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9. Additions, Alterations, and Repairs

9.1 Introduction

This chapter covers key aspects of how the Energy Standards apply to construction of residential additions, alterations to an existing residential building, or both. As explained further below, the 2016 Building Energy Efficiency Standards (Energy Standards) do not apply to repairs.

The chapter is organized as follows:

1. **Section 9.1 - Introduction.** Highlights the applicable standards definitions for additions, alterations, and repairs and provides several examples of each.
2. **Section 9.2 - What's New in the 2016 Energy Standards.** Highlights of the requirements and compliance options that have changed or are entirely new in the *2016 Energy Standards* as compared with the *2013 Energy Standards*.
3. **Section 9.3 - Compliance Approaches.** An overview of all prescriptive and performance compliance options available to meet the standards for additions only, for alterations only, and for projects that include both additions and alterations.
4. **Section 9.4 - Mandatory Requirements.** Mandatory requirements for additions and alterations as they apply to the envelope, fenestration, mechanical system, water heating system, indoor lighting, and outdoor lighting.
5. **Section 9.5 - Additions.** Detailed information on prescriptive and performance compliance methods and related information for additions, with or without alterations.
6. **Section 9.6 - Alterations.** Detailed information on prescriptive and performance compliance methods and related information for alterations, with or without an addition.
7. **Section 9.7 - Performance Method.** An explanation of the Existing + Addition + Alteration Approach with examples.

Whenever additions and alterations trigger mandatory measures – whether envelope, mechanical, water heating, indoor lighting or outdoor lighting – the certificate of compliance must be submitted with the permit documentation and included in the building plans.

When additions and alterations include changes to the envelope, mechanical systems, and/or water heating systems, a certificate of compliance must be completed prescriptively or generated by compliance software with the performance approach. The prescriptive certificate of compliance that should be used for additions and alterations in all climate zones is the CF1R-ADD or CF1R-ALT form. For HVAC-only change-outs and other mechanical system alterations, a climate zone specific CF1R-ALT-HVAC form for prescriptive compliance may be used. In addition, note that most additions and alterations that include changes in HVAC systems will include one or more measures that require HERS diagnostic testing and field verification. When a HERS measure is specified, the certificate of compliance must be registered online with an approved HERS Provider web site. Refer to Chapter 2 and to Residential Appendix RA2 for more information about document registration.

For copies of the appropriate compliance forms, refer to Appendix A of this manual.

9.1.1 Additions

An *addition* is any change to an existing building that increases conditioned floor area and conditioned volume. See §100.1.

Examples of projects considered as additions include:

1. Adding a conditioned sunroom or other rooms to an existing house.
2. Converting a garage or other existing unheated space into conditioned living space.;
3. Enclosing and conditioning an existing patio area.
4. Obtaining a permit to legalize an existing, habitable, and conditioned space that was added to a residential dwelling without a permit.
5. Adding a bay window that extends to the floor increasing both floor area and volume.

9.1.2 Alterations

An *alteration* is any change to a water-heating system, space-conditioning system, lighting system, or envelope of a building that is not an addition. See § 100.1.

Examples of projects considered alterations include:

1. Adding insulation to any existing exterior roof or ceiling, exterior wall, or raised floor over a crawl space, garage, or unheated basement.
2. Replacing or installing a new top surface to an existing roofing assembly (reroofing) and replacing portions of or the entire roof assembly.
3. Replacing existing fenestration or adding fenestration area (for example, windows, bay windows, greenhouse/garden windows, dynamic glazing, clerestories, or glass glazed doors) to existing walls.
4. Replacing an existing skylight or increasing the area of skylight to an existing roof.
5. Constructing an entirely new roof over an existing conditioned space.
6. Adding a loft within the existing conditioned volume of a home.
7. Replacing an existing heating system or adding a heating system (for example, a furnace, wall heater, heat pump or radiant floor).
8. Replacing an existing cooling system or adding a cooling system (for example, an air conditioner or heat pump).
9. Extending or replacing an existing duct system or adding an entirely new duct system.
10. Replacing the existing water heater or adding water heaters and/or hot water piping.
11. Replacing existing lighting or adding new hardwired lighting fixtures.
12. Adding window film, when complying under the performance approach only.

9.1.3 Repairs

A *repair* is “the reconstruction or renewal for the purpose of maintenance of any component, system, or equipment of an existing building. Repairs shall not increase the pre-existing energy consumption of the repaired component, system, or equipment. Replacement of any component, system, or equipment for which there are requirements in the Energy Standards is considered an alteration and not a repair.” (See §100.1).

Note: Repairs to residential buildings are not within the scope of the Energy Standards.

For example, when a component, system, or equipment of an existing building breaks or is malfunctioning and maintenance fixes are needed for it to work properly again, it is considered a repair and not subject to the standards. However, if instead of fixing the break or malfunction, it is decided to replace the component, system, or equipment with a new or different one, the scope of work is considered an alteration and not a repair and requirements of the Energy Standards pertaining the that measure must be met.

Examples of work considered repairs include:

1. Replacing a broken pane of glass but not the entire window.
2. Removing fenestration and other envelope components for maintenance or repair and then reinstalling the same fenestration or other envelope components in the same location;
3. Replacing a failed fan motor or gas valve in a furnace but not replacing the entire furnace;
4. Replacing a heating element in a water heater but not replacing the entire water heater.

Note: When any existing envelope component is moved to a new location, even when that location partially overlaps the previous location of the item, the work is considered an alteration.

Note 2: Replacement of some HVAC components for repair are defined by the Energy Standards as alterations, therefore triggering requirements that must be met. §150.2(b)1E of the Energy Standards defines the following HVAC component replacements as an alteration that triggers the requirement for duct sealing: *“replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil.”* Similarly, if more than 40 linear feet of new or replacement space conditioning ducts are installed, then the entire duct system must be insulated, sealed, tested and verified for low duct leakage. (See §150.2 (b)1D)

Example 9-1

Question:

A sunspace addition is designed with no mechanical heating or cooling and a glass sliding door separating it from all existing conditioned space. This design is approved by the enforcement agency as nonhabitable or unimproved space. Under what conditions will the Energy Standards apply to this addition?



Unconditioned Sunspace

Answer:

The mechanical and envelope requirements of the Energy Standards do not apply if the space is not considered habitable or improved and, therefore, can be unconditioned as defined in §100.1; however, per §100.0(c)2, the sunspace must still comply with the applicable lighting requirements of §150.0(k). The sunspace is unconditioned if:

- The new space is not provided with heating or cooling (or supply ducts).
- All openings between the new space and the existing house can be closed off with weatherstripped doors and windows.
- The addition is not indirectly conditioned space (defined in §100.1 under CONDITIONED SPACE, INDIRECTLY).

A building official may require a sunspace to be conditioned if it appears to be habitable space, in which case the Energy Standards apply.

Example 9-2

Question:

An existing duplex is remodeled, which includes only the installation of new faucets and bathroom lighting. Do the Energy Standards apply?

Answer:

Yes, this remodel is considered an alteration. However, due to the limited scope of work and since no new conditioned space is being created, the remodel must comply only with the applicable mandatory measures described in §110.1 for appliances and §150.0(k) for residential lighting.

Example 9-3

Question:

An existing house is remodeled by adding additional floor area but not increasing the volume of the house. This was accomplished by adding a loft through an area in the house with a vaulted ceiling. As part of this remodel, new windows are replacing existing ones, and two new windows are being added. Several exterior walls are being opened up to install new wiring. What requirements will apply?

Answer:

Since floor area is being added but not conditioned volume, this is an alteration and not an addition. It will need to comply with the Energy Standards using either the prescriptive or performance method, as well as meet all the applicable mandatory measures. To comply prescriptively, the new and replacement windows must meet the maximum U-factor and SHGC requirements of §150.2(b)1. This may be done by area-weighted averaging. Newly installed and replacement windows must also comply with the mandatory measures for caulking/sealing around windows per §110.7. In alterations, it is recommended to install insulation in the exposed walls if no insulation was found when the walls were opened; for 2x4 wood framing install the mandatory minimum R-13 and for 2x6 wood framing install R-19.

Alternatively, the performance approach may be used to demonstrate compliance for the entire house, even if individual windows fail to meet the prescriptive requirements, as long as the building meets all applicable mandatory requirements. At this time, since the exterior walls are exposed or open, this allows the opportunity to insulate the walls and contribute the ability to meet energy compliance; otherwise it would be difficult to comply with overall building compliance.

9.2 What’s New in the 2016 Energy Standards

The 2016 Energy Standards include new mandatory measures and different compliance requirements for additions and alterations. This section highlights the key changes from the 2013 Energy Standards.

9.2.1 Mandatory Measures in Additions and Alterations

9.2.1.1 Envelope

- A. Ceiling and Rafter Roof: For additions of 700 ft² or less, insulation shall be installed between wood-framing members with insulation R-value of R-22 or a weighted average U-factor not exceeding U-0.043. Altered roofs limited by space may have only R-19 or 0.054 weighted average U-factor. Depending on the attic ventilation, insulation shall be installed either:
1. At the ceiling level for a ventilated attic, or
 2. At the ceiling or roof level for an unvented attic.
- B. The roofs and ceilings of additions that are 700 ft² or less shall meet the mandatory insulation requirement of §150.0(a). Additions that are greater than 700 ft² must comply with prescriptive ceiling and roof insulation (§150.1(c)1).

9.2.1.2 HVAC and Water Heating

Liquid line filter dryers are required for new HVAC systems or replaced condensers when provided by the manufacturer of the system.

9.2.1.3 Ducts and Air Distribution Systems

Installation of all new (or full replacement) duct systems:

1. Higher duct insulation levels for ducts located in unconditioned space resulting in either R-6 or R-8 dependent on climate zone §150.2(b)1D.
2. New target leakage level of 5 percent for entirely new or complete replacement duct systems §150.2(b)1D.

9.2.1.4 Lighting

The 2016 Energy Standards have simplified the residential lighting requirements with the following important changes:

1. All installed luminaires must be high-efficacy light sources as specified in Table 150.0-A of the Energy Standards. This change eliminates the previously required kitchen wattage calculation.
2. The definition of *high-efficacy lighting* has been expanded to include luminaires (including screw-based luminaires) that are installed with light sources or lamps that meet the requirements of JA8. This allows for installation of efficient lamps to be used for compliance with §150.0(k).
3. The only place screw-based luminaires **cannot** be used is for recessed downlights in ceilings. Recessed downlights are required to contain JA8-compliant light sources that also meet elevated temperature requirements.

More details of the 2016 Energy Standards residential lighting requirements can be found in Chapter 6.

9.2.2 Prescriptive Additions

1. All new size (conditioned floor area) categories and new special requirements for prescriptive additions as outlined in this section and Tables 9-3A through 9-3E.
2. Extensions of existing wood-framed walls may retain the dimensions of the wall being extended. For example, continuous insulation would not be required for an extension if the existing wall did not already have continuous insulation. Wall extensions shall be insulated with cavity insulation of R-15 in 2x4 framing and R-19 in 2x6 framing.

9.2.3 Prescriptive Alterations

New requirements for duct insulation apply when the new ducts are located in unconditioned spaces.

See Table 9-4 in this chapter for a summary of how the compliance software sets the standard design (energy budget) for alterations.

9.3 Compliance Approaches

Apart from meeting all applicable mandatory requirements as outlined in Section 9.4, an addition or alteration must also demonstrate energy compliance using a prescriptive or performance method.

There are several compliance alternatives or compliance paths to demonstrate that an addition or alteration meets the Energy Standards. Compliance alternatives depend on whether the scope of permitted work is:

1. **Addition only**, where no changes are being made to the existing building except removal of roofs, exterior walls, and floors required as a result of the addition; and removal of any fenestration in those same removed roofs and exterior walls to make way for the addition.
2. **Alterations only**, where there is no addition (that is, no increase in conditioned floor area and volume).
3. **Addition and alterations**, where there are both additions and alterations to the existing building.

For each of these permit scenarios, Table 9-1 summarizes the available compliance approaches for low-rise residential additions and alterations.

Table 9-1: Compliance Alternatives for Residential Additions and Alterations

Project Scope	Prescriptive Approach	Performance Approach ^{1, 2}
1. Addition Only:	Additions ≤ 400 ft ² ; or	Addition Alone
	Additions > 400 ft ² and ≤ 700 ft ²	
	Additions > 700 ft ² ; or	
2. Alteration Only:	Meet All Applicable Requirements for Prescriptive Alterations	Existing + Alterations Without Third Party Verification of Existing Conditions; or
		Existing + Alterations With Third Party Verification of Existing Conditions; or
		Existing + Alterations as All New Construction

3. Addition and Alteration Combined:	Meet All Applicable Requirements for Prescriptive Alterations and a Prescriptive Addition Approach (see Additions Only above)	Existing + Addition + Alterations Without Third Party Verification of Existing Conditions; or
		Existing + Addition + Alterations With Third Party Verification of Existing Conditions; or
		Existing + Addition + Alterations as All New Construction
<p>1) In the performance method, the building must be modeled with Energy Commission-approved compliance software as explained in Chapter 8 of this manual.</p> <p>2) The Existing + Alterations performance approach with or without third party verification may be used only if there are at least two types of altered components in the existing building. This requirement does not apply to the Existing + Addition + Alterations compliance method.</p>		

9.3.1 Additions Only

9.3.1.1 Prescriptive

The prescriptive requirements for new addition construction are listed in §150.2(a)1. Unless otherwise noted, the prescriptive requirements contained in §150.1(c) also apply.

- A. **Additions of ≤ 300 ft²:** Does not require a cool roof to be installed;
- B. **Additions ≤ 400 ft²:**
 - 1. Total glazing area up to 75 ft² or 30 percent of the conditioned floor area, whichever is greater.
 - 2. Total glazing area maximum for west facing glazing is 60 ft² or 5 percent in Climate Zones 2, 4, and 6-16.
 - 3. Mandatory ceiling insulation of R-22.
 - 4. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and require the following cavity insulation:
 - a. In 2x4 wood-frame walls, insulation shall be R-15.
 - b. In 2x6 or greater wood-frame walls, insulation shall be R-19.
- C. **Additions > 400 ft² and ≤ 700 ft²:**
 - 1. Total glazing area up to 120 ft² or 25 percent of the conditioned floor area.
 - 2. Total glazing area maximum for west-facing glazing is 60 ft² or 5 percent in Climate zones 2, 4, and 6-16.
 - 3. Mandatory ceiling insulation of R-22.
 - 4. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and require the following cavity insulation:
 - a. In 2x4 wood-frame walls, insulation shall be R-15.
 - b. In 2x6 or greater wood-frame walls, insulation shall be R-19.
- D. **Additions > 700 ft²:**
 - 1. Total glazing area up to 175 ft² or 20 percent of the conditioned floor area, whichever is greater.

2. Total glazing area maximum for west-facing glazing is 70 ft² or 5 percent in Climate zones 2, 4, and 6-16.
3. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and require the following cavity insulation:
 - a. In 2x4 wood-frame walls, insulation shall be R-15.
 - b. In 2x6 or greater wood-frame walls, insulation shall be R-19.

Note: Except as noted, all applicable prescriptive requirements for additions must be met when using the prescriptive approach. Otherwise, the building must comply using the performance approach.

For prescriptive additions, a certificate of compliance (CF1R-ADD) form must be completed and submitted for permit. If any mandatory or prescriptive measures require HERS verification and/or testing, the certificate of compliance for the project must be registered online with a HERS Provider before submittal to the enforcement agency. Refer to Section 2.2.2 and Section 2.5.

9.3.1.2 Performance

Additions may comply using the performance approach by meeting the requirements in §150.2(a)2 and explained further in Section 9.7. The performance options are:

A. Addition Alone

In this compliance scenario, the addition alone is modeled using the compliance software, and the existing building is not modeled at all. This approach may work well when the existing building is not undergoing alterations, and the permitted work scope covers only the addition.

1. **Advantages:** Data for the existing building are not needed except for the total existing conditioned floor area that is used to calculate the fractional “number of dwelling units” for the addition. The existing building is not modeled and not analyzed for altered components or systems. This typically saves a large amount of time performing the analysis.
2. **Disadvantages:** The prescriptive allowances for additions do not apply to the addition alone performance approach. If the addition includes a large area of glazing or is otherwise deficient in comparison with the prescriptive requirements, it may be difficult to demonstrate compliance under this approach. Alterations to the existing conditions that improve the energy performance of the existing building cannot be used in this approach as “trade-offs” with the addition.

B. Existing + Addition + Alteration

In this compliance scenario, the entire building is included in the analysis. This approach does not require unaltered existing components to be brought in to compliance.

1. **Advantages:** This approach offers the most flexibility by modeling improvements to the existing building. The energy budgets include the more generous glazing allowances given to prescriptive compliance.
2. **Disadvantages:** Plans and data for the existing building are needed, increasing the time and complexity of the calculations.

C. Existing + Addition as New Construction

Demonstrating compliance as a whole new building, which entails combining existing plus the addition as all new construction, is another approach. This approach is used when the addition alone does not comply or changes are extensive. Compliance can be hard to achieve because all existing features must be brought up to the current code.

9.3.2 Alterations Only

9.3.2.1 Prescriptive

Alterations may comply prescriptively by meeting all applicable requirements in §150.2(b), which are explained further in Section 9.6 and summarized in Tables 9-5 and 9-9. Several prescriptive alteration requirements are specific to the building site climate zone. There are also several exceptions to the prescriptive requirements based on either climate zone or other conditions listed in the Energy Standards.

