

# Proposal Summary



## 2022 California Energy Code (Title 24, Part 6)

### Nonresidential Reduced Infiltration – Whole Building Air Leakage Testing

Updated: April 10, 2020

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#### Introduction

This document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on April 14, 2020. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email [info@title24stakeholders.com](mailto:info@title24stakeholders.com).

#### Measure Description

Currently only Climate Zones 1-9 require an air barrier. For Climate Zones 10-16, there are three ways to meet the prescriptive air barrier requirement: whole building air leakage testing, the use of compliant materials, or compliant assemblies of materials. This measure proposes the following changes:

- Expand the air barrier requirement to all climate zones;
- Require whole building air leakage testing and the use of compliant materials, or compliant assemblies of materials;
- Require air barrier design and installation details on the construction documents;
- Lower the maximum permitted whole building air leakage rate from 0.4 to 0.3 cfm/ft<sup>2</sup>;
- Require corrective action if the maximum permitted leakage is exceeded; and
- Apply the air barrier requirements to major alterations.

#### 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(a)

**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. Construction documents shall include all air barrier design and installation details, including air barrier boundaries, interconnections and penetrations, as well as associated square foot calculations for

all sides of the air barrier, as applicable. 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<sup>2</sup>, under a pressure differential of 0.3 in. of water (1.57 psf) (0.02 L/(sec-m<sup>2</sup>) 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<sup>2</sup>, under a pressure differential of 0.3 in. of water (1.57 psf) (0.2 L/m<sup>2</sup> at 75 pa), when tested in accordance with ASTM E2357, ASTM E1677, ASTM E1680, or ASTM E283; ~~or~~ **and**

**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 ~~0.400.30~~ cfm/ft<sup>2</sup> at a pressure differential of 0.3 in of water (1.57 psf) (2.0 L/ m<sup>2</sup> at 75 pa), when the entire building is tested, after completion of construction, in accordance with ASTM ~~E779~~ E3158 by Blower Door Fan Assembly (Architectural Only), multi-point regression testing or another test method approved by the Commission in accordance with the applicable procedures in Reference Nonresidential Appendices NA2.4. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and building owner.

If the tested rate exceeds 0.30 cfm/ft<sup>2</sup>, a diagnostic evaluation, such as a smoke tracer test or infrared imaging survey shall be conducted while the building is pressurized, and any observed leaks shall be sealed if such sealing can be completed without destruction of existing building components. In addition, a visual inspection of the air barrier shall be conducted, and any observed leaks shall be sealed to the extent practical. An additional report identifying the corrective actions taken to seal air leaks should be submitted to the building owner and code official, and any further requirement to meet the air leakage rate will be waived.

If the original tested rate was less than or equal to 0.60 cfm/ft<sup>2</sup>, then an additional report identifying the corrective actions taken to seal air leaks and highlighting any leaks that could not be sealed without destruction of existing building components shall be submitted to the building owner and the Code Official and any further requirement to meet the leakage air rate will be waived.

If the test rate exceeds a leakage rate of 0.60 cfm/ft<sup>2</sup>, a visual inspection of the air barrier shall be conducted, and any leaks noted should be repaired. The building will then be re-tested until either the building envelope air leakage rate less than 0.30 cfm/ft<sup>2</sup>, or the building envelope air leakage rate is in the range of 0.3 cfm/ft<sup>2</sup> but is less than 0.60 cfm/ft<sup>2</sup> and a visual inspection and repair program is executed.

In the event that testing in accordance with the method outlined above cannot be performed, a code variance request is to be submitted to the code official documenting the reasoning that the test cannot be performed, and a proposed alternative method of verification. The code official reserves the right to determine if testing methods and repair programs have satisfied the requirement of the code.

**EXCEPTION to Section 140.3(a)9C:** Verification of the design and installation of the continuous air barrier shall be determined by an independent third party in accordance with the following requirements:

- i. A design review shall be conducted to verify and document compliance with the requirements Section 140.3(a)9:
  - a. All air barrier components are identified or noted on construction documents

- b. The joints, interconnections, and penetrations of the continuous air barrier components shall be detailed or otherwise noted.
- c. The continuous air barrier extends on all surfaces of the building envelope (walls, roof, and lowest floor)
- d. The air barrier is designed to resist positive and negative pressures from wind, stack effect, and mechanical ventilation
- ii. Periodic field inspection of the continuous air barrier materials and assemblies shall be conducted to verify building envelope air barrier construction is in accordance with construction documents. The review should include but is not limited during construction while the continuous air barrier is still accessible for inspection and repair to verify and document compliance with the requirements of section 140.3(a)9. A more thorough breakdown of conditions to be reviewed are as follows:
  - a. Initial assemblies of all air barrier systems, with additional periodic reviews of progress installation (defined as once per week of construction or every 1000 square foot of envelope area installed if construction is not continuous)
  - b. Transitions to adjacent air barrier systems (including but not limited to: Roof parapet transitions, glazed framing systems to adjacent framed wall assemblies transitions , plaza waterproofing to podium transitions, vertical wall to soffit transitions)
  - c. Detailing of penetrations through air barrier systems.
  - d. Building assemblies used as ducts or plenums
  - e. Contractor internal quality control/quality assurance procedures

