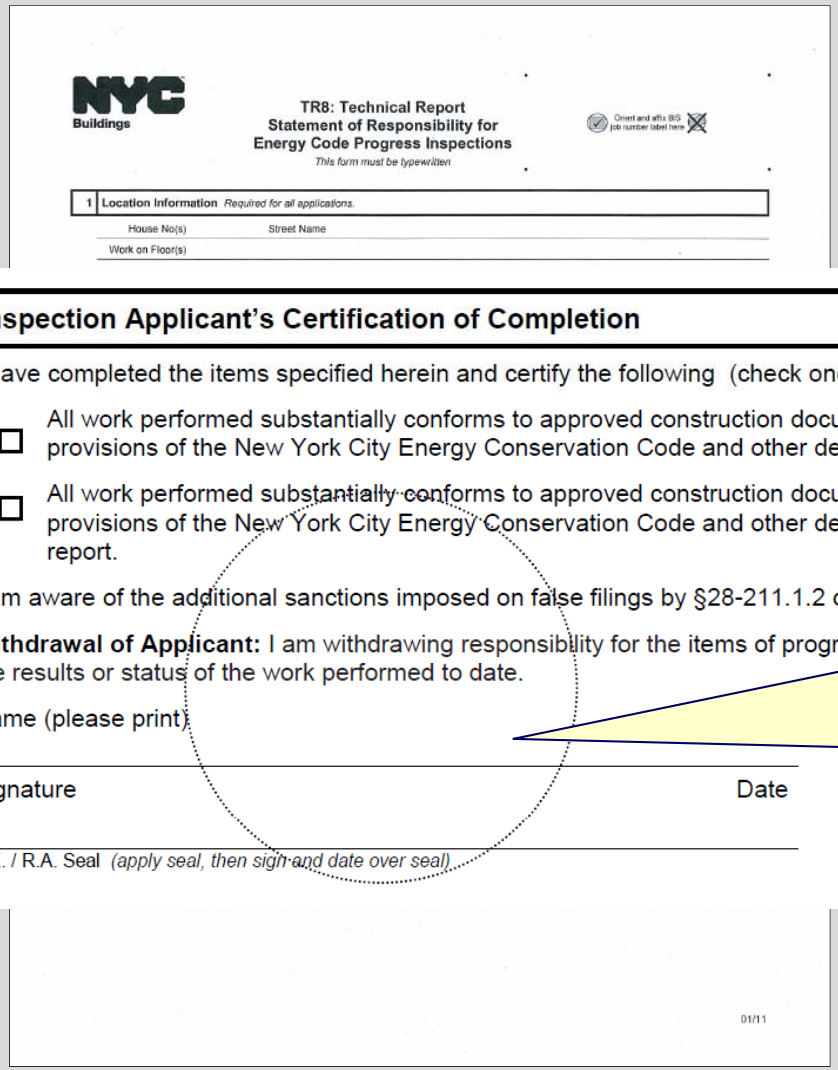
Signature Date

P.E. / R.A. Seal *(apply seal, then sign and date over seal)*

01/11

Progress Inspections – TR8 Report

10. Submissions & Inspections



NYC Buildings

TR8: Technical Report
Statement of Responsibility for
Energy Code Progress Inspections
This form must be typewritten

Orient and affix BIS job number label here

1 **Location Information** *Required for all applications.*

House No(s) Street Name

Work on Floor(s)

6 Inspection Applicant's Certification of Completion

☐ I have completed the items specified herein and certify the following (check one only):

☐ All work performed substantially conforms to approved construction documents and has been performed in accordance with applicable provisions of the New York City Energy Conservation Code and other designated rules and regulations.

☐ All work performed substantially conforms to approved construction documents and has been performed in accordance with applicable provisions of the New York City Energy Conservation Code and other designated rules and regulati
report.

I am aware of the additional sanctions imposed on false filings by §28-211.1.2 of the Administrative Code.

☐ **Withdrawal of Applicant:** I am withdrawing responsibility for the items of progress inspecti
the results or status of the work performed to date.

Name (please print)

Signature Date

P.E. / R.A. Seal *(apply seal, then sign and date over seal)*

01/11

Upon completion of the applicable inspections, the Progress Inspector initials and dates each inspection performed (column 3C). Any inspections assigned to the Progress Inspector that are not performed are addressed through column 3D (withdraw responsibilities). Final signatures and seals are provided in section 6 of the TR8 form.

Progress Inspections – Back-up

Per NYC Administrative Code §28-116.2.3

- A record of all inspections shall be kept by the person performing the inspection.
  - The commissioner can require inspection reports to be filed with the department.
  - Records of inspections shall be maintained for a period of six years after sign-off, or for such other period of time as the commissioner may require
  - Records of inspections shall be made available to the DOB upon request.