Note: Every applicable prescriptive alteration requirement must be met to use the prescriptive approach; otherwise, the building must comply using a performance approach.

Under the prescriptive alteration approach, the appropriate certificate of compliance (for example, CF1R-ALT or CF1R-ALT-HVAC) form must be completed and submitted for a permit. If any mandatory or prescriptive measures require HERS verification or testing (see Section 2.5, HERS Field Verification and Diagnostic Testing of this manual), the certificate of compliance for the project must be registered online with a HERS Provider (see Section 2.3 of this manual) before submittal to the enforcement agency.

9.3.2.2 Performance

Alterations may comply using the performance approach by meeting the requirements in §150.2(b)2. This is explained in Section 9.7 and summarized in Table 9-1. The main options are:

1. **Existing + Alterations:** When two or more types of components or systems are being altered in the existing building, then the existing + alterations performance approach may be used.
2. **Compliance Without Third-Party Verification** allows for compliance of the alterations without the need for third-party inspection to verify existing conditions being altered.
3. **Compliance With Third-Party Verification** allows for compliance of the alterations only with third-party inspection to verify existing conditions being altered.
4. **Existing + Alterations** as new construction: Demonstrating alterations compliance as a whole new building is usually difficult to achieve but still an option. Typically this approach is used when prescriptive alterations cannot meet the prescriptive requirements in Table 150.1-A in the Energy Standards.

Note: Every applicable prescriptive alteration requirement must be met to use the prescriptive approach; otherwise, the building must comply using a performance approach.

9.3.3 Additions and Alterations Combined

9.3.3.1 Prescriptive

When a low-rise residential project includes both an addition and any alterations, the prescriptive requirements for each condition must be met. The addition may comply with any of the prescriptive addition options explained above and documented with the appropriate

compliance forms (for example, CF1R-ADD). The alterations must also meet all prescriptive requirements and be documented with the specific compliance forms for alterations (for example, CF1R-ALT, CF1R-ALT-HVAC).

9.3.3.2 Performance

The performance path that includes both additions and alterations is the “**Existing + Addition + Alterations**” approach. (See Section 9.7.) There are two ways to analyze the building using this method: compliance with third-party verification of all existing conditions altered or compliance without third-party verification.

9.4 Mandatory Requirements

The mandatory measures apply to all newly added or altered envelope components regardless of whether the prescriptive or performance compliance method is used. This section describes the mandatory requirements for low-rise residential buildings as they apply to additions and alterations. More information on the mandatory measures can be found in Chapters 3, 4, 5, and 6.

9.4.1 Envelope Measures

Envelope mandatory measures are listed below, including the relevant reference in the Energy Standards and the section number in this manual. The following measures include fenestration products, exterior doors, insulation, roofing products, and radiant barriers. See Sections 3.2 – 3.8 and the Energy Standards for more information.

- A. Manufactured fenestration products and exterior doors air leakage infiltration rates, see §110.6(a)1, Section 3.5.3.1
- B. Fenestration U-factor, SHGC, VT ratings, see §10-111, §110.6(a)2, 3 & 4, Section 3.5.3.2
- C. Fenestration temporary and permanent labels, see §110.6(a)5, Section 3.5.3.3
- D. Fenestration maximum weighted average U-factor = 0.58, see §150.0(q), Section 3.5.3.4
- E. Installation of field-fabricated fenestration and exterior doors, see §110.6(b), Section 3.5.3
- F. Sealing joints and other openings, see §110.7, Section 3.6.1.1
- G. Certification of insulating materials, see §110.8(a), Section 3.6.1.2
- H. Restrictions on use of urea formaldehyde foam insulation, see §110.8(b), Section 3.6.1.3
- I. Flame spread insulation ratings, see §110.8(c), Section 3.6.1.4
- J. Insulation placement on roof/ceilings, see §150.0(a), Section 3.6.1.9;
- K. Minimum roof/ceiling insulation, see §150.0(a), Section 3.6.1.9
- L. Minimum roof/ceiling insulation in an existing attic, see §110.8(d)1 and §150.0(a), Section 3.6.1.9
- M. Roofing products (cool roofs) solar reflectance and thermal emittance rating and labeling, see §10-113 and §110.8(i), Section 3.6.1.7
- N. Radiant barrier, see §110.8(j), Section 3.6.1.8

- O. Loose-fill insulation, see §150.0(b), see Section 3.6.1.10
- P. Minimum wall insulation, see §150.0(c), see Section 3.6.1.11
- Q. Minimum floor insulation, see §150.0(d), see Section 3.6.1.12
- R. Slab edge insulation moisture resistance and physical protection, see §150.0(f), Section 3.6.2.3
- S. Insulation requirement for heated slab floors, see §110.8(g), Section 3.6.1.14
- T. Vapor retarder §150.0(g), see Section 3.6.1.15.

9.4.1.1 Ceiling/Roof and Wall Insulation

When insulation is installed in the attics of existing buildings, at least R-22 shall be installed in all climate zones. When ceilings without attics are altered, at least R-19 shall be installed between wood-framing members, or enough insulation shall be installed to achieve the equivalent of R-19 insulation between wood-framing members. When the space between framing members becomes accessible as a part of a ceiling/roof modification, the ceiling/roof is considered altered, and the insulation measure applies. However, if the roofing surface material is replaced but the roof sheathing is not being removed, there is no insulation requirement.

Existing buildings that already have R-11 insulation installed in framed walls are exempt from the mandatory minimum R-13 or R-19 wall insulation required by §150.0(c) if the building can demonstrate performance method compliance with the walls modeled as R-11.

9.4.1.2 Roofing Products: Cool Roof

Roofing products installed to meet prescriptive requirements or to take performance compliance credit for reflectance and emittance are referred to as “cool roofs” Cool roofs are specially designed to reflect much of the sun’s radiant energy back into space instead of transferring it as heat into the building below. The two basic characteristics that determine the performance of a cool roof are solar reflectance and thermal emittance. These roofing products must be certified by the Cool Roof Rating Council (www.coolroofs.org) per §10-113 and §110.8(i).

To be considered a cool roof, the roofing products manufacturer must have its roofing product tested for solar reflectance and thermal emittance, and be listed in the Cool Roof Rating Councils (CRRC) Rated Product Directory. Figure 9-1 provides an example of an approved CRRC product label.

Figure 9-1: CRRC Product Label and Information

	<u>Initial</u>	<u>Weathered</u>	
	Solar Reflectance	0.00	Pending
	Thermal Emittance	0.00	Pending
	Rated Product ID Number	-----	
Licensed Seller ID Number	-----		
Classification	Production Line		
<small>Cool Roof Rating Council ratings are determined for a fixed set of conditions, and may not be appropriate for determining seasonal energy performance. The actual effect of solar reflectance and thermal emittance on building performance may vary.</small>			
<small>Manufacturer of product stipulates that these ratings were determined in accordance with the applicable Cool Roof Rating Council procedures.</small>			

If the aged value for the reflectance is not available in the CRRC's Rated Product Directory, then the equation below can be used until the aged rated value for the reflectance is posted in the directory.

Equation 9-1: Aged Reflectance

$$\text{Aged Reflectance}_{\text{calculated}} = (0.2 + \beta[\rho_{\text{initial}} - 0.2])$$

Where:

ρ_{initial} = Initial Reflectance listed in the CRRC Rated Product Directory

β = soiling resistance value listed in Table 9-2

Table 9-2: Soiling Resistance Value β , by Product Type

PRODUCT TYPE	β
Field-applied coating	0.65
Other	0.70

9.4.1.3 Fenestration

New or replacement (altered) glazing, including skylights, must meet the maximum U-factor requirement in one of three ways:

1. All fenestration products (glazed opening) must meet the mandatory maximum U-factor of 0.58; or
2. All new or replacement fenestration combined must meet the mandatory maximum of 0.58 U-factor using an area weighted average calculation; or
3. The area of new and replacement fenestration up to 10 ft² or 0.5 percent of the conditioned floor area (CFA), whichever is greater, is exempt from the maximum U-factor requirement per Exception to §150.0(q).

Example: An existing 2,500 ft² house undergoes an alteration with all the existing windows being replaced. The owner may install up to 12.5 ft² of new glazing (that is, up to 0.5 percent of 2,500 ft²) without meeting the maximum U-factor of 0.58, if the overall alterations meet the Energy Standards with the prescriptive or performance approach.

Consistent with Exception 1 to §150.1(c)3A: For each dwelling unit, up to 3 ft² of new glazing area installed in doors and up to 3 ft² of new tubular skylight area with dual-pane diffusers shall not be required to meet or be included in the area-weighted average fenestration calculation to meet the mandatory requirement of §150.0(q).

9.4.1.4 Greenhouse Windows

Greenhouse or garden windows are special windows that project from the façade of the building. They are typically five-sided structures. NFRC-rated U-factors for greenhouse windows are comparatively high and may not meet the mandatory maximum U-factor of 0.58.

For new buildings and additions, §150.0(q) includes an exception from the U-factor requirement for dual-glazed greenhouse or garden windows that total up to 30 ft² of fenestration area. However, the exempted area shall be included in the area-weighted average calculation.

For additions with more than 30ft² of greenhouse and garden windows, the area-weighted average for all new and replacement fenestration must be used to show that the combined average U-factor complies with the U-factor requirement.

For alterations, dual-glazed greenhouse or garden windows are deemed to comply with U-factor requirements.

9.4.2 Mechanical (HVAC) and Water-Heating Measures

Mechanical (HVAC) system and water-heating mandatory measures are listed below for additions and alterations. They include measures applicable to space-conditioning equipment, controls, and systems; water heaters, controls, and systems, pool and spa equipment, controls, and systems; outdoor air ventilation; pipe insulation; air ducts and plenums; and fireplaces. See Energy Standards and manual section references below:

1. Appliance efficiencies and verification, see §110.1, Section 4.1.4
2. Space conditioning equipment efficiencies, see §110.2(a), Sections 4.2.1 & 4.3.1
3. Heat pump controls, see §110.2(b), Sections 4.2.1.2
4. Setback thermostats (in most cases), see §110.2(c), Section 4.5.1
5. No continuously burning gas pilot lights, see §110.5, Sections 4.2.1.5
6. Heating and cooling load calculations, see §150.0(h), Sections 4.2.1.3 & 4.3.1.4
7. Pipe insulation and refrigerant line insulation, see §150.0(j), Section 5.3.5.1 & 4.3.1.2
8. Duct insulation and protection of insulation, see §150.0(m), Section 4.4.1
9. Dampers to prevent air leakage, see §150.0(m), Section 4.4.1.8
10. Flexible duct labeling, see §150.0(m), Section 4.4.1.7
11. Duct connections and closures, see §150.0(m), Section 4.4.1.2
12. Duct system sealing and leakage testing, see §150.0(m)11, Section 4.4.1.12
13. Zonally controlled central forced-air systems, see §150.0(m)13, Section 4.4.1.17
14. Mechanical ventilation for indoor air quality, see §150.0(o), Section 4.6
15. Fireplaces, decorative gas appliances, and gas logs, see §150.0(e), Section 3.6.1.13
16. Water-heating systems, see §150.0(n), Chapter 5
17. Solar water heating, see §150.0(n)3, Section 5.5
18. Pool systems and equipment installation, see §150.0(p), Section 5.6.

9.4.3 Mechanical Ventilation

The whole-building ventilation airflow requirement in ASHRAE 62.2 is required only in new buildings and buildings with additions greater than 1,000 ft². However, all other mechanical ventilation requirements in §150(o), including local exhaust, must be met, as applicable, in all additions and alterations.

When whole-building ventilation airflow is required for compliance, field verification and diagnostic testing of airflow performance are required in accordance with the procedures in Residential Appendix RA3.7. In that case, a Certificate of Compliance CF1R form must be registered online with a HERS Provider. (See Section 2.5 and Appendix A.)

9.4.4 Lighting Measures

Highlights of the residential lighting measures are listed below. All residential indoor and outdoor lighting measures are mandatory. Details of the *2016 Energy Standards* residential lighting requirements can be found in Chapter 6.

1. Luminaire (light fixture) requirements, see §150.0(k)1, Section 6.2
2. Indoor lighting controls, see §150.0(k)2, Section 6.3
3. Lighting in bathrooms, garages, laundry rooms, and utility rooms, see §150.0(k)2J, Section 6.3.3
4. Recessed downlight fixtures, see §150.0(k)1C, Section 6.2.3
5. Outdoor lighting, see §150.0(k)3, Section 6.5
6. Internally illuminated address signs, see §150.0(k)4, Section 6.5.4
7. Residential garages for eight (8) or more vehicles, see §150.0(k)5, Section 6.6
8. Interior common areas of low-rise multifamily buildings, see §150.0(k)6, Section 6.4

Altered lighting and any newly installed lighting equipment are required to comply with the residential lighting standards, which apply to permanently installed lighting and associated lighting controls.

Only the lighting equipment that is altered needs to comply with the Energy Standards. Existing lighting equipment is not required to be replaced to comply with the Energy Standards.

Example 9-4

Question:

I am doing minor renovations to my kitchen that has six recessed incandescent cans and I am adding a new luminaire over the sink. Does this luminaire have to be a high-efficacy luminaire?

Answer:

Yes, in kitchens all new luminaires must be high efficacy.

Example 9-5

Question:

In the kitchen above, I am replacing one of the recessed downlight luminaires. Must the new downlight luminaire be high-efficacy?

Answer:

Yes, newly installed luminaires must be high-efficacy and meet the requirements in §150.0(k). Note that Screw-based sockets are not permitted for newly installed recessed downlight luminaires in ceilings.

Example 9-6

Question:

I am completely remodeling my kitchen and putting in an entirely new lighting system. How do the Energy Standards apply to this case?

Answer:

When an entirely new lighting system is installed, it is treated like new construction. The new lighting system must comply with all of the mandatory lighting requirements in §150.0(k)1 and (k)2.

See Section 6.2 and 6.3 of this manual for additional information.

Example 9-7

Question:

I am replacing my incandescent bath bar in the bathroom. Must the new luminaire meet the Energy Standards requirements?

Answer:

The new luminaire is the altered component and must meet requirements in §150.0(k), including the high-efficacy luminaire and lighting control requirements. The *2016 Energy Standards* now allow the installation of Joint Appendix JA8-compliant lamps in screw-based fixtures as a way to comply with the high-efficacy lighting requirements as long as the luminaire is not a recessed downlight in ceiling. See Sections 6.2 and 6.3 of this manual for details.

9.5 Additions

For a definition of an addition in the Energy Standards and several useful examples of additions, see Section 9.1 of this chapter.

For a summary of compliance alternatives for additions, see Section 9.3.1 of this chapter.

This section provides more specific information, descriptions, and guidelines on how to meet the Energy Standards using each of the available compliance paths. Copies of compliance forms referenced here are included in the Compliance Forms Summary, Appendix A of this manual.

9.5.1 Prescriptive Requirements

In general, the prescriptive requirements apply to additions in the same way they apply to entirely new buildings and must be documented on the CF1R-ADD Form. However, there are a few exceptions as noted below and summarized in Table 9-3A.

There are three prescriptive paths available for additions based on the total conditioned floor area (CFA) of the addition. The total CFA of the addition may include floor areas representing several physically separate additions to the building under the same permit.

Table 9-3A summarizes the key features of the prescriptive envelope requirements for the three prescriptive addition options in §150.2(a)1. Envelope requirements unique to that type of prescriptive addition are shown in bold face on white background. Table 9-3E shows that all prescriptive additions have the same mechanical system and water heating system requirements as the Package A prescriptive measures for new construction listed in §150.1(c) and explained in Chapters 4 and 5. For more details on the residential envelope requirements and compliance options, refer to Chapter 3.

A. Additions ≤ 400 ft²

All prescriptive Package A requirements must be met **except**:

1. Total glazing area may be up to 75 ft² or 30 percent of conditioned floor area, whichever is greater.
2. West-facing glazing area may be up to 60 ft².

3. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and require the following cavity insulation:
 - a. In 2x4 wood-framed walls, insulation shall be R-15.
 - b. In 2x6 or greater wood-framed walls, insulation shall be R-19.
4. No requirement for a whole-house fan (WHF) to provide ventilation cooling.
5. Mandatory roof and ceiling insulation requirements (§150.0a).
6. For additions $\leq 300 \text{ ft}^2$, cool roof compliance is not required.

