3. Defining the Proposed and Standard Designs

The space conditioning energy budget for the residential Standards is a custom budget, that is, the energy that would be used by a building similar to the *Proposed Design*, but that is modified to just meet the requirements of the prescriptive standards. The building that is modeled to create the custom budget is the *Standard Design*. This section of the *ACM Approval Manual* describes how the *Proposed Design* and *Standard Designs* are defined.

For the *Proposed Design,* the user enters information to describe the thermal characteristics of the proposed building envelope including its surface areas, air leakage, shading structures and attachments, thermal mass elements, heating and cooling equipment and distribution systems, and water heating equipment and distribution systems. These inputs are subject to a variety of restrictions which are defined in this section. Modeling assumptions and algorithms for making energy calculations are described in Chapter 4.

The process of generating the *Standard Design* and calculating the custom budget shall be performed automatically by the program, based on the allowed and default inputs for the *Proposed Design* as well as the fixed and restricted inputs and assumptions for both designs. The process of custom budget generation shall not be accessible to program users for modification when the program is used for compliance purposes or when compliance forms are generated by the program. The *Standard Design* generator shall automatically take user input about the *Proposed Design* and create the *Standard Design*, using all the applicable fixed and restricted inputs and assumptions described in this Chapter and in Chapter 4. All assumptions and algorithms used to model the *Proposed Design* shall also be used in a consistent manner in the *Standard Design* building.

The basis of the *Standard Design* is prescriptive Package D, which is contained in Section 151(f) of the Standards. The Package D prescriptive requirements are not repeated here. However, the following sections present the details on how the *Standard Design* is to be developed. Defining the *Standard Design* building involves two steps.

- First, the geometry of the proposed building is modified from the description entered for the *Proposed Design*.
- Second, building features and performance characteristics are modified to meet the minimum requirements of compliance with Package D.

3.1 Building Physical Configuration

Proposed Design. The building configuration is defined by the user through entries for floor areas, wall areas, roof and ceiling areas, fenestration areas, and door areas. Each are entered along with performance characteristics such as U-factors, SHGC, thermal mass, etc. Information about the orientation and tilt is required for walls, fenestration and other elements. The user entries for all of these building elements shall be consistent with the actual building design and configuration. If the ACM models the specific geometry of the building by using a coordinate system or graphic entry technique, the data entered shall be as consistent as necessary to achieve thermal modeling accuracy.

Standard Design. The *Standard Design* building has the same floor area, volume, and configuration as the *Proposed Design*, except that wall and window area are distributed equally between the four main compass points, North, East, South, and West. The details are described below.

3.1.1 Conditioned Floor Area

Proposed Design. The ACM shall require the user to enter the total conditioned floor area of the *Proposed Design* as well as the conditioned slab floor area. The conditioned slab floor area is the area of a slab floor with a minimum slab thickness of 3.5 inches or a minimum heat capacity of 7.0 Btu/ºF-ft² and conditioned space above and unconditioned space or the ground/gravel below. The non-slab conditioned floor area is the total conditioned floor area minus the conditioned slab floor area. Stairwell floor area shall be included in conditioned floor area as the horizontal area of the stairs and landings between two floors of each story of the house. The conditioned slab floor area may be either on-grade or a raised slab.

Standard Design. The total conditioned floor area and the conditioned slab floor area of the *Standard Design* building is the same as the *Proposed Design*.

Note. ACMs shall keep track of the conditioned floor area and shall at least be able to keep separate track of the total conditioned floor area and conditioned slab floor area. These areas are used to determine the default thermal mass for the *Proposed Design* and the thermal mass for the *Standard Design*.

3.1.2 Conditioned Volume

Proposed Design. The volume of the *Proposed Design* is the conditioned volume of air enclosed by the building envelope. The volume shall be consistent with the air volume of the actual design and may be determined from the total conditioned floor area and the average ceiling height or from a direct user entry for volume.

Standard Design. The volume of the *Standard Design* building is the same as the *Proposed Design*.

3.2 Opaque Envelope Elements

3.2.1 Insulation Installation Quality

Proposed Design. The ACM user may specify either *Standard* or *Improved* insulation installation quality for the *Proposed Design*. The presence of *Improved* insulation installation quality shall be reported in the *Field Verification and Diagnostic Testing* listings on the CF-1R. *Improved* insulation installation quality shall be certified by the installer and field verified.

Standard Design. The *Standard Design* shall be modeled with *Standard* insulation installation quality.

Note. Chapter 4 has the modeling rules for Standard and Improved insulation installation quality.

3.2.2 Ceilings/Roofs

Proposed Design. The ACM shall allow a user to enter one or more ceiling/roof areas for the *Proposed Design*. The roof/ceiling areas, construction assemblies, orientations, and tilts modeled shall be consistent with the corresponding areas, construction assemblies, and tilts in the actual building design and shall equal the overall roof/ceiling area with conditioned space on the inside and unconditioned space on the other side. U-factors shall be selected from ACM Joint Appendix IV. If new ceiling and wall construction assemblies do not meet the mandatory minimum U-factor required by Title 24, the building shall not pass compliance. If the *Proposed Design* has *Improved* insulation installation quality, then all ceiling/roof assemblies in the *Proposed Design* are modeled accordingly (see Section 3.2.1 and Chapter 4).

Standard Design. The ceiling/roof areas of the *Standard Design* building are equal to the ceiling/roof areas of the *Proposed Design*. The *Standard Design* roof and ceiling surfaces are assumed to be horizontal (no tilts) and have a U-factor specific to the package D requirements. The U-factors in Table R3-1 shall be used in the *Standard Design* for the appropriate R-value criteria in Package D. The *Standard Design* generator shall consider all exterior surfaces in the *Proposed Design* with a tilt less than 60 degrees as roof elements. Surfaces that tilt 60 degrees or more are treated as walls. The *Standard Design* is modeled with *Standard* insulation installation quality U-factors by correcting the U-factors in Table R3-1 with the standard insulation installation quality adjustment factors for ceilings/roofs from Section 4.2.3.

