7 Additions and Alterations

Additions, alterations and repairs are common construction projects for California homeowners. The *Standards* apply differently to each.

- An addition is a change to an existing building that increases conditioned floor area and volume. Converting a garage or unheated basement into a conditioned living space, enclosing and conditioning a patio, or building onto a home are all examples of an addition. The prescriptive Package D or the performance requirements apply to the increased floor area as if it is a new building. .
- An alteration is a change to an existing building that is not an addition. An alteration could include a new water heater, heating system, air conditioner, lighting system or a change to the building envelope, such as new window.
- A repair is the reconstruction or renewal of any part of an existing building for the purpose of its maintenance. Repairs to low-rise residential buildings are not within the scope of these *Standards*.

The *Standards* apply to both additions and alterations, but not to repairs. The application of the *Standards* is somewhat tricky to additions and alterations because of the need to work around existing conditions. As a result the *Standards* have some special requirements and performance modeling rules for additions and alterations, which are explained in this chapter. The chapter is organized in the following sections:

Compliance Approaches for Additions

Prescriptive Requirements for Additions

Performance Requirements for Additions

Documentation for Additions

Alterations

Repairs

7.1 Compliance Approaches for Additions

Definitions
§101(b)

ADDITION is any change to a building that increases conditioned floor area and conditioned volume. See also, NEWLY CONDITIONED SPACE.

…

NEWLY CONDITIONED SPACE is any space being converted from unconditioned to directly conditioned or indirectly conditioned space, or any space being converted from semiconditioned to directly conditioned or indirectly conditioned space. Newly conditioned space must comply with the requirements for an addition. See Section 149 for nonresidential occupancies and Section 152 for residential occupancies.

§152

(a) ***Additions***. *Additions to existing residential buildings shall meet the requirements of Sections 111 through 118, Section 150, and either Section 152 (a) 1 or 2.*

EXCEPTION 1 to Section 152 (a): *Existing structures with R-11 framed walls showing compliance with Section 152 (a) 2 (Performance Approach) are exempt from Section 150 (c).*

EXCEPTION 2 to Section 152 (a): *Any dual-glazed greenhouse window and dual-glazed skylight installed in an addition complies with Section 151 (f) 3 A.*

EXCEPTION 3 to Section 152 (a): *If the addition will increase the total number of water heaters in the building, one of the following types of water heaters may be installed to comply with Section 152 (a) 1 or Section 152 (a) 2 A, and Section 152 (c):*

1. *A gas storage nonrecirculating water-heating system that does not exceed 50 gallons capacity; or*
2. *If no natural gas is connected to the building, an electric storage water heater that does not exceed 50 gallons capacity, has an energy factor not less than 0.90; or*
3. *A water-heating system determined by the executive director 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.*

For prescriptive compliance with Section 152 (a) 1, the water-heating systems requirement in Section 151 (f) 8 shall not apply. For performance compliance for the addition alone, only the space-conditioning budgets of Section 151 (b) 2 shall be used; the water-heating budgets of Section 151 (b) 1 shall not apply.

The performance approach for the existing building and the addition in Section 152 (a) 2 B may be used to show compliance, regardless of the type of water heater installed.

EXCEPTION 4 to Section 152 (a): *When heating and/or cooling will be extended to an addition from the existing system(s), the existing equipment need not comply with Title 24, Part 6. The heating system capacity must be adequate to meet the minimum requirements of UBC Section 310.11.*

1. ***Prescriptive approach***. *Additions to existing buildings shall meet the following additional requirements:*

   A. *Additions up to 100 square feet shall not exceed 50 square feet of glazing, the glazing U-factor shall not exceed 0.75, and the glazing Solar Heat Gain Coefficient shall not exceed the value specified in Alternative Component Package D (Tables 1-Z1 through 1-Z16); or*

   B. *Additions less than 1000 square feet shall meet all the requirements of Package D (Section 151 (f) and Tables 1-Z1 through 1-Z16), except that the addition's total glazing area limit is the maximum allowed in Package D plus the glazing area that was removed by the addition, and the wall insulation value need not exceed R-13.*

      EXCEPTION to Section 152 (a) 1 B: *If an addition is less than 500 square feet, glazing may have a U-factor not to exceed 0.75 in lieu of any lower U-factor required by the package.*

   C. *Additions of 1000 square feet or greater shall meet all the requirements of Package D (Section 151 (f) and Tables 1-Z1 through 1-Z16).*

2. ***Performance approach**. Performance calculations shall meet the requirements of Section 151 (a) through (e), pursuant to either Item A or B, below.*

   A. The addition complies if the addition alone meets the combined water-heating and space-conditioning energy budgets.

   B. The addition complies if the energy efficiency of the existing building is improved such that the source energy consumption of the improved existing building and the addition is equal to or less than that of the unimproved existing building plus an addition that complies with the applicable energy budget.

…

(c) Electric-resistance water-heating or space-conditioning systems may be installed in or in conjunction with an addition only if the electric-resistance system meets the applicable energy budget(s) from Section 151 (b) pursuant to Section 152 (a) 2.

(d) Any addition or alteration may comply with the requirements of Title 24, Part 6 by meeting the requirements for new buildings for the building as a whole.

7.1.1 Basic Approaches

There are three general approaches for showing that residential additions comply with the *Standards*. For two of these there is a prescriptive and performance option.

1. The first approach is to consider just the addition and ignore the existing house. In this case either the prescriptive or performance standards are applied to the addition alone. It is not necessary to make any improvements to the existing building.
2. The second approach is to use the performance approach to make trade-offs between the addition and the existing house. For instance, ceiling insulation in the existing house might be increased to make up for extra glass in the addition. With this approach you show that energy use for the enlarged house (with improvements to the existing portion) would be no greater than the energy use of the unimproved existing house and an addition that met the prescriptive Package D requirements.
3. The third approach is to treat the project as if it were entirely new construction and apply either the prescriptive or performance approaches to the entire building.

For all three approaches, compliance with mandatory measures is required.

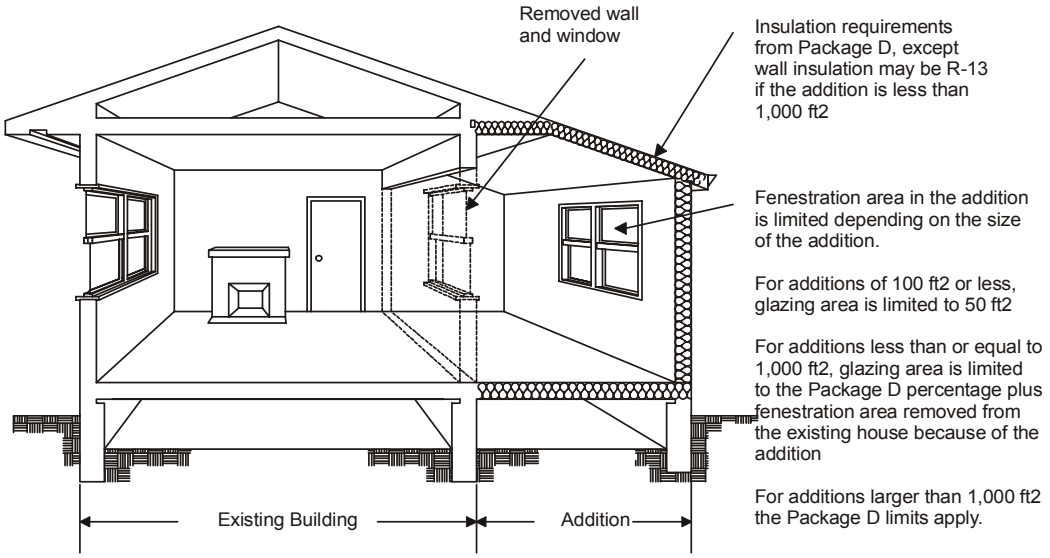
Table 7-1– Comparison of Compliance Methods for Additions

Approach	Prescriptive Method	Performance Method
Addition Alone	Simplest to document. Small additions have less stringent requirements. Limited to Package D. New space-conditioning systems require setback thermostat (exceptions do not apply). Glass area limited depending on the size of the addition (see Table 7-2).	Some flexibility If a non-central space-conditioning system is installed, no setback is required as long as a "no setback" condition is modeled for the proposed design. Allows tradeoffs in efficiency measures (e.g., R-19 ceilings with lower glass U-factor). Can exceed prescriptive limitations on glass.
Existing Plus Addition	Not applicable	Existing structures with R-11 in the framed walls do not have to meet the R-13 mandatory requirement. Same characteristics as noted above for performance compliance of addition alone. Most flexibility. Allows efficiency improvements to the existing structure to compensate for inefficiencies in the addition. Allows credit for energy efficiency improvements made in the past.
New Construction	The easiest compliance method for major renovations and gut rehabilitation projects where the distinction between the existing house and the addition is muddled.	Provides all the advantages of the performance approach for the addition alone and the addition plus existing.