**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
<b>Envelope</b>	<b>Maximum U-factor</b>	<b>Roofs/ Ceilings</b>	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	
			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
		<b>Walls</b>	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 <sup>1</sup>	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 <sup>1</sup>	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
		<b>Floors/ Soffits</b>	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
		<b>Roofing Products</b>	<b>Low-sloped</b>	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
	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
	<b>Steep-Sloped</b>		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
	<b>Air Barrier</b>				<b>NR REQ</b>	<b>NR REQ</b>	<b>NR REQ</b>	<b>NR REQ</b>	<b>NR REQ</b>	<b>NR REQ</b>	<b>NR REQ</b>	<b>NR REQ</b>	<b>NR REQ</b>	REQ	REQ	REQ	REQ	REQ	
	<b>Exterior Doors, Maximum U-factor</b>	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	

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
<b>Envelope</b>	<b>Maximum U-factor</b>	<b>Roofs/ Ceilings</b>	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	
			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
		<b>Walls</b>	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 <sup>1</sup>	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 <sup>1</sup>	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
		<b>Floors/ Soffits</b>	Raised Mass <sup>1</sup>	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
		<b>Roofing Products</b>	<b>Low-sloped</b>	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	0.55	0.55	0.55	NR	0.55	0.55	0.55
	Thermal Emittance			NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	NR	0.75	0.75	0.75	NR
	<b>Steep-Sloped</b>		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
	<b>Air Barrier</b>				<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	<b>REQ</b>	
	<b>Exterior Doors, Maximum U-factor</b>	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	

## Section 141.0(b)2

**2. 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.

C. Alterations to the building envelope shall comply with the requirements of Section 140.3(a)9 for air barrier applicable to those specific portions of the building that are being altered.

### **Exceptions to 141.0(b)2C**

1. Storm windows installed over existing fenestration.
2. Surface-applied window film installed on existing single-pane fenestration assemblies reducing solar heat gain, provided that the code does not require the glazing or fenestration to be replaced.
3. Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation.
4. Construction where the existing roof, wall, or floor cavity is not exposed.
5. Roof recover.
6. Roof replacement where the alterations or renovations to the building do not include alterations, renovations, or repairs to the remainder of the building envelope.

*Existing buildings that undergo major alteration are still required to perform the testing program as outlined above.*

*If a building undergoes a substantial replacement or improvement of the building envelope assembly, the building is to be tested and verified per the requirements above.*

*If a building undergoes a partial replacement or improvement of the building envelope assembly, and/or before altering the duct system, the building shall be tested. If the test rate exceeds a leakage rate of 0.30 cfm/ft<sup>2</sup>, a visual inspection and diagnostic review of the air barrier shall be conducted and any leaks noted should be sealed to the extent practical. An additional report identifying the corrective actions taken to seal air leaks should be submitted to the building owner and code official, and any further requirement to meet the air leakage rate will be waived. As noted above, the code official reserves the right to determine if testing methods and repair programs have satisfied the requirement of the code.*

## Appendix

### **NA2.4 Field Verification and Diagnostic Testing of Whole Building Air Leakage**

#### **NA2.4.1 Purpose and Scope**

The purpose of this test procedure is to measure the air leakage rate through a building.

The measurement procedure shall be based on the specifications of ASTM E3158 by blower door fan assembly (architectural only), multi-point regression testing as further specified in Subsections NA2.4.2, NA2.4.3, NA2.4.4, NA2.4.5, NA2.4.6, NA2.4.7 below.

This enclosure leakage procedure is applicable to nonresidential buildings.

#### **NA2.4.2 Instrument Specifications**

The instrumentation for the enclosure leakage measurements shall conform to the specifications in ASTM E3158.

#### **NA2.4.3 Pre-Test Inspection (to occur the day before testing day)**

- 1) Visually review the building for completion of air barrier components.
- 2) Meet with electrical and mechanical (or controls) subcontractors to review electrical needs for testing equipment and shutdown/sealing plan for mechanical systems and ductwork.
- 3) Contractor to provide dedicated electrical service for running of fans during the air leakage testing (minimum of 1 non-GFCI circuit 120V/20A per fan required).
- 4) Review weather forecasts and verify appropriate test conditions.