B. Additions > 400 ft² and $\leq 700 \text{ ft}^2$:

All prescriptive Package A requirements must be met **except**:

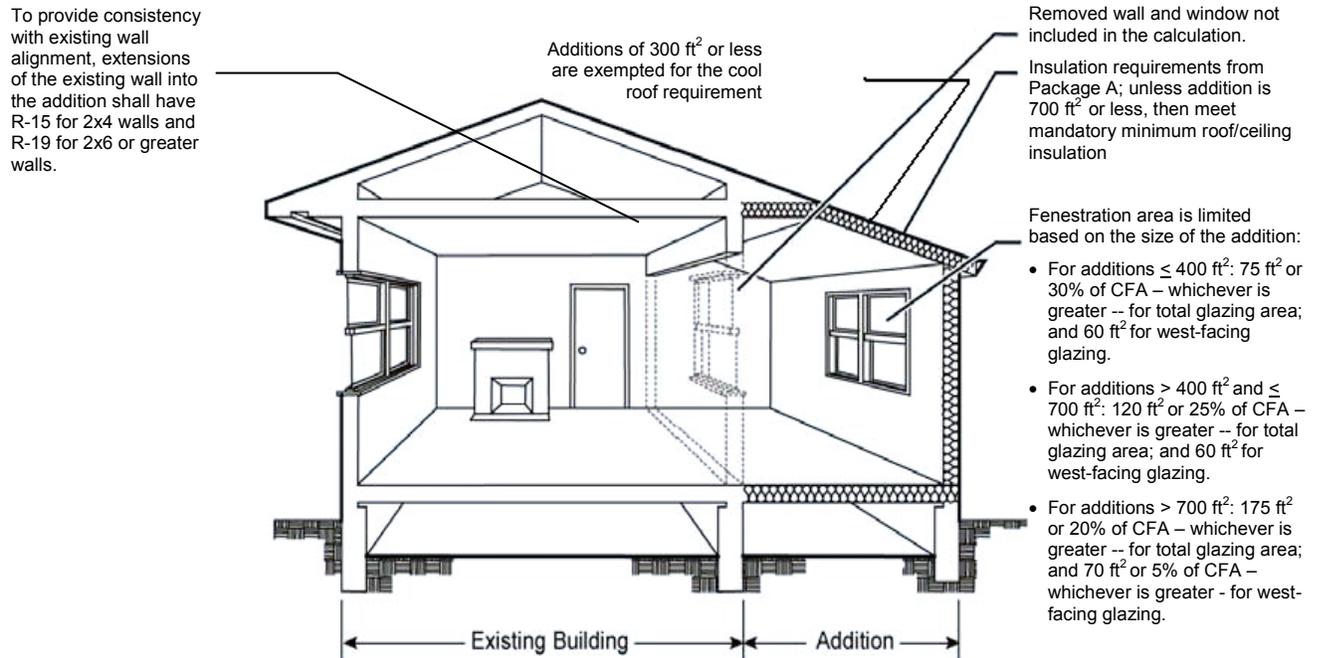
1. Total glazing area may be up to 120 ft^2 or 25 percent of conditioned floor area, whichever is greater.
2. West-facing glazing area may be up to 60 ft^2 .
3. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and require the following cavity insulation:
 - a. In 2x4 wood-framed walls, insulation shall be R-15.
 - b. In 2x6 or greater wood-framed walls, insulation shall be R-19.
4. No requirement for a whole-house fan (WHF) to provide ventilation cooling.
5. Mandatory roof and ceiling insulation requirements (§150.0(a)).

C. Additions > 700 ft²

All prescriptive Package A requirements must be met **except**:

1. Total glazing area may be up to 175 ft^2 or 20 percent of conditioned floor area, whichever is greater.
2. West-facing glazing area may be up to 70 ft^2 or 5 percent of conditioned floor area, whichever is greater.
3. If the total proposed fenestration area exceeds the standard maximum glazing area of 20 percent, then the performance compliance approach must be used. Likewise, if the proposed west-facing fenestration area in Climate Zones 2, 4, and 6-16 exceeds 5 percent of the conditioned floor area, then the performance compliance approach must be used.
4. To provide consistency with existing wall alignment, extensions of existing wood-framed walls may retain the dimensions of the existing walls and require the following cavity insulation:
 - a. In 2x4 wood-framed walls, insulation shall be R-15.
 - b. In 2x6 or greater wood-framed walls, insulation shall be R-19.
5. Whole-house fan (WHF) requirement:
 - a. If the addition is $1,000 \text{ ft}^2$ or less, there is no requirement for WHF to provide ventilation cooling.
 - b. Additions greater than $1,000 \text{ ft}^2$ must include provide ventilation cooling with a WHF, as indicated in §150.1(c)12 in climate zones 8-14.

Figure 9-2: Prescriptive Addition Envelope Requirements



9.5.2 Compliance Forms for Prescriptive Additions

The permit applicant must submit a completed version of the Certificate of Compliance, CF1R-ADD form for prescriptive additions when less than 1000 ft².

All projects that require third-party diagnostic testing and/or field verification by a HERS Rater *must also have the CF1R-ADD form uploaded and registered online with a HERS Provider.* (See Chapter 2.)

Use the CF1R-ADD form to document fenestration by orientation. The total percentage of fenestration should be no greater than the amount summarized above and in Table 9-3A. West-facing area includes skylights tilted to the west or tilted in any direction when the pitch is less than 1:12 (9.5 degrees from the horizontal) and must not exceed 5 percent of the conditioned floor area (CFA) in Climate Zones 2, 4, and 6-16.

Plan checkers will verify on the CF1R-ADD form that the total proposed glazing area is less than or equal to the standard maximum glazing area, and that the proposed west-facing glazing area is less than or equal to the standard west-facing glazing area.

9.5.3 Fenestration Exceptions

New fenestration in prescriptive additions must meet the area-weighted average U-factor and SHGC requirements in §150.1(c)3A, with the following exceptions particularly relevant to additions:

1. **EXCEPTION 1:** For each dwelling unit, up to 3 ft² of new glazing in doors and up to 3 ft² of tubular skylights with dual-pane diffusers are exempt.

2. **EXCEPTION 2:** For each dwelling unit, up to 16 ft² of skylights with a maximum U-factor of 0.55 and a maximum SHGC of 0.30 is exempt.

See Section 3.5 for further information on fenestration that meets or is exempt from §150.1(c)3A in new construction.

Other Prescriptive Addition Envelope Measures

For further information on prescriptive envelope measures which are not specific to additions and not mentioned above, see Chapter 3.

Prescriptive Mechanical Measures

For a summary and discussion of prescriptive mechanical requirements when installing new or replacement space-conditioning equipment and/or ducts, see Section 9.6.2.

Example 9-8

Question:

When using the performance approach for the addition alone, do the refrigerant charge requirements in §150.1(c)7A and fan airflow and watt draw measurements in §150.0(m)13 need to be met for existing central split-system air conditioners serving an addition?

Answer:

If existing equipment is used to serve the addition, the refrigerant charge, airflow, and watt draw requirements do not need to be met as specified by Exception 5 to §150.2(a). However, if added ducts to serve the addition are more than 40 linear feet and they are in unconditioned space, then the ducts must be tested and verified by a HERS Rater as described in §150.2(b)1D. All installed ducts regardless of length and location shall be sealed and meet insulation levels as described in §150.0(m) Items 1 through 6.

If a new central split system is installed to serve the addition, it must meet all of the requirements for air conditioners in a new residence.

Table 9-3A: Envelope Roof/Ceiling Requirements for Prescriptive Additions

Component	Requirements of Additions ≤ 400 ft ²	Requirements of Additions > 400 ft ² and ≤ 700 ft ²	Requirements of Additions > 700 ft ²
Roof/Ceiling Insulation:	Mandatory requirements	Mandatory requirements	Option A, B, or C (see Table 9-3B below).
Roof Products (Cool Roof):	<u>Package A:</u> <u>Steep-Sloped (> 2:12):</u> CZ10-15: Reflect.=0.20 and Emittance=0.75; or SRI=16	<u>Package A:</u> <u>Steep-Sloped (> 2:12):</u> CZ10-15: Reflect.=0.20 and Emittance=0.75; or SRI=16	<u>Package A:</u> <u>Steep-Sloped (> 2:12):</u> CZ10-15: Reflect.=0.20 and Emittance=0.75; or SRI=16
	<u>Package A:</u> <u>Low-Sloped (< 2:12):</u> CZ13 & 15: Reflect.=0.63 and Emittance=0.75; or SRI=75	<u>Package A:</u> <u>Low-Sloped (< 2:12):</u> CZ13 & 15: Reflect.=0.63 and Emittance=0.75; or SRI=75	<u>Package A:</u> <u>Low-Sloped (< 2:12):</u> CZ13 & 15: Reflect.=0.63 and Emittance=0.75; or SRI=75
	<u>Exception:</u> Additions ≤ 300ft ² exempt from all cool roof requirements.		
Radiant Barrier Above Attic:	<u>Package A:</u> CZ2-15: Radiant Barrier above Attic Spaces	<u>Package A:</u> CZ2-15: Radiant Barrier above Attic Spaces	<u>Package A:</u> CZ2-15: Radiant Barrier above Attic Spaces, except when complying with Option B from §150.1(c)

Figure 9-3: Ventilated Attic Prescriptive Compliance Choices for Additions >700ft²

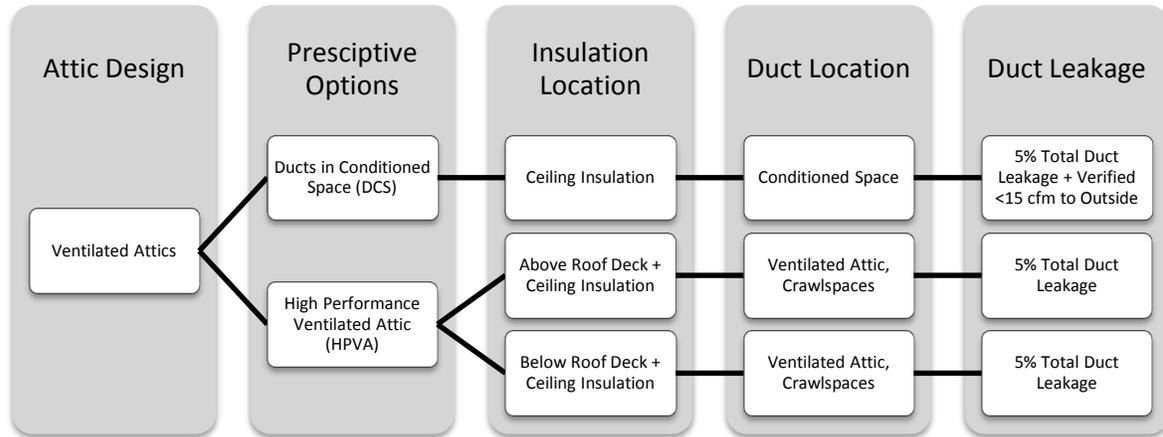


Table 9-3B: Roof and Ceiling Requirements for Prescriptive Additions

	Option A (CZ 4, 8-16)	Option B (CZ 4, 8-16)	Option C (CZ 4, 8-16)
Roof Deck Insulation ^{1,2}	Above deck continuous insulation: R6 (with air space), R8 (no air space)	Below deck insulation: R13 (with air space), R18 (no air space)	None required (NOTE: This attic requires ducts in conditioned space)
Ceiling Insulation	R38	R38	CZ 4, 8-10: R30 CZ 11-16: R38
Duct Location	Attic allowed	Attic allowed	Conditioned Space

1. Roof deck insulation should be installed flush with the roof deck. Above deck insulation is applied as continuous insulation. Below deck insulation is installed in the cavities between trusses.

2. A designed air space may exist between the roof deck and the finishing roofing material, triggering lower required insulation values.

Table 9-3C: Envelope Glazing Requirements for Prescriptive Additions

Component	Requirements of Additions ≤ 400 ft ²	Requirements of Additions > 400 ft ² and ≤ 700 ft ²	Requirements of Additions > 700 ft ²
Total Glazing Area:	Up to 75 ft ² or 30% of Conditioned Floor Area, whichever is greater	Up to 120 ft ² or 25% of Conditioned Floor Area, whichever is greater	Up to 175 ft ² or 20% of Conditioned Floor Area, whichever is greater
West-Facing Glazing Area: In Climate Zone 2, 4, 6-16	Up to 60 ft ²	Up to 60 ft ²	The greater of 70 ft ² or 5% of Conditioned Floor Area in Climate Zones 2, 4, 6-16
Glazing U-Factor & SHGC ¹ :	Package A: All CZs: U = 0.32 CZ 2, 4 & 6-16: SHGC = 0.25	Package A: All CZs: U = 0.32 CZ 2, 4 & 6-16: SHGC = 0.25	Package A: All CZs: U = 0.32 CZ 2, 4 & 6-16: SHGC = 0.25

1. See §150.0(q) and §150.1(c)3 for new and replaced window and skylight exceptions.

Table 9-3D: Envelope Insulation Requirements for Prescriptive Additions

Component	Requirements of Additions $\leq 400 \text{ ft}^2$	Requirements of Additions $> 400 \text{ ft}^2$ and $\leq 700 \text{ ft}^2$	Requirements of Additions $> 700 \text{ ft}^2$
Exterior Framed Wall ¹ Insulation:	Package A: CZ 1-5, 8-16: U=0.051 CZ 6 & 7:U=0.065	Package A: CZ 1-5, 8-16: U=0.051 CZ 6 & 7:U=0.065	Package A: CZ 1-5, 8-16: U=0.051 CZ 6 & 7:U=0.065
Raised Floor ¹ Insulation:	Package A: All CZs: R-19 or U=0.037	Package A: All CZs: R-19 or U=0.037	Package A: All CZs: R-19 or U=0.037
Slab Floor ¹ Insulation:	Package A: CZ1-15: No Requirement; CZ 16: R-7.0 or U=0.58	Package A: CZ1-15: No Requirement; CZ 16: R-7.0 or U=0.58	Package A: CZ1-15: No Requirement; CZ 16: R-7.0 or U=0.58
1. R-values refer to wood framing, and U-factors refer to metal framing.			

Table 9-3E: HVAC and Water Heating Requirements for Prescriptive Additions

Component	Requirements of Additions $< 400 \text{ ft}^2$	Requirements of Additions $> 400 \text{ ft}^2$ and $< 700 \text{ ft}^2$	Requirements of Additions $> 700 \text{ ft}^2$
Ventilation Cooling ¹ (Whole House Fan)	No Requirement.	No Requirement.	Additions $< 1,000 \text{ ft}^2$: No requirement Additions $> 1,000 \text{ ft}^2$: Package A Whole House Fan, §150.1(c)12 CZ 8-14
Adding New Space Conditioning System(s)	All Package A requirements.	All Package A requirements.	All Package A requirements except requirements for Ducts in Conditioned Space ²
Replacing Existing Space Conditioning System(s)	All Package A requirements.	All Package A requirements.	All Package A requirements except requirements for Ducts in Conditioned Space ²
Adding All New Complete Duct System(s)	All Package A requirements.	All Package A requirements.	All Package A requirements except requirements for Ducts in Conditioned Space ²
Extending Existing Duct System(s) by > 40 Feet	All Package A duct insulation requirements; duct system sealing and HERS Verified	All Package A duct insulation requirements; duct system sealing and HERS Verified	All Package A duct insulation requirements; duct system sealing and HERS Verified. Except requirements for Ducts in Conditioned Space ² .
<p>1. (Note: also mandatory mechanical ventilation per ASHRAE 62.2 with HERS verification for additions $> 1,000 \text{ ft}^2$)</p> <p>2. For more information about ducts in conditioned space, see Section 3.2.6</p>			

9.5.4 Prescriptive Water Heating System

If an addition increases the number of water heaters serving a dwelling unit, the addition can comply prescriptively if any one of the following conditions contained in §150.2(a)1D.i, ii and iii are met:

1. If the additional water heater is a natural gas or propane water heater, there are two options to comply. In all cases, if recirculation distribution system is used, only demand recirculation systems with manual control pumps shall be used. The two options are described below:

Option 1: Install a natural gas or propane instantaneous water heater with an input rating of 200,000 BTU per hour or less.

Option 2: Install a natural gas or propane storage water heater with a rated storage volume greater than 55 gallons and an input rating of 105,000 BTU per hour or less. The user must also do one of the following:
 1. Use a compact hot water distribution design for the addition, which requires a HERS Rater to verify that the system has been designed and installed in accordance with the Energy Standards. (See Reference Appendix RA4.4.16.)
 2. Insulate all domestic hot water pipes for the addition, which requires that a HERS Rater verify that the pipe insulation is designed and installed in accordance to the Energy Standards.
2. If the building does not have natural gas or propane connected to the building, the additional water heater is an electric storage or instantaneous water heater with an EF equal to or greater than the federal minimum standards. If recirculation distribution system is used, only demand recirculation systems with manual control pumps shall be used.
3. A water-heating system determined by the Executive Director of the Energy Commission to use no more energy than the one specified in Item 1 above or, if no natural gas is connected to the building, a water-heating system determined by the Executive Director to use no more energy than the one specified in Item 2 above.

If none of these conditions can be met when adding a water heater to an existing dwelling unit, then the prescriptive addition compliance path cannot be used. In that case, the existing + addition + alterations compliance approach must be used to demonstrate overall compliance with whatever combination of existing and new water heaters serves the dwelling unit. This is summarized in §150.2(a)1Div and discussed as part of the overall performance method in Section 9.7.

For other alterations to the water heating system that occur as part of an addition, see Section 9.6.

Example 9-9

Question:

A small addition of 75 ft² is being planned for a house in Climate Zone 7. An existing porch off the master bedroom is being enclosed by using 2x4 wood-framed walls. The existing heating and air-conditioning system will serve the new conditioned space, including an extension of less than 40 linear feet of new ducts. The contractor wants to follow the prescriptive requirements. What requirements apply?

