Proposal Summary

2022 California Energy Code (Title 24, Part 6)

Nonresidential Envelope – Cool Roof

Updated: October 23, 2019

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Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on October 24th. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by November 7th, 2019.

Measure Description

The nonresidential cool roof measure will reevaluate the existing prescriptive cool roof requirements for nonresidential buildings. The Statewide CASE Team will reevaluate requirements for aged solar reflectance, minimum thermal emittance, and Solar Reflectance Index (SRI) to determine if more stringent requirements are appropriate and cost-effective given the most recent product availability product costs. This initiative will evaluate requirements for both low-slope (roof that has a ratio of rise to run of less than 2:12; 9.5 degrees from horizontal) and steep-slope (roof that has a ratio of rise to run of greater than or equal to 2:12; 9.5 degrees from horizontal) roofs for new construction, additions, and alterations. Stricter reflectance, emittance, and/or SRI standards will reduce the energy needed to heat and cool non-residential buildings which in turn will allow building proprietors and occupants to save money and reduce their emission footprint. This measure will present an overview of current standards and proposed changes for low-slope and steep-slope roofs across all climate zones in the state of California.

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

Standards :

SECTION 140.3 – PRESCRIPTIVE REQUIREMENTS FOR BUILDING ENVELOPES

A building complies with this section by being designed with and having constructed to meet all prescriptive requirements in Subsection (a) and the requirements of Subsection (c) and (d) where they apply.

(a) **Envelope Component Requirements.**

1. **Exterior roofs and ceilings.** Exterior roofs and ceilings shall comply with each of the applicable requirements in this subsection:

   A. **Roofing Products.** Shall meet the requirements of Section 110.8 and the applicable requirements of Subsections i through ii:

      i. Nonresidential buildings:

         a. Low-sloped roofs in Climate Zones 1 through 16 shall have:

            1. A minimum aged solar reflectance of ~~0.63~~ XX and a minimum thermal emittance of ~~0.75~~ XX; or

            2. A minimum Solar Reflectance Index (SRI) of ~~75~~ XX.

            EXCEPTION 1 to Section 140.3(a)1Aia: Wood-framed roofs in Climate Zones 3 and 5 are exempt from the requirements of Section 140.3(a)1Aia if the roof assembly has a U-factor of ~~0.034~~ XX or lower.

            EXCEPTION 2 to Section 140.3(a)1Aia: Roof constructions with a weight of at least 25 lb/ft² over the roof membrane are exempt from the requirements of Section 140.3(a)1Aia.

            EXCEPTION 3 to SECTION 140.3(a)1Aia: An aged solar reflectance less than ~~0.63~~ XX is allowed provided the maximum roof/ceiling U-factor in TABLE 140.3 is not exceeded.

         b. Steep-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of ~~0.20~~ XX and a minimum thermal emittance of ~~0.75~~ XX, or a minimum SRI of ~~16~~ XX.

      ii. High-rise residential buildings and hotels and motels:

         a. Low-sloped roofs in Climate Zones 9, 10, 11, 13, 14 and 15 shall have a minimum aged solar reflectance of ~~0.55~~ XX and a minimum thermal emittance of ~~0.75~~ XX, or a minimum SRI of ~~64~~ XX.

            EXCEPTION to Section 140.3(a)1Aiia: Roof constructions with a weight of at least 25 lb/ft² over the roof membrane.

         b. Steep-sloped roofs in Climate Zones 2 through 15 shall have a minimum aged solar reflectance of ~~0.20~~ XX and a minimum thermal emittance of ~~0.75~~ XX, or a minimum SRI of ~~16~~ XX.

TABLE 140.3 ROOF/CEILING INSULATION TRADEOFF FOR AGED SOLAR REFLECTANCE

Nonresidential			
Aged Solar Reflectance	**Metal Building Climate Zone 1-16 U-factor**	**Wood framed and Other Climate Zone 6 & 7 U-factor**	**Wood Framed and Other All Other Climate Zones U-factor**
~~0.62-0.56~~	~~0.038~~	~~0.045~~	~~0.032~~
~~0.55-0.46~~	~~0.035~~	~~0.042~~	~~0.030~~
~~0.45-0.36~~	~~0.033~~	~~0.039~~	~~0.029~~
~~0.35-0.25~~	~~0.031~~	~~0.037~~	~~0.028~~

EXCEPTION to Section 140.3(a)1A: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	**Maximum U-factor**	**Roofs/ Ceilings**	Metal Building	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
			Wood Framed and Other	0.034	0.034	0.034	0.034	0.034	0.049	0.049	0.049	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
		Walls	Metal Building	0.113	0.061	0.113	0.061	0.061	0.113	0.113	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.061
			Metal-framed	0.069	0.062	0.082	0.062	0.062	0.069	0.069	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
			Mass Light[1]	0.196	0.170	0.278	0.227	0.440	0.440	0.440	0.440	0.440	0.170	0.170	0.170	0.170	0.170	0.170	0.170
			Mass Heavy[1]	0.253	0.650	0.650	0.650	0.650	0.690	0.690	0.690	0.690	0.650	0.184	0.253	0.211	0.184	0.184	0.160
			Wood-framed and Other	0.095	0.059	0.110	0.059	0.102	0.110	0.110	0.102	0.059	0.059	0.045	0.059	0.059	0.059	0.042	0.059
		Floors/ Soffits	Raised Mass	0.092	0.092	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.092	0.092	0.092	0.092	0.092	0.058
			Other	0.048	0.039	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.039	0.071	0.071	0.039	0.039	0.039
	Roofing Products	**Low-sloped**	Aged Solar Reflectance	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
			Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		Steep-Sloped	Aged Solar Reflectance	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
			Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0. 75	0.75	0.75	0.75	0.75	0.75	0.75
	Air Barrier			NR	NR	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Exterior Doors, Maximum U-factor		Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
			Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

CONTINUED: TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				All Climate Zones			
				Fixed Window	Operable Window	Curtainwall or Storefront	Glazed Doors[2]
Envelope	**Fenestration**	**Vertical**	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
				Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
			Maximum WWR%	40%				
		Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	Tubular Daylighting Devices (TDDs)
			Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	0.88
				Max SHGC	0.25	0.25	NR	NR
			Area-Weighted Performance Rating	Min VT (Min VT_{annual} for TDDs)	0.49	0.49	0.64	0.38
			Maximum SRR%	5%				

TABLE 140.3-C – PRESCRIPTIVE ENVELOPE CRITERIA FOR HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	**Maximum U-factor**	**Roofs/ Ceilings**	Metal Building	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
			Wood Framed and Other	0.028	0.028	0.034	0.028	0.034	0.034	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
		Walls	Metal Building	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
			Metal-framed	0.069	0.069	0.069	0.069	0.069	0.069	0.105	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.048	0.069
			Mass, Light[1]	0.170	0.170	0.170	0.170	0.170	0.227	0.227	0.227	0.196	0.170	0.170	0.170	0.170	0.170	0.170	0.170
			Mass, Heavy[1]	0.160	0.160	0.160	0.184	0.211	0.690	0.690	0.690	0.690	0.690	0.184	0.253	0.211	0.184	0.184	0.160
			Wood-framed and Other	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.042	0.059	0.059	0.042	0.042	0.042
		Floors/ Soffits	Raised Mass[1]	0.045	0.045	0.058	0.058	0.058	0.069	0.092	0.092	0.092	0.069	0.058	0.058	0.058	0.045	0.058	0.037
			Other	0.034	0.034	0.039	0.039	0.039	0.039	0.071	0.039	0.039	0.039	0.039	0.039	0.039	0.034	0.039	0.034
	Roofing Products	**Low-sloped**	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	0.55	0.55	0.55	NR	0.55	0.55	0.55	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	NR	0.75	0.75	0.75	NR
		Steep-Sloped	Aged Solar Reflectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0. 75	0.75	0.75	0.75	0.75	0.75	NR
	Exterior Doors, Maximum U-factor		Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
			Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

CONTINUED: TABLE 140.3-C – PRESCRIPTIVE ENVELOPE CRITERIA FOR HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS

				All Climate Zones			
				Fixed Window	Operable Window	Curtainwall/ Storefront	Glazed Doors[2]
Envelope	**Fenestration**	**Vertical**	Area-Weighted Performance Rating — Max U-factor	0.36	0.46	0.41	0.45
			Area-Weighted Performance Rating — Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating — Min VT	0.42	0.32	0.46	0.17
			Maximum WWR%	40%			
		Skylights		Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	
			Area-Weighted Performance Rating — Max U-factor	0.58	0.46	0.88	
			Area-Weighted Performance Rating — Max SHGC	0.25	0.25	NR	
			Area-Weighted Performance Rating — Min VT	0.49	0.49	0.64	
			Maximum SRR%	5%			

Notes:

1. As defined in Section 100.0, light mass walls are walls with a density less than or equal to 95 pounds per cubic foot. Heavy mass walls are walls with a density greater than 95 pounds per cubic foot.

