

What is an Opaque Envelope?

Opaque envelope assemblies are those that do not transmit light. California's Building Energy Efficiency Standards (Energy Code or Title 24, Part 6) include requirements for nonresidential building envelope components, such as those for insulation of wood-framed, metal-framed and masonry walls, framed and metal building roofs, and floors.

Why?

Loads from the building envelope are among the most significant that affect heating and cooling energy use. Opaque envelope assemblies and their insulation are long-lasting materials that are difficult to retrofit post-construction.

Relevant Code Sections

2019 California Building Energy Efficiency Standards, Title 24, Part 6:

- [Section 110.6](#) – Mandatory Requirements For Fenestration Products And Exterior Doors
- [Section 110.7](#) – Mandatory Requirements to Limit Air Leakage
- [Section 110.8](#) – Mandatory Requirements for Insulation, Roofing Products and Radiant Barriers
- [Section 120.7](#) – Mandatory Insulation Requirements
- [Section 120.8](#) – Nonresidential Building Commissioning
- [Section 140.3](#) – Prescriptive Requirements for Building Envelopes
- [Section 141.0\(b\)1](#) – Alterations to Existing Buildings
- [Joint Reference Appendix 4 \(JA4\)](#) – U-factor, C-factor, and Thermal Mass Data

Relevant Compliance Forms

- [NRCC-PRF-01-E](#): Certificate of Compliance – Building Components, Performance
- [NRCC-ENV-E](#): Certificate of Compliance – Envelope Component Approach
- [NRCC-CXR-E](#): Certificate of Compliance – Nonresidential Building Commissioning
- [NRCI-ENV-01-E](#): Certification of Installation – Opaque Envelopes

Compliance Requirements

The requirements for nonresidential opaque surfaces include both Mandatory measures and Prescriptive requirements.



Mandatory Measures

Insulation – New Construction Section 120.7

All newly constructed nonresidential, high-rise residential and hotel/motel buildings must meet the minimum insulation requirements in [Section 120.7](#), summarized below in Table 1.

	Assembly	Max U-factor*
Roof/Ceiling	Metal Building	0.098
	Wood Frame and Others	0.075
Walls	Metal Building	0.113
	Metal Framed	0.151
	Light Mass Walls (6" or greater)	0.440
	Heavy Mass Walls (8" or greater)	0.690
	Wood Frame and Others	0.110
	Spandrel Panels	0.280
	Demising Walls	0.099-wood / 0.151-metal
	Floors	Heated Slab-on-Grade Floors
Floors	Raised Mass Floors	0.269
	Other Floors	0.071

*The maximum U-factor applies to the weighted average of the assembly.

Table 1 – Mandatory U-factor Requirements per [§120.7](#)

Insulation should be installed to limit heat loss and gain between conditioned and unconditioned spaces. Insulation must be installed in direct contact with a continuous roof or finished ceiling. Insulation installed in contact with suspended ceilings with removable ceiling panels should not be considered when determining compliance with insulation requirements.

EXCEPTION: Conditioned spaces with a combined floor area <2000ft², and space between a suspended ceiling and roof > 12ft: Insulation directly in contact with suspended ceiling tiles complies with the Energy Code’s insulation requirements.

In addition to the requirements shown in Table 1, [Section 110.8](#) of the Energy Code includes Mandatory requirements for insulation products ([Section 110.8\(a\)-110.8\(c\)](#)), insulation in existing buildings ([Section 110.8\(d\)](#)), slab-on-grade insulation requirements ([Section 110.8\(g\)](#)), wet insulation systems ([Section 110.8\(h\)](#)), and solar reflectance and thermal emittance ([Section 110.8\(h\)](#)). Radiant barriers must have a thermal emittance no greater than 0.05 ([Section 110.8\(i\)](#)).

Insulation – Alterations Section 141.0(b)1

Any altered components of the building envelope must meet the Mandatory requirements for insulation per [Section 120.7](#) and either meet the Prescriptive requirements per [Section 141.0\(b\)](#), shown below in Table 2, or comply using the Performance approach. Designers and builders may choose between meeting the insulation requirements (R-value) or assembly U-factors for compliance.

U-factor? R-value?

The U-factor is the overall coefficient of thermal transmittance of a fenestration, wall, floor or roof/ceiling assembly, including air film resistance at both surfaces. “Weighted” is a term applied to U-factor to allow different performance for different sections of a wall or roof, as long as the area-weighted average performance complies.

The R-value is the measure of the [thermal resistance](#) of insulation or any material or building component.