Table R3-1 – Ceiling/Roof U-factors for the Standard Design

Building Component	R-value Requirement	U-factor	ACM Joint Appendix IV Reference
Roof			
	R-30	0.032	Table IV.1-A7
	R-38	0.026	Table IV.1-A8

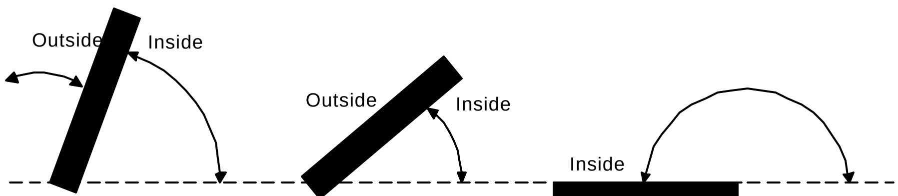

Figure R3-1 – Surface Definitions

Radiant Barriers

Proposed Design. The ACM shall allow the user to input a radiant barrier. The presence of a radiant barrier shall be reported in the *Special Features and Modeling Assumptions* listings on the CF-1R.

Standard Design. The *Standard Design* shall have a radiant barrier in accordance with Package D requirements. When required by Package D, radiant barriers are required on all ceiling/roof surfaces. See Section 4.2.1 for radiant barrier eligibility criteria.

Cool Roofs

Proposed Design. The ACM shall allow the user to input a cool roof. The presence of a cool roof shall be reported in the *Special Features and Modeling Assumptions* listings on the CF-1R.

Standard Design. The *Standard Design* shall be modeled without a cool roof.

3.2.3 Walls

Proposed Design. The ACM shall allow a user to enter one or more wall areas for the *Proposed Design*. The wall areas modeled shall be consistent with the corresponding wall areas in the actual building design and the total wall area shall be equal to the gross wall area with conditioned space on the inside and unconditioned space or exterior conditions on the other side. U-factors for *Proposed Design* wall constructions shall be selected from ACM Joint Appendix IV. If the *Proposed Design* has *Improved* insulation installation quality, then walls are modeled accordingly (see Chapter 4). Walls include all opaque surfaces with a slope greater than 60º but less than 120º from the horizontal (see Figure R3-1).

Standard Design. The gross wall area in the *Standard Design* run is equal to the gross wall area of the *Proposed Design*, including knee walls in the ceiling construction of the *Proposed Design*. The gross wall area in the *Standard Design* is equally divided between the four main compass points, North, East, South, and West. Window and door areas are subtracted from the gross wall area to determine the net wall area in each orientation. The *Standard Design* has *Standard* insulation installation quality. U-factors for the *Standard Design* walls shall be those from Table R3-2 for the appropriate Package D R-value criteria multiplied by the standard insulation installation quality factor for walls from Section 4.2.3.

Table R3-2 – Wall U-factors for the Standard Design

Building Component	Package D R-value Criteria	Standard Design U-factor	ACM Joint Appendix IV Reference
Wall	R-13	0.102	Table IV.9-A3
	R-19	0.074	Table IV.9-A5
	R-21	0.069	Table IV.9-A6

3.2.4 Basement Walls and Floors

Proposed Design. Portions of basement walls above grade shall be modeled as conventional walls above grade. For below-grade basement walls, the user shall enter the area at each of three depths: from zero to 2 feet below grade (shallow), greater than 2 feet to 6 feet below grade (medium), and greater than 6 feet below grade (deep). The ACM shall allow users to enter as many wall types as necessary to model the *Proposed Design*. The U-factor, C-factor, and mass characteristics of below-grade walls shall be calculated using methods consistent with ACM Joint Appendix IV. The thermal performance characteristics for the *Proposed Design* below-grade wall constructions shall be the same as the *Standard Design*.

Standard Design. The *Standard Design* shall have the same basement wall areas as the *Proposed Design* and at the same depths. The *Standard Design* basement wall shall be assumed to be a wall with a Heat Capacity of 15.7 Btu/(ft^2-^{o}F), a thickness of 8 inches, and a uniform R-value of 1.5.

3.2.5 Raised Floors

Proposed Design. In addition to the total conditioned floor area and total conditioned slab floor area (see 3.1.1), ACM users shall enter floor areas for the standard raised floor construction types listed in Table R3-3. The ACM shall require user input to distinguish floor areas and constructions that are over crawl spaces. The U-factor for floor constructions and areas shall be consistent with the actual building design. U-factors shall be those from ACM Joint Appendix IV.

Standard Design. The floor areas of the *Standard Design* are equal to the areas of the *Proposed Design*. The raised floor U-factor for the *Standard Design* is taken from Table R3-3 and depends on whether or not the floor assembly in the *Proposed Design* is located over a crawl space. For this reason, the ACM shall keep track of which raised floor surfaces are over crawl spaces and which are not.

Notes. The effect of a conventional crawl space is modeled with a thermal resistance of R-6; however, for controlled ventilation crawl spaces (an optional capability), the crawl space is modeled as a separate thermal zone and R-6 is not assumed. The R-6 value for a conventional crawlspace shall be automatically calculated by the ACM and shall not be allowed as a user input. The U-factors in Table R3-3 account for the additional R-6.

Table R3-3 – Floor U-factors for the Standard Design

Floor Type	Package D Criteria	U-factor	ACM Joint Appendix IV Reference
Raised Floor (crawl space)	R-19	0.037	IV20-A4
Raised Floor (no crawl space)	R-19	0.048	IV21-A4

3.2.6 Slab-on-Grade Perimeter

Proposed Design. The ACM shall allow users to enter at least two different slab perimeter constructions and their corresponding lengths. Typically, ACMs have no practical limit on the number of slab perimeter constructions that may be entered. The default condition for the *Proposed Design* is that 80% of any slab edge length entered is adjacent to rug-covered (R-2 for carpet and pad) slab and 20% is adjacent to exposed slab on the conditioned side. F-factors for slab loss shall be taken from Joint Appendix IV, Table IV.26 or be calculated using methods consistent with ACM Joint Appendix IV and accurately represent the conditions in the actual building. The ACM shall be able to determine the amount of slab edge adjacent to unconditioned spaces separately from the slab edge adjacent to the outside. In the *Proposed Design*, the F factor(s) may account for slab perimeter insulation for both slab edges exposed to the outside and slab edges adjacent to unconditioned spaces such as garages. In climate zone 16, slab edges adjacent to garages and unconditioned spaces may be considered to be insulated with R-7 insulation and have an F-factor of 0.51.