2. Glazed Doors applies to both site-built and to factory-assembled glazed doors.

TABLE 140.3-D PRESCRIPTIVE ENVELOPE CRITERIA FOR RELOCATABLE PUBLIC SCHOOL BUILDINGS FOR USE IN ALL CLIMATE ZONES

Roofs/ Ceilings	**Metal Buildings**	Maximum U-factor			0.041
	Non-Metal Buildings				0.034
Walls	**Wood frame buildings**				0.042
	Metal frame buildings				0.057
	Metal buildings				0.057
	Density ≤ 95				0.170
	All Other Walls				0.059
Floors and Soffits	**Floors and Soffits**				0.048
Roofing Products	**Low-Sloped**	Aged Solar Reflectance			0.63
		Thermal Emittance			0.75
	Steep-Sloped	Aged Solar Reflectance			0.20
		Thermal Emittance			0.75
Fenestration	**Windows**	Maximum U-factor			0.47
		Maximum SHGC			0.26
	Glazed Doors (Site-Built and Factory Assembled)	Maximum U-factor			0.45
		Maximum SHGC			0.23
	Skylights	Glass with Curb		Maximum U-factor	0.99
		Glass without Curb			0.57
		Plastic with Curb			0.87
		Glass Type	0-2% SRR	Maximum SHGC	0.46
			2.1-5% SRR		0.36
		Plastic Type	0-2% SRR		0.69
			2.1-5% SRR		0.57
Exterior Doors	**Non-Swinging doors**	Maximum U-factor			0.50
	Swinging doors				0.70

SECTION 141.0 – ADDITIONS, ALTERATIONS, AND REPAIRS TO EXISTING NONRESIDENTIAL, HIGH-RISE RESIDENTIAL, AND HOTEL/MOTEL BUILDINGS, TO EXISTING OUTDOOR LIGHTING, AND TO INTERNALLY AND EXTERNALLY ILLUMINATED SIGNS

Additions, alterations, and repairs to existing nonresidential, high-rise residential, and hotel/motel buildings, existing outdoor lighting for these occupancies, and internally and externally illuminated signs, shall meet the requirements specified in Sections 100.0 through 110.10, and 120.0 through 130.5 that are applicable to the building project, and either the performance compliance approach (energy budgets) in Section 141.0(a)2 (for additions) or 141.0(b)3 (for alterations), or the prescriptive compliance approach in Section 141.0(a)1 (for additions) or 141.0(b)2 (for alterations), for the Climate Zone in which the building is located. Climate zones are shown in FIGURE 100.1-A.

Covered process requirements for additions, alterations and repairs to existing nonresidential, high-rise residential, and hotel/motel buildings are specified in Section 141.1.

NOTE: For alterations that change the occupancy classification of the building, the requirements specified in Section 141.0(b) apply to the occupancy after the alterations.

(b) **Alterations.** Alterations to components of existing nonresidential, high-rise residential, hotel/motel, or relocatable public school buildings, including alterations made in conjunction with a change in building occupancy to a nonresidential, high-rise residential, or hotel/motel occupancy shall meet item 1, and either Item 2 or 3 below:

Prescriptive approach. The altered components of the envelope, or space conditioning, lighting, electrical power distribution and water heating systems, and any newly installed equipment serving the alteration, shall meet the applicable requirements of Sections 110.0 through 110.9, Sections 120.0 through 120.6, and Sections 120.9 through 130.5

A. Fenestration alterations other than repair and those subject to Section 141.0(b)2 shall meet the requirements below:

i. Vertical fenestration alterations shall meet the requirements in Table 141.0-A.

ii. Added vertical fenestration shall meet the requirements of TABLE 140.3-B, C, or D.

iii. All altered or newly installed skylights shall meet the requirements of TABLE 140.3-B, C or D.

EXCEPTION 1 to Section 141.0(b)2Ai: In an alteration, where 150 square feet or less of the entire building's vertical fenestration is replaced, RSHGC and VT requirements of TABLE 141.0-A shall not apply.

EXCEPTION 2 to Section 141.0(b)2Aii: In an alteration, where 50 square feet or less of vertical fenestration is added, RSHGC and VT requirements of TABLE 140.3-B, C or D shall not apply.

EXCEPTION 3 to Section 141.0(b)2Aiii: In an alteration, where 50 square feet or less of skylight is added, SHGC and VT requirements of TABLE 140.3-B, C or D shall not apply.

NOTE: Glass replaced in an existing sash and frame or sashes replaced in an existing frame are considered repairs. In these cases, Section 141.0(c) requires that the replacement be at least equivalent to the original in performance.

Table 141.0-A Altered Vertical Fenestration Maximum U-Factor and Maximum RSHGC

Climate Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
U-factor	0.47	0.47	0.58	0.47	0.58	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47

RSHGC	0.41	0.31	0.41	0.31	0.41	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.41
VT	See TABLE 140.3-B, C, and D for all Climate Zones															

B. Existing roofs being replaced, recovered or recoated, of a nonresidential, high-rise residential and hotels/motels shall meet the requirements of Section 110.8(i). Roofs with more than 50 percent of the roof area or more than 2,000 square feet of roof, whichever is less, is being altered the requirements of i through iii below apply:

i. Roofing Products. Nonresidential buildings:

a. Low-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75, or a minimum SRI of 75.

b. Steep-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

EXCEPTION to Section 141.0(b)2Bia: An aged solar reflectance less than 0.63 is allowed provided the maximum roof/ceiling U-factor in TABLE 141.0-B is not exceeded.

ii. Roofing Products. High-rise residential buildings and hotels and motels:

a. Low-sloped roofs in Climate Zones 10, 11, 13, 14 and 15 shall have a minimum aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.

b. Steep-sloped roofs Climate Zones 2 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

EXCEPTION 1 to Section 141.0(b)2Bi and ii: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

EXCEPTION 2 to Section 141.0(b)2Bi and ii: Roof constructions that have thermal mass over the roof membrane with a weight of at least 25 lb/ft² are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

Table 141.0-B Roof/Ceiling Insulation Tradeoff for Aged Solar Reflectance

Aged Solar Reflectance	Climate Zone 1, 3-9 U-factor	Climate Zone 2, 10-16 U-factor
0.62- 0.60	0.075	0.052
0.59-0.55	0.066	0.048
0.54-0.50	0.060	0.044
0.49-0.45	0.055	0.041
0.44-0.40	0.051	0.039
0.39-0.35	0.047	0.037
0.34-0.30	0.044	0.035

0.29-0.25	0.042	0.034

iii. For nonresidential buildings, high-rise residential buildings and hotels/motels, when low-sloped roofs are exposed to the roof deck or to the roof recover boards, and meets Section 141.0(b)2Bia or iia, the exposed area shall be insulated to the levels specified in TABLE 141.0-C.

EXCEPTION to Section 141.0(b)2Biii

a. Existing roofs that are insulated with at least R-7 insulation or that has a U-factor lower than 0.089 are not required to meet the R-value requirement of TABLE 141.0-C.

b. If mechanical equipment is located on the roof and will not be disconnected and lifted as part of the roof replacement, insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing.

c. If adding the required insulation will reduce the base flashing height to less than 8 inches (203 mm) at penthouse or parapet walls, the insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing, provided that the conditions in Subsections i through iv apply:

i. The penthouse or parapet walls are finished with an exterior cladding material other than the roofing covering membrane material; and

ii. The penthouse or parapet walls have exterior cladding material that must be removed to install the new roof covering membrane to maintain a base flashing height of 8 inches (203 mm); and

iii. For nonresidential buildings, the ratio of the replaced roof area to the linear dimension of affected penthouse or parapet walls shall be less than 25 square feet per linear foot for Climate Zones 2, and 10 through 16, and less than 100 square feet per linear foot for Climate Zones 1, and 3 through 9; and

iv. For high-rise residential buildings, hotels or motels, the ratio of the replaced roof area to the linear dimension of affected penthouse or parapet walls shall be less than 25 square feet per linear foot for all Climate Zones.

v. Tapered insulation may be used which has a thermal resistance less than that prescribed in TABLE 141.0-C at the drains and other low points, provided that the thickness of insulation is increased at the high points of the roof so that the average thermal resistance equals or exceeds the value that is specified in TABLE 141.0-C.

TABLE 141.0-C INSULATION REQUIREMENTS FOR ROOF ALTERATIONS

	Nonresidential		***High-Rise Residential and Guest Rooms of Hotel/Motel Buildings***	
Climate Zone	***Continuous Insulation R-value***	***U-factor***	***Continuous Insulation R-value***	***U-factor***
1	***R-8***	***0.082***	***R-14***	***0.055***
2	***R-14***	***0.055***	***R-14***	***0.055***

3-9	***R-8***	***0.082***	***R-14***	***0.055***
10-16	***R-14***	***0.055***	***R-14***	***0.055***

Proposal Summary

2022 California Energy Code (Title 24, Part 6)

High Performance Envelope – Thermal Bridging

Updated: Date last updated: Friday, October 7, 2019

Prepared by: Benny Zank, Energy Solutions

Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on October 24, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by November 7, 2019.