7.1.2 Addition Alone, Prescriptive

Any addition may comply with the applicable prescriptive requirements in Package D. This procedure does not involve the existing structure. The analysis may be performed using either a special prescriptive package according to the size of the addition. Using prescriptive compliance to show compliance for an addition alone is the simplest (although least flexible) approach.

Figure 7-1 – Addition Alone Compliance Approach



7.1.3 Addition Alone, Performance

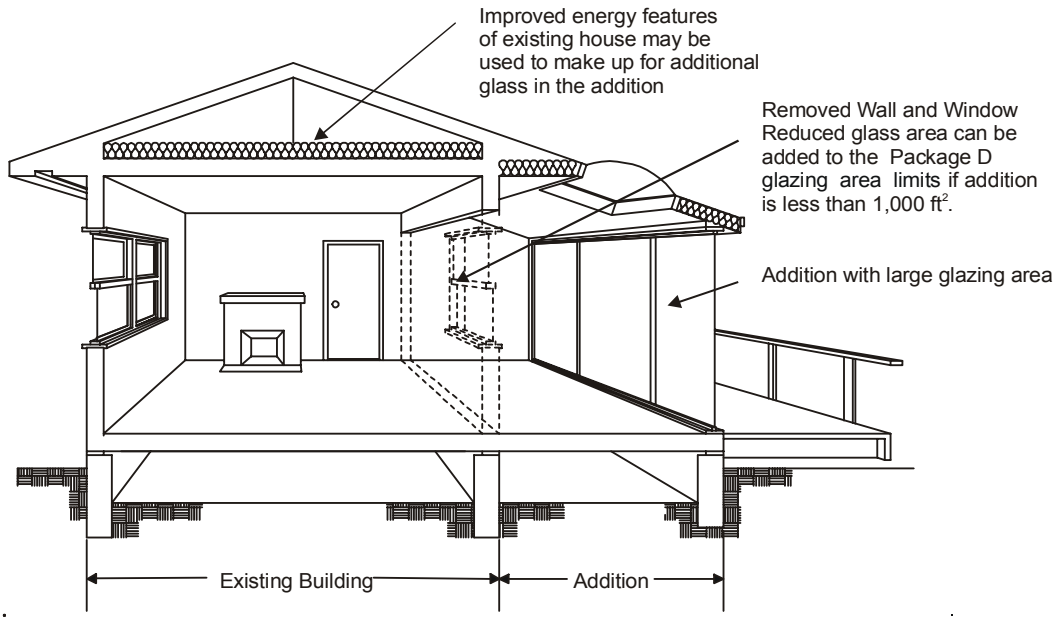
Any addition may be analyzed alone using an approved computer method. Compliance for the addition is the same as showing compliance for a new building[1] (see also Chapter 5). Refer also to the compliance supplement provided by the vendor of the program you're using for further information on modeling additions alone. Analyzing additions alone works well for relatively large additions with moderate window and skylight area. If an addition alone does not comply with the *Standards*, improvements to the existing building may be necessary.

7.1.4 Existing Plus Addition, Performance Only

The most flexible method for showing compliance for an addition is to consider the entire existing building along with the addition. By comparing energy consumption before and after the remodel, credit may be taken for improvements to the energy efficiency features in the existing building. Compliance is shown using an approved computer program. Refer also to the program compliance supplement provided by the program vendor for additional information on modeling additions.

[1] When modeling additions alone, the number of dwelling units is input as the ratio of the addition conditioned floor area to the entire existing house plus addition conditioned floor area. This is needed in order for the internal gains, occupant density and other modeling assumptions to be properly prorated.

Figure 7-2 – Existing House Plus Addition Compliance Approach



7.1.5 New Construction, Prescriptive or Performance

The easiest compliance method for major renovations and gut rehabilitation projects, where the distinction between the existing house and the addition is muddled, is to treat the entire project like it is new construction. This approach has considerable flexibility, but is more stringent than the Existing Plus Addition Method.

7.2 Prescriptive Requirements for Additions

The Package D requirements apply to additions in much the same way that they apply to new buildings. However, some of the building envelope requirements depend on the size of the addition, and there are exceptions for other measures. The prescriptive requirements for additions are summarized in Table 7-2. More detail is provided in the paragraphs that follow.

The Alternative to Package D, which requires more energy efficient windows and space conditioning equipment in lieu of measures that require field verification and diagnostic testing, may also be used with additions (see Table 3-2). This may be a desirable prescriptive option.

Table 7-2 – Prescriptive Requirements for Additions

Component	Size of Addition: 100 ft² or less (1)	Less than 500 ft² (1)	Less than 1,000 ft² (1)	All Additions (1)
Ceiling Insulation	R-19	Package D (2)	Package D (2)	Package D (2)
Wall Insulation (3)	R-13	R-13	R-13	Package D (2)
Floor Insulation	R-13	Package D (2)	Package D (2)	Package D (2)
Fenestration U- factor (5)	0.75 (10)	0.75 (10)	Package D (2)	Package D (2)
Glazing Area	< 50 ft² (6)	Package + Glass Removed (7)	Package + Glass Removed (7)	Package D (2)
Solar Heat Gain Coefficient (SHGC)	Package D (2)	Package D (2)	Package D (2)	Package D (2)
Radiant Barriers (4)	N/A	Package D (2)	Package D (2)	Package D (2)
Space Heating & Cooling (8)	Mandatory	Package D (2)	Package D (2)	Package D (2)
Refrigerant Charge and Airflow (or TXV) (9)	N/A	Package D (2)	Package D (2)	Package D (2)
Duct Sealing (9)	N/A	Package D (2)	Package D (2)	Package D (2)
Water Heater Replacement	N/A	N/A	N/A	N/A
Add Water Heater	See Table 7-5	See Table 7-5	See Table 7-5	See Table 7-5

Notes:

1. Additions for any specific size range column can also use prescriptive requirements listed in any column to the right as long as all requirements in the chosen column are met.
2. Areas shown in gray are the Package D requirements that apply to additions in the same manner as they apply to new construction. For these requirements, either the standard Package D or the Alternative to Package D may be used (see Table 3-2).
3. "Heavy Mass" and "Light Mass" walls may meet the Package D requirements for mass wall insulation instead of R-13 (see Table 3-1).
4. The radiant barrier requirement only applies to the addition roof area. It is not necessary to retrofit a radiant barrier in the existing attic.
5. Dual-glazed greenhouse windows and dual-glazed skylights are assumed to meet the applicable U-factor requirements.
6. This approach does not allow credit for glass removed. As described in Note 1, compliance with all the requirements for the column for additions of less than 500 square feet is allowed, in which case credit for glazing removed is allowed.
7. Glazing area is limited to the Package D fenestration area plus the area of any glazing removed because of the addition.
8. When heating and/or cooling will be extended to an addition from the existing system(s), the existing equipment need not comply with Title 24, Part 6. The heating system capacity must be adequate to meet the minimum requirements of UBC Section 310.11. No electric resistance space heating may be installed.
9. The requirements for testing refrigerant charge and airflow (or installing a thermostatic expansion valve (TXV)) apply only if a new split system air conditioner or heat pump is installed as part of the addition. If a separate air distribution system is installed for the addition, then this new system must be tested and sealed to have a leakage less than or equal to 6% of the fan airflow. If an existing air distribution system is extended to serve the addition, this too must be tested, but the tested target duct leakage depends on the size of the addition and other factors discussed in Section 7.2.3, Determining the Target Percent Leakage. In lieu of testing duct leakage and refrigerant charge and airflow (or installing and verifying a TXV), the builder can choose to meet the Alternative to Package D requirements. See Table 3-2.
10. When the Alternative to Package D is used for additions of 500 ft² or less, the fenestration U-factor and SHGC criteria of the Alternative to Package D must be met. See Table 3-2 for a summary of the requirements.
11. When replacing a central air conditioner that serves both the addition and existing building, the replacement is an alteration and must meet the requirements described in 7.5.2, New Space Conditioning Equipment.

Example 7-1 – Prescriptive Requirements – Additions Less than 100 ft²

Question

A small addition of 75 ft² is being planned – an existing porch is being covered off a master bedroom. A new duct to be extended from the existing heating and air conditioning system will serve the new conditioned space. The contractor wants to follow the prescriptive requirements. What requirements apply? The house is located in climate zone 7.

Answer

Since the addition is smaller than 100 ft², glass area is limited to a maximum of 50 ft². The glass must have a U-factor of 0.75 or less. At least R-19 roof insulation and R-13 wall insulation must be installed. The new windows must have an SHGC of 0.40 or less. There are no requirements for upgrading the existing heating and cooling system, e.g. no need to retrofit a thermostatic expansion valve (TXV) or to test the refrigerant charge and airflow of the existing unit.

Example 7-2 – Reuse of Windows

Question

If I remove a window from the existing house while doing an addition, can I re-use this window in the addition, or does it need to meet a certain U-factor?