Standard Design. The total slab perimeter length in the *Standard Design* is the same as in the *Proposed Design*. For the *Standard Design,* the slab edge F-factor, is 0.76 for all climate zones except Climate Zone 16 where the F-factor is 0.51. See Package D. For the *Standard Design* for heated slabs, the slab edge heat loss F-factors shall be those specified in Column B of Joint Appendix IV, Table IV.27 for the installed depth or horizontal distance of the proposed design for all climate zones except climate zone 16 where the F-factor shall be those specified in Column D. For the *Standard Design* unconditioned spaces such as the garage are assumed to be detached.

Table R3-4 – Slab Edge F-factors for the Standard Design

Slab Edge Condition	Package D Criteria	F-factor	ACM Joint Appendix IV Reference
No Insulation	None	0.73	Table IV.26-A1
R-7 Insulation	R-7	0.56	Table IV.26-C7

3.3 Fenestration and Doors

3.3.1 Doors

Proposed Design. ACMs shall allow users to enter at least two different door construction types, their U-factors, areas, and orientations. Door U-factors shall accurately represent the doors installed in the building and be calculated in a manner consistent with ACM Joint Appendix IV.

Standard Design. The *Standard Design* has 40 square feet of door area for each dwelling unit. All doors are assumed to face north and have a U-factor of 0.50 from Joint Appendix IV reference IV28-A3. The net opaque wall area facing north is reduced by 40 ft² for each dwelling unit for the *Standard Design* run.

3.3.2 Fenestration Types and Areas

Proposed Design. ACMs shall allow users to enter fenestration or window types, specify the U-factor, SHGC, area, orientation, and tilt. Performance data (U-factors and SHGC) shall be NFRC values or taken from the CEC default tables.

Standard Design. If the *Proposed Design* fenestration area is less than 20%, the *Standard Design* fenestration area is set equal to the *Proposed Design* fenestration area. Otherwise, the *Standard Design* fenestration area is set equal to 20% of the conditioned floor area. The *Standard Design* fenestration area is distributed equally between the four main compass points—North, East, South and West. The *Standard Design* has no skylights. The net wall area on each orientation is reduced by the fenestration area (and door area) on each facade. The U-factor and SHGC performance factors for the *Standard Design* are taken from the Package D specification.

3.3.3 Overhangs and Sidefins

Proposed Design. ACMs shall allow users to enter a set of basic generic parameters for a description of an overhang and sidefinfor each individual fenestration or window area entry. The basic parameters shall include *Fenestration Height, Overhang/Sidefin Length, and Overhang/Sidefin Height.* ACM user entries for overhangs may also include *Fenestration Width, Overhang Left Extension* and *Overhang Right Extension.* ACM user entries for sidefins may also include *Fin Left Extension* and *Fin Right Extension* for both left and right fins. (See Sections 2.2.9 and 2.2.10.)

Standard Design. The *Standard Design* does not have overhangs.

3.3.4 Solar Heat Gain Coefficients

Proposed Design. ACMs shall require the user to enter the fenestration Solar Heat Gain Coefficient for each window, skylight, or other fenestration system type. This requirement may be met by having the user select from a default list of fenestration systems or by direct entry using NFRC-certified values for windows, doors with glass or skylights. In addition, for each fenestration element the ACM shall allow the user to select an exterior shading treatment from the lists given in Table R3-7. The ACM will then determine the overall SHGC for the complete fenestration system based on the fenestration SHGC and the SHGCs assigned to the Commission-approved exterior shading devices and assigned interior shading devices from Table R3-5 and Table R3-7.

Standard Design. The *Standard Design* fenestration Solar Heat Gain Coefficients (SHGCs) are determined by the appropriate Package D specifications for the applicable climate zone. Note that the frame type and the presence or absence of muntins or dividers is irrelevant for the *Standard Design* as the Package D values for $SHGC_{fen}$ and the U-factor include the effects of fenestration features such as framing, dividers, and muntins.

3.3.5 Interior Shading Devices

Internally, ACMs shall use two values to calculate solar heat gain through windows: $SHGC_{open}$ and $SHGC_{closed}$. $SHGC_{open}$ is the total solar heat gain coefficient of the fenestration and its exterior shading device when the operable interior shading device is open. $SHGC_{closed}$ is the total solar heat gain coefficient when the interior shading device is closed. $SHGC_{open}$ is the setting that applies when the air conditioner is not operating, which typically is most of the 24-hour period, while $SHGC_{closed}$ applies only for periods when the air conditioner operates. The *Standard Design* values for these SHGCs are shown in Table R3-6 below. $SHGC_{open}$ and $SHGC_{closed}$ are not user specified inputs. See Chapter 4 for more details.

The ACM shall require the user to directly or indirectly specify $SHGC_{fen}$ and frame type. The ACM shall assign an interior shading device as listed in Table R3-5 and require the user to specify exterior shading device as listed in Table R3-7. The ACMs shall calculate the overall SHGC for the fenestration with shading devices as shown in Chapter 4.

For both the *Proposed Design* and the *Standard Design,* all windows are assumed to have draperies and skylights are assumed to have no interior shading.

Table R3-5 – Allowed Interior Shading Devices and Recommended Descriptors

Recommended Descriptor	Interior Shading Attachment Reference	Solar Heat Gain Coefficient
Standard	Draperies or No Special Interior Shading - Default Interior Shade	0.68 (see Note 1)
None (see Note 2)	No Interior Shading - Only for Skylights (Fenestration tilt <60 degrees)	1.00

Note (general): No other interior shading devices or attachments are allowed credit for compliance with the building efficiency standards.

Note 1: Standard shading shall be assumed for all fenestration with a tilt of 60 degrees or greater from horizontal.