Measure Description

Thermal bridging occurs when conductive elements penetrate a building's thermal insulation and allow heat to bypass the insulating layer. This reduces the overall effectiveness of the insulation and decreases the efficiency of the building's thermal envelope by allowing additional heat to escape the building. The current requirements only prescribe U-factors for an assembly (e.g., wall, roof, etc.). These assembly U-factors do not account for thermal bridges that occur at the intersection of two assemblies, such as a wall and a roof. Thermal bridging for poorly designed details at the intersection of assembly can result in overall assembly U-factors that are as much as 50 percent higher than the requirement. Thus, the U-factor requirement for assemblies alone is not enough to capture the impact of thermal bridges because assemblies meeting the requirements may not achieve that level of performance in the field. This submeasure will prescribe detailing of the thermal envelope at major thermal bridges, thereby increasing the efficiency of the envelope and resulting in energy savings. The goal is to mitigate heat transfer through major thermal bridges in a building including wall-roof intersections, wall-intermediate floor intersections, wall-fenestration intersections, and wall-exterior projections, including balconies and overhangs. This submeasure will build upon (though not necessarily replicate) the ASHRAE 90.1 proposal (addendum AV to ASHRAE 90.1-2016).

Draft Code Language

The Statewide CASE Team is currently in the process of developing draft code language. This will not be available for the October 24th stakeholder meeting.

Examples of language in other codes that may be drawn from:

Canadian National Energy Code for Buildings:

Adapted from Section 3.1.1.7. The only changes are the removal of references to other sections of the code.

1) In calculating the overall thermal transmittance of assemblies, the effect of thermal bridging shall be considered for:

A. closely spaced repetitive structural members, such as studs and joists, and ancillary members, such as lintels, sills, and plates
B. major structural elements that penetrate or intersect the building envelope
C. junctions between the follow building envelope materials, components, and assemblies:
    i. Glazing assemblies,
    ii. Spandrels,
    iii. Parapets,
    iv. Roof-to-wall junctions,
    v. Corners, and
    vi. Edges of walls or floors
D. Secondary structural members

2) In calculating the overall thermal transmittance of assemblies, the thermal bridging effect of major structural members, such as columns and spandrel beams, that are parallel to the plane of the building envelope and partly penetrate that building envelope assembly need not be taken into account, provided they do not increase the overall thermal transmittance at the projected area of the member to more than twice that permitted.

3) In calculating the overall thermal transmittance of assemblies, pipes, ducts, equipment with through-the-wall venting, packaged terminal air conditioners or heat pumps, shelf angles, anchors and ties and associated fasteners, and other minor structural members that must completely penetrate the building envelope to perform their intended function need not be taken into account.

4) In calculating the overall thermal transmittance of major structural penetrations, such as balcony slabs, beams, girders, columns, and ornamentation or appendages that must completely penetrate the building envelope to perform their intended function need not be taken into account, provided that the sum of the cross-sectional areas at such major structural penetrations is limited to a maximum of 2% of the above-ground building envelope area.

5) Where a component of the building envelope is protected by an enclosed unconditioned space, such as a sun porch, enclosed veranda or vestibule, the unconditioned enclosure may be considered to have an overall thermal transmittance of 6.25 $W/(m^2*K)$.

6) roof assemblies shall be considered to include all related structural framing.

7) wall assemblies inclined less than 60° from the horizontal shall be considered as roof assemblies, and roof assemblies inclined 60° or more from the horizontal shall be considered as wall assemblies.

8) wall assemblies shall be considered to include all related structural framing and perimeter areas of intersecting interior walls but shall not include the perimeter areas where floor or roof slabs interrupt the wall's construction.

Adapted from Section 3.2.2.2. The only changes are the removal of references to other sections of the code.

1)the overall thermal transmittance of above-ground opaque building assemblies shall be not more than that shown in Table 3.2.2.2. for the building or part thereof enclosed by the opaque building assembly, for the applicable heating degree-day category taken at 65 Fahrenheit.

2)the overall thermal transmittance of above-ground opaque building assemblies in semi-heated buildings shall be not more than that shown in Table 3.2.2.2. for the building or part thereof enclosed by the opaque building assembly, for the applicable heating degree-day category taken at 65 Fahrenheit.

Table 3.2.2.2.
Overall Thermal Transmittance of Above-ground Opaque Building Assemblies
Forming Part of Sentences 3.2.2.2.(1) and (2)

Above-ground *Opaque Building Assembly*	Heating Degree-Days of *Building* Location,(1) in Celsius Degree-Days					
	Zone 4:(2) < 3000	Zone 5:(2) 3000 to 3999	Zone 6:(2) 4000 to 4999	Zone 7A:(2) 5000 to 5999	Zone 7B:(2) 6000 to 6999	Zone 8:(2) ≥ 7000
	Maximum *Overall Thermal Transmittance*, W/(m²·K)					
Walls	0.315	0.278	0.247	0.210	0.210	0.183
Roofs	0.193	0.156	0.156	0.138	0.138	0.121
Floors	0.227	0.183	0.183	0.162	0.162	0.142

3)The overall thermal transmittance of portions of a foundation wall that are above ground, where the top of a foundation wall is less than 0.4 m above the adjoining ground level, shall be not more than that shown in Table […].

4) Where radiant heating cables or heating or cooling pipes or membranes are embedded in the surface of an above-ground opaque building assembly, this assembly shall have an overall thermal transmittance no greater than 80% of that required by 1).

Example language adapted from ASHRAE Addendum AV

To the extent that linear thermal bridges and point thermal bridges exist at locations on the building envelope as described, they shall comply with the requirements of either:

a. Section […]

b. Section […], provided that the total length of all balconies or floor overhangs does not exceed the maximum allowed in Section […] Exception […]

Alternatives to individual requirements provided shall be permitted in accordance with Appendix […]. Details for linear thermal bridges and point thermal bridges shall be clearly identified or otherwise noted on construction documents.

Proposal Summary

2022 California Energy Code (Title 24, Part 6)

Nonresidential High Performance Envelope – Roof Alterations

Updated: October 23, 2019

Prepared by: Alamelu Brooks, Energy Solutions

Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on October 24, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by November 7, 2019.

Measure Description

The roof alterations submeasure requires low-slope roof alterations where insulation is exposed to insulate roofs to the full R-value required by Title 24, Part 6. This submeasure offers an opportunity to bring existing building stock up to current Title 24, Part 6 requirements.

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

Standards

Section 100.1

ROOF is the outside cover of a building or structure including the structural supports, decking, and top layer that is exposed to the outside with a slope less than 60 degrees from the horizontal.

ROOF, LOW-SLOPED is a roof that has a ratio of rise to run of less than 2:12 (9.5 degrees from the horizontal).

ROOF, STEEP-SLOPED is a roof that has a ratio of rise to run of greater than or equal to 2:12 (9.5 degrees from the horizontal).

ROOFING PRODUCT is the top layer of the roof that is exposed to the outside, which has properties including but not limited to solar reflectance, thermal emittance, and mass.

ROOF RECOVER BOARD is a rigid type board, installed directly below a low-sloped roof membrane, with or without above deck thermal insulation, to: (a) improve a roof system's compressive strength, (b) physically separate the roof membrane from the thermal insulation, or (c) physically separate a new roof covering from an underlying roof membrane as part of a roof overlay project.

ROOF RECOVER is the process of installing an additional roof covering over a prepared existing roof covering without removing the existing roof covering.

ROOF REPLACEMENT is the process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.