Answer

You can use this existing window in the addition; however, you must use the actual or default U-factor and SHGC of this window in showing compliance. You may not be able to comply with the prescriptive requirements, so performance compliance may be the only option. Window certification and labeling requirements of §116(a) do not apply to used windows.

7.2.1 Mandatory Measures

The mandatory measures apply to all new construction, including additions. For example, if a new space-heating system is being installed in the addition, the equipment must be certified, sizing calculations are required, ducted systems must meet insulation and installation requirements, and a setback thermostat is required. General exceptions apply to many of these requirements (including additions). See Chapter 2.

7.2.2 Envelope Measures

The Package D envelope measures apply to additions in the same way they apply to new construction, however, there are exceptions to some of the requirements as described in Table 7-2

Dual-Glazed Skylights and Greenhouse Windows

Dual-glazed skylights or dual-glazed greenhouse windows are treated as though they have the U-factor required for compliance, regardless of the approach (prescriptive or performance). However, greenhouse windows must meet the Package D SHGC requirements for prescriptive compliance. The U-factor required by Package D should be included in compliance documentation for these fenestration products (or 0.75 for additions of less than 500 square feet). The U-factors to be used in compliance calculations for additions and alterations greater than 500 ft² are shown in Table 7-3. Green house windows add volume, but not floor area to the building and are therefore alterations, not additions, if this is the only change.

Table 7-3 – Double Glazed Skylight and Greenhouse Window U-factors for use in Compliance

Package D		Alternative to Package D[1, 2]	
Climate Zones	**U-factor**	**Climate Zones**	**U-factor**
1, 2, 11, 12, 13, 14, 15	0.65	2, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15	0.40
3, 4, 5, 6, 7, 8, 9, 10	0.75		
16	0.60	1, 3, 5, 6, 16	0.55

1 Alternative to Package D is not used in performance calculations.

2 See Table 3-2.

Example 7-3 – Accounting for Greenhouse Windows

Question

For additions that include a greenhouse window or a skylight, what are the U-factor requirements? What is the area used for calculations for greenhouse windows?

Answer

In additions, you can assume that double-glazed greenhouse windows or skylights have the U-factor required to comply with the prescriptive standards and that this U-factor can also be used to determine compliance with performance approaches. However, the actual or default SHGC of greenhouse windows and skylights are used for showing prescriptive or performance compliance. Note, in new construction that is not associated with an existing building, the actual U-factor of fenestration products must be used for compliance documentation/calculations. For greenhouse windows, the window area is the rough opening.

Radiant Barriers

The Package D prescriptive standard requires that radiant barriers be installed in the climate zones that have significant cooling loads (climate zones 2, 4, and 8 through 15). The radiant barrier requirement also applies to additions in these climate zones (except for additions less than 100 ft^2).

Example 7-4 – Radiant Barriers in Additions

Question

Where do radiant barriers need to be installed when using the prescriptive Package D or meeting the performance standards where no 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 the roof assembly associated with the addition.

7.2.3 Space Conditioning Measures

In general, the space heating or cooling requirements only apply if new equipment is being installed to serve the addition. A common situation with additions is to use existing heating and/or cooling equipment and extend it to the addition. For larger additions, existing systems will likely not have adequate capacity and new systems may need to be installed. When existing systems are extended to meet the needs of additions, the *Standards* apply only to the new ductwork or piping needed to provide the extension (see Duct Sealing below). When a new central air conditioner is installed in conjunction with an addition that will serve the addition and the existing building, the new air conditioner is an alteration. Such new systems must meet the mandatory requirements and have either diagnostically tested refrigerant charge and airflow measurement or a field verified TXV or must have a minimum 12 SEER efficiency. This requirement applies regardless of the size of the addition. The Alternative to Package D can not be used to determine

compliance if a new central air conditioner is installed in conjunction with an addition that will serve the addition and the existing building

Electric Heat

The Package D prescriptive requirements do not allow electric resistance space heating, however, if an existing house has electric resistance heat, this existing system may serve the new addition if it has adequate capacity. No new electric heaters may be installed.

Mandatory Measures

If a new space-conditioning system is installed to serve the addition alone, or the existing-plus-addition building, all mandatory measures shall apply including load calculations, certified equipment, duct insulation and installation, and a setback thermostat. No electric resistance space heating is allowed with prescriptive compliance. Only gas heating or heat pumps are permitted.

When existing heating and/or cooling equipment serves an addition, the existing equipment need not comply with the mandatory or compliance requirements of the *Standards*. However, the requirements for duct sealing apply (see Section 7.2.3, Duct Sealing).

Setback Thermostats

The prescriptive packages require a setback thermostat. With performance methods, the budget building has a setback thermostat and the proposed building suffers an energy penalty if it does not also have one. If a non-central space-conditioning system of one of the following types is installed and is modeled without a setback thermostat, then the mandatory measures do not require a setback thermostat.

- Gravity-gas wall heaters
- Gravity floor heaters
- Gravity room heaters
- Non-central electric heaters
- Room air conditioners
- Room air conditioner heat pumps

New Distribution Systems

If a new HVAC distribution system serves the addition and the existing building, the new air distribution system may be modeled in the existing-plus-addition case to receive energy credit. The system must be diagnostically tested by a HERS rater (see Chapter 4). Testing can be avoided with the performance method, but 22% leakage must be assumed and this is a significant energy penalty. The Alternative to Package D (see Table 3-2) may also be used, but this package requires more energy efficient space conditioning equipment and windows, depending on climate zone.

Additions or alternations with no new ducts or with non-ducted equipment do not require diagnostic testing or field verification, since there is nothing to test or verify. Table 5-4 and Table 5-5 show the system used in the standard design for such systems.

Equipment Sizing Methods

There are two options for sizing and installing heating, ventilation and air-conditioning (HVAC) equipment for additions. The first is to perform design heating and cooling load calculations for the addition by itself and to install separate HVAC equipment for the addition that does not connect to the existing HVAC system.

The second option is to calculate heating and cooling loads for the existing-plus-addition. The calculated size can be used to justify the use of existing equipment or to select new HVAC equipment. It is acceptable to use existing heating equipment to heat the existing-plus-addition, provided the existing equipment meets or exceeds the design heating load per *UBC* requirements (see Section 2.5).

Cooling load calculation requirements are specified in the *Standards* when cooling equipment is installed. If you are using an existing air conditioner to cool an addition, cooling load calculations for the existing-plus-addition are recommended but not required.

Example 7-5 – Existing Electric Resistance Heaters

Question

An existing house has an electric resistance furnace. Can this furnace be used to serve the needs of the addition?

Answer

Yes, as long as it has adequate capacity. However, no additional electric heaters may be installed in the addition.

Refrigerant Charge And Airflow Measurements / Thermostatic Expansion Valves

If a new split system air conditioner or heat pump is installed as part of a Package D addition, then the equipment must be diagnostically tested by the installer and diagnostically tested and field verified as having the correct refrigerant charge and airflow across the evaporator coils or having a thermostatic expansion valve installed." As an alternative, a thermostatic expansion valve may be installed and field verified by a HERS rater instead of the refrigerant charge and airflow measurement. The alternative to Package D can be used in lieu of the requirements for refrigerant charge and airflow testing or a TXV if the new split system central air conditioning serves only the addition (See Table 3-2). If the new split system central air conditioner serves both the addition and the existing building, the Alternative to Package D can be used for determining compliance, however, installation of a new air conditioner to serve both the existing house and the addition is considered an alteration, and would have to meet the requirements for diagnostically tested refrigerant charge and airflow measurement or install a field verified TXV. To avoid the diagnostic testing and field verification, a SEER 12 or greater would be required.

If existing equipment is extended to serve the addition, then these requirements do not apply.

Example 7-6 – Refrigerant Charge and Airflow or TXV in Additions

Question

Do the TXV or refrigerant charge and airflow measurement in §151 (f) need to be met for central split system air conditioners serving an addition?

Answer

If existing equipment is used to serve the addition, this requirement does not need to be met as specified by Exception 4 to §152(a).

If a new central split system is installed to serve the addition, it must either:

- meet the TXV or refrigerant charge and airflow measurement in order to comply with Package D; or
- meet the requirements of alternative to Package D (the building must also meet the window requirements and equipment efficiency requirements in the Alternative to Package D. However, installation of a new air conditioner to serve both the existing house and the addition is considered an alteration, and would have to meet the requirements for diagnostically tested refrigerant charge and airflow measurement or install a field verified TXV. To avoid the diagnostic testing and field verification, a SEER 12 or greater would be required); or

Duct Sealing

Prescriptive Package D requires that air distribution ducts be diagnostically tested so that leakage is 6% of fan airflow or less. The Alternative to Package D (see Table 3-2) does not require diagnostic testing of duct leakage, but instead requires more efficient windows

and space conditioning equipment. Performance compliance requires diagnostic testing when duct sealing is chosen for compliance (in either the addition alone or in existing-plus-addition)."