Note 2: *None* is the default interior shading device in the standard and proposed design for fenestration tilted less than 60 degrees from horizontal (skylights) and is only allowed for fenestration tilted less than 60 degrees from horizontal (skylights), i.e. *None* is not an interior shading option for ordinary vertical windows

Table R3-6 – Standard Design *Shading Conditions*

	Package Specification	
Characteristic	$SHGC_{fen}$ = NR	$SHGC_{fen}$ = 0.37
$SHGC_{fen}$	0.67	0.37
$SHGC_{open}$	0.649	0.358
$SHGC_{closed}$	0.614	0.339
Glazing	Double Clear	Double Low Solar Low E
Interior Shade	Drapes (*Standard*)	Drapes (*Standard*)
$SHGC_{int}$	0.68	0.68
Exterior Shade	Bugscreen (*Standard*)	BugScreen (*Standard*)
$SHGC_{ext}$	0.76	0.76

3.3.6 Exterior Shading Devices

Proposed Design. The ACM shall require the user to either accept the default exterior shading device or select from a specific Commission-approved list of exterior shading devices for each fenestration element. The default choice for exterior shading device is *Standard,* which is assigned an average SHGC of 0.76. The ACM Compliance Supplement shall explicitly indicate that credit is allowed only for one exterior shading device. See Table R3-7 for other choices.

Standard Design. The *Standard Design* shall assume the default exterior shading, which is the standard bug screen.

Table R3-7 – Allowed Exterior Shading Devices and Recommended Descriptors

Recommended Descriptor	Exterior Shading Device Reference	Solar Heat Gain Coefficient
Standard	Bug Screen or No Shading	0.76
WvnScrn	Woven SunScreen (SC<0.35)	0.30
LvrScrn	Louvered Sunscreen	0.27
LSASnScrn	LSA Sunscreen	0.13
RlDwnAwng	Roll-down Awning	0.13
RlDwnBlnds	Roll -down Blinds or Slats	0.13
None (see Note 1)	For skylights only - No exterior shading	1.00

Note 1: None is the default for fenestration tilted less than 60 degrees from horizontal (skylights) and is only allowed for fenestration tilted less than 60 degrees from horizontal (skylights), i.e. None is not an exterior shading option for ordinary vertical windows.

3.4 Thermal Mass

Prescriptive Package D, the basis of the *Standard Design*, has no thermal mass requirements. Package D and the performance approach assume that both the *Proposed Design* and *Standard Design* building have a minimum mass as a function of the conditioned area of slab floor and non-slab floor.

Proposed Design. The *Proposed Design* will be modeled with the same thermal mass as the Standard design unless the Proposed Design is a high mass building as defined below.

Standard Design. The conditioned slab floor in the *Standard Design* is assumed to be 20% exposed slab and 80% slab covered by carpet or casework. The non-slab floor in the *Standard Design* is assumed to be 5% exposed with two inch thick concrete with the remainder low-mass wood construction. No other mass elements are modeled in the *Standard Design*. The *Standard Design* mass is modeled with the following characteristics.

- The conditioned slab floor area (slab area) shall have a thickness of 3.5 inches; a volumetric heat capacity of 28 Btu/ft^3-°F; a conductivity of 0.98 Btu-in/hr-ft^2-°F. The exposed portion shall have a surface conductance of 1.3 Btu/hr-ft^2-°F (no thermal resistance on the surface) and the covered portion shall have a surface conductance of 2.0 Btu/hr-ft^2-°F, typical of a carpet and pad.
- The “exposed” portion of the conditioned non-slab floor area shall have a thickness of 2.0 inches; a volumetric heat capacity of 28 Btu/ft^3-°ºF; a conductivity of 0.98 Btu-in/hr-ft^2-°ºF; and a surface conductance of 1.3 Btu/hr-ft^2-°F (no added thermal resistance on the surface). These thermal mass properties apply to the “exposed” portion of non-slab floors for both the *Proposed Design* and *Standard Design*. The covered portion of non-slab floors is assumed to have no thermal mass.

Definition of High Mass Building. Additional thermal mass in the proposed design may only be modeled when the *Proposed Design* is a high mass building. A high mass building has mass equivalent to 30% of the conditioned slab floor area being exposed slab and 70% slab covered by carpet or casework, and 15% of the conditioned non-slab floor area being exposed with two inch thick concrete with the remainder low-mass wood construction. ACMs may let users indicate a high mass design before entering mass elements for the proposed design, or ACMs can let users enter mass elements, but only consider them in the proposed design if the building qualifies as a high mass building. Thermal mass equivalency is determined through the concept of the Unit Interior Mass Capacity (UIMC) described in ACM RB-2005. The thermal mass of the *Proposed Design,* other than the default *Standard Design* mass is only modeled and displayed on compliance output if the *Proposed Design* qualifies as a high mass building.

3.5 Infiltration/Ventilation

The intentional or unintentional replacement of conditioned indoor air by unconditioned outdoor air creates heat gains or heat losses for a conditioned building. This exchange of indoor and outdoor air occurs for all buildings to a greater or lesser extent. Mechanical ventilation gives a certain degree of control of the rate of this exchange and depending on the balancing of the ventilation may create building pressurization.

Proposed Design. As a default, ACMs shall not require the user to enter any values related to infiltration or mechanical ventilation for air quality and shall set the infiltration level to be the same as the standard design. Specific data on infiltration may be entered if the building will be diagnostically tested during building construction or if a qualifying air-retarding wrap is specified.

Air Retarding Wrap. An air retarding wrap can qualify for a default reduction in Specific Leakage Area (SLA) of 0.50 without confirmation by diagnostic testing. The air retarding wrap shall be tested and labeled by the manufacturer to comply with ASTM E1677-95, *Standard Specification for an Air Retarder (AR) Material or system for Low-Rise Framed Building Walls* and have a minimum perm rating of 10. The air-retarding wrap shall be installed per the manufacturer's specifications that shall be provided to comply with ASTM E1677-95 (2000). The air retarding wrap specifications listed above shall also be reported in the *Special Features and Modeling Assumptions* listings when an air retarder is modeled by the ACM.

Reduced Infiltration due to Duct Sealing. The default infiltration (no diagnostic testing and measurement of infiltration) credit for reduced duct leakage is also an SLA reduction of 0.50. The ACM shall automatically apply this credit when the *Proposed Design* has sealed and tested ducts. The use of this SLA reduction credit for Low-leakage HVAC ducts shall be listed in the *Special Features and Modeling Assumptions* listings of the CF-1R.

Diagnostic Testing for Reduced Infiltration. Neither of the above credits shall be taken if the user chooses a diagnostic testing target for reduced infiltration. When the user chooses diagnostic testing for reduced infiltration, the diagnostic testing shall be performed using fan pressurization of the building in accordance with ASTM E 779-03, *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization* and the equipment used for this test shall meet the instrumentation specifications found in ACM RF. The specifications for diagnostic testing and the target values specified above shall be reported in the *Field Verification and Diagnostic Testing* listings on the CF-1R.