Section 141.0(b)2B: Existing roofs being replaced, recovered or recoated, of a nonresidential, high-rise residential and hotels/motels shall meet the requirements of Section 110.8(i). Roofs with more than 50 percent of the roof area or more than 2,000 square feet of roof, whichever is less, is being altered the requirements of i through iii below apply:

i. Roofing Products. Nonresidential buildings shall meet the requirements in 140.3 (a)1Ai.~~:~~

a. ~~Low-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75, or a minimum SRI of 75.~~

~~b. Steep-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.~~

~~**EXCEPTION to Section 141.0(b)2Bia:** An aged solar reflectance less than 0.63 is allowed provided the maximum roof/ceiling U-factor in TABLE 141.0-B is not exceeded.~~

ii. Roofing Products. High-rise residential buildings and hotels and motels shall meet the requirements in 140.3 (a)1Aii.~~:~~

a. ~~Low-sloped roofs in Climate Zones 10, 11, 13, 14 and 15 shall have a minimum aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.~~

~~b. Steep-sloped roofs Climate Zones 2 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.~~

~~**EXCEPTION 1 to Section 141.0(b)2Bi and ii:** Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.~~

~~**EXCEPTION 2 to Section 141.0(b)2Bi and ii:** Roof constructions with a weight of at least 25 lb/ft² are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.~~

~~*Table 141.0-B Roof/Ceiling Insulation Tradeoff for Aged Solar Reflectance*~~

~~Aged Solar Reflectance~~	~~Climate Zone 1, 3-9 U-factor~~	~~Climate Zone 2, 10-16 U-factor~~
~~0.62-0.60~~	~~0.075~~	~~0.052~~
~~0.59-0.55~~	~~0.066~~	~~0.048~~

~~0.54-0.50~~	~~0.060~~	~~0.044~~
~~0.49-0.45~~	~~0.055~~	~~0.041~~
~~0.44-0.40~~	~~0.051~~	~~0.039~~
~~0.39-0.35~~	~~0.047~~	~~0.037~~
~~0.34-0.30~~	~~0.044~~	~~0.035~~
~~0.29-0.25~~	~~0.042~~	~~0.034~~

Section 141.0(b)2Biii: For nonresidential buildings, high-rise residential buildings and hotels/motels, when low-sloped roofs are exposed to the roof deck or to the roof recover boards, and meets Section 141.0(b)2Bia or iia, the exposed area shall be insulated above the roof deck to the levels specified in TABLE 140.3-C ~~141.0-C~~.

EXCEPTION to Section 141.0(b)2Biii

~~a. Existing roofs that are insulated with at least R-7 insulation or that has a U-factor lower than 0.089 are not required to meet the R-value requirement of TABLE 141.0-C.~~

~~b. If mechanical equipment is located on the roof and will not be disconnected and lifted as part of the roof replacement, insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing.~~

~~c. If adding the required insulation will reduce the base flashing height to less than 8 inches (203 mm) at penthouse or parapet walls, the insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing, provided that the conditions in Subsections i through iv apply:~~

~~i. The penthouse or parapet walls are finished with an exterior cladding material other than the roofing covering membrane material; and~~

~~ii. The penthouse or parapet walls have exterior cladding material that must be removed to install the new roof covering membrane to maintain a base flashing height of 8 inches (203 mm); and~~

~~iii. For nonresidential buildings, the ratio of the replaced roof area to the linear dimension of affected penthouse or parapet walls shall be less than 25 square feet per linear foot for Climate Zones 2, and 10 through 16, and less than 100 square feet per linear foot for Climate Zones 1, and 3 through 9; and~~

~~iv. For high-rise residential buildings, hotels or motels, the ratio of the replaced roof area to the linear dimension of affected penthouse or parapet walls shall be less than 25 square feet per linear foot for all Climate Zones.~~

d. Tapered insulation may be used which has a thermal resistance less than that prescribed in TABLE 140.3-C ~~141.0-C~~ at the drains and other low points, provided that the thickness of insulation is increased at the high points of the roof so that the average thermal resistance equals or exceeds the value that is specified in TABLE 140.3-C ~~141.0-C~~.

~~*TABLE 141.0-C INSULATION REQUIREMENTS FOR ROOF ALTERATIONS*~~

	~~Nonresidential~~		~~High-Rise Residential and Guest Rooms of Hotel/Motel Buildings~~	
~~Climate Zone~~	~~Continuous Insulation R-value~~	~~U-factor~~	~~Continuous Insulation R-value~~	~~U-factor~~
~~1~~	~~R-8~~	~~0.082~~	~~R-14~~	~~0.055~~
~~2~~	~~R-14~~	~~0.055~~	~~R-14~~	~~0.055~~
~~3-9~~	~~R-8~~	~~0.082~~	~~R-14~~	~~0.055~~
~~10-16~~	~~R-14~~	~~0.055~~	~~R-14~~	~~0.055~~

Reference Appendices

Proposal Summary

2022 California Energy Code (Title 24, Part 6)

Nonresidential High Performance Envelope: High Performance Windows

Updated: Wednesday, October 2, 2019

Prepared by: Kiri Coakley and Alamelu Brooks, Energy Solutions; Karen Bushey and Leslie Badger, VEIC

Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on October 24, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by November 7, 2019.

Measure Description

This measure proposal will consider updates to the U-factor, solar heat gain coefficients (SHGC), and visible transmittance (VT) for windows in nonresidential buildings while recognizing that updates are most critical in heating dominated climate zones.

The structural, thermal, and optical characteristics of fenestration influence total energy performance in buildings. The California Energy Code already sets certification requirements for U-factors, SHGCs, VT and air leakage for fenestration products and exterior doors in Section 110.6(a) of Title 24, Part 6. This measure proposal would evaluate improvements to the requirements of this key envelope component.

Improving the performance of windows could improve daylighting, occupant comfort, and overall envelope efficiency.

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

We are not proposing to remove any multifamily Title 24, Part 6 requirements at this time. The Multifamily Team has not decided whether they will create a table in their section or refer our tables in their sections. One potential issue is that if the multifamily codes are scattered in multiple places, it is is going to create confusion to the design community and the enforcement team.

SECTION 110.6 – MANDATORY REQUIREMENTS FOR FENESTRATION PRODUCTS AND EXTERIOR DOORS

(a) **Certification of Fenestration Products and Exterior Doors other than Field-fabricated.** Any fenestration product and exterior door, other than field-fabricated fenestration products and field-fabricated exterior doors,

may be installed only if the manufacturer has certified to the Commission, or if an independent certifying organization approved by the Commission has certified that the product complies with all of the applicable requirements of this subsection.

1. **Air leakage.** Manufactured fenestration products and exterior doors shall have air infiltration rates not exceeding 0.3 cfm/ft² of window area, 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), incorporated herein by reference.

   NOTES TO SECTION 110.6(a)1:Pet doors must meet 0.3 cfm/ft² when tested according to ASTM E283 at 75 pascals (or 1.57 pounds/ft²). AAMA/WDMA/CSA 101/I.S.2/A440-2011 specification is equivalent to ASTM E283 at a pressure differential of 75 pascals (or 1.57 pounds/ft²) and satisfies the air leakage certification requirements of this section.

   EXCEPTION to Section 110.6(a)1: Field-fabricated fenestration and field-fabricated exterior doors.

2. **U-factor.** The fenestration product and exterior door's U-factor shall be rated in accordance with NFRC 100, or use the applicable default U-factor set forth in TABLE 110.6-A.

   EXCEPTION 1 to Section 110.6(a)2: If the fenestration product is a skylight or a vertical site-built fenestration product in a building covered by the nonresidential standards with less than 200 square feet of site-built fenestration, the default U-factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

   EXCEPTION 2 to Section 110.6(a)2: If the fenestration product is an alteration consisting of any area replacement of glass in a skylight product or in a vertical site-built fenestration product, in a building covered by the nonresidential standards, the default U-factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

3. **Solar Heat Gain Coefficient (SHGC).** The fenestration product's SHGC shall be rated in accordance with NFRC 200, or use the applicable default SHGC set forth in TABLE 110.6-B.

   EXCEPTION 1 to Section 110.6(a)3: If the fenestration product is a skylight or a vertical site-built fenestration product in a building covered by the nonresidential standards with less than 200 square feet of site-built fenestration, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.

   EXCEPTION 2 to Section 110.6(a)3: If the fenestration product is an alteration consisting of any area replacement of glass in a skylight product or in a vertical site-built fenestration product, in a building covered by the nonresidential standards, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.

4. **Visible Transmittance (VT).** The fenestration product's VT shall be rated in accordance with NFRC 200 or ASTM E972, for tubular daylighting devices VT shall be rated using NFRC 203**.**

   EXCEPTION 1 to Section 110.6(a)4: If the fenestration product is a skylight or a vertical site-built fenestration product in a building covered by the nonresidential standards with less than 200 square feet of site-built fenestration, the default VT may be calculated as set forth in Reference Nonresidential Appendix NA6.

   EXCEPTION 2 to Section 110.6(a)4: If the fenestration product is an alteration consisting of any area; replacement of glass in a skylight product or in a vertical site-built fenestration product in a building covered by the nonresidential standards, the default VT may be calculated as set forth in Reference Nonresidential Appendix NA6.

5. **Labeling.** Fenestration products and exterior doors shall:

   A. Have a temporary label for manufactured fenestration products and exterior doors or a label certificate when the Component Modeling Approach (CMA) is used and for site-built fenestration meeting the requirements of Section 10-111(a)1. The temporary label shall not be removed before inspection by the enforcement agency; and

B. Have a permanent label or a label certificate when the Component Modeling Approach (CMA) is used and for site-built fenestration meeting the requirements of Section 10-111(a)2 if the product is rated using NFRC procedures.

6. **Fenestration Acceptance Requirements.** Before an occupancy permit is granted, site-built fenestration products in other than low-rise residential buildings shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified in the Reference Nonresidential Appendix NA7 to ensure that site-built fenestration meet Standards requirements, including a matching label certificate for product(s) installed and be readily accessible at the project location. A Certificate of Acceptance certifying that the fenestration product meets the acceptance requirements shall be completed, signed and submitted to the enforcement agency.