There are two common situations for air distribution systems in residential additions. The first is when a separate air distribution system serves an addition. This is straightforward; the new system is tested by the installer and a HERS rater using the procedures in Appendix J of this *Manual*. To meet the prescriptive requirements, measured leakage in the new duct system must be less than or equal to 6% of the fan airflow.

The second situation is where an existing air distribution system is extended to serve the house addition. Typically new registers are installed and duct runs are added from an existing plenum box. The prescriptive requirements still apply in this case, but it is not possible to test just the new ducts. Instead, the entire duct system must be tested, both existing and new. The remainder of this section discusses this situation.

Determining the Target Percent Leakage

There are two ways to determine the target leakage for existing duct systems with new runs serving an addition. The easiest, but most stringent approach is to use the 6% leakage target, which is appropriate for new duct systems. While this goes beyond the minimum requirements, it will likely be cost effective and provide great benefit to the homeowner in terms of energy savings.

The second approach is to assume that the new duct system leaks at the 6% rate required by prescriptive Package D and that the existing duct system leaks at the default Duct Leakage rate from Table 7-6. The default leakage rate in the existing house is 28% of fan airflow (pre-1999), 22% of fan airflow (1999-2001) and 6% of fan airflow (2001 to present). The target leakage rate is then weighted according to the floor area of the addition and the existing house. For example, assume that the new addition represents 25% of the existing-plus-addition floor area. The total system would have to be tested to have a flow less than 22.5% as shown in the following calculations.

$$\text{Maximum Leakage} = \text{Fraction}_{\text{Addition}}(6\%\ \text{Leakage}) + \text{Fraction}_{\text{Existing}}(28\%\ \text{Leakage})$$

$$\text{Maximum Leakage} = 0.25\ (6\%) + 0.75(28\%) = 1.5\% + 21\% = 22.5\%$$

Target air leakage percents are pre-calculated in Table 7-4 for various floor area combinations for the existing house and the addition. This table is based on 28% leakage for the existing house, which is only appropriate for houses constructed prior to 1999.

Table 7-4 – Target Percent Leakage for Air Distribution Ducts Serving Existing-Plus-Addition Duct Systems

Total Floor Area of Existing House	Floor Area of Addition														
	100	200	300	400	500	600	700	800	900	1000	1200	1400	1600	1800	2000
1000	26	24	22	21	20	19	18	18	17	17	16	15	14	13	13
1100	26	24	23	22	21	20	19	18	18	17	16	15	14	14	13
1200	26	24	23	22	21	20	19	19	18	18	17	16	15	14	14
1300	26	25	23	22	21	21	20	19	19	18	17	16	15	15	14
1400	26	25	24	23	22	21	20	20	19	18	17	17	16	15	15
1500	26	25	24	23	22	21	21	20	19	19	18	17	16	16	15
1600	26	25	24	23	22	22	21	20	20	19	18	17	17	16	15
1700	26	25	24	23	23	22	21	20	20	19	18	18	17	16	16
1800	26	25	24	24	23	22	21	21	20	20	19	18	17	17	16
1900	26	25	25	24	23	22	22	21	20	20	19	18	17	17	16
2000	26	26	25	24	23	22	22	21	21	20	19	18	18	17	17
2100	27	26	25	24	23	23	22	21	21	20	20	19	18	17	17
2200	27	26	25	24	23	23	22	22	21	21	20	19	18	18	17
2300	27	26	25	24	24	23	22	22	21	21	20	19	18	18	17
2400	27	26	25	24	24	23	23	22	22	21	20	19	19	18	18
2500	27	26	25	24	24	23	23	22	22	21	20	20	19	18	18
2600	27	26	25	25	24	23	23	22	22	21	21	20	19	19	18
2700	27	26	25	25	24	24	23	22	22	22	21	20	19	19	18
2800	27	26	25	25	24	24	23	23	22	22	21	20	20	19	18
2900	27	26	25	25	24	24	23	23	22	22	21	20	20	19	19
3000	27	26	26	25	24	24	23	23	22	22	21	21	20	19	19
3100	27	26	26	25	24	24	23	23	23	22	21	21	20	19	19
3200	27	26	26	25	25	24	24	23	23	22	22	21	20	20	19

Note: These target percentages are based on the existing house being constructed before 1999, e.g. the default leakage is 28%. Values are rounded down to the nearest whole percentage.

Determining Fan Airflow

With either of the above methods, it is necessary to determine the fan airflow before the leakage can be calculated. Fan airflow can be determined using one of four methods described below:

1. Fan airflow can be based on the cooling capacity of the equipment. With this method the fan airflow is assumed to be 400 cfm/ton times the capacity of the equipment in tons. This is the most common and easiest method to determine fan flow.
2. Fan airflow can be based on the heating capacity of the equipment. In this case the fan airflow is assumed to be 21.7 cfm/(kBtu/h) times the capacity of the heating equipment in thousands of Btu/h. This method is typically used for heating only systems.
3. The fan airflow can be based on floor area. For climates 8 through 15, fan airflow can be assumed to be 0.7 cfm/ft² times the floor area served by the system. For climates 1 through 7 and 16, the fan airflow can be assumed to be 0.5 cfm/ft² times the floor area served. This is the default method used by the approved computer methods.
4. The fan airflow can be measured in the field (see Appendix J for measurement procedures).

Calculating Duct Leakage

Once the percent leakage and the fan airflow are determined using the methods discussed above, the duct leakage is calculated by multiplying the two values. For instance if the fan airflow is 1,200 cfm and the target percent leakage is 25%, then the target duct leakage is 1,200 cfm x 25% or 300 cfm. Since there is more than one method

of determining the fan airflow and the percent leakage, the target duct leakage value can be the greater of the values determined.

Verifying Compliance

Once the target leakage is determined, the installer and a HERS rater must perform diagnostic testing to verify that the leakage is less than the target value. The procedures that the installer and HERS rater follow are documented in Appendix J of this *Manual*.

Alternatives to Diagnostic Testing

There are several alternatives to diagnostic testing of duct systems in additions. When the prescriptive method is used for the addition alone, the Alternative to Package D may be used (see Table 3-2). This alternative package requires windows with a lower U-factor and SHGC. The alternative package also requires air conditioning or heating equipment with a higher efficiency, but only for new equipment installed to serve the addition. See Refrigerant Charge And Airflow Measurements / Thermostatic Expansion Valves above for related requirements when replacing existing equipment. The Alternative to Package D may also be used when the existing-plus-addition house is treated entirely as new construction.

Example 7-7 – Duct Sealing in Additions – Extending a Duct from an Existing System

Question

When extending a duct to an addition from an existing system, what is required to meet the leakage requirements for that piece of duct using the prescriptive method? The existing house is 1,800 ft² and the addition is 400 ft². The existing system has a cooling capacity of 4 tons and a heating capacity of 75,000 Btu/h. The building is located in climate zone 12.

Answer

One option is to use the Alternative to Package D (see Table 3-2), which requires windows with a lower U-factor and SHGC, but eliminates the need for diagnostic testing. See Refrigerant Charge And Airflow Measurements / Thermostatic Expansion Valves above for requirements related to replacing equipment. If Package D is used, then it is necessary to test the entire duct system, which combines both the new and existing portions. It is not possible to test just a portion of the duct system. The leakage against which the system is tested can be determined by two methods: either the system can be tested against a criteria of 6% leakage or an area weighted average target leakage percentage can be calculated based on the floor area of the addition and the existing house. See a discussion of these methods in the text above. Based on the 1,800 ft² existing house and 400 ft² addition, the target leakage is 24% from Table 7-4.

The target percent leakage rates must be multiplied by the estimated fan airflow in order to determine the target duct leakage in cfm. The fan flow can be estimated from the cooling capacity (400 cfm/ton times 4 tons equals 1,600 cfm), from the heating capacity (21.6 cfm/(kBtu/h) times 75 kBtu/h equals 1,620 cfm) or from the floor area of the space (0.7 cfm/ft² times 2,200 ft² equals 1,540 cfm).

The largest of these values can be used to determine the target leakage rate in cfm. The largest value in this example is based on heating and is 1,620 cfm. 24% of this is 389 cfm, which is the target leakage rate against which the installer and HERS rater must test the duct system.

Question

An addition is 300 ft². Ductwork from the existing house will be extended to serve the addition. Is there a way to use the prescriptive standards for the addition alone and avoid having to test the duct leakage? The house is located in climate zone 10.

Answer

Yes. You may use the Alternative to Package D (see Table 3-2). For climate zone 10, this requires installing new windows in the addition with a U-factor of 0.40 or less and a

SHGC of 0.35 or less. If a new air conditioner were installed, it would have to have an SEER of 11.0 or greater to meet the Alternative to Package D requirements. However, installation of a new air conditioner to serve both the existing house and the addition is considered an alteration, and would have to meet the requirements for diagnostically tested refrigerant charge and airflow measurement or install a field verified TXV. To avoid the diagnostic testing and field verification, a SEER 12 or greater would be required. Other requirements of Package D apply to the addition, as applicable (see Table 3-1).