Answer:

Since the addition is smaller than 400 ft², the total fenestration area is limited to a maximum of 75 ft², and west-facing fenestration area is limited to 60 ft². The fenestration must meet the U-factor and SHGC requirements of Package A. For Climate Zone 7, these fenestration requirements are a maximum U-factor of 0.32 and a maximum SHGC of 0.25. For an addition of this size, insulation must meet only the mandatory requirements of R-22 ceiling insulation and R-19 floor insulation. The new 2x4 walls are extensions of existing walls, so they need only R-15 cavity insulation. Since the addition is also less than 300 ft², there is no cool roof requirement.

Since the existing heating and cooling equipment is being used for the addition, that equipment does not have to meet the mandatory equipment efficiency requirements. Mandatory duct insulation requirements of §150.0(m) apply, including R-6.0 minimum in unconditioned space. All other mandatory requirements in §150.0 must be met.

Example 9-10

Question:

If I remove a window from the existing house and reuse this window in an addition to that house, does the relocated window have to meet the prescriptive requirements of Package A?

Answer:

Yes, if using prescriptive compliance, in which case the relocated window must be treated as a new window and must meet the U-factor and SHGC requirements of Package A, §150.1(c)3. If you use this existing window in the addition, you must use the actual or default U-factor and SHGC of the window in showing compliance. Therefore, meeting the prescriptive requirements may not be possible, and performance compliance may be the only option. Window certification and labeling requirements of §110.6(a) do not apply to existing used windows.

Relocated windows must also meet the maximum area-weighted average U-factor in §150.0(q) with the EXCEPTION of up to 10 ft² or 0.5 percent of conditioned floor area, whichever is greater.

Example 9-11

Question:

I am doing an alteration in Climate Zone 12 in which I am moving an existing 25 ft² window to another location within the same existing wall and am not increasing total glazing area. Does the relocated window need to meet any prescriptive requirements?

Answer:

Removing an area of glazing in an existing wall and reinserting up to the same area of glazing in a different opening is considered replacement fenestration as defined in §150.2(b)1B. Exception 1 to §150.2(b)1B states that up to 75 ft² of vertical replacement fenestration in Climate Zone 12 must meet a prescriptive U-factor = 0.40 and an SHGC = 0.35.

Example 9-12

Question:

For additions and alterations that include a greenhouse window (also known as garden window), what are the U-factor and SHGC requirements? What is the area used for calculations for greenhouse windows?

Answer:

Not many greenhouse windows meet the mandatory maximum fenestration U-factor of 0.58 or the prescriptive addition or alteration U-factors or SHGCs on their own. The default U-factor for a dual-pane, metal-framed greenhouse window from Table 110.6-A is 1.40, while the default SHGC from Table 110.6-B assumes fixed clear, glass is 0.73. By comparison, fenestration in prescriptive additions has to meet the Package A U-factor of 0.32 for all climate zones and an SHGC of 0.25 in all climate zones except 1, 3 and 5, which have no SHGC requirement. However, there are several options and exceptions available in the Energy Standards.

For alterations, Exception 1 to §150.2(b) allows any dual-pane greenhouse windows to meet the prescriptive U-factor and SHGC requirements of Package A. This makes it possible for greenhouse windows to comply with the Energy Standards as part of a prescriptive alteration, as long as the U-factor and SHGC meet the requirements either by themselves or when area-weighted with all of the new and replacement fenestration in the project. The existing plus alteration performance method may also be considered if at least one other component of the building that will be upgraded in addition to the fenestration.

For new construction and additions, Exception 2 to §150.0(q) exempts up to 30 ft² of dual-pane greenhouse windows from the mandatory maximum U-factor of 0.58. This allows additions with up to 30 ft² of dual-pane greenhouse windows to comply using the performance approach, even if the actual NRFC-rated or default U-values of the greenhouse windows are greater than 0.58. Compliance in that case would depend on higher than average energy efficiency for some other components of the project to offset the poor performance of the greenhouse windows.

Alternatively, greenhouse windows can also meet the prescriptive maximum area-weighted average U-factor and SHGC in combination with other new and replacement fenestration in the project.

Greenhouse windows may use one of three methods for determining the proposed SHGC:

- 1) NFRC rated SHGC
- 2) Default SHGC from Table 110.6-B
- 3) If site-built greenhouse windows, then $SHGC_T$ can be calculated from the manufacturer's center of glass SHGC ($SHGC_c$) and using the following equation: $SHGC_T = 0.08 + 0.86 \times SHGC_c$.

Comparable methods are available for determining U-factors.

For compliance, the area used for greenhouse windows is the rough opening in the wall.

9.5.5 Performance Method: Additions and Existing + Addition + Alterations Approach

The table below summarizes the basic rules for modeling a low-rise residential building using the existing + addition + alterations performance approach. For more detailed information, see Section 9.7 and the *Residential ACM Reference Manual*.

Table 9-4: Modeling Rules for Existing + Addition + Alterations

Type of Component or System Modeled	Standard Design <i>Without</i> Third Party Verification of Existing Conditions	Standard Design <i>With</i> Third Party Verification of Existing Conditions
"EXISTING" – Components or Systems That Remain Unchanged	Model each component or system as "Existing"	Model each component or system as "Existing"
"ALTERED" – Components or Systems Being Changed/Replaced	Model each altered component or system as "Altered" but do not model the "Praltered Existing" conditions	Model each component or system as "Altered" and also model the "Praltered Existing" conditions
"NEW" – Components or Systems Being Added	Model each component or system as "New"	Model each component or system as "New"
"REMOVED" – Components or Systems Being Removed and Not Replaced	These components and systems are omitted entirely from the model	These components and systems are omitted entirely from the model

9.6 Alterations

This section provides a road map and a few relevant summaries that identify the requirements in the Energy Standards that are unique to alterations. Envelope, mechanical, and water-heating system alterations must meet all applicable mandatory measures as discussed in Section 9.4 and must comply with the Energy Standards using the prescriptive or performance approach. If a building does not meet all applicable prescriptive measures, then the performance method using approved compliance software is the alternative. (See Section 9.7.)

Residential lighting alterations need to meet applicable mandatory measures since there are no prescriptive lighting requirements in residential buildings.

9.6.1 Prescriptive Requirements

Although alterations must meet many of the same prescriptive requirements for new construction and additions, there are several exceptions or special allowances for certain types of alterations. Table 9-5 provides a detailed outline of envelope requirements for alterations, and Table 9-10 provides a similar outline for HVAC and water-heating alterations. For each type of alteration, the tables list:

1. The highlights of the mandatory measures applicable to that kind of alteration.
2. A summary of the relevant prescriptive measures.
3. Key exceptions, exemptions, or special allowances to the prescriptive measures.
4. The list of prescriptive compliance forms that must be submitted for permit.

9.6.1.1 Prescriptive Envelope Alterations

Table 9-5 summarizes requirements for the following types of residential envelope alterations:

1. Adding ceiling or roof insulation to an existing roof, or constructing a new roof on an existing building.
2. Replacing the roof sheathing of an existing roof.
3. Replacing part or the entire roof surface of an existing building.
4. Replacing or adding skylights.
5. Adding exterior wall insulation, or constructing new walls in an existing building.
6. Adding raised floor insulation over unconditioned space.
7. Replacing vertical fenestration: windows, clerestories, and glazed doors.
8. Adding vertical fenestration: windows, clerestories, and glazed doors.

Table 9-5: For Residential Alterations, Summary of Mandatory and Prescriptive Measures

Type of Envelope Alteration	Highlight(s) of Applicable Mandatory Measures ¹	Summary of Relevant Prescriptive Measure(s) ²	Exception(s) to the Prescriptive Measures	Prescriptive Compliance Form(s)
Adding Ceiling or Roof Insulation to an Existing Roof; or a New Roof on an Existing Building	Ceiling w/ Attic and Roof Rafters: R-19, U=0.054 §150.0(a) Exception: Where the space in the attic or rafter area is not large enough to accommodate R-19, the entire space shall be filled with insulation provided it does not violate Section 1203.2 of Title 24, Part 2.		N/A	CF1R-ALT
Adding Exterior Framed Wall Insulation³ or a New Wall in an Existing Building	In 2x4 Framing: R-13, U=0.102 In 2x6 Framing: R-19, U=0.074 Exception: Walls already insulated to R-11 §150.1(c)	In 2x4 Framing: R-13, U=0.102 In 2x6 Framing: R-19, U=0.074 (same as Mandatory)	N/A	CF1R-ALT
Replacing Roof Sheathing	§110.8(j)	CZ 2 - 15: Radiant Barrier above Attic Spaces	(a) No requirement in CZ1 and CZ16; (b) Not required when installing below roof deck insulation	CF1R-ALT

<p>Replacing > 50% of the Existing Roof Surface</p>	<p>§110.8(i)</p>	<p><u>Steep Sloped</u> (≥ 2:12): CZ 10 - 15: Reflect.=0.20 and Emittance=0.75; or SRI=16</p>	<p>(a) Air space of 1.0" between roof deck and bottom of roofing product. (b) Profile ratio of rise to width of 1:5 for >50% width of roofing product. (c) Existing ducts in attic insulated and sealed per §150.1(c)9. (d) Roof has ≥ R-38 ceiling insulation. (e) Roof has a radiant barrier per §150.1(c)2. (f) There are no ducts in the attic. (g) In CZ10-15, ≥R-4.0 insulation above the roof deck.</p>	<p>CF1R-ALT</p>
		<p><u>Low Sloped</u>< 2:12: CZ13 & 15: Reflect.=0.63 and Emittance=0.75; or SRI=75</p>	<p>(a) There are no ducts in the attic. (b) Reflectance and Roof Deck Insulation R-value in Table 150.2-A are met.</p>	<p>CF1R-ALT</p>
<p>Replacing Entire Roof, including sheathing</p>	<p>§150.0(a) Ceilings and rafter roofs achieve R19 or weighted U=0.054</p>	<p>CZ 4, 8-16: Roof deck, ceiling insulation, and radiant barrier according to §150.1(c)1A using Option A or B.</p>	<p>N/A</p>	<p>CF1R-ALT</p>
<p>Adding or Replacing Skylight³</p>	<p>Weighted average U-factor = or < 0.58 <u>Exemption:</u> Up to 10 ft² or 0.5% of Conditioned Floor Area, whichever is greater, is exempt from the U-factor requirement §150.1(q)</p>	<p>Must not exceed the 20% Total or 5% West Fenestration Area with a U-factor = 0.32 (all CZs); in CZ2, 4 & 6-16: SHGC = 0.25 §150.2(b)1.A.</p>	<p>Added fenestration up to 75 ft² need not meet Total or West-facing fenestration area per §150.2(b)1A Exception 1. Replacement skylights up to 16 ft² with a U=0.55 and SHGC=0.30 and not meet the total fenestration and West-facing area requirements per §150.2(b)1 A Exception 2.</p>	<p>CF1R-ALT</p>
<p>Adding Raised Floor Insulation</p>	<p>R-19 or equivalent U-factor Exception: Floors over controlled ventilation or unvented crawlspaces per §150.1(d)</p>	<p>R-19 or equivalent U-factor (same as Mandatory)</p>	<p>N/A</p>	<p>CF1R-ALT</p>

<p>Replacing Vertical Fenestration⁴ (Altered Glazing)</p>	<p>Weighted average U-factor = or < 0.58 <u>Exemption:</u> Up to 10 ft² or 0.5% of Conditioned Floor Area, whichever is greater, is exempt from the U-factor requirement §150.0(q)</p>	<p>All CZs: U-factor = 0.32 CZ 2, 4 & 6-16: SHGC = 0.25 §150.2(b)1.B.</p>	<p>Replacement of vertical fenestration up to 75 ft²: U=0.40 (in all CZs) and SHGC=0.35 in CZs 2, 4 & 6-16 as per §150.2(b)1B Exception 1 .</p>	<p>CF1R-ALT</p>
<p>Adding Vertical Fenestration⁴ (New Glazing) and Greenhouse</p>	<p>Weighted average U-factor = or < 0.58 <u>Exemption:</u> Up to 10 ft² or 0.5% of Conditioned Floor Area, whichever is greater, is exempt from the U-factor requirement §150.0(q)</p>	<p>Must not exceed the 20% Total or 5% West Fenestration Area U-factor = 0.32 (in all CZs); In CZ2, 4 & 6-16: SHGC = 0.25 §150.2(b)1.A.</p>	<p>Added fenestration up to 75 ft² need not meet total or west-facing fenestration area requirements as per §150.2(b)1A Exception 1. Added Greenhouse must either meet the maximum U-factor of 0.58 or weighted average U-factor of 0.58 or up to 10ft² or 0.5% of CFA whichever is greater as per §150.0(q)1.</p>	<p>CF1R-AL</p>
<p>1: Alterations must comply with all applicable mandatory measures in §110.0 and §150.0 of the Energy Standards as explained in Chapters 3, 4, 5 and 6 of this Manual, except as noted in §150.2(b).</p>				
<p>2: Several prescriptive measures are Climate Zone (CZ) specific.</p>				
<p>3: There are no mandatory measures or prescriptive requirements when altering below-grade or exterior mass walls.</p>				
<p>4: Replacement fenestration is new fenestration that is located in the same existing wall or roof in which the same or larger area of existing fenestration is being removed. It labeled as "altered." Any new fenestration area that increases the total net area of fenestration in any existing wall or roof is labeled as "new."</p>				

9.6.1.2 Greenhouse Windows

Greenhouse or garden windows are special windows that project from the façade of the building and are typically five sided structures. An NFRC-rated U-factor for greenhouse windows is typically high and may not meet the mandatory requirements for the fenestration U-factor of 0.58.

To meet this mandatory measure, greenhouse windows:

1. Must have a maximum U-factor of 0.58 or better; or
2. Must use the area-weighted average for all new and replacement fenestration with a combined mandatory maximum of 0.58 U-factor as per §150.0(q)2; or
3. Must meet the Exception to §150.0(q)1 for up to 10 ft² or 0.5 percent of CFA, whichever is greater; or
4. When using the performance approach Exception 1 as per §150.2(b) - Any dual-glazed greenhouse or garden window installed as part of an alteration complies automatically with the U-factor and meets the requirements as per §150.1(c)3.

9.6.1.3 Adding Insulation to Existing Roof/Ceilings, Walls and Raised Floors

The prescriptive requirement for alterations is to add the equivalent of the specified level of insulation that fits within the cavity of wood framed assemblies:

1. R-19 or greater in between wood-framing members or a weighted average U-factor equal to or less than 0.054 for insulation installed at ceilings and rafter roofs; and

2. R-13 in 2x4 exterior walls, and R-19 in 2x6 or greater exterior walls, with no exterior rigid insulation required; or
3. R-19 in raised floors over crawl spaces, over open outdoor areas, unheated basements, and garages.

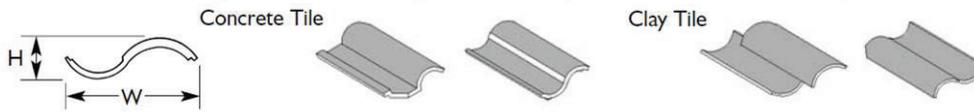
9.6.1.4 Replacing the Roof Surface or Roof Sheathing (partial or entire replacement)

A. Steep-Sloped Roofs ($\geq 2:12$)

In Climate Zones 10 through 15, if 50 percent or more of the existing building's roof surface is being replaced, the minimum cool roof requirement for the replaced steep-sloped roofing area shall have an aged solar reflectance of 0.20, thermal emittance equal to 0.75, or a minimum SRI of 16. The requirements above apply unless one of the following is present (considered equivalent to the cool roof requirements in §150.2(b)1Hi):

1. Air space of 1.0" (25mm) between the roof deck and the bottom of the roofing product.
2. Roofing product profile ratio of rise to width is at least 1:5 for >50 percent width of roofing product.

High Profile Tile – Tiles having a rise to width ratio greater than 1:5 (measured in installed condition)



3. Existing ducts in attic are insulated and sealed according to §150.1(c)9.
4. Building has at least R-38 roof/ceiling insulation.
5. Roof of attic spaces has a radiant barrier according to §150.1(c)2.
6. There are no ducts in the attic space.
7. In Climate Zones 10 through 15, greater than R-2.0 insulation above the roof deck.

B. Low-Sloped Roofs ($< 2:12$)

In Climate Zones 13 and 15, if 50 percent or more of the existing building's roof surface is being replaced, the minimum cool roof requirements for low-sloped roofs shall have an aged solar reflectance of 0.63, thermal emittance of 0.75, or a minimum SRI of 75 per §150.2(b)1Hii. These apply unless one of the following is present which are considered equivalent to the cool roof requirements in §150.2(b)1Hii:

1. There are no ducts in any attic space.
2. The aged solar reflectance can be traded off with additional insulation added at the roof deck as specified in Table 150.2-A of the Energy Standards.

Table 9-6: Aged Solar Reflectance Insulation Trade Off

Aged Solar Reflectance	Roof Deck Insulation R-value	Aged Solar Reflectance	Roof Deck Insulation R-value
0.62 – 0.60	2	0.44 – 0.40	12
0.59 -0.55	4	0.39 – 0.35	16
0.54 - 0.50	6	0.34 – 0.30	20
0.49 – 0.45	8	0.29 – 0.25	24

C. Roof Sheathing

In Climate Zones 2 through 15, if roof sheathing over an attic space with a continuous radiant barrier is being replaced, a continuous radiant barrier must be re-installed.