If the user specifies they will be using diagnostic testing during construction, for either reduced infiltration or reduced infiltration with mechanical ventilation, the ACM shall require the user to enter a target value for measured $CFM50_H$ or the SLA corresponding to the target $CFM50_H$, and, if mechanical ventilation is to be used, the wattage and cfm of the ventilation supply and exhaust fans. Note that when the *Proposed Design* target value for reduced infiltration falls below a value corresponding to an SLA of 3.0, mechanical ventilation is required and this requirement shall be reported as described in Chapter 2. Whenever mechanical ventilation is modeled (required or not), the volumetric capacity modeled shall be at least 0.047 cfm/ft^2 of conditioned floor area. This minimum capacity is needed to provide adequate ventilation for indoor air quality. If the user attempts to model total mechanical volumetric capacity (balanced + unbalanced) less than 0.047 cfm/ft^2, then the ACM shall indicate an input error and automatically block compliance output.

Tested infiltration below a value corresponding to an SLA of 1.5 is not allowed unless mechanical *supply* ventilation is installed adequate to maintain the residence at a pressure greater than -5 pascals relative to the outside average air pressure with other continuous ventilation fans operating.

Standard Design. The *Standard Design* does not use mechanical ventilation and assumes infiltration corresponding to a Specific Leakage Area (SLA) of 4.9 for ducted HVAC systems and an SLA of 3.8 for non-ducted HVAC systems. See Chapter 4 for more detailed information.

3.5.1 Free Ventilation Area

Proposed Design: Free ventilation area for the proposed design is calculated by the ACM based on the types and areas of windows specified in the *Proposed Design*. The free ventilation area is modeled as 20% of the fenestration area for hinged type windows such as casements, awnings, hoppers, patio doors and French doors that are capable of a maximum ventilation area of approximately 80% of the rough frame opening. If the ACM user increases the ventilation area for hinged type windows, the ACM shall also consider the possible effect of fixed glazing in the building which has no free ventilation area (window opening type *Fixed*). The ACM user may account for additional free ventilation area by entering the total area for sliding windows, the total area for hinged windows, and the total area of fixed windows. The ACM shall verify that the total area entered for these three types is the same as the total area of windows calculated elsewhere or the ACM may determine the area of fixed windows by subtracting the slider window area and the hinged window area from the total window area if it is less than the total window and skylight area. If the total window and skylight area is less than the area specified for sliding windows and hinged windows the ACM shall reduce the area of hinged windows by the difference. The total ventilation area is calculated from the areas of the three possible fenestration opening types, as shown below:

Equation R3-1 $$Vent_{Area} = (Area_{Slider} \times 0.1) + (Area_{Hinged} \times 0.2) + (Area_{Fixed} \times 0.0)$$

The ACM's ability to accept a customized ventilation area is an optional capability. When this optional capability is used, the fact that the user entered a customized free ventilation area and the total areas of each of these three fenestration opening types shall be reported in the *Special Features and Modeling Assumptions* listings on the CF-1R. Note that the maximum free ventilation area that may be modeled by any ACM for compliance purposes is 20% of the total area of windows and skylights assuming that all windows and skylights are hinged.

Free ventilation area is the adjusted area taking into account bug screens, window framing and dividers, and other factors.

Standard Design: The *Standard Design* value for free ventilation area is 10% of the fenestration area (rough frame opening). This value assumes that all windows are opening type *Slider*. The approved ACM compliance manual shall note that fenestration-opening type *Slider* also may be selected by the user or automatically used by the ACM as a default or "*Standard*" opening type.

3.5.2 Ventilation Height Difference

Proposed Design: The default assumption for the *Proposed Design* is 2 ft for one story buildings and 8 ft for two or more stories. Greater height differences may be used with special ventilation features such as high, operable clerestory windows. In this case, the height difference entered by the user is the height between the average center height of the lower operable windows and the average center height of the upper operable windows. Such features shall be fully documented on the building plans and noted in the *Special Features and Modeling Assumptions* listings of the CF-1R.

Standard Design: The *Standard Design* modeling assumptions for the elevation difference between the inlet and the outlet is two feet for one story buildings and eight feet for two or more stories.

3.6 Heating and Cooling System

3.6.1 System Type

Proposed Design. ACMs shall require the user to enter simple heating and cooling seasonal efficiencies that characterize basic package single zone HVAC systems used to heat and/or cool the modeled building. ACMs shall be able to distinguish what fuel is being used to heat the building and what fuel is used to cool the dwelling. This may be based on direct user input or indirectly determined from the user's selection of HVAC equipment types. ACMs shall require the user to enter the type of distribution system that is used in the proposed design.

For building using more than one system type, equipment type or fuel type, and the types do not serve the same floor area, the user shall either zone the building or enter the floor area served by each type. The ACM shall weight the load to each type by zone or floor area.

For floor areas served by more than one heating system, equipment, or fuel type, the user of the program shall specify which system, equipment, and fuel type satisfies the heating loads.

For floor areas served by more than one cooling system, equipment, or fuel type, the user of the program shall specify which system, equipment, and fuel type satisfies the cooling loads.

Standard Design. The standard heating and cooling system for central HVAC systems is a single zone system with ducts in the attic. The standard heating and cooling system for non-central HVAC systems is an unducted system.

For buildings using more than one system, equipment, or fuel type where each conditions a different floor area within the building, the *Standard Design* shall use the weighted allocation of loads to each system, equipment, or fuel type as used for the *Proposed Design.*

For floor areas in the proposed design served by more than one system, equipment, or fuel type, loads for those floor areas shall be assumed to be satisfied in the *Standard Design* as specified in Section 3.6.3 and 3.6.4 for each system, equipment, and fuel type the user specifies in the proposed design.

3.6.2 No Cooling

Proposed Design: When the *Proposed Design* has no air conditioning system, the *Proposed Design* is required to model a split system air conditioner meeting Package D requirements. If the heating system is ducted, the location and R-value of those ducts shall be used for the cooling system. If the heating system has no ducts the cooling system ducts shall be modeled as located in the attic, insulated to Package D levels. Since the Standard Design has these same features, there is no penalty or credit related to the lack of ducts.