Determining Envelope U-factor

[Joint Reference Appendix 4 \(JA4\)](#) provides data tables containing effective U-factors for common roof/ceilings, walls and floor assemblies. U-factors found in these tables can be used only for the Prescriptive approach. CBECC-Com (the California Building Energy Code Compliance modeling software for nonresidential buildings) calculates assembly U-factors for the Performance approach.

U-factors can be determined using the [JA4](#) tables by finding the row for the framing size, spacing and cavity insulation R-value, then identifying the continuous insulation R-value (columns A through G) to find the U-factor at the intersection between the row and column. Interpolation is not allowed. If the product insulation value falls between two adjacent values, use the less efficient of the two assemblies.

	Assembly	Insulation Requirements	Max U-factor*
Roof	Low Sloped	Table 141.0-C**	Table 141.0-C**
	Steep Sloped	Table 141.0-C**	Table 141.0-C**
Walls	Metal Building	R-13	0.113
	Metal Framed	R-13	0.217
	Light Mass Walls	Exempt	Exempt
	Heavy Mass Walls	Exempt	Exempt
	Wood Frame and Others	R-11	0.110
	Spandrel Panels and Glass Curtain Wall	R-4	0.280
Floors	Raised Framed Floors	R-11	0.071
	Raised Mass (High-rise Res, Hotel/Motel)	R-6	0.111
	Raised Mass (All Other)	None	None

*The maximum U-factor applies to the weighted average of the assembly.

**Exceptions apply. See Section 141.0(b)2Biii. Table 141.0-C applies when roofing is removed to the roof deck, otherwise the insulation requirement is based on Table 140.3-B, C, or D. Table 141.0-B applies to tradeoffs for aged solar reflectance and U-Factor.

Table 2 – Mandatory U-factor Requirements for Alterations per Section 141.0

Air Sealing Section 110.7

All newly constructed and any altered components of nonresidential, high-rise residential and hotel/motel buildings must meet the requirements of Section 110.7. In order to improve building energy efficiency by limiting air leakage (infiltration and exfiltration), all joints, penetrations and other openings in the building envelope that could be potential sources of air leakage must be caulked, gasketed, weather stripped or otherwise sealed.

Exterior Doors with Less Than 50% Glazing Section 110.6(a)

All exterior doors in newly constructed nonresidential, high-rise residential and hotel/motel buildings must meet the requirements of Section 110.6(a). Exterior doors with less than 50% glazing are treated as an opaque surface, and must be certified by the manufacturer for the following standards, as well as have a label indicating compliance that is not to be removed before inspection by the enforcement agency.

Except for field-fabricated doors, air infiltration rates do not exceed 0.3 cfm/ft² of door area for residential doors, 0.3 cfm/ft² of door area for nonresidential single doors (swinging and sliding) and 1.0 cfm/ft² for nonresidential double doors (swinging), when tested according to NFRC-400 or ASTM E283 at a pressure differential of 75 pascals (or 1.57 pounds/ft²). AAMA/WDMA/CSA 101/I.S.2/A440-2011 specification may be substituted as equivalent to ASTM E283 at a pressure differential of 75 pascals (or 1.57 pounds/ft²).

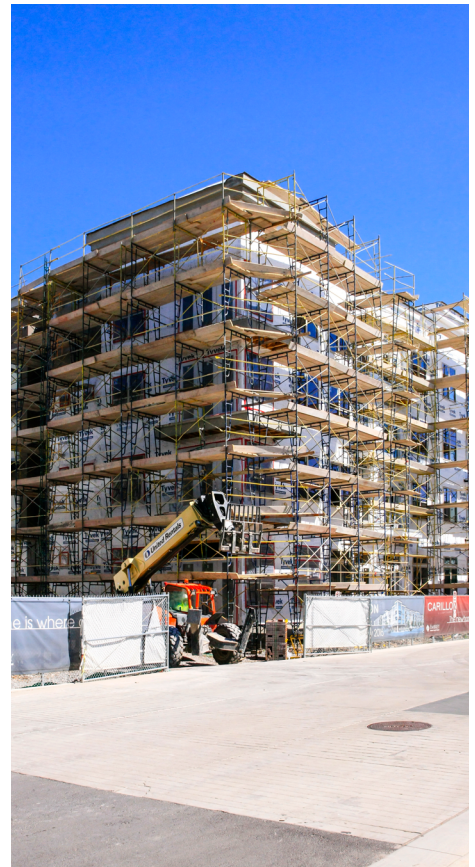
U-factor must be rated in accordance with NFRC 100 or use the applicable default U-factor indicated in Joint Reference Appendix 4.5.1.