7.2.4 Water Heating

Addition Alone Compliance

When compliance is shown for the addition alone, water heating is considered separately and may not be traded off with space conditioning energy (heating and cooling). If the existing-plus-addition method is used or if the construction project is treated as entirely new construction, then water heater energy can be traded off.

With the addition alone method, an additional water heater may be added to the house, but it must have a storage capacity no larger than 50 gallons and a recirculating system is not permitted. If natural gas is provided to the building, the new water heater must be a natural gas water heater with an energy factor (EF) of 0.53 (the requirement of the minimum efficiency standards of §112). If the EF of the new water heater is less than 0.58, then an R-12 external wrap must be installed. An additional electric water heater may be added only if there is no gas service at the site; it too is limited to 50 gallons of storage capacity and must have an energy factor of 0.90 or better. If you want to add a water heater with a larger storage capacity than 50 gallons, then the energy factor must be improved or a more efficient water distribution system must be used. Table 7-5 shows water heating system types that are permitted in additions.

Table 7-5 – New Water Heaters Permitted in Additions – Addition Alone Compliance Method

A water heater with the following characteristics may be installed in an addition to a building with a *natural gas connection*, without credit/penalty in compliance calculations:			
Fuel/Type	Capacity	Efficiency	Distribution
Gas/Storage	50 gallon	≥ 0.525 EF	Standard
Gas/Storage	75 gallon	≥ 0.52 EF	PI
Gas/Storage	75 gallon	≥ 0.52 EF	POU
Gas/Storage	75 gallon	≥ 0.52 EF	HWR
Gas/Storage	75 gallon	≥ 0.52 EF	PP
Gas/Storage	75 gallon	≥ 0.52 EF	WSB
Gas/Instantaneous	N/A	≥ 0.62 EF	Standard
A water heater with the following characteristics may be installed in an addition to a building with *no natural gas connection*, without credit/penalty in compliance calculations:			
Fuel/Type	Capacity	Efficiency	Distribution
Electric/Storage	50 gallon	> 0.90 EF	Standard
Electric/Storage	50 gallon	> 0.86 EF	POU
Electric/Storage	50 gallon	> 0.86 EF	HWR
Electric/Storage	50 gallon	> 0.86 EF	WSB
Electric/Storage	50 gallon	> 0.86 EF	PI
Electric/Storage	50 gallon	> 0.86 EF	PP
Electric/Storage	50 gallon	> 0.86 EF	R/D & HWR
Electric/Storage	75 gallon	> 0.95 EF	Standard
Electric/Instantaneous	N/A	> 98% RE	Standard

Notes:

EF = Energy Factor

RE = Recovery Efficiency

Distribution Systems (see Sections **6.1** and **6.6**, for complete information on distribution system installation criteria):

Standard: No pumps, R-4 insulation on first 5 feet of hot and cold water pipes

POU: Point of Use

PI: Pipe Insulation

HWR: Hot Water Recovery System

PP: Parallel Piping

WSB: Wood Stove Boiler

R/D & HWR: Recirculation system with a Demand control, combined with Hot Water Recovery

7.3 Performance Requirements for Additions

With the performance method, either for the addition alone or for the existing-plus-addition building, tradeoffs can be made with other building measures, as long as the source energy of the proposed building is less than or equal to the source energy of the budget building. There are some constraints on these trade-offs.

The budget building with the performance method is based on prescriptive Package D. Credit is offered for more energy efficient measures and penalty for less efficient measures. The only limitation is minimum mandatory measures: ceilings must have a weighted average equivalent to R-19 installed between wood framing, and framed walls must have a weighted average equivalent to R-13 installed between wood framing (except as noted above for existing walls insulated to R-11).

When using performance compliance where there is either no cooling or no new cooling system, modeling assumptions for this hypothetical cooling system should match the Package D requirements for refrigerant charge and airflow (e.g., Climate Zone 12, no cooling assumptions are 10 SEER with refrigerant charge and airflow). (See Section 7.2.3, Refrigerant Charge And Airflow Measurements / Thermostatic Expansion Valves)

Performance compliance requires diagnostic testing when duct sealing is chosen for compliance (in either the addition alone or in existing-plus-addition – see Section 7.2.3, Duct Sealing). If a separate air distribution system is installed for the addition, then this new system must be tested and sealed to have a leakage less than or equal to 6% of the fan airflow. If an existing air distribution system is extended to serve the addition, this too must be tested, but the testing target leakage depends on the size of the addition and other factors discussed in Section 7.2.3, Determining the Target Percent Leakage.

7.3.1 Mandatory Measures

As for prescriptive compliance the mandatory measures apply to all new construction, including additions (see Section 7.2.1).

If the performance method is used for compliance (either the addition alone or existing plus addition approaches), the mandatory requirement for R-13 wall insulation does not apply if walls in the existing building already are insulated with at least R-11 (see §152(a)).

7.3.2 Addition Alone Procedure

Compliance for the addition alone is determined as for a new building but accounting for the fact that an addition is attached to an existing building with which is shares walls, internal loads, systems and equipment. This procedure is described in Section 5.4. Installation of a new split system central air conditioner to serve both the existing house and the addition is considered an alteration, and for existing alone compliance would have to meet the requirements for diagnostically tested refrigerant charge and airflow measurement or install a field verified TXV. To avoid the diagnostic testing and field verification, a SEER 12 or greater would be required, or compliance will need to be met using the existing plus addition approach.

Example 7-8 – Refrigerant Charge and Airflow or TXV in Additions

Question

When using the performance approach for the addition alone, do the TXV or refrigerant charge and airflow measurement in §151 (f) need to be met for central split system air conditioners serving an addition?

Answer

If existing equipment is used to serve the addition, this requirement does not need to be met as specified by Exception 4 to §152(a). For performance compliance in climate zones that require a TXV or refrigerant charge and airflow measurement in Package D, a hypothetical 10 SEER split system with this credit would be modeled in both the standard and the proposed designs, resulting in neither credit nor penalty related to this feature.

If a new central split system is installed to serve the addition, it must either:

- meet the TXV or refrigerant charge and airflow measurement in order to comply with Package D; or
- to avoid the diagnostic testing and field verification, meet a SEER 12 or greater; or
- meet the criteria modeled for the proposed design in the performance approach.

7.3.3 Existing-Plus-Addition Procedure

The following steps are used to demonstrate compliance using the existing-plus-addition approach:

1. Collect and document information on the existing building before the remodel. This will generally require an audit or survey of the existing building. Data collected should include:

   - Geometric information about the house, including floor, ceiling, wall and fenestration areas, separated by orientation.
   - Insulation installed in floor, ceiling and wall cavities
   - Fenestration performance characteristics including U-factor, SHGC, and shading conditions (overhangs or sidefins)
   - HVAC equipment type and efficiency
   - Water-heating system type and efficiency
   - Duct leakage if tested
   - Other data as needed

2. Analyze the energy performance of the **existing building** using an approved computer method. The default assumptions from Table 7-6 are used in the analysis, unless actual field conditions are documented. The approved computer method automatically creates a budget building, which represents the existing building with Package D prescriptive requirements. Both the unmodified existing building and the budget building are simulated using consistent modeling rules, and an estimate of energy use is generated for each as described below:

   EU_e = The energy use in kBtu/y-ft² of the unmodified existing building. This energy use is calculated based on the default assumptions from Table 7-6, unless actual field conditions are documented.

   EB_e = The energy budget in kBtu/y-ft² of the existing building. This represents the energy use of the existing house if it were upgraded to meet all the requirements of the 2001 Energy Efficiency Standards.

3. Analyze the energy performance of the **existing-plus-addition building**, including any changes to the existing building. Data entered should account for all characteristics of the addition and the improved existing building, including windows and skylights that are removed from the existing house as part of the remodel. Data is entered about the existing-plus-addition building and the computer program automatically creates a budget building, representing the house, but in minimum compliance with Package D. The proposed building and the custom budget building are simulated and estimates of energy use are generated as described below: Audited/surveyed data on the characteristics of the existing building is entered.

   EU_{e+a} = The estimated energy use in kBtu/y-ft² of the existing-plus-addition house as it is proposed and shown on the plans and specifications. In this case, either the conditions used for determining EU_e, or the proposed improvements to the existing building are used.

   EB_{e+a} = The energy budget in kBtu/y-ft² of the custom budget version of the existing-plus-addition house.

   Note: If the energy budget for the existing-plus-addition is greater than its energy use, then the addition complies automatically and no additional calculations are required. This is equivalent to the new construction compliance approach

4. Calculate the ratio (F) by dividing the conditioned floor area (CFA) of the existing house (A_e) by the CFA of the existing-plus-addition house (A_{e+a}).

Equation 7-1

$$F = (A_e) / (A_{e+a})$$

Where:

A_e = Total conditioned floor *area* of the *existing* building, in square feet.

A_{e+a} = Total conditioned floor *area* of the remodeled *existing-plus-addition* building, in square feet.