Standard Design: The *Standard Design* has a split system air conditioning system meeting the Package D requirements and with air distribution ducts located in the attic. The *Proposed Design* is assumed to have the same features so there is no penalty or credit.

3.6.3 Heating Equipment

Proposed Design. ACMs shall be able to model the basic types of heating equipment and the efficiency metrics listed in the Appliance Efficiency Regulations, except for combined hydronic space and water heating systems, which is an optional modeling capability. ACMs shall require the user to enter the basic information to model the energy use of these pieces of equipment. At a minimum this includes some type of seasonal efficiency for heating and information on whether or not the HVAC system has ducts and the performance characteristics of those ducts. With gas heating systems, the ACM shall require the user to identify if the gas heating system is ducted or non-ducted. The gas heating system type shall also be identified: central gas furnace or non-central gas furnace system. If the system is a non-ducted non-central gas furnace system, the ACM shall require the user to select the type and size of the equipment from the Appliance Efficiency Regulations for Gas Fired Wall Furnaces, Floor Furnaces and Room Heaters, where the system size, as a default, may be determined as 34 Btu/hour per square foot of conditioned floor area.

Standard Design. When electricity is used for heating, the heating equipment for the *Standard Design* shall be an electric split system heat pump with a Heating Seasonal Performance Factor (HSPF), meeting the Appliance Efficiency Regulations requirements for split systems. However, when the *Proposed Design* uses a single package heat pump, the *Standard Design* shall have a heat pump with an HSPF meeting the Appliance Efficiency Regulations requirements for single package equipment. When a *Proposed Design* uses both a single package heat pump and another type of electric heat, the *Standard Design* HSPF shall be a conditioned floor area weighted average of the minimum single package HSPF for the floor area conditioned by single package equipment and the minimum split system HSPF for the remaining floor area. When electricity is not used for heating, the equipment used in the *Standard Design* building shall be either a gas furnace with an Annual Fuel Utilization Efficiency (AFUE) meeting the Appliance Efficiency Regulations minimum efficiency for central systems, or shall be a gas furnace of the type specified in the proposed design at the efficiency level shown in the Appliance Efficiency Regulations for Gas Fired Wall Furnaces, Floor Furnaces and Room Heaters. When a *Proposed Design* uses both a nonelectric central system and another type of nonelectric system, the *Standard Design* efficiency shall be a conditioned floor area weighted average of the efficiencies of the heating equipment.

Note: Minimum efficiencies for heat pumps change effective January 23, 2006 (see Table C-2 of the Appliance Efficiency Regulations). The *Standard Design* shall use those new efficiencies after that date.

3.6.4 Cooling Equipment

Proposed Design. ACMs shall be able to model the basic types of cooling equipment and the efficiency metrics listed in **Error! Reference source not found.**. ACMs shall require the user to enter the basic information to model the energy use of these pieces of equipment. At the minimum this includes some type of seasonal distribution system efficiency for cooling, identification of whether the cooling system is ducted or non-ducted and whether it is central or non-central and the type of equipment as identified in the Appliance Efficiency Regulations. If the cooling system is non-ducted, non-central, the ACM shall require the user to select the type and size of the equipment from the Appliance Efficiency Regulations for Room Air Conditioners, Room Air Conditioning Heat Pumps, Package Terminal Air Conditioners and Package Terminal Heat Pumps.

Standard Design. The cooling system for the *Standard Design* building with a central system shall be of the same type identified in the Appliance Efficiency Regulations and selected for the proposed design with a SEER meeting the Appliance Efficiency Regulations minimum requirements. For non-ducted non-central cooling equipment, the efficiencies shall be from the Appliance Efficiency Regulations for Room Air Conditioners, Room Air Conditioning Heat Pumps, Package Terminal Air Conditioners and Package Terminal Heat Pumps for the type and size in the *Proposed Design* where the size may be a user input or shall default to 24 Btu per hour per square foot of conditioned floor area. When a *Proposed Design* uses both a split system air conditioner and another type of air conditioner, the *Standard Design* SEER shall be a conditioned floor area weighted average of the SEERs of the cooling equipment.

Note: Minimum efficiencies for air conditioners and heat pumps change effective January 23, 2006 (see Table C-2 of the Appliance Efficiency Regulations). The *Standard Design* shall use those new efficiencies after that date.

3.6.5 Refrigerant Charge or TXV

Proposed Design. The ACM shall allow the user to indicate if split system air conditioners or heat pumps have diagnostically tested refrigerant charge or a field verified thermostatic expansion valve (TXV). This applies only to split system air conditioners and heat pumps. It does not apply to package air conditioners and heat pumps. These features require field verification or diagnostic testing and shall be reported in the *Field Verification and Diagnostic Testing* listings on the CF-1R.

Standard Design. If a split system ducted central air conditioner or heat pump (*SplitAirCond* or *SplitHeatPump*) is used for the *Proposed Design* then the cooling system used in the *Standard Design* building shall be modeled with either diagnostically tested refrigerant charge or a field verified TXV if required by Package D.

3.6.6 Air Distribution Ducts

Proposed Design. ACMs shall be able to model the basic types of HVAC distributions systems and locations listed in Table R2-3. As a default, for ducted systems HVAC ducts and the air handler are located in the attic. Proposed HVAC systems with a duct layout and design on the plans may locate the ducts in the crawlspace or a basement if the layout and design specify that all of the supply registers are located in the floor or within two feet of the floor, and show the appropriate locations for the ducts. Otherwise, the default location is the attic as shown in Table R4-11. If all supply registers are at the floor, but the building has both a crawlspace and a basement, the duct location may be taken as a floor area weighted average of the duct efficiencies of a crawlspace and a basement. If the modeled duct location is not in the attic, the ACM shall specify that all supply registers for the building are located in the floor or within two feet of the floor, and this shall be noted in the *Special Features and Modeling Assumptions* listings of the CF-1R.

Proposed HVAC systems with a complete duct design, including the duct layout and design on the plans, may allocate duct surface area in more detail in the ACM model but the distribution of duct surface areas by location shall appear on the *Field Verification and Diagnostic Testing* list of the CF-1R. The HERS rater shall verify the existence of duct design and layout and the general consistency of the actual HVAC distribution system with the design. The HERS rater shall also measure and verify adequate fan flow, see Section 3.6.9.