   EXCEPTION to Section 110.6(a): Fenestration products removed and reinstalled as part of a building alteration or addition.

(b) **Installation of Field-fabricated Fenestration and Exterior Doors.** Field-fabricated fenestration and field-fabricated exterior doors may be installed only if the compliance documentation has demonstrated compliance for the installation using U-factors from Table 110.6-A and SHGC values from Table 110.6-B. Field-fabricated fenestration and field-fabricated exterior doors shall be caulked between the fenestration products or exterior door and the building, and shall be weatherstripped.

EXCEPTION to Section 110.6(b): Unframed glass doors and fire doors need not be weather stripped or caulked.

TABLE 110.6-A DEFAULT FENESTRATION PRODUCT U-FACTORS

FRAME	PRODUCT TYPE	SINGLE PANE [3, 4] U-FACTOR	DOUBLE PANE [1, 3, 4] U-FACTOR	GLASS BLOCK [2,3] U-FACTOR
Metal	Operable	1.28	0.79	0.87
	Fixed	1.19	0.71	0.72
	Greenhouse/garden window	2.26	1.40	N.A.
	Glazed Doors	1.25	0.77	N.A.
	Skylight	1.98	1.30	N.A.
Metal, Thermal Break	Operable	N.A.	0.66	N.A.
	Fixed	N.A.	0.55	N.A.
	Greenhouse/garden window	N.A.	1.12	N.A.
	Glazed Doors	N.A.	0.59	N.A.
	Skylight	N.A.	1.11	N.A.
Nonmetal	Operable	0.99	0.58	0.60
	Fixed	1.04	0.55	0.57
	Glazed Doors	0.99	0.53	N.A.
	Greenhouse/garden windows	1.94	1.06	N.A.
	Skylight	1.47	0.84	N.A.

1. For all dual-glazed fenestration products, adjust the listed U-factors as follows:

   a. Add 0.05 for products with dividers between panes if spacer is less than 7/16 inch wide.

   b. Add 0.05 to any product with true divided lite (dividers through the panes).

2. Translucent or transparent panels shall use glass block values when not rated by NFRC 100.

3. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential Appendix NA6.

4. Windows with window film applied that is not rated by NFRC 100 shall use the default values from this table.

TABLE 110.6-B DEFAULT SOLAR HEAT GAIN COEFFICIENT (SHGC)

FRAME TYPE	PRODUCT	GLAZING	FENESTRATION PRODUCT SHGC		
			Single Pane[2,3] SHGC	Double Pane[2,3] SHGC	Glass Block[1,2] SHGC
Metal	Operable	Clear	0.80	0.70	0.70
	Fixed	Clear	0.83	0.73	0.73
	Operable	Tinted	0.67	0.59	N.A.
	Fixed	Tinted	0.68	0.60	N.A.
Metal, Thermal Break	Operable	Clear	N.A.	0.63	N.A.
	Fixed	Clear	N.A.	0.69	N.A.
	Operable	Tinted	N.A.	0.53	N.A.
	Fixed	Tinted	N.A.	0.57	N.A.
Nonmetal	Operable	Clear	0.74	0.65	0.70
	Fixed	Clear	0.76	0.67	0.67
	Operable	Tinted	0.60	0.53	N.A.
	Fixed	Tinted	0.63	0.55	N.A.

1 Translucent or transparent panels shall use glass block values when not rated by NFRC 200.

2. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential Appendix NA6.

3. Windows with window film applied that is not rated by NFRC 200 shall use the default values from this table.

SECTION 140.3 – PRESCRIPTIVE REQUIREMENTS FOR BUILDING ENVELOPES

A building complies with this section by being designed with and having constructed to meet all prescriptive requirements in Subsection (a) and the requirements of Subsection (c) and (d) where they apply.

shall:

A. Percent window area shall be limited in accordance with the applicable requirements of i and ii below:

   i. a west-facing area no greater than 40 percent of the gross west-facing exterior wall area, or 6 feet times the west-facing display perimeter, whichever is greater; and

   ii. a total area no greater than 40 percent of the gross exterior wall area, or 6 feet times the display perimeter, whichever is greater; and

   NOTE: Demising walls are not exterior walls, and therefore demising wall area is not part of the gross exterior wall area or display perimeter, and windows in demising walls are not part of the window area.

B. Have an area-weighted average U-factor no greater than the applicable value in TABLE140.3-B, C or D.

   EXCEPTION to Section 140.3(a)5B: For vertical windows containing chromogenic type glazing:

   i. The lower-rated labeled U-factor shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

   ii. Chromogenic glazing shall be considered separately from other glazing; and

   iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

C. Have an area-weighted average Relative Solar Heat Gain Coefficient, RSHGC, excluding the effects of interior shading, no greater than the applicable value in TABLE 140.3-B, C or D.

   For purposes of this paragraph, the Relative Solar Heat Gain Coefficient, RSHGC, of a vertical window is:

   i. The Solar Heat Gain Coefficient of the window; or

   ii. Relative Solar Heat Gain Coefficient is calculated using EQUATION 140.3-A, if the window has an overhang that extends beyond each side of the window jamb by a distance equal to the overhang's horizontal projection.

   EXCEPTION 1 to Section 140.3(a)5C: An area-weighted average Relative Solar Heat Gain Coefficient of 0.56 or less shall be used for windows:

   a. That are in the first story of exterior walls that form a display perimeter; and
   b. For which codes restrict the use of overhangs to shade the windows.

   EXCEPTION 2 to Section 140.3(a)5C: For vertical windows containing chromogenic type glazing:

   i. the lower-rated labeled RSHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

   ii. chromogenic glazing shall be considered separately from other glazing; and

   iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

   NOTE: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to SHGC requirements.

D. Have an area-weighted average Visible Transmittance (VT) no less than the applicable value in TABLE 140.3-B and C, or EQUATION 140.3-B, as applicable.

EXCEPTION 1 to Section 140.3(a)5D: When the window's primary and secondary sidelit daylit zones are completely overlapped by one or more skylit daylit zones, then the window need not comply with Section 140.3(a)5D.

EXCEPTION 2 to Section 140.3(a)5D: If the window's VT is not within the scope of NFRC 200, or ASTM E972, then the VT shall be calculated according to Reference Nonresidential Appendix NA6.

EXCEPTION 3 to Section 140.3(a)5D: For vertical windows containing chromogenic type glazing:

i. The higher rated labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity; and

ii. Chromogenic glazing shall be considered separately from other glazing; and

iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

NOTE: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to VT requirements.

EQUATION 140.3-A RELATIVE SOLAR HEAT GAIN COEFFICIENT, RSHGC

$$RSHGC = SHGC_{win} \times \left[1 + \frac{aH}{V} + b\left(\frac{H}{V} \right)^2 \right]$$

WHERE:

RSHGC = Relative Solar Heat Gain Coefficient.

$SHGC_{win}$ = Solar Heat Gain Coefficient of the window.

H = Horizontal projection of the overhang from the surface of the window in feet, but no greater than V.

V = Vertical distance from the window sill to the bottom of the overhang in feet.

a = -0.41 for north-facing windows, -1.22 for south-facing windows, and -0.92 for east and west-facing windows.

b = 0.20 for north-facing windows, 0.66 for south-facing windows, and 0.35 for east and west-facing windows.

EQUATION 140.3-B VERTICAL FENESTRATION MINIMUM VT

$VT \geq 0.11/ WWR$

WHERE:

WWR = Window Wall Ratio, the ratio of (i) the total window area of the entire building to (ii) the total gross exterior wall area of the entire building. If the WWR is greater than 0.40, then 0.40 shall be used as the value for WWR in EQUATION 140.3-B.

VT = Visible Transmittance of framed window.

6. **Skylights.** Skylights shall:

   A. Have an area no greater than 5 percent of the gross exterior roof area Skylight Roof Ratio (SRR); and

      EXCEPTION to Section 140.3(a)6A: Buildings with an atria over 55 feet high shall have a skylight area no greater than 10 percent of the gross exterior roof area.

   B. Have an Area-Weighted Performance Rating U-factor no greater than the applicable value in TABLE 140.3-B, C or D.

      EXCEPTION to Section 140.3(a)6B: For skylights containing chromogenic type glazing:

      i. the lower-rate labeled U-factor shall be used with automatic controls to modulate the amount of U-factor heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

      ii. chromogenic glazing shall be considered separately from other glazing; and

      iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

   C. Have an area-weighted performance rating Solar Heat Gain Coefficient no greater than the applicable value in TABLE 140.3-B, C or D.