5. Calculate the energy budget for the existing-plus-addition and compare this to the energy use of the existing-plus-addition house. The energy budget is the energy budget of the existing-plus-addition house (EB_{e+a}) plus additional energy representing improvement in the existing house. The additional energy is the difference between the energy use and energy budget of the existing house, but weighted by the fraction of the total conditioned floor area represented by the existing house. Compliance is achieved if the following expression is true.

Equation 7-2

$$EU_{e+a} \leq EB_{e+a} + (F(EU_e - EB_e))$$

Note: If $(EU_e - EB_e)$ is less than zero (0), use zero in the calculation.

Example 7-9 – Existing-Plus-Addition Analysis Using an Approved Computer Method

Question

An addition of 590 ft^2 is being added to an existing 2,389 ft^2 single-family house. How do you demonstrate compliance using the existing-plus-addition method?

Answer

This process requires the following steps:

Collect information about the existing building.

Analyze the existing building before the addition. The energy budget of the existing building is calculated as 45.58 kBtu/y-ft², while the energy use of the existing building is 108.39 kBtu/y-ft².

Analyse the existing-plus-addition building. The energy budget of the existing-plus-addition is calculated as 42.37 kBtu/y-ft², while the energy use of the existing-plus-addition is 88.21 kBtu/y-ft².

Calculate the ratio of the existing building to the existing-plus-addition building:
F = 2,389/(2,389 + 590) = 0.802

Calculated energy budget for the existing-plus-addition building and compare to the proposed existing-plus-addition building.

$$EB_{e+a} + (F)(EU_e - EB_e)$$

$$= 42.37 + (0.802)(108.39 - 45.58)$$

$$= 42.37 + (0.802)(62.81)$$

$$= 92.74 \text{ kBtu/yr-ft}^2$$

Since the energy use of the existing-plus-addition (88.21 kBtu/y-ft² is less than its adjusted energy budget (92.74 kBtu/y-ft²), the addition complies.

Example 7-10 – Refrigerant Charge and Airflow or TXV in Additions

Question

When using the existing plus addition performance approach, do the TXV or refrigerant charge and airflow measurement in §151 (f) need to be met for central split system air conditioners serving an addition?

Answer

If existing equipment is used to serve the addition, this requirement does not need to be met as specified by Exception 4 to §152(a). For performance compliance in climate zones that require a TXV or refrigerant charge and airflow measurement in Package D, a hypothetical 10 SEER split system with this credit would be modeled in both the standard and the proposed designs, 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 criteria modeled in the performance approach. However, installation of a new air conditioner to serve both the existing house and the addition is considered an alteration, and would have to meet the requirements for diagnostically tested refrigerant charge and airflow measurement or install a field verified TXV. To avoid the diagnostic testing and field verification, either a SEER 12 or greater would be required or the performance of other building features must be improved.

Question

When using the existing-plus-addition performance compliance method, can credit be gained by installing a TXV or doing refrigerant charge and airflow measurement on the existing central split system air conditioner in the existing house?

Answer

Yes, the same requirements for the TXV or refrigerant charge and airflow measurement for a new central split system air conditioner must be met, including HERS rater verification. The credit is offered through the performance method, which adjusts the efficiency of equipment, depending on whether or not the refrigerant charge and airflow have been diagnostically tested.

Example 7-11 – Duct Sealing in Additions – Compliance Credit for Sealing Existing Ducts

Question

When using the existing plus addition performance method, can compliance credit be gained by sealing the existing ducts?

Answer

Yes. The budget building is based on ducts with a leakage of 6% serving the addition (as required by Package D) and ducts serving the existing house having a leakage of 28% (default for pre-1999 construction) or 22% (default for 1999 to 2001 construction. If the entire duct system is designed and tested to have a leakage of 6% or less and is diagnostically verified by a HERS rater, then significant compliance credit is available. See the discussion of the performance approach in the text above.

Example 7-12 – Radiant Barriers in Additions

Question

Where do radiant barriers need to be installed when using the performance standards where no 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 the roof assembly associated with the addition.

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.

7.3.4 Default Assumptions About the Existing Building

The existing-plus-addition compliance method requires that data be entered for two conditions, the existing house and the improved existing-plus-addition house. For the first case, use actual conditions where known. Where existing conditions cannot be determined, use default performance characteristics from Table 7-6. For the existing-plus-addition house, credit may be taken for any proposed improvements to the existing house (that will be constructed under the same permit as the addition).

Residential construction and additions built in California from 1978 to the present were required to comply with the *Standards*. Select the values from Table 7-6 that corresponds to the year that the building was constructed or the date of the most recent addition, which ever is later. Existing non-central systems are always assumed to have a non-setback thermostat. Existing central systems are always assumed to have a setback thermostat. Floor and fenestration areas must always be accurately calculated in both the existing and the existing-plus-addition analyses.

Table 7-6 – Default Assumptions for Existing Buildings

Feature		Construction Date or Date of Last Remodel: Before 1978	1978 to 1983	1984 to 1991	1992 to 1998	1999 to 2001	2001 to Present
Roof U-factor Notes: (1)		0.047	0.047	0.047	0.047	0.047	0.047
Wall U-factor Notes: (1)		0.385	0.098	0.098	0.088	0.088	0.088
Raised Floor U-factor Notes: (1)	Crawlspace	0.097	0.097	0.097	0.037	0.037	0.037
	No Crawlspace	0.238	0.238	0.238	0.049	0.049	0.049
Slab Edge F-factor (2)		0.76	0.76	0.76	0.76	0.76	0.76
Duct R-value		R-2.1	R-2.1	R-2.1	R-4.2	R-4.2	R-4.2
Building Leakage (SLA)		4.9	4.9	4.9	4.9	4.9	4.9
Duct Leakage		28%	28%	28%	28%	22%	6%
Fenestration U-factor		Use Table 1-D, Title 24, Part 6, §116 for all vintages					
Fenestration SHGC		Use Table 1-E, Title 24, Part 6, §116 for all vintages					
Shading Device		Use current value for installed device					
Gas Furnace (Central), AFUE		0.75	0.78	0.78	0.78	0.78	0.78
Gas Heaters (Room), AFUE		0.65	0.65	0.65	0.65	0.65	0.65
Heat Pump, HSPF		5.6	5.6	6.6	6.6	6.8	6.8
Electric Resistance, HSPF		3.41	3.41	3.41	3.41	3.41	3.41
Space Cooling Efficiency SEER		8.0	8.0	8.9	9.7	9.7	9.7
Charge and Airflow Test or TXV		No	No	No	No	No	Yes
Water Heater	Energy Factor	0.53	0.53	0.53	0.53	0.58	0.58
	Rated Input, MBtu/h	28.0	28.0	28.0	28.0	28.0	28.0

Note that existing non-central systems are always assumed to have a non-setback thermostat. Existing central systems are always assumed to have a setback thermostat.

AFUE = Annual Fuel Utilization Efficiency

HSPF = Heating Seasonal Performance Factor

SEER = Seasonal Energy Efficiency Ratio

MBtu/hr = 1,000,000 Btu/hr

This table is based on Table 3.7 of the Residential ACM Approval Manual.

Notes:

(1) See Appendix I for equivalent assemblies and R-values.

(2) Also called F2-factor.

Note: The same values should be modeled for the existing house in both the existing and the existing-plus-addition analyses unless specific improvements, including those previously installed, are documented.

7.3.5 Water Heating Performance Compliance

Compliance credit for improved water heating systems can be gained through the performance method for existing-plus-addition and the new construction methods. For the existing house computer run, the efficiency and other characteristics of the water heater in the existing house is prescribed in Table 7-6. For the existing-plus-addition computer run, the proposed water heating system is modeled.

If an existing water heater is being replaced, use Table 7-6 to define the properties of the existing water heater and distribution system in the existing building run. Model the water

heater that replaces the existing water heater, including any water heating distribution system changes, in the existing-plus-addition computer run.

If a water heater is being added, increasing the total number of water heaters in the building, model the existing (pre-construction) water heater and the existing distribution system in the existing house computer run. When modeling the existing-plus-addition computer run, include any changes to the water heating distribution system and all of the water heaters that will be a part of the building's water heating system when the construction is finished.

7.4 Documentation for Additions

All Additions

For additions, the documentation needs are greater than for new construction since compliance credit is available for improvements to the existing building. The compliance needs vary, depending on the compliance approach and method. In all cases, however, it is necessary to complete the following compliance forms:

1. Certificate of Compliance (CF-1R) (see Chapter 1), and
2. Mandatory Measures Checklist (MF-1R) (see Chapter 2).

Note: When using the existing-plus-addition computer compliance method, upon compliance, the CF-1R may need to be filled out by hand.

Performance Methods

When the performance method is used for the addition alone, the existing-plus-addition building, or the entire building (new construction), then the CF-2R Computer Method form will be automatically generated by the certified computer program, in addition to the CF-1R and the MF-1R.

Other Documentation

Other compliance forms may also be needed as described below:

Form 3R — Proposed Construction Assembly. Complete this form for special wall, roof or floor constructions used in the addition.