The ACM shall allow users to specify if they will be using diagnostic testing of HVAC distribution efficiency of a fully-ducted system during the construction of the building to confirm the modeling of improved HVAC distribution efficiency measures such as duct leakage. The default shall be that no diagnostic testing will be done. Duct efficiency credits may not be taken and diagnostic testing may not be done on any HVAC system that uses nonducted building cavities such as plenums or platform returns, to convey conditioned air unless they are defined or constructed with sealed sheet metal or duct board Building cavities, including support platforms, may contain ducts. If the user does not select diagnostic testing, the ACM shall require users to input at least two (2) basic parameters to determine HVAC distribution efficiency: the total conditioned floor area of the building as specified above and the R-value of the duct insulation which may be defaulted to the minimum duct insulation requirements. Additional data may be required to determine seasonal distribution system efficiency. The default input parameters are presented in Chapter 4. If the user specifies diagnostic testing to be performed during construction, the ACM shall prompt the user to enter the data described Section 4.8.2, *Seasonal Distribution System Efficiency* and shall report all required measurements and the features used to achieve higher HVAC distribution efficiencies in the *Field Verification and Diagnostic Testing* listings on the CF-1R. When the user chooses diagnostic testing, the diagnostic testing shall be performed as described in ACM RC-2005.

Standard Design. The standard heating and cooling system for central systems is modeled with non-designed air distribution ducts located in an attic space, with the duct leakage factor for sealed and tested new duct systems (see Table R4-13) and a radiant barrier in climate zones where required by Package D. The *Standard Design* duct insulation is determined by the Package D specifications for the applicable climate zone. The *Standard Design* building is assumed to have the same number of stories as the *Proposed Design* for purposes of determining the duct efficiency. HVAC distribution system efficiencies shall be calculated using the algorithms and equations in Chapter 4 of this manual for both the *Proposed Design* and the *Standard Design*. The *Standard Design* calculation shall use the default values of that procedure. For non-central HVAC systems, the *Standard Design* shall have no ducts.

3.6.7 Fan Energy

Proposed Design. The ACM shall allow the user to specify whether or not the proposed design will take credit for reduced fan Watts, see Chapter 4. The credit for reduced fan Watts shall be reported in the *Special Features and Modeling Assumptions* listings on the CF-1R.

Standard Design. The *Standard Design* shall have the default fan watts.

3.6.8 Maximum Cooling Capacity Credit

Proposed Design. The ACM shall allow the user to specify that the maximum cooling capacity determined using ACM RF-2005 will be met. Compliance credit may be taken if the installed cooling capacity is less than or equal to the maximum cooling capacity, and the system will have verified adequate airflow, sealed and tested ducts and proper refrigerant charge (or alternatively a TXV). The ACM shall not allow compliance credit to be taken for cooling capacity less than the maximum cooling capacity if any of these other features are not also specified for compliance. If this alternative is not used, the *Proposed Design* shall make no adjustment to the duct efficiency of the *Standard Design* for this feature. If compliance credit is taken for this alternative, it must be reported in the *Field Verification and Diagnostic Testing* listings of the CF-1R along with the other measures that are required to take the credit.

Standard Design. When this alternative is selected, the *Standard Design* shall model the Maximum Allowable Cooling Capacity as calculated using the procedure in ACM RM-2005, otherwise the *Standard Design* shall match the *Proposed Design*.

3.6.9 Adequate Airflow

Proposed Design. The default for the Proposed Design assumes inadequate airflow (see Section 4.7.4). However, compliance credit may be taken if adequate airflow is diagnostically tested using the procedures of Appendix RE. Adequate airflow shall be reported in the *Field Verification and Diagnostic Testing* listings of the CF-1R.

Standard Design. The standard design shall assume inadequate airflow as specified in section 4.7.4.

3.7 Water Heating

Proposed Design. ACMs shall be able to model the basic types of water heaters listed in Table R2-7, the water heating distribution system choices (within the dwelling unit) listed in Table R3-8 (and R2-5), and the multiple dwelling unit recirculating system control choices listed in R3-9 (and R2-6). ACM users shall specify the following information about each water heating system:

- The number of dwelling units served by the water heating system (needed only when the system serves multiple dwelling units).
- The number of water heaters that are a part of the system
- The performance characteristics of each water heater:
  - For gas water heaters with an input rating of 75,000 Btu/h or less and for electric water heaters with an input rating of 12 kW or less, the energy factor (EF) is entered.
  - For small instantaneous gas or oil water heaters as defined in the Appliance Efficiency Standards, the Energy Factor (EF) is entered.
  - For large instantaneous gas or oil water heaters as defined in the Appliance Efficiency Standards, the thermal efficiency (TE), pilot light energy (Pilot), standby loss (SBE or SBL), tank surface area (TSA), and R-value of exterior insulation wrap (REI) is entered.
  - For large storage water heaters, the hourly jacket loss, thermal efficiency (TE), and type (indirect or direct) and pilot light energy (Pilot) are entered. If not available from the manufacturer, jacket loss may be calculated from the tank surface area (TSA), the R-value of exterior insulating wrap (REI) and the standby loss expressed either as a fraction of the heat content of the stored water (SBL) or in Btu/hr (SBE). Tank surface area may also be calculated based on the tank capacity in gallons. See ACM RN for details.
- Information about any solar or wood stove supplementary heating that is provided. See ACM Appendix RG for details.
- The type of distribution system used within the dwelling unit. This is a selection from Table R3-8. For recirculating systems that serve multiple dwelling units, the brake horsepower of the circulation pump (hp), the efficiency of the pump, the efficiency of the motor, and the type of control (choose from Table R3-9).
- If multiple water heating systems serve a single dwelling unit, then the ACM shall keep track of the conditioned floor area served by each water heating system.
- For water heating systems serving multiple dwelling units, the ACM shall keep track of the dwelling units served by each system.

For systems serving multiple dwelling units, the characteristics of an average or typical dwelling unit, e.g. conditioned floor area and number of stories (within the dwelling unit), may be used in making calculations.