Building Commissioning Section 120.8

All newly constructed nonresidential buildings, other than healthcare facilities, with conditioned space $\geq 10,000$ ft² and mixed-use buildings with $\geq 10,000$ ft² of nonresidential occupancy must meet the requirements for building commissioning defined in Section 120.8. Section 120.8 does require the energy performance of roofs, walls, floors and doors to be considered when defining energy goals for the project.

Misc. (Section 120.7) In Both Conditioned and Unconditioned Spaces

Data center buildings with a design process load greater than 750 kW do not need to comply with Mandatory minimum envelope insulation requirements.



Prescriptive Requirements

Various Components Section 140.3

Building envelopes complying with the Energy Code Prescriptively must meet requirements for various applicable envelope components included in [Section 140.3](#).

Air Barriers

Continuous air barriers are required for nonresidential buildings in Climate Zones 10-16, for conditioned spaces excluding those in high-rise residential and hotel/motel spaces.

Air Leakage Rates

There are three options to meet the air barrier requirements:

- Air barrier material must have an air permeance not exceeding 0.004 cfm/ft² (at a pressure differential of 0.3 w.g.)
 - To meet the Prescriptive requirement, the air barrier must be constructed of an approved material (see [Table 140.3-A](#)) and have sealed joints for the entire length of edges
- Assemblies of material and components must have an average air leakage not exceeding 0.04 cfm/ft² (at a pressure differential of 0.3 w.g.)
- The entire building must have an air leakage rate not exceeding 0.40 cfm/ft² (at a pressure differential of 0.3 w.g.)

Exterior Doors

All non-swinging doors separating conditioned space from unconditioned space or from ambient air must have a maximum U-factor of 1.45 for Climate Zones 2-15 or 0.50 in Climate Zones 1 and 16. All swinging exterior doors must have a maximum U-factor of 0.70 in all Climate Zones.

Insulation at Roof and Ceilings, Exterior Walls, and Exterior Floors

Prescriptive requirements for roof, ceiling, wall and floor insulation are covered in the following tables:

- [Table 140.3-B](#) Nonresidential buildings
- [Table 140.3-C](#) High-rise residential buildings and hotel/motel
- [Table 140.3-D](#) Public school relocatables

These tables are easy to follow and specify required U-factors, which are calculated based on assembly components (e.g., framing, continuous and cavity insulation). Requirements are dependent upon Climate Zone, which is how the tables are arranged.

Prescriptive compliance calculations must use assembly values included in [Joint Reference Appendix 4 \(JA4\)](#). JA4 includes tables that will help determine U-factors based on nominal framing size, type and spacing, cavity insulation R-value and continuous insulation R-value.

Daylighting

In Climate Zones 1-15, large spaces >5000 ft² in both conditioned and unconditioned spaces, with ceiling heights > 15 ft, must have a minimum skylight area of 3% of the skylit daylit area to ensure adequate daylight for dimming. Additional requirements for complying Prescriptively are outlined in [Section 140.3\(c\)](#)

Performance Compliance Path

Compliance can be achieved using the Performance approach for envelope only, whole building, or in conjunction with indoor lighting or mechanical, as long as these scopes are permitted at the same time. The Performance approach provides the most flexible path to compliance by allowing trade-offs between measures.

If the **envelope-only** Performance approach is used, only trade-offs between envelope measures are allowed. With the envelope-only approach, the envelope portion is permitted as a first step, and the other building systems (lighting, HVAC and service water heating) must be permitted separately. Where the **whole-building** Performance approach is used, trade-offs can be made amongst the envelope, space conditioning, service water heating and indoor lighting systems that are included in the permit application.

Forms – Which & When

During Design:

- **NRCC-ENV-E: Envelope Component Approach**
 - Completed and signed by the designer or installing contractor
 - Submitted to the building department during permit application

Why?: To show compliance with Mandatory requirements related to roof, wall and floor assemblies, and Prescriptive requirements related to these assemblies, and to door, fenestration and daylighting.

- **NRCC-PRF-01-E: Building Components, Performance**
 - Completed and signed by the designer, engineer or installing contractor
 - Submitted to the building department during permit application

Why?: The PRF-01 form is the only form needed to show building components compliance through the Performance path for conditioned spaces. If daylighting is triggered, the **NRCC-ENV-E** may also be required to document the Prescriptive envelope requirements have been met. This form is generated through approved compliance software.

- **NRCC-CXR-E: Nonresidential Building Commissioning**
 - Completed and signed by the commissioning provider
 - Submitted to the building department during permit application

Why?: Section 120.8 requires building commissioning to be performed as part of the commissioning process for newly constructed buildings with 10,000 ft² or more of conditioned space. This form is a template for projects to use in developing an OPR, BOD, design review checklist, commissioning plan and functional performance testing for the project.