In Climate Zones 4, and 8 through 16, if the entire roof sheathing over a ventilated attic space is being replaced, roof and ceiling insulation must be installed to meet the following prescriptive requirements (as specified in §150.1(c)1A):

1. Option A: R-8 or R-6 above roof deck insulation (see explanation on required R-value in Chapter 3) **and** R-38 ceiling insulation.
2. Option B: R-18 or R-13 below roof deck insulation (see explanation on required R-value in Chapter 3) **and** R-38 ceiling insulation.
3. Option C: Verified ducts in conditioned space **and** R-30 or R-38 ceiling insulation.

Example 9-13

Question

There is a Victorian building that has been converted to an office building and needs to have a shake roof replacement. This building has a vented unconditioned attic with the insulation on the ceiling. Would I need to meet §150.2(b)Hi?

Answer

No, this section does not apply. The occupancy type has been changed to nonresidential. Since the Victorian building has a shake roof and is considered a steep sloped roof, §141.0(b)2Bib for nonresidential buildings would apply.

Example 9-14

Question

On an existing building, 50 ft² of 85 ft² of vertical glazing is being removed from an existing south facing wall and new glazing will be replaced as part of the alteration in the same opening. What requirements apply?

Answer

Since 50 ft² is treated as “replacement” fenestration and 35 ft² is considered existing, the replaced fenestration must comply with the requirements in §150.2(b)1B; or for this example Exception 1 to §150.2(b)1B can be used. Vertical fenestration no greater than 75 ft² can meet the requirements by installing fenestration no greater than a U-factor of 0.40 in Climate Zones 1-16 and SHGC of 0.35 in Climate Zones 2, 4, and 6 through 16.

9.6.1.5 Replacement Fenestration

Any fenestration (i.e., windows, skylights, clerestories, and glazed doors) that is being removed and replaced in an exterior wall or roof is considered “replacement fenestration.”

Replacement fenestration is an area of new fenestration that replaces an equal or greater area of glazing removed in the same existing wall or roof area. It is labeled as “altered” fenestration, and it need not occur in the same exact openings as the glazing being removed as long as it is being installed in the same existing wall or roof surface which remains a part of the existing building. Any added fenestration area that is larger than the total altered glazing area) is labeled as “new.”

9.6.1.6 New Fenestration in Alterations

The Energy Standards have relaxed some of the prescriptive restrictions on new vertical fenestration for alterations in existing dwellings. When new vertical fenestration is added in existing dwellings, up to 75 ft² are not required to meet the overall total fenestrations limit (20 percent of the CFA) and the west facing area limit (5 percent of the CFA). This provides for additional flexibility to meet the Energy Standards requirements using the prescriptive approach, without having to resort to the performance approach. However, this additional fenestration must meet the prescriptive U-factor and SHGC requirements of Package A or meet the U-factor and SHGC requirements of Exceptions 1 and 2 to §150.2(b)1B.

Example 9-15

Question

An existing house in Climate Zone 12 has all single-pane windows. All of the windows (300 ft² total) will be replaced within existing openings, except a pair of 40 ft² French doors, which will replace an existing 30 ft² window. What requirements apply?

Answer

For prescriptive compliance, replacement fenestration (equal to or less than the area of existing windows in each wall being altered) and new additional fenestration area must both meet the U-factor (0.32) and SHGC (0.25) in Package A. There are only 10 ft² of added fenestration, so the project meets Exception 1 to 150.2(b)1A and is not required to meet the Package A total glazing area requirement. All installed fenestration also must meet applicable mandatory measures.

To use the performance approach, two or more energy measures must be used as a trade-off within the house per §150.2(b)2. The two altered components may be the same type, such as trade-off between two or more windows, or different types such as replacing one window and a water heater. Once the project has at least two altered components, then the Existing + Alterations calculation is available as a compliance alternative. In that case:

- (a) In the Existing + Alterations approach *without* third party verification, replacement fenestration that achieves the fenestration values in Table 150.2-B of the Energy Standards is compared to those same values in the Standard Design. Replacement fenestration that does not reach these values is penalized.
- (b) In the Existing + Alterations approach *with* third party verification, replacement fenestration that achieves the fenestration values in Table 150.2-B of the Energy Standards is compared to §Tables 110.6-A and 110.6-B default values for the existing fenestration condition. Replacement fenestration that does not reach these values is penalized.
- (c) The use of window films in lieu of fenestration replacement are considered as an alteration option to existing fenestration for energy compliance. Similar to fenestration replacement, the window film must also meet the Standard Design for an altered component *with* or *without* third party verification as indicated in Table 150.2-B of the Energy Standards. Also, see window film installation protocols in RA4.2.3.

Example 9-16

Question

An existing building has all single-pane, metal-frame windows. A proposed remodel will replace all the windows; no other work is being done as part of the remodel. What applies?

Answer

Since only the windows are being replaced, all replacement windows must meet the prescriptive requirements of Package A, and new fenestration must also meet applicable mandatory measures of §110.6, §110.7 and §150.0.

If the prescriptive requirements of Package A cannot be met, the Existing + Alteration performance method can be used because more than two windows are being replaced.

Example 9-17

Question

An existing building has all single-pane, wood-frame windows. Two double-pane, metal-frame greenhouse windows will be added as part of a remodel. How should the greenhouse windows be treated?

Answer

Since greenhouse windows add conditioned volume, but do not add conditioned floor area, this remodel is considered an alteration rather than an addition. For the purposes of alterations, any dual-glazed greenhouse windows installed as part of an alteration may use §150.0(q) to meet the U-factor and Package A to meet SHGC requirement.

If two or more types of altered energy measures are in the existing building, the Existing + Alterations performance method may be used. All applicable mandatory measures must be met.

Note: Any dual glazed greenhouse or garden window installed as an alteration shall comply with the U-factor requirements in §150.1(c)3.

Example 9-18

Question

Why are low-sloped roofing products requirement only listed for Climate Zones 13 and 15?

Answer

These two climate zones are the only climate zones which show energy cost-effectiveness for having a low-slope roofing product (cool roof) requirement.

Example 9-19

Question

Why are there so many exceptions to the addition and alterations section that can be considered equivalents to roofing products?

Answer

There are several energy features that are equivalent or having greater impact on energy savings than the roofing products. For example, older homes often have ducts under the house, and newer homes may have materials slightly below current requirements or equal to one of the items considered to be equivalent. If the ducts are insulated and air leakage controlled to meet current requirements, energy savings are expected to be at least equal the benefit of reflective roof coverings.

Example 9-20

Question

What happens if I have a low-slope roof on most of the house but steep-sloped roof on another portion? Do I have to meet two different criteria for the roofing products?

Answer

Yes. If your house is in Climate Zones 13 or 15, you will need to meet the low-slope criteria for the areas with low-slope. The areas with steep-slope roof will need to meet the other cool roof criteria.

Example 9-21

Question

I am replacing my existing wood shake roof with asphalt shingles. Would this be considered a repair?

Answer

No. A repair is defined as a reconstruction or renewal for the purpose of maintenance of any component, system or equipment of an existing building. A replacement of any component (i.e., roof top), system, or equipment for which there are requirements in the Energy Standards is considered an alteration and not a repair.

Example 9-22

Question

Where do radiant barriers need to be installed when using prescriptive Package A or meeting the performance standards where credit is taken for retrofitting a radiant barrier in the existing house?

Answer

The radiant barrier only needs to be installed on the underside of an attic roof assembly and the gable wall ends associated with an addition. The prescriptive requirement is the same for entirely new buildings.

Example 9-23

Question

I am considering reroofing my house. Under what conditions will I be required to put on a cool roof?

Answer

Cool roof requirements are triggered when 50 percent or more of the roof area is being replaced. Prescriptive requirements are waived if one of the Exceptions to §150.2(b)1H below applies:

Prescriptive Exceptions for Steep-Sloped Roofs

1. Air-Space of 1.0 inch (25 mm) is provided between the top of the roof deck and the bottom of the roofing product.
2. The installed roofing product has a profile ratio of rise to width of 1 to 5 for 50 percent or greater of the width of the roofing product.
3. If existing ducts in the attic are insulated and sealed according to §150.1(c)9.
4. Buildings with at least R-38 ceiling insulation.
5. Buildings with an attic radiant barrier meeting the requirements of §150.1(c)2.
6. Buildings with no ducts in the attic.
7. Buildings in Climate Zones 10-15, R-2 or greater insulation above the roof deck.

Prescriptive Exceptions for Low-Sloped Roofs

1. Buildings with no ducts in the attic.
2. Aged solar reflectance and roof deck insulation R-value in Table 150.2-A are met.

Alternatively, the building may show compliance using the performance approach.

Example 9-24**Question**

I am building a 450 ft² addition on my house. Do I have to meet cool roof requirements in the prescriptive package?

Answer

Yes. If using prescriptive compliance, the roof must meet the cool roof requirements of Package A for the type of roof slope and density. To avoid the cool roof requirements, you may use the performance approach and tradeoff against other energy efficiency features of the addition alone or the existing building by using the Existing + Addition + Alterations approach.

9.6.2 Prescriptive HVAC System and Water Heating Alterations

The Energy Standards apply to alterations of the heating and cooling system whether or not the alterations correspond to an addition to the building. This section describes the conditions where compliance is necessary and describes the corresponding prescriptive requirements.

If the heating and cooling system is left unchanged as part of an addition or alteration, then compliance with the requirements for altered HVAC systems is not necessary. Extension of a duct is not considered a change to the existing heating and cooling equipment. However, the new ducts must meet mandatory requirements described in Section 9.4.2; and prescriptive requirements described below.

To meet the prescriptive alteration requirement for water heating, the water heating system shall be one of the following:

1. A natural gas storage or propane, non-recirculating water heater with an EF (Energy Factor) equal to or greater than the federal minimum; or
2. If no natural gas is connected to the building, electric storage tank water heater less than 60 gallons, or electric instantaneous with an EF equal to or greater than the federal minimum standards.
3. A water-heating system determined by the Executive Director to use no more TDV energy than item 1 above, or item 2 above if no natural gas is connected to the building.

Note: The performance compliance approach can be used to demonstrate that the proposed water heating system uses no more TDV energy than the system defined in item 1 above.

If it takes an extended period of time for hot water to get to a fixture, a common and cost effective solution may be to install a demand recirculation system. These systems can reduce both wait time and water waste (see Section 5.3.2 for more information). The installation of a manually controlled demand recirculation system that meets the requirement of RA4.4.9 meets the prescriptive alteration requirement of the Standards. Any other alteration to the hot water distribution system, such as timer or temperature control

recirculation systems, must be analyzed using the performance compliance approach to show that the energy use of the building has not been increased.

To decrease the wait time, another alternative may be to install a second water heater close to the fixture. Installing an additional water heater into an existing building's water heating system must be analyzed using the performance compliance approach to show that the energy use of the building has not been increased. However, if a natural gas or propane instantaneous water heater is added, the water heating system is pre-determined to comply with the prescriptive water heating alteration requirements. If instead, an additional storage water heater were to be added, the performance compliance approach must be used, as the added storage will increase the standby losses of the water heating system and that energy increase will need to be offset with other efficiency improvements.

Example 9-25

Question

I want to install an additional water heater to a single family residence with an existing natural gas water heater. Does this comply?

Answer

When there is an increase in the number of water heaters with an existing water heating system, the system must be analyzed using the performance compliance approach to show that the energy use of the system has not been increased. However, if the additional water heater is a natural gas or propane instantaneous water heater, the system automatically complies. No water heating calculations are needed.

The following table lists replacement heat pump water heating systems by climate zones that have equal or lower TDV energy than a standard design system with natural gas, LPG, or electric fuel source. These systems have been pre-calculated to comply with the prescriptive water heating alteration requirements when serving a single dwelling unit, with or without natural gas connection. These are only a few of many possible combinations that will comply using the performance compliance approach.

Table 9-7: Pre-calculated Replacement Heat Pump Water Heating Systems for Single Dwelling Units

CZ	Energy Factor greater than or equal to
1	2.75
2	2.75
3	2.75
4	2.8
5	2.75
6	2.33
7	2.5
8	2.33
9	2.33
10	2.33
11	2.5
12	2.8
13	2.5
14	2.5
15	2.33
16	EF \geq 3, plus a solar water heating system with solar saving fraction \geq 0.4

Example 9-26**Question**

An existing 1,500 ft² single family residence is getting a 500 ft² addition. A new 50 gallon gas water heater will replace the existing water heating system. How do the water heating requirements apply?

Answer

Since this is an alteration to an existing water heating system, no water heating calculations are required for compliance of the addition alone. However, applicable mandatory measures apply. For newly installed piping, all the applicable insulation requirements of §150.0(j)2 shall be met. For existing piping that are accessible, the insulation requirements §150.0(j)2i, iii, and iv shall be met, which include the first five feet of hot and cold water lines from the storage tank, piping between heating source to storage tank, and all piping associated with a recirculation system. If building energy compliance is achieved with the Existing + Addition + Alterations calculation, the EF and other energy features of the water heating system are modeled in the performance method.

Example 9-27**Question**

An existing 2,000 ft² single family residence has one 50 gallon gas water heater, and a 600 ft² addition with a new instantaneous gas water heater is proposed. How does this comply?

Answer

When there is an increase in the number of water heaters with an addition, the Energy Standards allow addition alone compliance in certain circumstances. Since this is an instantaneous gas water heater, it may be installed prescriptively with no water heating calculations. The mandatory requirements still apply.

The alternative to show compliance is by using the existing-plus-addition or whole building compliance.

Example 9-28**Question**

An existing single family residence with one electric water heater has a 500 ft² addition with a 30 gallon electric water heater proposed. Does this comply?

Answer

When there is an increase in the number of water heaters with an addition, the Energy Standards allow addition alone compliance in certain circumstances.

If this residence does not have natural gas connected to the building and the new water heater has an EF equal to or greater than the federal minimum standards, the system complies prescriptively. No water heating calculations are required.

If it does have natural gas connected, then the new water heater must be natural gas, or calculations are required to show the proposed water heater would use no more TDV energy than an instantaneous natural gas water heater.

9.6.2.1 HVAC "Changeouts"

The Energy Standards make a distinction between two HVAC "changeout" situations:

1. Entirely new or complete replacement space conditioning systems;
2. Altered space conditioning systems.

The differences in the requirements for these two types of HVAC changeout situations are discussed in the following sections.

A. Entirely New or Complete Replacement Space Conditioning Systems

When an *Entirely New or Complete Replacement Space Conditioning Systems* is installed, the system must meet all applicable mandatory measures, including:

§150.0(h) – Space conditioning equipment loads, design, installation, etc.

§150.0(i) – Thermostat requirements.

Note: The Mercury Thermostat Collection Act of 2008 requires manufacturers to establish a collection and recycling program for out-of-service mercury-added thermostats. For more information go to: www.dtsc.ca.gov/thermostats

§150.0(j)2 – Refrigerant line insulation thickness.

§150.0(j)3 – Refrigerant line insulation protection.

§150.0(m)1 – California Mechanical Code(CMC) compliance.

§150.0(m)2 – Factory fabricated duct system UL requirements.

§150.0(m)3 – Field fabricated duct system UL requirements.

§150.0(m)4 – Duct R-value minimum ratings.

§150.0(m)5 – Duct insulation thickness and R-value.

§150.0(m)6 – Duct labeling requirements.

§150.0(m)7 – Backdraft damper requirements on vent systems.

§150.0(m)8 – Gravity ventilation system dampers.

§150.0(m)9 – Protection of insulation.

§150.0(m)10 – Prohibition of using porous inner core.

§150.0(m)11 – Duct system sealing and leakage testing for new systems.

§150.0(m)12 – Air filtration requirements.

§150.0(m)13A – HSPP/PSPP, mandatory return duct sizing (or diagnostically tested airflow and fan efficacy).

§150.0(m)13B-C – Requirements for zonally controlled systems.

These systems must also meet the prescriptive requirements found in:

§150.1(c)6 – Allowed heating system types.

§150.1(c)7 – Space heating and cooling system minimum efficiencies and refrigerant charge verification in Climate Zones 2, 8 through 15.

§150.1(c)9 - Duct insulation requirements.

§150.1(c)10 – Central fan integrate systems added or required as part of an addition or alteration must meet the 0.58 watts per cfm requirement.

These requirements are discussed in detail in Chapter 4, HVAC Requirements.

Note: Completely New or Replacement Duct Systems in *multifamily* dwelling units shall meet the 12 percent (total leakage protocol), or 5 percent (leakage to outside protocol) criteria used for newly constructed systems (may also use the smoke test protocol if the system does not meet these criteria). Otherwise, altered duct systems in multifamily dwelling units shall meet the 15 percent (total leakage protocol), or 10 percent (leakage to outside protocol), or smoke test criteria given in §150.2(b)1Diib.

A system installed in an existing dwelling shall be considered an Entirely New or Complete Replacement Space Conditioning System when:

1. The air handler and all of the system heating/cooling equipment (e.g., outdoor condensing unit and indoor cooling or heating coil for split systems; or complete replacement of a package unit), are new, and
2. The duct system meets the definition of an *Entirely New or Complete Replacement Duct System (including systems less than 40 feet in length)*.

An altered duct system installed in an existing home shall be considered an Entirely New or Complete Replacement Duct System when:

1. At least 75 percent of the duct material is new, and
2. Any remaining components from the previous system are accessible and can be sealed.

Altered duct systems that do not meet the definition of *Entirely New or Complete Replacement Duct Systems* shall be considered an *Extension of an Existing System*.