Form S — Solar Heat Gain Coefficient (SHGC) Worksheet. Use this form to document compliance with the SHGC criteria.

CF-4R — Certificate of Field Verification and Diagnostic Testing. The HERS rater completes this form when testing or field verification is required. For instance, if compliance credit is taken for duct sealing, field verification and diagnostic testing is required.

CF-6R — Installation Certificate. Complete this form to document the installation of equipment.

IC-1 — Insulation Certificate. Submit this form to document that insulation is properly installed.

Make note of any construction requirements on the plans and Certificate of Compliance (CF-1R), particularly improvements to the existing building necessary to achieve compliance with the *Standards*.

For detailed construction guidelines and documentation requirements for the builder, see Chapters 2 and 3.

As applicable, an Installation Certificate (CF-6R) for equipment and fenestration products must be completed and signed, as well as an Insulation Certificate (IC-1). Construction must be equal or better than information on the Certificate of Compliance (CF-1R).

The inspector should make note of any improvements required to achieve compliance, as indicated on the CF-1R. The plan checker should have either verified proof of past energy efficiency improvements, or have indicated on the CF-1R under “special features” any improvements that must be inspected. Proposed construction that is needed to achieve compliance will be indicated on the CF-1R.

For detailed inspection guidelines and documentation requirements, see Chapters 2 and 3.

Before making a visual inspection, check the Certificate of Compliance (CF-1R) and compare it to the Installation Certificate (CF-6R) for equipment and fenestration products, and to the Insulation Certificate (IC-1).

Check for features that require field verification and diagnostic testing, e.g. - reductions in building envelope leakage, more energy efficient duct location; duct sealing. Verify a CF-4R has been provided by a HERS rater for these features.

7.5 Alterations


§152

(b) ***Alterations.*** *Alterations to existing residential buildings or alterations in conjunction with a change in building occupancy to a low-rise residential occupancy shall meet either Item 1 or 2 below.*

1. Prescriptive Approach. The altered component and any newly installed equipment serving the alteration, shall meet the applicable requirements of Sections 110 through 118 and 150; and

A. Alterations that add fenestration area to a building shall be limited to a maximum 0.75 U-factor and the Solar Heat Gain Coefficient for new fenestration products as specified in Alternative Component Package D (Tables 1-Z1 through 1Z16).

B. New space conditioning systems or components shall:

i meet the requirements of Section 150(h) and (i) and Section 151 (f) 7.; and

ii be limited to natural gas, liquefied petroleum gas, or the existing fuel type unless it can be demonstrated that the source energy use of the new system is more efficient than the existing system.

C. New service water heating systems or components shall:

(i) meet the requirements of Sections 150; and

(ii) be limited to natural gas, liquefied petroleum gas, or the existing fuel type unless it can be demonstrated that the source energy use of the new system is more efficient than the existing system.

2. Performance Approach

A. The altered components shall meet the applicable requirements of Sections 110 through 118 and 150; and

B. Either:

i. The permitted space alone, which shall be a minimum of the square footage of the room in which the alteration is made, shall comply with Section 151; or

ii. The energy efficiency of the existing building shall be improved so that the building meets the energy budget in Section 151 that would apply if the

existing building was unchanged and the permitted space alone complied with Item i. The permitted space shall be a minimum of the square footage of the room in which the alteration is made.

EXCEPTION to Section 152 (b) 1 A: Any dual-glazed greenhouse window and dual-glazed skylight installed as part of the alteration complies with the U-factor requirements applicable to the prescriptive alterations.

NOTE: Fenestration products repaired or replaced, not as part of an alteration, need not comply with the U-factor and Solar Heat Gain Coefficient requirements applicable to alterations.

EXCEPTION to 152(b)2.B.: When the existing fuel type is electric, the existing or replacement equipment for heating, cooling and/or domestic water heating of the proposed building shall be assumed to be the same fuel type as the standard building.

…

(d) Any addition or alteration may comply with the requirements of Title 24, Part 6 by meeting the requirements for new buildings for the building as a whole.

7.5.1 Introduction

Alterations are changes to a building's envelope, space-conditioning system, water-heating system or lighting system, which are not additions. An alteration does not increase both conditioned volume and floor area. Examples include:

- Adding a new skylight (or window) to an existing building. If the skylight has a light well that cuts through an existing attic, the alteration adds conditioned volume but is not an addition because it does not add conditioned floor area.
- Adding a new greenhouse window to an existing building. This is an alteration rather than an addition because it adds conditioned volume to the building but not conditioned floor area.
- Adding a loft within the existing conditioned volume of a residence. This is an alteration rather than an addition because it adds conditioned floor area but not conditioned volume.

Prescriptive Prescriptive compliance requires meeting mandatory measures on new systems or components being altered. New windows being added must meet a maximum U-factor of 0.75 (except dual-glazed skylights and dual-glazed greenhouse windows) and the maximum SHGC of Package D. Changing fuel types on equipment replacements is restricted.

Performance Performance compliance requires meeting mandatory measures on new systems or components being altered. There is no limit on the U-factor of windows, and there is no restriction on changing fuel types, as long as the energy budget can be met.

7.5.2 Prescriptive Requirements

Alterations are remodels or replacements that do not increase a building's conditioned volume and conditioned floor area. Alterations may include changes to the building envelope, space-conditioning system, water-heating system and/or lighting system. In any alteration:

- All mandatory requirements apply to the component being changed.
- Any new fenestration products must have a U-factor equal to or less than 0.75 and meet the Package D SHGC requirements.

- Equipment replacements that involve a change in fuel type are restricted (see below).

Mandatory Measures

Any building or equipment alteration must comply with the relevant mandatory measures contained in §111 - §118, and §150 of the *Standards* (see Chapter 2 for a full discussion). The application of mandatory measures to alterations is discussed below.

Fenestration Requirements

Any added (not replaced) window, skylight, glass door or other fenestration installed must have a rated U-factor of 0.75 *or less* and meet the Package D SHGC criteria (see Section 2.3 and Section 3.3.3 on Fenestration). For the purposes of compliance for alterations, dual-glazed greenhouse windows and dual-glazed skylights may be assumed to meet the U-factor requirement (see Example 7-16).

Fenestration products that are replaced or repaired are not required to meet a maximum U-factor level or the SHGC criteria (see Examples 7-14 and 7-15).

Documentation

Compliance for a prescriptive alteration is documented on a:

- Certificate of Compliance (CF-1R) (see Chapter 1) and
- Mandatory Measures Checklist (MF-1R) (see Chapter 2).

Example 7-13 – Moving Existing Windows

Question

If I am doing an alteration, can I move an existing window to another location? Does it need to meet a 0.75 U-factor?

Answer

Once you move the window to a location where a window did not previously exist, it must meet the 0.75 U-factor requirements and the Package D SHGC criteria, because it is added fenestration rather than a window replacement or repair.

Example 7-14 – Alteration with New Windows

Question

An existing building has all single-pane, windows. All of the windows will be replaced, and one wall will be altered to have French doors in place of an existing window. What requirements apply?

Answer

The 0.75 U-factor and Package D SHGC requirements apply only to the new French doors, since these are considered new fenestration. There are no U-factor or SHGC requirements for the remainder of the windows being replaced. All of the installed fenestration must meet applicable mandatory measures described in Section 2.3.

Example 7-15 – Replacing windows

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 there is no added fenestration, the 0.75 U-factor requirement or the SHGC requirement does not apply. However, the installed fenestration must meet applicable mandatory measures listed in Chapter 2.

Example 7-16 – Adding a greenhouse window to an existing building

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 (and some skylights) 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 or skylights installed as part of an alteration may be treated as though they comply with the U-factor requirements applicable to prescriptive alterations. However, the Package D SHGC requirement applies to these windows. All applicable mandatory measures must be met.

New Space Conditioning Equipment

New heating and/or air conditioning systems installed in existing buildings are considered alterations. The appliance standards regulate the efficiency of most new residential heating and air conditioning equipment at the point of sale. However, the mandatory requirements for low-rise residential buildings also apply. In particular, §150 (h) requires that systems be appropriately sized and §150 (i) requires that the new systems have setback thermostats (see Section 2.5.3). The prescriptive requirements of §151 (f) 7 specify that new split system air conditioners or heat pumps installed in alterations must either be verified to have a thermostatic expansion valves (TXV) or be diagnostically tested to verify the correct refrigerant charge and airflow. As an alternative to the requirements for field verification and diagnostic testing for refrigerant charge and airflow measurement or a TXV, an air conditioner or heat pump with an SEER of 12 or greater may be installed. The Package D requirement for diagnostic testing of ducts does not apply to alterations.

Example 7-17 – Alteration of Existing Duct System

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 since no new conditioned space is being added. The mandatory measures for ducts apply, but not the Package D requirement for diagnostic testing of the duct system. See Sections 2.5.6 and 2.5.7 for a summary of the mandatory measures for ducts.