#### **NA2.4.3 Pre-Test Set Up (To be performed by General Contractor)**

- 1) Seal all intentional penetrations where they penetrate the air barrier (i.e. louvers, vents, etc.).
- 2) Fill plumbing traps with water. Toilets, sinks, floor drains, waterless urinals must be primed. Airtight caps on drains are acceptable.
- 3) Shut off the HVAC system – or leave in “pilot” mode (to avoid introducing air movement that is not included in the calculations). Any automated pressure relief dampers must either be disabled, sealed or set to a pressure well above 75 Pa.
- 4) Disable combustion equipment or leave in “pilot” position.
- 5) Seal all intentional openings in building envelope so that they are air-tight. Acceptable sealing materials include carpet protection plastic, adhesive grill mask and tape and plastic (4 mil poly sheeting or thicker). Intentional openings include, but are not limited to, the following:
  - i. Supply air intakes
  - ii. Make-up air and other intakes/louvers
  - iii. Exhaust ducts/vents/louvers
  - iv. Plumbing exhausts
  - v. Pressure relief dampers or louvers
  - vi. Fume hoods
  - vii. Other exhaust vents (kitchen, bathroom, dryer, etc.)
  - viii. Any other locations where air leakage can occur within the mechanical system during inactive periods
  - ix. Any other intentional opening in the building envelope other than doors and operable windows
- 6) Close and lock exterior windows and doors. Close any vents within window frames.
- 7) Prop interior doors open to create a single uniform zone.
- 8) Where drop ceilings are installed in a location that constitutes a barrier to air flow between the testing equipment and the plane of air tightness of the space being tested, remove ceiling tiles at a rate of one per 500 ft<sup>2</sup> to prevent movement of tiles during test and to ensure a uniform pressure within plenum space. Additional tiles can be removed to ensure a uniform pressure distribution in the plenum space.
- 9) Install exterior electrical box caps (if applicable).

#### **NA2.4.4 Run Preliminary Test**



Pressurize the building to 75 Pa to determine (approximately) if building is expected to pass test and to confirm that pre-test set up is complete and that temporary sealing stays in place while under pressure.

#### **NA2.4.5 Enclosure Measurement Procedures**

- 1) Reference ASTM E3158-18 for Whole Building Air Leakage Testing.
- 2) Record interior and exterior weather conditions.
- 3) Record average wind speeds.
- 4) Record interior and exterior temperatures before the testing begins.
- 5) Record site elevation in feet above sea level.
- 6) Measure bias pressures with fans off and covered.
- 7) Perform a multi-point pressurization test from at least +25 to +50 Pa (leakage is reported at 75 Pa, as attained or extrapolated).
- 8) Record a minimum of 5 points between minimum and maximum induced pressures.
- 9) Measure bias pressures at end of multi-point test with fans off and covered.
- 10) Record interior and exterior temperatures.
- 11) If the pressure exponent n is less than 0.45 or greater than 1.0 per Section 9.5.1 of ASTM E3158-18, then the pressurization test is invalid and shall be repeated.
- 12) Reverse direction of fans.
- 13) Measure bias pressures with fans off and covered.
- 14) Perform a multi-point depressurization test from at least -25 to -50 Pa (optional).
- 15) Record a minimum of 5 points between minimum and maximum induced pressures.
- 16) Measure bias pressures at end of multi-point test with fans off and covered.
- 17) Record interior and exterior temperatures after the testing is complete.
- 18) If the pressure exponent n is less than 0.45 or greater than 1.0 per Section 9.5.1 of ASTM 3158-18, then the depressurization test is invalid and shall be repeated.

#### **NA2.4.6 Determination of Test Results**

- 1) If the building envelope air leakage rate exceeds 0.30 cfm/ft<sup>2</sup> but is less than 0.60 cfm/ft<sup>2</sup>, a visual inspection of the air barrier shall be conducted, and any leaks observed should be sealed to the extent practical. An additional report identifying the corrective actions taken to seal air leaks should be submitted to the building owner and code official, and any further requirement to meet the air leakage rate will be waived.
- 2) If the building envelope air leakage rate exceeds 0.60 cfm/ft<sup>2</sup>, a visual inspection of the air barrier shall be conducted, and any leaks noted should be repaired. The building will then be re-tested until either the building envelope air leakage rate less than 0.30 cfm/ft<sup>2</sup>, or the building envelope air leakage rate is in the range of 0.30 cfm/ft<sup>2</sup> but is less than 0.60 cfm/ft<sup>2</sup> and a visual inspection and repair program is executed.
- 3) A visual inspection program includes (but is not limited to):
  - a. Ensure that all temporary seals and covers for intentional openings such as at louvers, exhaust/intake vents, fireplaces, and rooftop units are properly sealed and not damaged or loosened during the test.
  - b. Ensure that all plumbing-traps are filled with water and/or sealed with tape or self-adhesive plastic.
  - c. Ensure that all operable windows, trickle-vents, and doors are properly shut and locked.
  - d. Ensure that all mechanical systems are shut-off and any mechanical dampers set to the closed position.
  - e. Identify locations with air leakage in accordance with ASTM E1186-17. Typical locations to focus on include:
    - i. The perimeter of windows and doors.

- ii. Around operable window hardware and door hardware
- iii. Penetrations through the roof, wall, and floor assemblies along the plane of the intended air-barrier.
- iv. Electrical outlets located on exterior-facing walls.
- v. Lighting and other electrical penetrations through the roof level ceiling.
- vi. Above- and below-grade vestibules.
- vii. Stairs leading to unconditioned space.

#### **NA2.4.7 Reporting**

- 1) Generate report in accordance with ASTM E3158 reporting instructions.
- 2) The report shall include the tested building envelope area, conditioned floor area, conditioned air-by-volume, stories above grade, and air leakage rates.
- 3) Results shall be reported at the upper 95 percent confidence interval.