Space conditioning systems that do not meet the definition of Entirely New or Complete Replacement Space Conditioning Systems shall be considered Altered Space Conditioning Systems.

B. Altered Duct Systems – Duct Insulation and Sealing Requirements

When more than 40 linear feet of ducts are installed in an unconditioned space, it must be insulated to an installed minimum R-value as described in Table 9-8.

Table 9-8: Duct Minimum R-Value

<i>Climate Zone</i>	1 -10, 12 & 13	11, 14 -16
<i>Duct R-value</i>	R-6	R-8

When more than 40 linear feet of ducts are installed in conditioned space, the ducts must be insulated to the minimum mandatory insulation level of R-4.2 and be verified to be in conditioned space by both visual verification and diagnostic testing in accordance to RA3.1.4.3.8.

Entirely New or Complete Replacement Duct Systems must meet the mandatory requirements of:

1. §150.0(m)12 – Air filtration requirements, and
2. §150.0(m)13 – HSPP/PSPP, mandatory return duct sizing (or diagnostically tested airflow and fan efficacy).

These requirements are discussed in detail in Chapter 4.

Entirely New or Complete Replacement Duct Systems must also be sealed to the criteria for “new duct systems” found in Table RA3.1-2, discussed below.

An Entirely New or Complete Replacement Duct Systems may also include the original air handler, which may leak substantially more than the new equipment. Therefore, an attempt should be made to seal the duct system and the air handler to meet the 5 percent (of nominal system central fan airflow) leakage rate criteria. If the 5 percent leakage rate criteria cannot be met, a smoke test should be performed to verify that the excess leakage is

non-accessible, and not from other *accessible* portions of the duct system. Note that the protocol for Smoke Test for accessible-duct sealing is given in RA3.1.4.3.7.

Note that this will satisfy the sealing requirement and does not cause the system to no longer meet the definition of an *Entirely New or Complete Replacement Duct Systems*.

Altered duct systems that do not meet the definition of *Entirely New or Complete Replacement Duct Systems* shall be considered an *Extension of an Existing System*. These duct systems are required to meet one of the leakage criteria for “altered existing systems” cases in Table RA3.1-2.

Duct sealing is a mandatory measure; therefore, alterations to an existing duct system, such as adding or replacing sections of duct, will trigger duct sealing. However, cost-effectiveness must also be taken into account. Having to seal an entire system because one foot of duct is being removed may not be cost effective. The Energy Standards set the length of 40 feet of duct that triggers this requirement.

If 40 feet of duct are being added or replaced, this work alone can trigger the requirement for duct sealing and field verification. The system would have to meet one of the leakage criteria for “altered existing systems” cases in Table RA3.1-2.

In addition to the duct sealing requirements, the added or replaced ducts must also meet the air distribution requirements of §150.0(m) and the duct insulation requirements of §150.1(c)9. The air distribution and duct insulation requirements must comply in all climate zones; however, these requirements apply to only new or replaced ducts, the existing and unaltered ducts do not need to comply with these requirements.

Installing 40 feet or less of new or replacement ducts alone will not trigger the sealing requirements described above; however, the new ducts and connections must still meet the air distribution and duct insulation requirements of §150.0(m) and §150.1(c)9.

C. Altered Space-Conditioning Systems - Duct Sealing

Existing duct systems must be sealed and verified by a HERS rater when portions of the heating and cooling system are altered. The requirement applies in all climate zones.

An air handler is installed or replaced.

Ducts must be sealed (as described below) under any of the following conditions:

1. An outdoor condensing unit of a split system air conditioner or heat pump is installed or replaced.
2. A cooling or heating coil is installed or replaced.
3. More than 40 feet of new or replacement ducts are installed.

If a residence has more than one duct system, only the ducts connected to the altered equipment need to be sealed and verified.

There are three options for showing compliance for existing duct systems listed below. The HERS Rater or installing contractor must at least attempt compliance with the first option (15 percent leakage); then any of the other options can be utilized:

1. Total leakage is less than 15 percent of nominal system fan airflow (RA3.1.4.3.1).
2. Leakage to the outside is less than 10 percent of system fan airflow (RA3.1.4.3.4).
3. If the first option (15 percent) leakage target cannot be met, then compliance can be achieved by sealing all accessible leaks verified by a HERS Rater inspection. When using this option, sampling is not allowed (RA3.1.4.3.5-7).

- a. HERS field verification is required for all options listed above. For options 1, and 2, verification can be accomplished through sampling as described in *Sampling for Additions or Alterations* below. For option 3, sampling is not allowed; a certified HERS Rater must do the visual inspection and the smoke test on every house.
- b. Since test equipment must be set up for the first three options, it may be most efficient to test and record the results for the existing system and then attempt to meet each option sequentially until compliance is achieved.
- c. There are a few cases where duct sealing and duct leakage verification are not required. These exceptions include the following:
 - Ducts that have already been sealed, tested, and certified by a HERS rater;
 - Duct systems with less than 40 feet of duct;
 - Duct systems that are insulated or sealed with asbestos.

D. Accessible Ducts

Several code sections and protocols require a smoke test to demonstrate that all accessible leaks have been sealed.

Accessible is defined in JA1 as “having access thereto, but which first may require removal or opening of access panels, doors, or similar obstructions.”

Ducts located in an attic or crawlspaces are generally considered accessible because code requires access to those spaces. Access is usually gained by opening a door, hatch, or other moveable panel. If this can be done without causing damage that would need to be repaired, this is considered accessible. It is not expected that drywall sections have to be cut or damaged to gain access.

Some judgment is required in determining if ducts are accessible. The local code enforcement agency will have the final say when it is not immediately obvious.

For example:

If a boot is buried in insulation, then the boot would be considered accessible since the insulation could be moved or the register could be taken off to gain access so that it can be sealed.

When an air handler is replaced, the removal of the air handler would give the installer access to the attached plenums and ducts. These newly accessible areas of the duct work shall be sealed since they may be source of air leakage. Special attention should be given to where wall cavities are used as plenums and ducts.

If the ducts are buried under insulation, and gaining access to the leaks in these ducts would require moving insulation, this would also be considered accessible.

If a leak in the duct system is in a space between framing members that is too small for the average person to reach the joint to seal it, this area is probably not accessible.

If ducts are suspended far above the ground and reaching them would require scaffolding or special equipment other than normal ladders, then these are probably not accessible.

If sheet metal ducts are wrapped with insulation and a smoke test indicates multiple small leaks along the lengthwise seams in the ducts in many locations, it is probably not cost effective to remove the insulation to find and seal these leaks. However, if one or more location shows a very obvious and substantial leak, it must be sealed.

All other portions of the duct system for which a smoke test identifies the presence of leakage must be sealed to comply. The exemption for inaccessible portions of the duct system is applicable only if the other criteria for duct leakage compliance cannot be met.

The installing contractor may perform a smoke test to locate and seal accessible leaks, or assess whether or not the duct leaks are accessible. However, compliance by smoke test and sealing all accessible leaks must be determined by a smoke test that has been conducted by a HERS rater.

E. Refrigerant Charge Verification

In climate zones 2, and 8 through 15, when a refrigerant containing component of an air conditioner or heat pump is replaced or installed in an existing building, §150.2(b)1F requires a system that does not have a fault indicator display (FID) installed to have refrigerant charge field verified in accordance with all applicable procedures specified in RA3.2.2, or RA1.

The Refrigerant Charge Verification (RCV) procedures in RA3.2 are not intended to replace the equipment manufacturer's charging procedures and specifications. The installer must first charge the system according to the manufacturer's instructions and specifications. It is important to know that the procedures in RA3.2 are not procedures for charging a system; rather, they are procedures for verifying proper charge. HERS raters are not allowed to adjust the refrigerant charge in systems that they are verifying. Raters are also prohibited from performing the weigh-in charge verification procedures. However, when specified by the Energy Standards, a rater may observe the installer while the installer performs the weigh-in procedure to verify compliance as specified in RA3.2.3.2 (described below).

In both cases the HERS rater must also confirm minimum system airflow.

1. **Fault indicator display.** As an alternative to RCV, the installer may install a special device called a fault indicator display (FID). When this alternative is used by the installer, a HERS rater must still field verify the installation and operation of the FID as well as confirm minimum system airflow.

This device provides real-time monitoring of the air conditioning system and will show a warning visible to the home's occupants when the system is either over or undercharged, or if the system airflow rate does not meet the minimum requirement. The display unit must be located within one foot of the thermostat.

When applicable, systems shall be equipped with an FID device that provides a clearly visible indication to the occupant when the air conditioner fails to meet the required system operating parameters specified in Section JA6 for the installed FID technology. The FID indication display shall be constantly visible and within one foot of the air conditioners thermostat. FID installations shall be confirmed by field verification and diagnostic testing utilizing the procedures specified in RA3.4.2.

2. **Minimum Airflow.** When RCV is required for compliance, the system must also comply with the minimum airflow of 300 cfm/ton according to the procedures specified in RA3.3.

Entirely New or Complete Replacement Space Conditioning Systems, as specified in §150.2(b)1C, must meet the minimum 350 cfm/ton airflow rate compliance criterion or the duct design alternative specified in §150.0(m)13.

3. **Alternative to Refrigerant Charge and Verification requiring at least 300 cfm per ton of airflow.** If the altered HVAC that requires RC&V is not able to comply with the 300 cfm per ton of airflow, the HVAC installer may choose the alternative procedure outlined in RA3.3.3.1.5, *Alternative to Compliance with Minimum System Airflow*

Requirements for Altered Systems, provided that the system thermostat is an Occupant Controlled Smart Thermostat (OCST) which conforms to the requirements of JA5.

Under RA3.3.3.1.5, the installer must take a series of remedial steps, including but not limited to cleaning filters, removing obstructions from registers and dampers, replacing crushed or blocked ducts, cleaning the evaporator coil, making sure that the air handler is set to high speed and conforms to manufacturer specifications, and enlarging/adding the return duct and the return grill. These steps must be verified by a HERS Rater.

Again, as mentioned above, when the installer chooses this option, the system thermostat must be an OCST.

- 4. Applicability of the protocols.** The RCV protocols in RA3.2 and RA1 are applicable only to air-cooled air conditioners and air-source heat pumps. Equipment types such as ground source, water source, and absorption air conditioners and heat pumps cannot be verified using the protocols in RA3.2 and RA1. When a system other than an air-cooled air conditioner or air-source heat pump is installed, the requirements in §110.1 may provide further direction for compliance.

If an aspect of the RA3.2.2 or RA1 verification protocol is not applicable to the system, alternative requirements may be specified §150.2(b)1F; however, the procedures in RA3.2.2 or RA1 that are applicable to the system shall be performed.

For example, if a system does not have both a high side and low side refrigerant access port, and cannot conform to the sub-cooling or superheat RCV procedure, but is a ducted system that can conform to the airflow measurement protocol, the system must comply with the minimum airflow requirement specified in RA3.2.2.7. Similarly, if the outdoor temperature is below 55°F which precludes use of the RA3.2.2 protocol for verification of the charge, and if the RA1 protocol cannot be used, then the weigh-in charging procedure in RA3.2.3.1 shall be used, and the minimum system airflow rate shall be verified using the protocols in RA3.3.

The installer must determine which procedures are applicable to a system and verify compliance accordingly.

- 5. Thermostats.** When an existing system has a refrigerant containing component added or replaced, the thermostat must be upgraded to a digital setback type that meets §110.2(c)
- 6. Package Units.** Package units are typically pre-charged at the factory prior to shipment. When a new package unit is being installed or is replacing an older unit, it may not require RCV if the installer certifies that it is factory charged and the installation did not alter the system in any way that would affect the refrigerant. The installer must submit a certificate of installation documenting this and third party verification of refrigerant charge by a HERS rater is not required. This only applies to new equipment shipped from the manufacturer. Any modification to existing equipment that adds or replaces refrigerant containing components voids this exception. It is important to note that this does not relieve the contractor from the requirement to verify that the system meets the minimum 300 cfm per ton airflow rate requirement.
- 7. Mini-Splits and Other System Types.** Some air-cooled air conditioning systems and air-source heat pumps cannot use the standard charge verification procedure, as specified in RA3.2.2, due to the design or construction of the system components. These include certain “mini-split” systems and variable speed condenser systems. In these cases, the installer must use the weigh-in charge procedures specified in RA3.2.3.1, and these systems must be HERS verified using the RA3.2.3.2 procedure for HERS Rater observation of the weigh-in charge procedure. These systems must also be

equipped with an Occupant Controlled Smart Thermostat (OCST) which complies with the requirements of JA5.

It is important that the installation of these types of systems be coordinated with the third party verification. When these systems are ducted, they are still subject to the minimum system airflow requirements.

1. **Winter Refrigerant Charge Verification.** Most systems will normally be verified using the RA3.2.2 standard charge verification procedure to demonstrate compliance. However, when the outdoor temperature is less than 55°F, and the standard charge verification procedure or an RA1 protocol cannot be used, the installer may elect to use the weigh-in charge method to demonstrate compliance. Compliance with HERS verification when the outdoor temperatures are less than 55°F can be demonstrated using one of the following alternatives:
 - a. The installer may use the weigh-in charging procedure, but elect to have the system verified by a HERS rater using the RA3.2.2 standard charge verification procedure at a time when the temperature is warmer. However, this option can delay the project. In this case, the installer must include the signatures of the homeowner and the HERS Rater on the CF2R - MCH25c form to notify the local enforcement agency that a correct refrigerant charge will be verified at a later time (RA 2.4.4). The installer must also provide written notice to the homeowner that the charge has not yet been verified (RA2.4.4).
 - b. EXCEPTION 1 to §150.2(b)1Fiib provides for an alternative HERS verification procedure if the weigh-in method is used. This exception allows the installer to use the HERS Rater verification procedure in RA3.2.3.2 in which the rater observes the installer while the installer performs the weigh-in charging procedure. However, when the HVAC installer elects this option, as specified in RA3.2.3.2, the system thermostat must be an OCST that conforms to the requirements of JA5.
2. **Weigh-in Procedure During Warm Weather.** The installer may use the weigh-in procedure when the outdoor temperature is at or above 55°F; in this case the rater must use the standard charge verification procedure.
3. **Weigh-in Procedure Description.** The weigh-in procedure involves charging the system by determining the appropriate weight of refrigerant based on the size of the equipment and refrigerant lines rather than by actual performance of the system. Systems using the weigh-in procedure by the installer for any reason may not be third party verified by using sample groups.

There are two variations of the weigh-in procedures. One involves the adjustment to the amount of refrigerant in a system by adding or removing a fraction of the refrigerant as specified by the manufacturer (weigh-in charge adjustment). The other involves evacuating the entire system and recharging it with the correct amount of refrigerant by weight (weigh-in total charge).

The weigh-in charge adjustment procedure may only be used when a new factory-charged condenser is being installed and the manufacturer provides adjustment specifications based on evaporator coil size and refrigerant line size and length.

The weigh-in total charge may be used for any weigh-in procedure but still requires manufacturer's adjustment specifications.

4. **Standard Charge Procedure Description.** The standard charge verification procedure also has two variations. One is for systems that have a fixed orifice and the

other is for systems that have a variable metering device such as a thermostatic expansion valve (TXV) or electronic expansion valve (EXV).

Both procedures, whether performed by the installer or the rater require that adequate airflow be confirmed prior to verifying charge. If the airflow is less than the minimum requirement of 300 cfm per ton, the system is not operating near its designed capacity or efficiency and the standard charge verification procedure is not valid.

The standard charge verification procedures involve taking refrigerant line temperatures and pressures, calculating equipment performance parameters and comparing those to targets either provided by the manufacturer or obtained from standard tables. All temperature and pressure measurements must be taken using calibrated digital meters. Analog gauges are no longer allowed for refrigerant charge verification procedures due to a lack of accuracy and precision.

In systems that have metering devices, the proper installation and performance can be verified by similar measurements and is an important part of the standard charge verification procedure for systems that have metering devices.

- 5. Verifying Minimum System Airflow.** The procedures for measuring total system airflow are found in RA3.3. They include plenum pressure matching using a fan flow meter, a flow grid, a powered flow hood, and the traditional (non-powered flow hood). The airflow verification procedures for refrigerant charge verification no longer include the temperature split method.

If a system does not meet the minimum airflow requirements, remedial steps may be required to bring the airflow up. More airflow is generally better for systems with air conditioning. Not only does this allow proper refrigerant charge to be verified, but it also improves the overall performance of the system. Minimum system airflow must always be verified regardless of the refrigerant charge verification procedure. §150.2(b)1F states that systems must be installed with “all applicable procedures,” which includes the minimum system airflow requirements.

In some cases, improving airflow may be cost prohibitive. The process for documenting this is in RA3.3.3.1.5. When this option is used, verification by sample groups is not allowed.

- 6. Temperature Measurements.** To properly perform the standard RCV procedure, a means of taking an accurate return air dry-bulb temperature must be provided by the installer. In most systems, this is accomplished by drilling a 5/16” measurement access hole in the return side of the air handler or return plenum as shown in Figure RA3.2-1. If the correct location for these holes is not accessible, an alternative location may be provided as long as an accurate return air temperature measurement of the air as it enters the return side of the equipment can be made.

In other cases, taking the return air dry-bulb temperature at the return grill may be appropriate. This is true when the return is located entirely within conditioned space and not subject to leakage or conduction that may change the temperature of the air after it passes through the return grill and before it enters the evaporator coil. This may also apply to equipment where the return grill is an integral part of the air handler, such as enclosed soffit-mounted air handlers (pancake units).