During Construction:

- **NRCI-ENV-01-E: Certification of Installation – Opaque Envelopes**
 - Completed by the installing contractor
 - Made available for the Inspector when they are onsite

Why?: To document the compliant installation of envelope components for inspectors. This form is used for both Prescriptive and Performance compliance methods.

Envelope Component Approach
 CERTIFICATE OF COMPLIANCE
 This document is used to demonstrate compliance with mandatory requirements in §120.8(a) for newly constructed buildings, and §120.8(b)(1) for alterations, retrofits, roof, wall and floor assemblies. It is also used to demonstrate compliance with prescriptive requirements in §120.4 for newly constructed buildings, and §120.4 for additions and alterations, related to roof, wall, floor, door, fenestration and daylighting requirements.

A. GENERAL INFORMATION

01 Project Location (city)	05 # of Stories (Habitable Above Grade)
02 Space	06 Total Conditioned Floor Area (ft ²)
03 Climate Zone	07 Total Unconditioned Floor Area (ft ²)
04 Occupancy Types Within Project (select all that apply): If one occupancy constitutes > 80% of the conditioned floor area, the entire building envelope may be designed to comply with the provisions of that occupancy per §120.8(b). <input type="checkbox"/> Certified for use in one climate zone <input type="checkbox"/> Relocatable Public School Building <input type="checkbox"/> Relocatable Public School Building for use in all climate zones <input type="checkbox"/> High Rise Residential <input type="checkbox"/> Hotel/Motel Guest Rooms Occupancy A / B / E / F / H / M / J / S / U Occupancy E Occupancy R / V / P / 3 If one or more enclosed spaces > 5,000 ft ² directly under roof with ceiling height > 15ft in climate zones 2 through 15 are required to meet the minimum daylighting requirements defined in §120.8(c). Compliance with §120.8(c) is documented in Table L. This is the only prescriptive requirement which applies to unconditioned spaces.	

B. PROJECT SCOPE

Table Instructions: Include any building envelopes that are within the scope of the permit application and are demonstrating compliance using the prescriptive paths outlined in §120.4, and §120.8(a) and §120.8(b) and 2 for additions and alterations.

My project consists of (check all that apply)	Component Types			
01	02	03	04	05
<input type="checkbox"/> New Construction or Newly Conditioned Space One or more enclosed spaces > 5,000 ft ² directly under roof with ceiling height > 15ft	<input type="checkbox"/> Roof	<input type="checkbox"/> Walls	<input type="checkbox"/> Exterior Doors	<input type="checkbox"/> Fenestration/Glazed Door
<input type="checkbox"/> Addition of conditioned space One or more enclosed spaces > 5,000 ft ² directly under roof with ceiling height > 15ft	<input type="checkbox"/> Roof	<input type="checkbox"/> Walls	<input type="checkbox"/> Exterior Doors	<input type="checkbox"/> Fenestration/Glazed Door
<input type="checkbox"/> Alteration of conditioned space One or more enclosed spaces > 5,000 ft ² directly under roof with ceiling height > 15ft and lighting system installed for the first time	<input type="checkbox"/> Roof Assembly	<input type="checkbox"/> Walls	<input type="checkbox"/> Exterior Doors NA for Alts.	<input type="checkbox"/> Fenestration/Glazed Door

FOOTNOTE: Doors that are more than one-half glass in area are considered Glazed Doors and should be documented on Table K with Fenestration.

Nonresidential Building Commissioning
 CERTIFICATE OF COMPLIANCE
 This document is used to demonstrate compliance with mandatory commissioning requirements in §120.8 for nonresidential buildings and hotels/motel or high-rise residential buildings with nonresidential spaces. This document does not demonstrate compliance with commissioning requirements within Title 24, Part 12, which need to be documented separately if they apply.

A. GENERAL INFORMATION

01 Project Location (City)	04 Building Size (ft ²)
02 Occupancy Type	05 Nonresidential Conditioned Floor Area (ft ²)
03 Project Type	06 HVAC System Type

B. PROJECT SCOPE

Table Instructions: Based on project information provided in Table A, Table B indicates which commissioning related requirements apply per §120.8. Table B is not editable by the user.