      EXCEPTION to Section 140.3(a)6C: For skylights containing chromogenic type glazing:

      i. the lower-rated labeled SHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

      ii. chromogenic glazing shall be considered separately from other glazing; and

      iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

   D. Have an Area-Weighted Performance Rating VT no less than the applicable value in TABLE 140.3-B or C; and

      EXCEPTION to Section 140.3(a)6D: For skylights containing chromogenic type glazing:

      i. the higher-rated labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity and;

      ii. chromogenic glazing shall be considered separately from other glazing; and

      iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

   E. Have a glazing material or diffuser that has a measured haze value greater than 90 percent, determined according to ASTM D1003, or other test method approved by the Energy Commission.

      EXCEPTION to Section 140.3(a)6E: Skylights designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles or the geometry of the skylight and light well.

TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	**Maximum U-factor**	**Roofs/ Ceilings**	Metal Building	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
			Wood Framed and Other	0.034	0.034	0.034	0.034	0.034	0.049	0.049	0.049	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
		Walls	Metal Building	0.113	0.061	0.113	0.061	0.061	0.113	0.113	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.061
			Metal-framed	0.069	0.062	0.082	0.062	0.062	0.069	0.069	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
			Mass Light[1]	0.196	0.170	0.278	0.227	0.440	0.440	0.440	0.440	0.440	0.170	0.170	0.170	0.170	0.170	0.170	0.170
			Mass Heavy[1]	0.253	0.650	0.650	0.650	0.650	0.690	0.690	0.690	0.690	0.650	0.184	0.253	0.211	0.184	0.184	0.160
			Wood-framed and Other	0.095	0.059	0.110	0.059	0.102	0.110	0.110	0.102	0.059	0.059	0.045	0.059	0.059	0.059	0.042	0.059
		Floors/ Soffits	Raised Mass	0.092	0.092	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.092	0.092	0.092	0.092	0.092	0.058
			Other	0.048	0.039	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.039	0.071	0.071	0.039	0.039	0.039
	Roofing Products	**Low-sloped**	Aged Solar Reflectance	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
			Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		Steep- Sloped	Aged Solar Reflectance	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
			Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0. 75	0.75	0.75	0.75	0.75	0.75	0.75
	Air Barrier			NR	NR	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Exterior Doors, Maximum U-factor		Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
			Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

CONTINUED: TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				All Climate Zones			
				Fixed Window	Operable Window	Curtainwall or Storefront	Glazed Doors[2]
Envelope	**Fenestration**	**Vertical**	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
				Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
			Maximum WWR%	40%			
		Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	Tubular Daylighting Devices (TDDs)
			Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	0.88
				Max SHGC	0.25	0.25	NR	NR
			Area-Weighted Performance Rating	Min VT (Min VT_{annual} for TDDs)	0.49	0.49	0.64	0.38
			Maximum SRR%	5%			

TABLE 140.3-C – PRESCRIPTIVE ENVELOPE CRITERIA FOR HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS

			Climate Zone															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	Maximum U-factor	Roofs/ Ceilings	Metal Building	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
			Wood Framed and Other	0.028	0.028	0.034	0.028	0.034	0.034	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
		Walls	Metal Building	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
			Metal-framed	0.069	0.069	0.069	0.069	0.069	0.069	0.105	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.048	0.069
			Mass, Light[1]	0.170	0.170	0.170	0.170	0.170	0.227	0.227	0.227	0.196	0.170	0.170	0.170	0.170	0.170	0.170	0.170
			Mass, Heavy[1]	0.160	0.160	0.160	0.184	0.211	0.690	0.690	0.690	0.690	0.690	0.184	0.253	0.211	0.184	0.184	0.160
			Wood-framed and Other	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.042	0.059	0.059	0.042	0.042	0.042
		Floors/ Soffits	Raised Mass[1]	0.045	0.045	0.058	0.058	0.058	0.069	0.092	0.092	0.092	0.069	0.058	0.058	0.058	0.045	0.058	0.037
			Other	0.034	0.034	0.039	0.039	0.039	0.039	0.071	0.039	0.039	0.039	0.039	0.039	0.039	0.034	0.039	0.034
	Roofing Products	Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	0.55	0.55	0.55	NR	0.55	0.55	0.55	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	NR	0.75	0.75	0.75	NR
		Steep- Sloped	Aged Solar Reflectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0. 75	0.75	0.75	0.75	0.75	0.75	NR
	Exterior Doors, Maximum U-factor		Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
			Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

CONTINUED: TABLE 140.3-C – PRESCRIPTIVE ENVELOPE CRITERIA FOR HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS

				All Climate Zones			
				Fixed Window	Operable Window	Curtainwall/ Storefront	Glazed Doors[2]
Envelope	Fenestration	Vertical	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
				Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
			Maximum WWR%	40%				
		Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	
			Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	
				Max SHGC	0.25	0.25	NR	
			Area-Weighted Performance Rating	Min VT	0.49	0.49	0.64	
			Maximum SRR%	5%				

Notes:

1. As defined in Section 100.0, light mass walls are walls with a heat capacity of at least 7.0 Btu/ft^2-oF and less than 15.0 Btu/ft^2-oF. Heavy mass walls are walls with a heat capacity of at least 15.0 Btu/ft^2-oF.

2. Glazed Doors applies to both site-built and to factory-assembled glazed doors.

TABLE 140.3-D PRESCRIPTIVE ENVELOPE CRITERIA FOR RELOCATABLE PUBLIC SCHOOL BUILDINGS FOR USE IN ALL CLIMATE ZONES

Roofs/ Ceilings	**Metal Buildings**	Maximum U-factor			0.041
	Non-Metal Buildings				0.034
Walls	**Wood frame buildings**				0.042
	Metal frame buildings				0.057
	Metal buildings				0.057
	Mass/7.0≤ HC				0.170
	All Other Walls				0.059
Floors and Soffits	**Floors and Soffits**				0.048
Roofing Products	**Low-Sloped**	Aged Solar Reflectance			0.63
		Thermal Emittance			0.75
	Steep-Sloped	Aged Solar Reflectance			0.20
		Thermal Emittance			0.75
Fenestration	**Windows**	Maximum U-factor			0.47
		Maximum SHGC			0.26
	Glazed Doors (Site-Built and Factory Assembled)	Maximum U-factor			0.45
		Maximum SHGC			0.23
	Skylights	Glass with Curb		Maximum U-factor	0.99
		Glass without Curb			0.57
		Plastic with Curb			0.87
		Glass Type	0-2% SRR	Maximum SHGC	0.46
			2.1-5% SRR		0.36

		Plastic Type	0-2% SRR		0.69
			2.1-5% SRR		0.57
Exterior Doors	**Non-Swinging doors**	Maximum U-factor			0.50
	Swinging doors				0.70

Proposal Summary

2022 California Energy Code (Title 24, Part 6)

Nonresidential High Performance Envelope: Opaque Envelope

Updated: Wednesday, October 2, 2019

Prepared by: Kiri Coakley and Alamelu Brooks, Energy Solutions

Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on October 24, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by October 10, 2019.

Measure Description

Opaque envelope will be a prescriptive measure that requires changes to compliance software but does not require new field verification tests. This proposal looks at modifying Table 140.3-B, 140.3-C of Title 24, Part 6. This measure requires that existing assembly U-factor requirements be re-evaluated for the 2022 cycle using the latest cost parameters. All components of the opaque envelope, including walls, roofs, floors, and opaque doors will be re-evaluated using nonresidential building prototypes to determine if cost-effective reductions in U-factor are justified in all climate zones.

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

We are not proposing to remove any multifamily Title 24, Part 6 requirements at this time. The Multifamily Team has not decided whether they will create a table in their section or refer our tables in their sections. One potential issue is that if the multifamily codes are scattered in multiple places, it is is going to create confusion to the design community and the enforcement team.

SECTION 140.0 – PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

Nonresidential, high-rise residential and hotel/motel buildings shall comply with all of the following:

(a) The requirements of Sections 100.0 through 110.12 applicable to the building project (mandatory measures for all buildings).

(b) The requirements of Sections 120.0 through 130.5 (mandatory measures for nonresidential~~, high-rise residential and hotel/motel~~ buildings).

(c) Either the performance compliance approach (energy budgets) specified in Section 140.1 or the prescriptive compliance approach specified in Section 140.2 for the Climate Zone in which the building will be located. Climate zones are shown in FIGURE 100.1-A.

NOTE to Section 140.0(c): The Commission periodically updates, publishes, and makes available to interested persons and local enforcement agencies precise descriptions of the Climate Zones, which is available by zip code boundaries depicted in the Reference Joint Appendices along with a list of the communities in each zone.

NOTE to Section 140.0: The requirements of Sections 140.1 through 140.9 apply to newly constructed buildings. Section 141.0 specifies which requirements of Sections 140.1 through 140.9 also apply to additions or alterations to existing buildings.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 140.3 – PRESCRIPTIVE REQUIREMENTS FOR BUILDING ENVELOPES

A building complies with this section by being designed with and having constructed to meet all prescriptive requirements in Subsection (a) and the requirements of Subsection (c) and (d) where they apply.