- 7. Maintaining 70°F Return Air Temperature.** During the data collection portion of the standard charge verification procedures, the return air dry bulb temperature, as measured at the measurement access hole, must remain at or above 70°F. This is to ensure proper refrigerant charge conditions, including but not limited to preventing the moisture on the coil from freezing. This requirement may be problematic during cooler

outdoor conditions (above 55°F but below 70°F). The return air temperature can be maintained above 70°F by utilizing the home's heating system or supplemental heaters. Note that the weigh-in method is always an option for the installer in these cases.

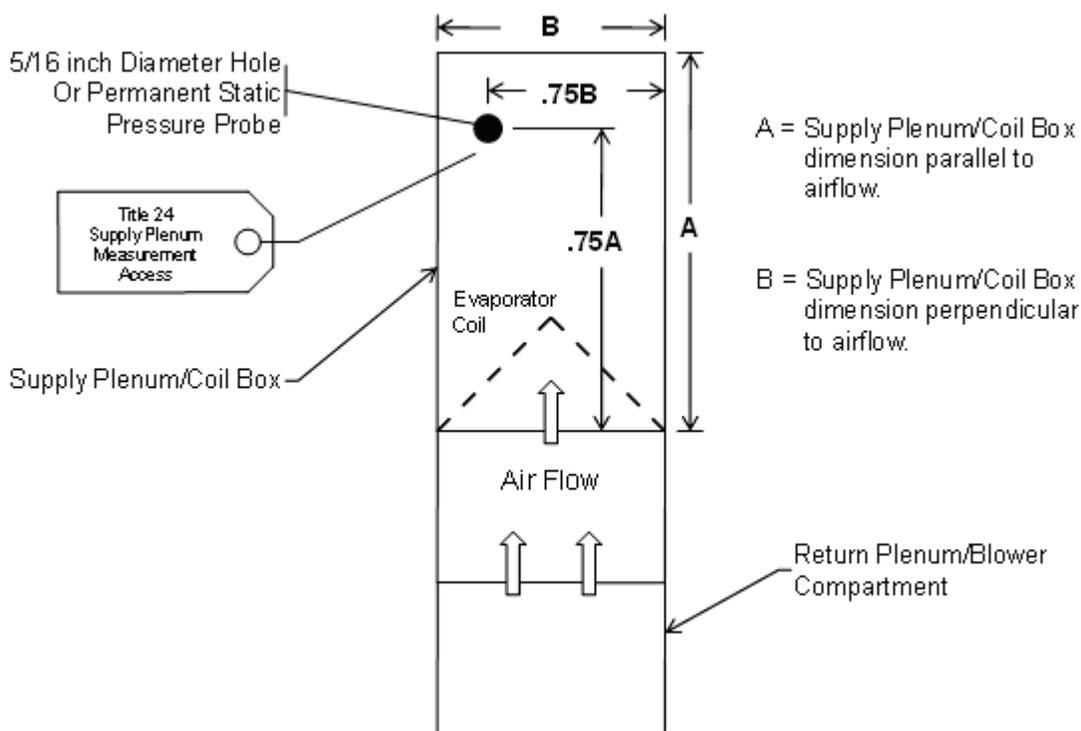
F. Airflow and Fan Efficacy

In all climate zones when an entirely new or replacement duct system is installed, the central forced air fan of all ducted air conditioners and heat pumps must simultaneously, in every zonal control mode, demonstrate airflow of greater than 350 CFM/ton of nominal cooling, and a fan watt draw of less than 0.58 W/CFM in accordance with the procedures in RA3.3.

As an alternative to the field verified air flow and fan efficacy requirements, the system's return ducts can be sized according to Tables 150.0-C or 150.0-D.

In addition to either the airflow/fan efficacy or return duct sizing alternative, the system installer must provide in the supply plenum, a hole for the placement of a static pressure probe (HSPP) or a permanently installed static pressure probe (PSPP), downstream of the evaporator coil that meets the specifications of RA3.3.1.

Figure 9-4: Hole for the Placement of a Static Pressure Probe (HSPP) or Permanently Installed Static Pressure Probe (PSPP)



These requirements are mandatory measures and cannot be traded off by using the performance approach; which is discussed in detail in Chapter 4.

Heating only space-conditioning systems are not required to meet the prescriptive cooling coil airflow and fan watt draw requirements.

G. Sampling for Alterations

When compliance for an alteration requires field verification and diagnostic testing, the building owners or their agents may choose to have testing and field verification completed for the dwelling unit alone, or as part of a closed sample group of dwelling units for which the same installing company has completed work that requires testing and field verification for compliance.

Registration of the compliance documentation is required and the procedures for this must be followed as described in Chapter 2 of this manual and in RA2.

Notes regarding sampling for alterations:

1. The sample group shall be no larger than seven.
2. The installing company may request a smaller group for sampling.
3. Homes in a sample group must all have the same set of features to be verified (duct testing, airflow/fan efficacy, refrigerant charge, etc.)
4. Homes with systems utilizing the weigh-in method for refrigerant charge verification by the installer cannot be sampled.
5. Whenever the HERS Rater for the group is changed, a new group will be established.
6. Field verification and diagnostic testing shall be completed by the HERS rater for at least one randomly selected dwelling unit in each group.
7. Re-sampling, full testing, and corrective action shall be completed if necessary, as specified in RA2.6.3.
8. The installing contractor must self-test and register certificates of installation for all features to be tested prior to the rater choosing a home for verification by sampling.
9. **Third Party Quality Control Program.** An approved Third Party Quality Control Program may serve some of the functions of HERS raters for field verification and diagnostic testing purposes but does not have authority to sign the Certificate of Verification (CF3R) as a HERS rater, as specified in RA2.7.

When a Third Party Quality Control Program is used, the HERS Rater must still submit completed, signed, registered copies of the CF3R to the enforcement agency, the installing contractor, and the builder or building owner for all dwellings that must demonstrate compliance.

1. **Setback Thermostat.** When a split system air conditioner or heat pump is altered by the installation or replacement of any refrigerant containing component and the existing thermostat is not a setback thermostat, then a new setback thermostat must be installed as described in Chapter 4 of this manual and as specified in §150.2(b)1Fi.
2. **Fuel Switching.** For prescriptive compliance, new electric resistance heating systems are prohibited in alterations unless the system being replaced is an electric resistance heating system. If the existing system is gas, propane, or LPG, then new electric resistance systems are not permitted. However, changing from a gas, propane, or LPG space heating system to an electric heat pump is allowed as long as the heat pump efficiency meets minimum efficiency standards, and the heat pump installed size is shown to result in no more TDV energy use than the standard design heat pump using the performance method as specified in §150.2(b)1C.

Table 9-9: Acceptable Replacement Heating System Fuel Source(s)

Existing Heating System Fuel Source	Acceptable Replacement Heating System Fuel Source(s)
Electric	Electric, natural gas, or equipment with efficiency equal to or better than existing system.*
Natural gas	Natural gas or equipment with efficiency equal to or better than existing system* or a heat pump with equal or lower TDV energy use than a standard design system.
LPG	Liquefied petroleum gas, natural gas, or equipment/system with efficiency equal to or better than existing system* or a heat pump with equal or lower TDV energy use than a standard design system.

* Proof that equipment has an efficiency that is equal to or better than the existing system can be demonstrated by an approved compliance program or other approved alternative calculation method to compare the TDV energy use of the existing system to the proposed system.

Table 9-10 summarizes requirements for the following types of residential mechanical and water heating system alterations:

1. New or complete replacement space conditioning system: all new equipment and all new ducts with more than 40 linear feet of duct.
2. Altered space conditioning system with forced air ducts.
3. Altered mechanical cooling system.
4. Altered duct systems: when more than 40 linear feet of new or replacement ducts.
5. Installed a zonally controlled central forced air system.
6. Replaced water heater(s) and altered hot water pipe(s).

It is important to accurately identify the type(s) of alteration within the permitted scope of work. For example, duct sealing and HERS testing is a mandatory measure when there is a new or complete replacement space conditioning system and greater than 40 linear feet of duct. However, when only new or replacement ducts are being installed, and there is no new space conditioning equipment involved, duct sealing and HERS testing is a prescriptive measure. A key to using Table 9-10 effectively is to have a good understanding of the scope of the proposed alterations.

Example 9-29

Question

Do I have to seal the ducts if I replace the outdoor units in my house without changing the indoor unit?

Answer

Yes, replacing the outdoor unit (or indoor unit) by itself will trigger the duct sealing and verification requirement (§150.2(b)1E). However, there are two exceptions that might apply:

1. If the ducts have been previously sealed and verified as sealed, the ducts do not have to be sealed again and re-verified.
2. If there is less than 40 linear feet of the duct.

Example 9-30

Question

I have an existing electric furnace and I'm adding a new bedroom. Can I extend the existing ducts to the new room and use the existing furnace?

Answer

Yes. If ducts are extended from an existing space conditioning system, §150.2(b)1D allows the existing system but requires duct sealing if more than 40 linear feet of the new duct work is installed. The existing furnace must have adequate heating capacity to meet California Building Code requirements for the additional space.

Example 9-31

Question

I am adding a bedroom to a house that has a central forced air natural gas furnace. I would like to heat the room with an electric resistance baseboard heater rather than extend the existing ductwork to reach the new space. Is this allowed?

Answer

No. If using prescriptive compliance and since the existing system is gas, the addition cannot use an electric heating system. Options for heating the space include:

1. Extending the existing natural gas furnace system as long as there is adequate capacity to meet the California Building Code requirement.
2. Heating the added bedroom with an electric resistance heater is allowed if the performance approach is taken and the relatively high TDV energy consumption of the electric resistance heater is made up by TDV energy reductions from energy efficiency measures in the addition or in an accompanying alteration.

Note: If there are more than 40 linear feet of added ducts, then the ducts must be sealed, tested and verified as sealed by a HERS rater.

Example 9-32

Question

My central gas furnace stopped working. Since it is about 30 years old, I decided to get a new more efficient unit rather than repair the existing one. What are the requirements?

Answer

Mandatory requirements apply to the components being replaced. The furnace, of course, must meet minimum efficiency requirements, but all systems sold in California should already meet the minimum efficiency requirements. If the existing thermostat is not a setback thermostat, it must be replaced with a setback thermostat, as specified in §150.2(b)1Fi that meets the requirements described earlier in this chapter.

All new ducts must meet insulation and construction requirements. All existing and new ducts must be sealed and HERS verified, as specified §150.2(b)1E.

Prescriptively, the new heating unit must be natural gas or heat pump.

The performance approach could be applied but only if the alteration includes “tradeoffs between two or more altered components that are listed in Table 150.2-B” (insulation, fenestration, space conditioning equipment, air distribution systems, water heating system, roofing, and other measures). Thus, if other alterations are also being done, one could specify other heating equipment such as a high efficiency heat pump, condensing gas furnace, or electric resistance, as long as the overall project has a lower TDV energy consumption than the “standard design.” When using the performance approach one can decide to either use the default standard design efficiencies that the alteration is compared against. Alternately one can hire a HERS rater to document the existing efficiencies and these existing efficiencies can be used in the standard design of performance calculation.

Example 9-33

Question

As part of an upgrade in an existing house, one of the ducts is being replaced because of deterioration of the insulation and jacket. What requirements apply to the replacement duct?

Answer

This is an alteration to the space conditioning system; therefore the mandatory measures for ducts apply. If more than 40 feet of the ducts are altered, then the requirements of §150.2(b)1D would trigger diagnostic testing and HERS verification of the whole duct system.

Example 9-34

Question

An upflow air-handling unit with a furnace and air conditioning coil is located on a platform in the garage of an existing house. The platform is used as a return air plenum. The air-handling unit is being replaced and the platform is being repositioned to the corner of the garage (three feet away from the current location). What requirements apply to this alteration?

Answer

The mandatory requirements apply to this alteration. In particular, §150.0(m) prohibits raised platforms or building cavities from being used to convey conditioned air (including return air and supply air). When the platform is relocated, it is being altered, and the mandatory requirement applies. Ducts made from sheet metal, duct board, or flexible ducts must be installed to carry the return air to the replaced air handler. This requirement would not apply if the platform were not being altered.

Since the air handler is being replaced the prescriptive duct sealing requirements apply per §150.2(b)1E, unless the ducts have been previously sealed and confirmed through verification or there is less than 40 linear feet of duct.

Example 9-35

Question

What is meant by the term "air handler?"

Answer

The term "air handler" is used to identify the system component that provides the central system forced air movement for the ducted heating or cooling space-conditioning system. The term "air handler" may be properly used to identify various types of central system forced air-moving components that must meet the functional requirements for different types of space-conditioning systems. For instance, a "gas furnace" air handler includes a gas combustion heat exchanger and the central system fan, but does not include a DX cooling coil; an "electric furnace" air handler has electric heating coils and the central system fan, but does not include a DX cooling coil; a "fan-coil unit" air handler for a split system heat pump has a DX cooling/heating coil and a central system fan; a "hydronic heat pump" air handler includes the air-side DX coil, compressor, water-cooled condenser, and the central system fan. There are other air handler configuration variations as well.

Example 9-36

Question

I have a residential building that was constructed in the 1920s. It has a freestanding gas furnace and I want to change it to an electric wall heater. Is this permitted?

Answer

No. §150.2(b)1Cii states that the new space-conditioning system be limited to natural gas, liquefied petroleum gas, or the existing fuel type unless it can be demonstrated that the TDV energy use of the new system is more efficient than the existing system. For your situation you would have to use gas or a heat pump for compliance.

Table 9-10: Residential Alteration, Summary of Mandatory and Prescriptive Measures

Type of Mechanical System Alteration	Highlight(s) of Applicable Mandatory Measures ¹	Summary of Relevant Prescriptive Measure(s)	Exception(s) to the Prescriptive Measures	Prescriptive Compliance Form(s)
<p>New or Complete Replacement Space Conditioning System (New Equipment and All New Ducts > 40 ft.)</p>	<p>New equipment must meet all minimum efficiency and other requirements in §150.0(h), 150.0(i), 150.0(j)2, 150.0(j)3, 150.0(m)1 thru 11: duct sealing & HERS testing with forced air duct systems</p>	<p>All requirements of §150.1(c)6,7,9 & 10, 150.2(b)1D; and heating system limited to natural gas, LPG or existing fuel type</p>	<p>Exemption from fuel type requirement if new system can be shown to use less TDV energy than the existing system.</p>	<p>CF1R-ALT or CF1R-ALT-HVAC; (CF1R must be registered w/ a HERS Provider)</p>
<p>Altered Space Conditioning System with Forced Air Ducts</p>	<p>New equipment must meet all the minimum efficiency and other requirements in §150.0(h), §150.0(i), §150.0(j)2, §150.0(j)3, §150.0(m)1 thru 11</p>	<p>Duct sealing & HERS testing per §150.2(b)1.E</p>	<p>(1) Duct systems documented as previously sealed and HERS tested; or, (2) Duct systems with < 40; or, (3) Existing duct system constructed, insulated or sealed with asbestos</p>	<p>CF1R-ALT or CF1R-ALT-HVAC; (CF1R must be registered w/ a HERS Provider)</p>
<p>Altered⁽⁵⁾ Mechanical Cooling (Refrigerant-Containing) System</p>	<p>New equipment must meet all the minimum efficiency and other requirements in §110.2(c), §150.0(h), §150.0(i), §150.0(j)2, §150.0(j)3, §150.0(m)1 thru 11</p>	<p>In CZ2, 8-15: refrigerant charge per RA3.2.2 and & HERS testing per §150.2(b)1.F.i.b. Minimum system airflow per §150.2(b)1Fia</p>	<p>(1) Packaged systems w/ correct, verified and documented refrigerant charge do not require HERS testing (2) When outdoor temperature < 55o F. and refrigerant weigh-in charging used and HERS test RA3.2.3.2 used, system thermostat must be Demand Response.</p>	<p>CF1R-ALT or CF1R-ALT-HVAC; (CF1R must be registered w/ a HERS Provider)</p>

<p>Altered Duct Systems: When > 40 ft. of New or Replacement Ducts are Installed</p>	<p>New ducts must meet applicable portions of §150.0(m)1 thru 11 including duct insulation in Table 150.1-A. Entirely new and complete replacement duct systems must meet additional requirements in §150.0(m)12 and 13.</p>	<p>New or Replacement Duct System: duct insulation per §150.2(b)1i., sealing & HERS testing per §150.2(b)1.D.ii.a. Extension of Existing Ducts By > 40 ft: HERS testing of existing duct system per §150.2(b)D.ii.b.</p>	<p>Exception to 150.2(b)D.ii.b. Duct Sealing: when existing duct system is constructed, insulated or sealed with asbestos.</p>	<p>CF1R-ALT or CF1R-ALT-HVAC; (CF1R must be registered w/ a HERS Provider)</p>
<p>Installing Zonally Controlled Central Forced Air System</p>	<p>Airflow > 350 CFM/Ton cooling Fan < 0.58 W/CFM HERS testing §150.0(m)13</p>	<p>Bypass ducts that deliver conditioned supply air directly to the return duct airflow may not be used §150.1(c)13</p>	<p>N/A</p>	<p>CF-1R-ALT or CZ-Specific CF-1R-ALT-HVAC, MF-1R (CF-1R must be registered w/a HERS Provider)</p>
<p>Replacement Water Heaters and Altered Piping</p>	<p>New equipment must meet minimum efficiency and other requirements in §110.1, 110.3 and 150.0(j)2 Exception to §150.0(j)2: Inaccessible piping requires no insulation</p>	<p>(1) A natural gas or propane water heater. With recirculation system, only Demand Recirculation with manual controls or, (2) If no natural gas is connected to the building: an electric water heater. For electric resistance storage water heaters, storage tank < or = 60 gallons. With recirculation system, only Demand Recirculation with manual controls</p>	<p>According to a calculation method approved by the CEC. Any water heating system that uses no more TDV energy than the prescriptive natural gas/propane water heater, or When no natural gas is connected to the building, any heating system that uses no more TDV energy than the prescriptive electric water heater.</p>	<p>CF-1R-ALT, or CF-1R-ALT-HVAC, MR-1R</p>
<p>Note: Alterations must comply with all applicable mandatory measures in §110.0 and §150.0 of the Energy Standards as explained in Chapters 3, 4, 5, and 6 of this manual, except as noted in §150.2(b).</p>				

9.7 Performance Method

9.7.1 Addition Alone

Additions may comply using the performance approach for an addition alone. With only two exceptions, the energy budget is the same as is required for new construction. The two exceptions are: (1) For additions that are 300 ft² or less no cool roof requirements apply, and (2) if Package A requires a whole house fan, the requirement does not apply to additions that are 1,000 ft² or less.