EN2 Form

- This DOB form is signed by the progress inspector, certifying that the values in the last-approved Energy Analysis or the as-built Energy Analysis represent values in the constructed building.

While a specific format is not stated, inspection records can include:

- Logs, reports, meeting minutes
- Photographs
- Annotated Drawings

Progress Inspections – EN2 Form

10. Submissions & Inspections

NYC Buildings

EN2: As Built Energy Analysis

This form must be typewritten and submitted in person to the Certificate of Occupancy Division's Borough Office where energy analysis was reviewed.

Orient and affix BIS job number label here

1 Progress Inspector Information *Required for all applications.*

Last Name	First Name	Middle Initial
Business Name		Business Telephone
Business Address		Business Fax
City	State Zip	Mobile Telephone
License Type *choose one:* ☐ P.E. ☐ R.A.:		License Number

2 Location Information *Required for all applications.*

3 As Built Information *P.E./R.A. responsible for progress inspections, choose one below and sign/seal.*

☐ The as-built conditions of the completed building conform to the originally approved energy analysis and do not require a revised energy analysis.

☐ The energy analysis has been revised according to *one* of the statements below:

- ☐ Attached is a revised energy analysis, prepared, signed and sealed by the registered design professional who prepared the previously submitted and approved energy analysis. The as-built conditions of the completed building conform to this revised energy analysis.
- ☐ The last revised energy analysis was submitted and approved as a post approval amendment on _____(date). The as-built conditions of the completed building conform to this revised energy analysis.

sealed and submitted TR8.

Name (please print)

Signature Date

P.E. / R.A. Seal *(apply seal, then sign and date over seal)*

01/11

Progress Inspections – EN2 Form

10. Submissions & Inspections

NYC Buildings

EN2: As Built Energy Analysis

This form must be typewritten and submitted in person to the Certificate of Occupancy Division's Borough Office where energy analysis was reviewed.

Orient and affix BIS job number label here

1 Progress Inspector Information *Required for all applications.*

Last Name | First Name | Middle Initial

Business Name | Business Telephone

Business Address | Business Fax

City | State | Zip | Mobile Telephone

License Type *choose one:* ☐ P.E. ☐ R.A.: | License Number

2 Location Information *Required for all applications.*

3 As Built Information *P.E./R.A. responsible for progress inspections, choose one below and sign/seal.*

☐ The as-built conditions of the completed building conform to the originally approved energy analysis and do not require a revised energy analysis.

☐ The energy analysis has been revised according to *one* of the statements below:

☐ Attached is a revised energy analysis, prepared, signed and sealed by the registered design professional who prepared the previously submitted and approved energy analysis. The as-built conditions of the completed building conform to this revised energy analysis.

☐ The last revised energy analysis was submitted and approved as a post approval amendment on _____(date). The as-built conditions of the completed building conform to this revised energy analysis.

sealed and submitted TR8.

Name (please print)

Signature | Date

P.E. / R.A. Seal *(apply seal, then sign and date over seal)*

01/11

The Progress Inspectors and design applicants will need to coordinate to ensure that the as-built conditions and approved Energy Analysis are consistent. An as-built Energy Analysis update may be required.

Slides 165 to 168

11. Resources

Resources and Links

11. Resources

The resources below have been referenced in this module

Resource	Link
Local Law 1 of 2011	http://www.nyc.gov/html/dob/downloads/pdf/ll1of2011.pdf
Local Law 48 of 2010	http://www.nyc.gov/html/dob/downloads/pdf/ll48of2010.pdf
1 RCNY §5000-01	http://www.nyc.gov/html/dob/downloads/rules/1_RCNY_5000-01.pdf
1 RCNY §101-07	http://www.nyc.gov/html/dob/downloads/rules/1_RCNY_101-07.pdf
Buildings Bulletins	http://www.nyc.gov/html/dob/html/reference/buildings_bulletin.shtml
EN1, EN2, and TR8 Forms	http://www.nyc.gov/html/dob/html/forms/forms_energy.shtml
REScheck/COMcheck	http://www.energycodes.gov/software.stm
PlaNYC	http://www.nyc.gov/html/planyc2030/html/home/home.shtml
New York City Construction Codes	http://www2.iccsafe.org/states/newyorkcity/

DOB Assistance

Questions on the NYCECC can be submitted to the DOB at:

EnergyCode@buildings.nyc.gov

Image / Photo Credits & Copyrights

Company or Individual	Slide Numbers
Samantha Modell	165
NFRC	111, 123
US DOE Building Energy Codes University	71, 127, 128