Commissioning Requirements per §120.8	
01 Table F: Design Review Kickoff §120.8(d)(1) and §120.8(d)(2)	The design review kickoff meeting establishes who will play the role of the design reviewer, the project schedule and identify owner's requirements. This meeting should be conducted during schematic design.
02 Table G: Owner's Project Requirements (OPR) §120.8(d)	This requirement does not apply.
03 Table H: Basis of Design (BOD) §120.8(c)	This requirement does not apply.
04 Table I: Design Review §120.8(e) and §120.8(e)	The design reviewer(s) reviews the construction documents for clarity, completeness, and adherence to the owner's goals. Commissioning measures must be included in the construction documents to facilitate the design review and commissioning process. For projects with a 10,000 ft ² or more of nonresidential conditioned floor area, or with complex mechanical systems, the design review is for adherence with the Owner's Project Requirements (OPR) and Basis of Design (BOD). This should be conducted during design.
05 Table J: Commissioning Plan §120.8(f)	This requirement does not apply.
06 Performance Testing §120.8(g)	This requirement does not apply.
07 Table L: Documentation and Training §120.8(d)	This requirement does not apply.
08 Table M: Commissioning Report §120.8(e)	This requirement does not apply.

ENVELOPE
 CERTIFICATE OF INSTALLATION
 This form is used to document the compliant installation of envelope components for inspectors. This form is used for both Prescriptive and Performance compliance methods.

GENERAL INFORMATION

DATE OF BUILDING PERMIT:	PERMIT #
BUILDING TYPE	<input type="checkbox"/> Nonresidential <input type="checkbox"/> High-Rise Residential <input type="checkbox"/> Hotel/Motel Guest Room
PHASE OF CONSTRUCTION	<input type="checkbox"/> New Construction <input type="checkbox"/> Addition <input type="checkbox"/> Alteration <input type="checkbox"/> Unconditioned

SCOPE OF RESPONSIBILITY

Enter the date of approval by enforcement agency of the Certificate of Compliance that provides the specifications for the energy efficiency measures for the scope of responsibility for this Installation Certificate.

Document Title or Description	Applicable Sheets or Pages, Tables, Schedules, etc.	Date Approved By the Enforcement Agency

For More Information

Primary Documents

- Energy Code Section 110.6 – Mandatory Requirements For Fenestration Products And Exterior Doors
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1106mandatoryrequirementsforfenestrationproductsandexteri.htm
- Energy Code Section 110.7 – Mandatory Requirements to Limit Air Leakage
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1107mandatoryrequirementstolimitairleakage.htm
- Energy Code Section 110.8 – Mandatory Requirements for Insulation, Roofing Products and Radiant Barriers
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1108mandatoryrequirementsforinsulationroofingproductsandr1.htm
- Energy Code Section 120.7 – Mandatory Insulation Requirements
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1207mandatoryinsulationrequirements.htm
- Energy Code Section 120.8 – Nonresidential Building Commissioning
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1208nonresidentialbuildingcommissioning.htm
- Energy Code Section 140.3 – Prescriptive Requirements for Building Envelopes
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1403prescriptiverequirementsforbuildingenvelopes.htm
- Energy Code Section 141.0(b)1 – Alterations to Existing Buildings
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1410additionalterationsandrepairsstoexistingnonresidential1.htm#balterations.htm
- Energy Code Nonresidential Compliance Manual Chapter 3.3, Envelope Assembly
energycodeace.com/site/custom/public/reference-ace-2019/Documents/33fenestrationwindow skylightglazeddoor.htm
- Energy Code Joint Reference Appendix 4 (JA4) – U-factor, C-factor, and Thermal Mass Data:
energycodeace.com/site/custom/public/reference-ace-2019/Documents/appendixja4ufactorcfactorandthermalmassdata.htm

Compliance Forms

- Nonresidential Compliance Forms
energycodeace.com/NonresidentialForms/2019

California Energy Commission Information & Services

- Energy Code Hotline: 1-800-772-3300 (Free) or Title24@energy.ca.gov
- Online Resource Center:
energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/online-resource-center
 - The Energy Commission’s main web portal for the Energy Code, including information, documents, and historical information

Additional Resources

- Energy Code Ace:
EnergyCodeAce.com
 - An online “one-stop-shop” providing free resources and training to help appliance and building industry professionals decode and comply with Title 24, Part 6 and Title 20. The site is administered by California’s investor-owned utilities.

Of special interest:

- Fact Sheets
EnergyCodeAce.com/content/resources-fact-sheets
 - Nonresidential Cool Roofs 2019
 - Nonresidential Daylighting and Daylighting Controls 2019
 - Nonresidential Fenestration 2019
- Trigger Sheets
EnergyCodeAce.com/content/resources-trigger-sheets
 - Nonresidential Fenestration 2019
- Application Guides
energycodeace.com/content/resources-ace/file?type=application-guide
 - Nonresidential Envelope and Solar Ready 2019

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