9.7.2 Summary of Existing + Additions + Alterations

1. Performance compliance may not be used for tradeoffs for an alteration alone unless there are at least two or more altered components listed in §150.2 and Table 150.2-C.
2. Existing roofs/ceilings removed as part of an addition or alteration--and all existing skylights being removed as part of the removed roofs/ceilings--**are excluded** (not modeled) in the Existing + Addition + Alterations (E+A+A) performance calculations.
3. Existing exterior walls removed as part of an addition or alterations--and all existing vertical fenestration (windows, clerestories, glazed doors) being removed as part of the removed walls--**are excluded** (not modeled) in the E+A+A performance calculations.
4. Only “Existing,” “Altered,” and “New” building components and/or systems are included and modeled in the E+A+A performance calculations.
5. Existing fenestration not being removed as part of an alteration can now be improved with window films and can be modeled in the E+A+A performance calculations.
6. **Without** third party verification of the building’s existing (pre-alteration) conditions, the E+A+A approach no longer provides energy credits based on altered components which upgrade (improve) the existing conditions until a fairly high threshold is met. See §150.2(b)2B and Table 150.2-C of the Energy Standards.
7. **With** third party verification of the building’s existing (i.e., pre-alteration) conditions, the E+A+A approach still provides energy credits based on altered components which upgrade (improve) the existing conditions. See §150.2(b)2B and Table 150.2-C of the Energy Standards.

9.7.3 Performance Method: Existing + Addition + Alterations Approach

Additions may comply using the performance approach with one of the following compliance paths summarized in Section 9.3, Table 9-1:

1. E + A + A Without Third Party Verification;
2. E + A + A With Third Party Verification;
3. E + A + A as New Construction.

Energy Commission-approved compliance software is used to model the building as explained in Chapter 8. Whichever compliance path is selected, the Certificate of Compliance (CF1R) generated by the software must be submitted for permit. If the CF1R includes energy measures that require HERS testing or verification, the CF1R must also be registered online with a HERS provider. See Chapter 2 of this manual.

To learn more about using the Existing + Addition + Alterations performance approach, see Table 9-4.

9.7.3.1 Existing + Addition + Alterations Without Third Party Verification

The existing building with all alterations is modeled together with the addition and **existing** conditions are not verified by a third party HERS Rater. The Standard Design that sets the energy budget for this approach is automatically based only on the type of each altered component and not on the existing conditions. Under this performance path the building is modeled as follows:

1. Addition: All new components at the addition and all new systems serving the addition are modeled including roof/ceilings, skylights, exterior walls, glazing (fenestration),

raised floors and slab floors, HVAC equipment, ducts, and water heating. All of these components are tagged within the compliance software as “New.”

2. **Existing Components to Remain Unchanged:** Existing components and systems to remain as is (untouched) are modeled and tagged within the compliance software as “Existing.”
3. **Existing Components to be Altered or Replaced:** Each altered component (i.e., a new component which replaces an existing component) is modeled and tagged within the performance compliance program as “Altered.” For example, a new water heater that replaces an existing water heater would be labeled “altered” whereas a new water heater that is added to supplement an existing water heater would be labeled “new.” Also, new mechanical equipment that does not replace existing mechanical equipment would be tagged as “new.” Verification of existing conditions is not required for this compliance path; therefore, no “existing” (pre-alteration) conditions are specified.
4. **Existing to be Removed:** Existing roof/ceilings to be removed as part of the permitted work, plus any skylights within those removed roof/ceilings, are excluded from the model (i.e., they are completely omitted from the calculations); exterior walls to be removed and all fenestration areas in those walls are not modeled; raised floors and slab-on-grade floors to be removed are also omitted.

Note: Portions of new fenestration including skylights that will occur in the existing opening of fenestration to be replaced are tagged “altered.” Portions of new fenestration that will occur where there is no existing fenestration opening are labeled “new.”

- **Advantages:** Energy improvements to the existing building that go beyond the Standard Design levels are an energy credit that can be “traded” against features of the addition that are less energy efficient than required by the prescriptive levels that set the Standard Design for the addition alone. For example, an addition with a large glazing area may comply by replacing the existing HVAC system with high-efficiency equipment.
- **Disadvantages:** Detailed plans and other information on the existing building may be difficult to document and obtain. The E+A+A analysis may be relatively complex and time-consuming.

9.7.3.2 Existing + Addition + Alterations With Third Party Verification

The existing building with alterations is modeled together with the addition(s); and existing conditions of the components being altered must be verified by a third party HERS Rater before construction begins. The Standard Design that sets the energy budget may, depending on the energy efficiency of the altered component or system, be based on the pre-altered existing conditions. In those instances, energy credit is calculated as a function of the difference between pre-altered existing conditions and post-alteration energy measures. Under this approach the building is modeled as follows:

1. **Addition:** All new components for the addition and all new systems serving the addition are modeled including roof/ceilings and skylights, exterior walls and glazing (fenestration), raised floors and slab floors, HVAC equipment, ducts, and water heating. All these elements are tagged within the compliance software as “new.”
2. **Existing Components to Remain Unchanged:** Existing components and systems to remain as is (untouched) are modeled and tagged within the compliance software as “Existing.”

3. **Existing Components to be Altered or Replaced:** First, select “HERS verification of existing conditions” in the compliance software. This unlocks software inputs for both “existing” and “altered” characteristics for those particular building features. The compliance software will not give the option to enter pre-altered existing conditions, if you do not specify that the existing conditions will be HERS-verified.

Each altered component (i.e., a new component that replaces an existing component) is modeled and tagged within the performance compliance program as “Altered.” The corresponding HERS verified existing component or system to be changed is modeled and tagged within the same entry in the compliance software as “existing.” For example, if existing HERS-verified single pane metal frame window are replaced with NFRC-rated super-efficient windows, to receive the maximum energy credit one must identify the existing windows to be HERS-verified. Then, each altered window input would include both “existing” and “altered” window types.

Note: Any window area in addition to that being replaced would be labeled “new” not “altered.”

5. **Removed Surfaces:** Existing roof/ceilings to be removed as part of the permitted work, plus any skylights within those removed roof/ceilings, are excluded from the model (i.e., they are completely omitted from the calculations). Exterior walls to be removed and all fenestration areas to be removed in those walls are not modeled; raised floors and slab-on-grade floors to be removed are also omitted.
- **Advantages:** Energy improvements meeting certain threshold values are credited based on the difference between existing conditions and the altered component or system. These energy credits can be “traded” against features of the addition that are less energy efficient than required by the prescriptive levels that set the Standard Design for the addition alone. For example, an addition with a large glazing area may comply by upgrading insulation levels in the existing house.
 - **Disadvantages:** Detailed plans and other information on the existing building may be difficult to document and obtain. The E+A+A analysis may be relatively complex and time-consuming. A third party verification must be conducted of selected existing conditions to be altered prior to construction, and verification must be registered online with a HERS provider prior to permit submittal.

9.7.3.3 Existing + Addition + Alterations as New Construction

A compliance approach rarely used, but available within the Energy Standards, is to model Existing + Addition + Alterations as all “new” components and systems and the compliance software sets the energy budget as if the project were an entirely new building.

- **Advantages:** Modeling the existing building with alterations and additions as all new makes the performance analysis relatively simple and less time-consuming. This method will provide the owner and designer with energy efficiency compliance relative to requirements for new construction. Any owner who wants to bring their building up to new construction efficiency levels should have their project modeled as “new.”
- **Disadvantages:** The energy budget with this approach is very stringent. Unless a building is going through a complete retrofit of all its envelope components, as well as replacing all mechanical and water heating systems, it is unlikely that the building will meet the Energy Standards with this approach.

9.7.3.4 Summary of Modeling Rules

Table 9-4 summarizes the basic rules for compliance software users analyzing a residential addition or alteration using the Existing + Addition + Alterations approach. For further information, see the specific compliance software user's manual for details on how to input data correctly.

Example 9-37

Question

A 1,600 ft² house built in 1980 in climate zone 12 is being renovated as follows:

1. A 500 ft² room will be added, including 120 ft² of new windows.
2. A 200 ft² wall and 100 ft² of old window will be removed.
3. Attic insulation in the existing house will be upgraded to R-38.
4. The addition will be connected to the existing HVAC and duct system.

If the performance approach is used to demonstrate compliance, how does the compliance software establish the standard and proposed designs?

Answer

Table 9-4 summarizes the Modeling Rules for Existing + Addition + Alterations which must be followed to have the compliance software accurately set the standard design and model the proposed design. Under the 2016 Standards performance rules, the 200 ft² wall removed and the 100 ft² of old window within it are not included in the energy model and will have no impact on the standard design. The standard design for the addition portion is set using the prescriptive requirements of §150.1(c). If the existing duct system is extended by 40 linear feet or more, the standard design assumes the duct alterations requirements summarized in Table 9-5.

The standard design assumptions for the existing house follow the rules summarized in §150.2(b)2 and Table 150.2-B based on whether there is a third party verification of the existing conditions. Without third party verification, upgraded energy components in the existing house are modeled as fixed assumptions in the standard design that represent levels of efficiency reasonably expected for each altered component. If the energy analyst using the compliance software selects third party verification of energy components in the existing house to be upgraded, the standard design assumes the existing conditions for those components to be as part of the alterations.

If the proposed design including Existing + Addition + Alterations does not pass, other energy components of the existing building and/or the addition may have to achieve compliance. For example, the water heater or the HVAC equipment in the existing portion of the house may be upgraded to achieve additional credits towards compliance. In the addition, higher performing windows and higher levels of roof and wall insulation may also be used to achieve compliance.

Example 9-38

Question

For the 1980 house in the examples above, an operable single pane metal window is replaced with a 0.55 U-factor window. Does this alteration result in a compliance credit? How about the case where the existing window is replaced with a window that has a U-factor of 0.35?

Answer

As explained in Example 9-36, altered components that receive compliance credit must exceed the requirements of Table 150.2-B. Windows in the addition must have a U-factor of < 0.32 and SHGC < 0.25 to receive credit. Replacement windows in the existing house must have a U-factor of < 0.40 and SHGC < 0.35 to receive credit.

A window replacement with a 0.55 U-factor will receive a penalty as compared with a 0.40 U-factor standard design assumption for that window. **Without** third party verification of existing conditions, a 0.35 U-factor window replacement will receive a credit as compared with a 0.40 U-factor standard design assumption for that window. **With** third party verification of existing conditions, a 0.35 U-factor window replacement will receive a credit as compared with a 1.28 U-factor standard design assumption for an operable single pane metal existing window.

Although this example describes a window alteration, the same principles apply to other building systems, such as other building envelope components as well as HVAC and water heating equipment.

Example 9-39

Question

An addition of 590 ft² is being added to a 2,389 ft² single family house. How do you demonstrate compliance using the Existing + Addition + Alterations method?

Answer

The first step is to determine whether alterations to the existing building include at least two components (e.g., upgrading attic insulation and replacing the water heater, or more than one window.) If so, use the E+A+A approach. If not, do not use the performance approach.

Assuming the E+A+A calculation is permissible, the next steps are:

1. Collect accurate envelope and mechanical information about the existing building from scaled drawings (plans, sections, and elevations); determine what components, (HVAC, ducts, water heating, etc.) are being altered as part of the permitted scope of work.
2. Enter the information about the addition and the existing building into the compliance software program, identifying each modeled feature as “existing,” “altered,” or “new” as summarized in Table 9-4. Proper tagging of each of these inputs is critical to correctly and accurately determine compliance.
3. Run the compliance software to determine if the proposed building TDV energy is equal or less than the standard design TDV energy.
4. If it is not, modify the energy features of the addition and/or the existing building until compliance is achieved; print out the compliance report for permit submittal.
5. All projects that include energy measures requiring HERS field verification and diagnostic testing--which represent almost all buildings under the 2016 Energy Standards--must be registered online with a HERS provider as explained in Section 2.3.

Example 9-40

Question

When using the existing-plus-addition performance approach, do the refrigerant charge, access holes (MAH and STMS) or FID, see §150.1(c)7, airflow, watt draw measurement, and static pressure probe (HSPP), or a permanently installed static pressure probe (PSPP) as specified in §150.0(m)13 and need to be met for central split system air conditioners serving an addition?

Answer

If existing equipment is extended to serve the addition, these space conditioning requirements do not need to be met as specified by Exception 4 to §150.2(a). However, Exception 5 to §150.2(a) indicates that the duct system that is to be extended must be sealed, tested, and HERS verified according to §150.2(b)1D.

For performance compliance in climate zones that require a refrigerant charge and airflow measurement in Package A, a hypothetical standard design SEER split system with this credit would be modeled in both the standard and the proposed designs (for example, values from the vintage table, or minimally complying equipment), resulting in neither credit nor penalty related to this feature.

If a new central split system is installed to serve the addition, it must meet the requirements of §150.2(b)1C where installation of a new air conditioner to serve both the existing house and the addition is considered an alteration, and must meet the requirements for diagnostically tested refrigerant charge measurement fan airflow, watt draw, and other requirements described. The duct sealing, testing, and verification requirements of §150.2(b)1E must also be met.

Example 9-41

Question

When using the E+A+A performance method, can compliance credit be gained by sealing the existing ducts when it was not required for prescriptive compliance?

Answer

Yes. Credit can be obtained from sealing, testing, and HERS verification of duct sealing.

However, as shown in Table 150.2-B “Standard Design for an Altered Component,” the base case duct leakage will be the requirements in §150.2(b)1D (i.e., with 15 percent duct leakage or 10 percent leakage to the outside). Sealing below 15 percent can be difficult if the ducts are not readily accessible and large holes are present in the ducts. An alternative approach is to replace the ducted system with a ductless system such as a mini-split.

Example 9-42

Question

When using the existing plus addition performance compliance method, can credit be gained by installing a radiant barrier in the existing house attic? If so, where does the radiant barrier need to be installed?

Answer

Yes, installing a radiant barrier in the existing building will result in a credit relative to the standard design for existing buildings permitted (or constructed) prior to June 1, 2001. The radiant barrier must be installed over the entire attic/roof area including gable walls. If there are roof/ceiling assemblies where it is not possible to reach the underside of the roof, such as roof/ceiling assemblies using enclosed rafters which are not proposed to be exposed as part of the project, the radiant barrier cannot be properly installed and compliance credit is not possible.

Example 9-43

Question

I am adding a room to and altering an existing building in climate zone 12. I am upgrading a single-pane clear glass window with a U-factor of 1.2 and SHGC of 1.0 to a dual-pane window with a U-factor of 0.50 and SHGC of 0.45. Do I receive credit toward the addition compliance for installing this window?

Answer

No. There will be a penalty toward achieving compliance since the window is not as efficient as required by Table 150.2-B for climate zone 12 which requires a U-factor of 0.40 and an SHGC of 0.35. The penalty for the U-factor is based on the difference between 0.40 and 0.50 and for the SHGC is based on the difference between 0.35 and 0.45. If fenestration is installed which exceeds the performance of the values in Table 150.2-B, then credit is available.

Example 9-44**Question**

I am planning on installing R-19 insulation in the attic of an existing house built in 1970. Can I use this added insulation as a credit for trading with the energy features of an addition?

Answer

No. When insulation is added to an attic, it must comply with §150.0(a) which sets a mandatory minimum for attic insulation of R-22. No credit is allowed until the mandatory minimum R-22 is reached.

Example 9-45**Question**

I am planning on installing R-25 insulation in an un-insulated vaulted ceiling without an attic space in an existing house built in 1970. Can I use this added insulation as a credit for trading with the energy features of an addition?

Answer

Yes. Since there is no attic space, the requirements of §150.0(a) require only R-19 or the equivalent between roof rafters. When you install R-25 you are allowed to take credit for the difference between R-25 and R-19 without third party verification of existing conditions. With third party site verification of the existing un-insulated vaulted ceiling prior to construction, you may take credit for the difference between the R-25 and R-0 (no insulation) in the vaulted ceiling.