(a) **Envelope Component Requirements.**

1. **Exterior roofs and ceilings.** Exterior roofs and ceilings shall comply with each of the applicable requirements in this subsection:

   A. **Roofing Products.** Shall meet the requirements of Section 110.8 and the applicable requirements of Subsections i through ii:

      i. Nonresidential buildings:

         a. Low-sloped roofs in Climate Zones 1 through 16 shall have:

            1. A minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75; or

            2. A minimum Solar Reflectance Index (SRI) of 75.

            EXCEPTION 1 to Section 140.3(a)1Aia: Wood-framed roofs in Climate Zones 3 and 5 are exempt from the requirements of Section 140.3(a)1Aia if the roof assembly has a U-factor of 0.034 or lower.

            EXCEPTION 2 to Section 140.3(a)1Aia: Roof constructions with a weight of at least 25 lb/ft² over the roof membrane are exempt from the requirements of Section 140.3(a)1Aia.

            EXCEPTION 3 to SECTION 140.3(a)1Aia: An aged solar reflectance less than 0.63 is allowed provided the maximum roof/ceiling U-factor in TABLE 140.3 is not exceeded.

         b. Steep-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

      ii. High-rise residential buildings and hotels and motels:

         a. Low-sloped roofs in Climate Zones 9, 10, 11, 13, 14 and 15 shall have a minimum aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.

            EXCEPTION to Section 140.3(a)1Aiia: Roof constructions with a weight of at least 25 lb/ft² over the roof membrane.

         b. Steep-sloped roofs in Climate Zones 2 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

TABLE 140.3 ROOF/CEILING INSULATION TRADEOFF FOR AGED SOLAR REFLECTANCE

Nonresidential			
Aged Solar Reflectance	**Metal Building Climate Zone 1-16 U-factor**	**Wood framed and Other Climate Zone 6 & 7 U-factor**	**Wood Framed and Other All Other Climate Zones U-factor**
0.62-0.56	0.038	0.045	0.032
0.55-0.46	0.035	0.042	0.030
0.45-0.36	0.033	0.039	0.029
0.35-0.25	0.031	0.037	0.028

EXCEPTION to Section 140.3(a)1A: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

B. **Roof Insulation.** Roofs shall have an overall assembly U-factor no greater than the applicable value in Table 140.3- B, C or D, and where required by Section 110.8 and 120.7(a)3, insulation shall be placed in direct contact with a continuous roof or drywall ceiling.

2. **Exterior Walls.** Exterior walls shall have an overall assembly U-factor no greater than the applicable value in TABLE 140.3-B, C or D.

3. **Demising Walls.** Demising walls shall meet the requirements of Section 120.7(b)7. Vertical windows in demising walls between conditioned and unconditioned spaces shall have an area-weighted average U-factor no greater than the applicable value in TABLE140.3-B, C or D.

4. **Exterior Floors and Soffits.** Exterior floors and soffits shall have an overall assembly U-factor no greater than the applicable value in TABLE 140.3-B, C or D.

5. **Exterior Windows.** Vertical windows in exterior walls shall:

   A. Percent window area shall be limited in accordance with the applicable requirements of i and ii below:

      i. a west-facing area no greater than 40 percent of the gross west-facing exterior wall area, or 6 feet times the west-facing display perimeter, whichever is greater; and

      ii. a total area no greater than 40 percent of the gross exterior wall area, or 6 feet times the display perimeter, whichever is greater; and

      NOTE: Demising walls are not exterior walls, and therefore demising wall area is not part of the gross exterior wall area or display perimeter, and windows in demising walls are not part of the window area.

   B. Have an area-weighted average U-factor no greater than the applicable value in TABLE140.3-B, C or D.

      EXCEPTION to Section 140.3(a)5B: For vertical windows containing chromogenic type glazing:

      i. The lower-rated labeled U-factor shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

      ii. Chromogenic glazing shall be considered separately from other glazing; and

      iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

C. Have an area-weighted average Relative Solar Heat Gain Coefficient, RSHGC, excluding the effects of interior shading, no greater than the applicable value in TABLE 140.3-B, C or D.

For purposes of this paragraph, the Relative Solar Heat Gain Coefficient, RSHGC, of a vertical window is:

i. The Solar Heat Gain Coefficient of the window; or

ii. Relative Solar Heat Gain Coefficient is calculated using EQUATION 140.3-A, if the window has an overhang that extends beyond each side of the window jamb by a distance equal to the overhang's horizontal projection.

EXCEPTION 1 to Section 140.3(a)5C: An area-weighted average Relative Solar Heat Gain Coefficient of 0.56 or less shall be used for windows:

a. That are in the first story of exterior walls that form a display perimeter; and
b. For which codes restrict the use of overhangs to shade the windows.

EXCEPTION 2 to Section 140.3(a)5C: For vertical windows containing chromogenic type glazing:

i. the lower-rated labeled RSHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

ii. chromogenic glazing shall be considered separately from other glazing; and

iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

NOTE: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to SHGC requirements.

D. Have an area-weighted average Visible Transmittance (VT) no less than the applicable value in TABLE 140.3-B and C, or EQUATION 140.3-B, as applicable.

EXCEPTION 1 to Section 140.3(a)5D: When the window's primary and secondary sidelit daylit zones are completely overlapped by one or more skylit daylit zones, then the window need not comply with Section 140.3(a)5D.

EXCEPTION 2 to Section 140.3(a)5D: If the window's VT is not within the scope of NFRC 200, or ASTM E972, then the VT shall be calculated according to Reference Nonresidential Appendix NA6.

EXCEPTION 3 to Section 140.3(a)5D: For vertical windows containing chromogenic type glazing:

i. The higher rated labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity; and

ii. Chromogenic glazing shall be considered separately from other glazing; and

iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

NOTE: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to VT requirements.

EQUATION 140.3-A RELATIVE SOLAR HEAT GAIN COEFFICIENT, RSHGC

$$RSHGC = SHGC_{win} \times \left[1 + \frac{aH}{V} + b\left(\frac{H}{V} \right)^2 \right]$$

WHERE:

RSHGC = Relative Solar Heat Gain Coefficient.

$SHGC_{win}$ = Solar Heat Gain Coefficient of the window.

H = Horizontal projection of the overhang from the surface of the window in feet, but no greater than V.

V = Vertical distance from the window sill to the bottom of the overhang in feet.

a = -0.41 for north-facing windows, -1.22 for south-facing windows, and -0.92 for east and west-facing windows.

b = 0.20 for north-facing windows, 0.66 for south-facing windows, and 0.35 for east and west-facing windows.

EQUATION 140.3-B VERTICAL FENESTRATION MINIMUM VT

$VT \geq 0.11 / WWR$

WHERE:

WWR = Window Wall Ratio, the ratio of (i) the total window area of the entire building to (ii) the total gross exterior wall area of the entire building. If the WWR is greater than 0.40, then 0.40 shall be used as the value for WWR in EQUATION 140.3-B.

VT = Visible Transmittance of framed window.

6. **Skylights.** Skylights shall:

   A. Have an area no greater than 5 percent of the gross exterior roof area Skylight Roof Ratio (SRR); and

      EXCEPTION to Section 140.3(a)6A: Buildings with an atria over 55 feet high shall have a skylight area no greater than 10 percent of the gross exterior roof area.

   B. Have an Area-Weighted Performance Rating U-factor no greater than the applicable value in TABLE 140.3-B, C or D.

      EXCEPTION to Section 140.3(a)6B: For skylights containing chromogenic type glazing:

      i. the lower-rate labeled U-factor shall be used with automatic controls to modulate the amount of U-factor heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

      ii. chromogenic glazing shall be considered separately from other glazing; and

      iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

   C. Have an area-weighted performance rating Solar Heat Gain Coefficient no greater than the applicable value in TABLE 140.3-B, C or D.

      EXCEPTION to Section 140.3(a)6C: For skylights containing chromogenic type glazing:

      i. the lower-rated labeled SHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

      ii. chromogenic glazing shall be considered separately from other glazing; and

      iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

   D. Have an Area-Weighted Performance Rating VT no less than the applicable value in TABLE 140.3-B or C; and

      EXCEPTION to Section 140.3(a)6D: For skylights containing chromogenic type glazing:

i. the higher-rated labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity and;

ii. chromogenic glazing shall be considered separately from other glazing; and

iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

E. Have a glazing material or diffuser that has a measured haze value greater than 90 percent, determined according to ASTM D1003, or other test method approved by the Energy Commission.

EXCEPTION to Section 140.3(a)6E: Skylights designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles or the geometry of the skylight and light well.

7. **Exterior doors.** All exterior doors that separate conditioned space from unconditioned space or from ambient air shall have a U-factor not greater than the applicable value in TABLE 140.3-B, C or D. Doors that are more than one-half glass in area are considered Glazed Doors.