Example 7-18 – New Air Handler and Plenum Platform

Question

An up-flow air-handling unit with a furnace and air conditioning coils 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 (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. A sheet metal or other suitable duct 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.

Fuel Switching

For prescriptive compliance, new electric resistance heating systems and electric water heating are prohibited in alterations unless the system being replaced is an electric resistance heating system or electric water heater. If the existing system is gas, propane or LPG, then new electric 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 is at least a 6.6 HSPF for package systems and a 6.8 HSPF for split systems.

Existing Heating System Fuel Source	*Acceptable Replacement Heating System Fuel Source(s)*
Electric	Electric, natural gas, or equipment with efficiency equal or better than existing system*
Natural gas	Natural gas, or equipment with efficiency equal or better than existing system*
LPG	Liquefied petroleum gas, natural gas, or equipment/ system with efficiency equal or better than existing 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 (Chapter 5) to compare the energy use of the existing system to the proposed system.

Example 7-19 – Replacing HVAC System

Question

If I am going to replace the heating system(s) in an existing residential building, what requirements of the *Standards* apply? Can I change fuel type (from electric to gas)?

Answer

Replacing the heating system is an alteration.The following mandatory requirements apply (see chapter 2):

- Certification of the equipment (not applicable to electric resistance heating equipment) (§111).
- Duct construction and insulation, if new ducts are being installed (§150(m)). The Package D requirement for diagnostic testing of the duct system does not apply.
- Setback thermostat requirements apply if the thermostat is replaced, unless the equipment is a gravity gas wall heater, gravity floor or room heater, non-central electric heater, room air-conditioners, or room air conditioner heat pump (§150(l)). (Existing-plus-alteration compliance is not needed for alterations).
- Sizing calculations (§150(h)).
- Changing fuel types is restricted as described under Fuel Switching above.

7.5.3 Water Heating

Alteration Compliance

As an alteration, an additional water heater may be added to the house. If natural gas is provided to the building, the new water heater must be a natural gas water heater with an energy factor (EF) of 0.53 (the requirement of the minimum efficiency standards of §112). If the EF of the new water heater is less than 0.58, then an R-12 external wrap must be installed. An additional electric water heater may be added only if there is no gas service at the site and it must have an energy factor of 0.90 or better. There is no size limit on an additional water heater.

If an existing water heater is being replaced, only the mandatory measures apply. This is true even if the replacement water heater has a greater capacity than the old one. The mandatory measures include: certification, pipe insulation near the water heater, and tank insulation (see Section 2.6).

Example 7-20 – Replacing Water Heaters

Question

What are the prescriptive compliance requirements for replacing water heaters that are not part of an addition? What if the replacement unit is larger? Can I change fuel types?

Answer

Replacement water heaters (which can be larger) must be certified and, if new pipes are installed, the new pipes must have the insulation required by §150(j). If the replacement is a gas storage water heater with an energy factor less than 0.58 then an R-12 blanket must be installed on the water heater.

Changing fuel types is restricted as described under Fuel Switching above. For prescriptive compliance, an electric resistance water heater may only be used if it is replacing an existing electric resistance water heater.

7.5.4 Performance Requirements

Any alteration may be analyzed using the performance method. The alteration may be considered alone or tradeoffs may be made with the existing building. These performance approaches may be appropriate for projects where it is not feasible for new fenestration products to achieve a 0.75 or lower U-factor, or where a change in space-conditioning or water heating fuel type is desired.

Alteration Alone

With the alteration-alone method, The compliance requirements are the same as showing compliance for a new building, except that the compliance is being shown for a smaller area of the building. Refer to the program compliance supplement for further modeling information for alterations. See also Chapter 5.

Existing-Plus-Alteration

The most flexible method for showing compliance for an alteration is to consider the existing building along with the alteration. The compliance requirements are the same as showing compliance for an existing-plus-addition, except that the compliance may be shown for a smaller area of the building (at least the room where the alteration is occurring must be included in the compliance). By comparing building energy consumption before and after the remodel, credit may be taken for improvements to the energy efficiency features in the existing building.

Example 7-21 – Modeling Existing-plus-Alteration

Question

One of the performance (computer) options for showing compliance for alterations is to show that the building meets the energy budget that would apply if the permitted space complied and the remainder of the building was unchanged. Can you explain what this means and the process for showing compliance?

Answer

This process involves four steps and three separate computer runs:

1. Model the building or a part of the building before any alterations to determine the energy use (proposed design) of the existing building.
2. Model the altered space to determine the energy budget (standard design) of the alteration alone.
3. Calculate the energy budget for the existing-plus-alteration as:

$$Energy\ Use\ Goal = \frac{A_e \times PD_e + A_a \times SD_a}{A_e + A_a}$$

Where:

A_e = Area of the existing building less area of the alteration (from 1.)

PD_e = Proposed design of the existing building before the proposed alteration (from 1.)

A_a = Area of the proposed alteration (from 2.)

SD_a = Standard design for the proposed alteration (from 2.)

4. Model the building, including the proposed alteration, along with any improvements to the existing building. If the proposed design is less than or equal to the energy use goal (from 3.), the alteration complies.

For example, 250 ft² of an existing 1,500 ft² building is being altered. In step 1, computer modeling shows that the existing building uses 25.4 kBtu/ft². In step 2, the proposed alteration's energy budget is 14.2 kBtu/ft².

Calculate the energy use goal as:

$$\text{Energy Use Goal} = \frac{1{,}250 \times 25.4 + 250 \times 14.2}{1{,}500} = 23.5$$

The above answer explains the concept of this approach. You should consult the program user manual for complete instructions, as some of the steps may be automated.

Trade-Offs

There is no maximum U-factor requirement for window replacements with the performance approach, but the budget building has all the features of prescriptive Package D (including the fenestration U-factor) and the proposed design must be shown to have equal or less source energy.

DocumentationCompliance for a performance alteration alone is documented on a:

1. Certificate of Compliance (CF-1R),
2. Mandatory Measures Checklist (MF-1R), and
3. Computer Summary (C-2R).

Note: There is no special allowance for greenhouse windows and skylights with the performance compliance approach for alterations, as there is for prescriptive alterations.

Mandatory Measures

All mandatory measures apply to any alterations. For example, if a new space-heating system is being installed, the equipment must be certified, sizing calculations are required, ducted systems must meet insulation and installation requirements, and a setback thermostat is required except for specific non-central system types. All mandatory measures are explained in Chapter 2.

7.5.5 Documentation Requirements

Make note of any construction requirements on the plans and Certificate of Compliance (CF-1R).

For detailed construction guidelines and documentation requirements for the builder, see Chapters 2 and 3.

As applicable, an Installation Certificate (CF-6R) for equipment and fenestration products must be completed and signed, as well as an Insulation Certificate (IC-1). Construction must be equal or better than information on the Certificate of Compliance (CF-1R).

The inspector should make note of any improvements required to achieve compliance, as indicated on the CF-1R. The plan checker should have either verified proof of past energy efficiency improvements, or have indicated on the CF-1R under "special features" any improvements that must be inspected. Proposed construction that is needed to achieve compliance will be indicated on the CF-1R.

For detailed inspection guidelines and documentation requirements, see Chapters 2 and 3.

Before making a visual inspection, check the Certificate of Compliance (CF-1R) and compare it to the Installation Certificate (CF-6R) for equipment and fenestration products, and the Insulation Certificate (IC-1) if there are any building envelope alterations.

Check for features that require HERS rater field verification and diagnostic testing, i.e., refrigerant charge and airflow measurement or TXVs on new air conditioners.

7.6 Repairs

Definitions §101(b)

REPAIR is the reconstruction or renewal of any part of an existing building for the purpose of its maintenance. Note: Repairs to low-rise residential buildings are not within the scope of these standards.

A repair is the reconstruction or renewal of any part of an existing building for the purpose of its maintenance. In this case "part of a building" means a component, system or equipment, for which there are requirements in the Standards. In simple terms when such a component, system or equipment of an existing building breaks or is malfunctioning, and a maintenance person fixes it so it works properly again, that is a repair. If instead of fixing the break or malfunction, the component, system or equipment is replaced with a new or different one, that is an alteration not a repair. Repairs to low-rise residential buildings are not within the scope of these *Standards*. However, alterations must meet the applicable requirements of the Standards (see Section 7.5).

Some examples of repairs are 1) replacing a broken pane of glass but not replacing the entire window; 2) replacing a failed compressor in an air conditioner but not replacing the entire air conditioner; 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. Some examples of alterations would be 1) installation of a new central air conditioning and heating system, 2) replacement of an air conditioner or the exterior unit or indoor coil of a split system air conditioner, 3) replacement of a furnace or water heater.

Example 7-22 – Buildings Damaged by Natural Disasters

Question

The *Standards* do not specify whether buildings damaged by natural disasters can be reconstructed to their original energy performance specifications. What requirements apply under these circumstances?

Answer

Buildings destroyed or damaged by natural disasters must comply with the energy code requirements in effect when the builder or owner applies for a permit to rebuild for those portions of the building that are being rebuilt.