8. **Relocatable Public School Buildings.** In complying with Sections 140.3(a)1 to 7 shall meet the following:

A. Relocatable public school buildings shall comply with TABLE 140.3-B for a specific Climate Zone when the manufacturer or builder of the relocatable public school building certifies that the building is intended for use only in a specific Climate Zone; or

B. Relocatable public school buildings shall comply with TABLE 140.3-D for any Climate Zone when the manufacturer or builder of the relocatable public school building certifies that the building is intended for use in any Climate Zone; and

C. The manufacturer or builder of a relocatable public school building shall certify that components of the building comply with requirements of this section by:

i. The placement of two (2) metal identification labels on the building, one mechanically fastened and visible from the exterior and the other mechanically fastened to the interior frame above the ceiling at the end of the module, both labels stating (in addition to any other information by the Division of the State Architect or other law) "Complies with Title 24, Part 6 for all Climate Zones"; and

ii. Identification of the location of the 2 labels on the plans submitted to the enforcing agency.

9. **Air Barrier**. To meet the requirement of TABLE 140.3-B, all buildings shall have a continuous air barrier that is designed and constructed to control air leakage into, and out of, the building's conditioned space. The air barrier shall be sealed at all joints for its entire length and shall be composed of:

A. Materials that have an air permeance not exceeding 0.004 cfm/ft^2, under a pressure differential of 0.3 in. of water (1.57 psf) (0.02 L/(sec-m^2) at 75 pa), when tested in accordance with ASTM E2178; or

EXCEPTION to Section 140.3(a)9A: Materials in TABLE 140.3-A shall be deemed to comply with Section 140.3(a)9A provided if all joints are sealed and all of the materials are installed as air barriers in accordance with the manufacturer's instructions.

TABLE 140.3-A MATERIALS DEEMED TO COMPLY WITH SECTION 140.3(a)9A

	MATERIALS AND THICKNESS		**MATERIALS AND THICKNESS**
1	Plywood – min. 3/8 inches thickness	9	Built up roofing membrane
2	Oriented strand board – min. 3/8 inches thickness	10	Modified bituminous roof membrane
3	Extruded polystyrene insulation board – min. ½ inches thickness	11	Fully adhered single-ply roof membrane
4	Foil-back polyisocyanurate insulation board – min. ½ inches thickness	12	A Portland cement or Portland sand parge, or a gypsum plaster, each with min. 5/8 inches thickness
5	Closed cell spray foam with a minimum density of 2.0 pcf and a min. 2.0 inches thickness	13	Cast-in-place concrete, or precast concrete
6	Open cell spray foam with a density no less than 0.4 pcf and no greater than 1.5 pcf, and a min. 5½ inches thickness	14	Fully grouted concrete block masonry
7	Exterior or interior gypsum board min. 1/2 inches thickness	15	Sheet steel or sheet aluminum
8	Cement board – min. 1/2 inches thickness	---	----------

B. Assemblies of materials and components that have an average air leakage not exceeding 0.04 cfm/ft^2, under a pressure differential of 0.3 in. of water (1.57 psf) (0.2 L/m^2 at 75 pa), when tested in accordance with ASTM E2357, ASTM E1677, ASTM E1680, or ASTM E283; or

EXCEPTION to Section 140.3(a)9B: The following materials shall be deemed to comply with Section 140.3(a)9B if all joints are sealed and all of the materials are installed as air barriers in accordance with the manufacturer's instructions:

i. Concrete masonry walls that have at least two coatings of paint or at least two coatings of sealer coating.

ii. Concrete masonry walls with integral rigid board insulation.

iii. Structurally Insulated Panels.

iv. Portland cement or Portland sand parge, or stucco, or a gypsum plaster, each with min. 1/2 inches thickness

C. The entire building has an air leakage rate not exceeding 0.40 cfm/ft^2 at a pressure differential of 0.3 in of water (1.57 psf) (2.0 L/ m^2 at 75 pa), when the entire building is tested, after completion of construction, in accordance with ASTM E779 or another test method approved by the Commission.

EXCEPTION to Section 140.3(a)9: Relocatable Public School Buildings.

TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	Maximum U-factor	Roofs/ Ceilings	Metal Building	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
			Wood Framed and Other	0.034	0.034	0.034	0.034	0.034	0.049	0.049	0.049	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
		Walls	Metal Building	0.113	0.061	0.113	0.061	0.061	0.113	0.113	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.061
			Metal-framed	0.069	0.062	0.082	0.062	0.062	0.069	0.069	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
			Mass Light[1]	0.196	0.170	0.278	0.227	0.440	0.440	0.440	0.440	0.440	0.170	0.170	0.170	0.170	0.170	0.170	0.170
			Mass Heavy[1]	0.253	0.650	0.650	0.650	0.650	0.690	0.690	0.690	0.690	0.650	0.184	0.253	0.211	0.184	0.184	0.160
			Wood-framed and Other	0.095	0.059	0.110	0.059	0.102	0.110	0.110	0.102	0.059	0.059	0.045	0.059	0.059	0.059	0.042	0.059
		Floors/ Soffits	Raised Mass	0.092	0.092	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.092	0.092	0.092	0.092	0.092	0.058
			Other	0.048	0.039	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.039	0.071	0.071	0.039	0.039	0.039
	Roofing Products	Low-sloped	Aged Solar Reflectance	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
			Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		Steep-Sloped	Aged Solar Reflectance	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
			Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0. 75	0.75	0.75	0.75	0.75	0.75	0.75
	Air Barrier			NR	NR	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Exterior Doors, Maximum U-factor		Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
			Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

CONTINUED: TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				All Climate Zones			
				Fixed Window	Operable Window	Curtainwall or Storefront	Glazed Doors[2]
Envelope	**Fenestration**	**Vertical**	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
				Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
			Maximum WWR%	40%				
		Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	Tubular Daylighting Devices (TDDs)
			Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	0.88
				Max SHGC	0.25	0.25	NR	NR
			Area-Weighted Performance Rating	Min VT (Min VT_{annual} for TDDs)	0.49	0.49	0.64	0.38
			Maximum SRR%	5%				

TABLE 140.3-C – PRESCRIPTIVE ENVELOPE CRITERIA FOR HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS

				Climate Zone														
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	Maximum U-factor	Roofs/ Ceilings	Metal Building	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
			Wood Framed and Other	0.028	0.028	0.034	0.028	0.034	0.034	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
		Walls	Metal Building	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
			Metal-framed	0.069	0.069	0.069	0.069	0.069	0.069	0.105	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.048	0.069
			Mass, Light[1]	0.170	0.170	0.170	0.170	0.170	0.227	0.227	0.227	0.196	0.170	0.170	0.170	0.170	0.170	0.170	0.170
			Mass, Heavy[1]	0.160	0.160	0.160	0.184	0.211	0.690	0.690	0.690	0.690	0.690	0.184	0.253	0.211	0.184	0.184	0.160
			Wood-framed and Other	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.042	0.059	0.059	0.042	0.042	0.042
		Floors/ Soffits	Raised Mass[1]	0.045	0.045	0.058	0.058	0.058	0.069	0.092	0.092	0.092	0.069	0.058	0.058	0.058	0.045	0.058	0.037
			Other	0.034	0.034	0.039	0.039	0.039	0.039	0.071	0.039	0.039	0.039	0.039	0.039	0.039	0.034	0.039	0.034
	Roofing Products	Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	0.55	0.55	0.55	NR	0.55	0.55	0.55	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	NR	0.75	0.75	0.75	NR
		Steep-Sloped	Aged Solar Reflectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0. 75	0.75	0.75	0.75	0.75	0.75	NR
	Exterior Doors, Maximum U-factor		Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
			Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

CONTINUED: TABLE 140.3-C – PRESCRIPTIVE ENVELOPE CRITERIA FOR HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS

				All Climate Zones			
				Fixed Window	Operable Window	Curtainwall/ Storefront	Glazed Doors[2]
Envelope	**Fenestration**	**Vertical**	Area-Weighted Performance Rating – Max U-factor	0.36	0.46	0.41	0.45
			Area-Weighted Performance Rating – Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating – Min VT	0.42	0.32	0.46	0.17
			Maximum WWR%	40%			
		Skylights		Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	
			Area-Weighted Performance Rating – Max U-factor	0.58	0.46	0.88	
			Area-Weighted Performance Rating – Max SHGC	0.25	0.25	NR	
			Area-Weighted Performance Rating – Min VT	0.49	0.49	0.64	
			Maximum SRR%	5%			

Notes:

1. As defined in Section 100.0, light mass walls are walls with a heat capacity of at least 7.0 Btu/ft^2-oF and less than 15.0 Btu/ft^2-oF. Heavy mass walls are walls with a heat capacity of at least 15.0 Btu/ft^2-oF.

2. Glazed Doors applies to both site-built and to factory-assembled glazed doors.


PG&E
Pacific Gas and
Electric Company

SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL Company

SoCalGas
A Sempra Energy utility

SDGE
A Sempra Energy utility

LA
DWP
Los Angeles
Department of
Water & Power