Table R3-8 – Water Heater Distribution System Choices (Within the Dwelling Unit)

Distribution System Measure	Code
Pipe Insulation (kitchen lines = 3/4 inches) – Standard Case	STD
Pipe Insulation (all lines)	PIA
Standard pipes with no insulation	SNI
Point of Use	POU
Parallel Piping	PP
Recirculation (no control)	RNC
Recirculation + timer control	RTm
Recirculation + temperature control	RTmp
Recirculation + timer/temperature	RTmTmp
Recirculation + demand control	RDmd

Table R3-9 – Multiple Dwelling Unit Recirculating System Control Choices

Distribution System Measure	Code
No Control	NoCtrl
Timer Control	STD

Standard Design. For multiple dwelling unit systems, the *Standard Design* shall have the same number of water heating systems as the *Proposed Design*. For single dwelling unit systems, the *Standard Design* shall have one water heating system, regardless of the number of systems in the *Proposed Design*. Each *Standard Design* water heating system shall have the characteristics specified in Table R3-10.

Table R3-10 – Specification of Standard Design Water Heater

<table>
<tr><td rowspan="4">Does the water heating system serve a single dwelling unit?</td><td>Yes</td><td colspan="5">Standard design is a 50 gallon gas or LPG storage type water heater. If natural gas is available at the site, the standard design is a gas water heater, otherwise it is LPG.

EF is equal to 0.575, which is the NAECA minimum for the 50 gallon basecase water heater. EF = 0.67 – 0.0019 V, where V is the volume in gallons.

A standard distribution system with no circulation system. Actual efficiency depends on the size of the dwelling unit and the number of stories.</td></tr>
<tr><td rowspan="3">No</td><td rowspan="3">Does the proposed water heating system have a storage tank?</td><td rowspan="2">Yes</td><td rowspan="2">Is the input rating of each water heater in the proposed design less than or equal to 75,000 Btu/h or if electric, less than or equal to 12 kW.</td><td>Yes</td><td>Standard design is one or more NAECA gas or LPG water heater. If natural gas is available at the site, the standard design is a gas water heater, otherwise it is LPG.

If the total storage volume of the proposed design is less than 100 gallons, then the standard design is single water heater with a storage volume equal to the total storage volume of the proposed design.

If the total storage volume of the proposed design is larger than 100 gallons, then the standard design shall have multiple 100 gallon water heaters. The number of water heaters is equal to the total storage capacity of the proposed design divided by 100 and rounded up.

The EF of each 100 gallon water heater shall be 0.48, which is the NAECA minimum. If the standard design is less than 100 gallons, then the EF = 0.67 – 0.0019 V.

See specification of distribution system in the note below.</td></tr>
<tr><td>No</td><td>Standard design is composed of the same number of large storage gas or LPG water heaters as in the proposed design with a storage volumes the same as the storage volumes of the proposed design. If natural gas is available at the site, the standard design is a gas water heater, otherwise it is LPG.

The thermal efficiency is 0.80 and stand-by losses are as specified in Table 113A.

See specification of distribution system in the note below.</td></tr>
<tr><td>No</td><td colspan="3">Standard design is the same number of natural gas or LPG instantaneous water heaters as in the proposed design with input ratings equal to those in the proposed design. If natural gas is available at the site, the standard design is a gas water heater, otherwise it is LPG.

Thermal efficiency of the instantaneous water heaters shall be equal to the requirements in Section 111.

See specification of distribution system in the note below.</td></tr>
</table>

The *Standard Design* distribution system for systems serving multiple dwelling units is described in more detail below:

1. When the distribution system is a recirculating system, the standard design shall be a recirculating system with timer controls, e.g. the coefficients in Table RG-5 for “Timer Controls” shall be used in the calculation of energy use for the standard design, otherwise the standard design shall be a non-recirculating system.
2. Pipe length and location in the standard design shall be the same as the proposed design. There are three possible locations defined in ACM RG-2005.
3. The pipes in the recirculation system shall be insulated in accordance with Section 150(j).
4. The pumping head and motor size for the standard design shall be equal to the pumping head and motor size in the proposed design.

5. The motor efficiency of the recirculation pump in the standard design shall be equal to the requirements in the CEC appliance efficiency standards, e.g. NEMA high efficiency motors.
6. The distribution losses within the dwelling units shall be calculated based on one story and the average dwelling unit size for all the dwelling units served by the water heating system (see RG-3.2).

3.8 Additions and Alterations

There are three compliance approaches for additions to and alterations of existing buildings:

- Whole Building Approach
- Addition Alone Approach
- Existing + Addition + Alteration Approach

Each of these approaches and their accompanying rules are described in the following sections. The existing + addition + alteration approach is the most flexible.

3.8.1 Whole Building Approach

The entire proposed building, including all additions and/or alterations, is modeled the same as a newly constructed building. The building complies if the Proposed Design uses equal or less energy than the Standard Design.

Except in cases where the existing building is being completely remodeled, this is usually a difficult standard to meet as the existing building usually does not meet current standards and must be substantively upgraded.

Proposed Design. Entire building (including additions, alterations and existing building) modeled the same as new construction as described throughout the ACM manual.

Standard Design. Entire building modeled the same as new construction as described throughout the ACM manual.

3.8.2 Addition Alone Approach

The proposed addition alone is modeled the same as a newly constructed building except that the internal gains are prorated to the size of the dwelling, and any surfaces such as walls or ceilings that are between the existing building and the addition are modeled as adiabatic and not included in the calculations. Water heating is not modeled when using this approach. The addition complies if the Proposed Design uses equal or less space heating and space cooling TDV energy than the Standard Design.

The Addition Alone Approach shall not be used when alterations to the existing building are proposed or when there are proposed modifications to existing water heating or when additional water heaters are being added. Instead, the Existing + Addition + Alteration approach shall be used for these cases. Note that modifications to any surfaces between the existing building and the addition are part of the addition and are not considered alterations.

This approach works best when the energy features in the addition are similar to those in the prescriptive packages.

Proposed Design. The user shall indicate that an addition alone is being modeled and enter the conditioned floor area of the addition. The number of dwelling units shall be set to the fractional dwelling unit as specified in Section 4.1.4. Any surfaces that are between the existing building and the addition are not modeled or treated as an adiabatic surfaces. All other features of the addition shall be modeled as for a newly constructed building.

When an existing HVAC system is extended to serve the addition, the Proposed Design shall assume the same efficiency for the HVAC equipment as the Standard Design.

When a dual-glazed greenhouse window or a dual-glazed skylight is installed in an addition, the Proposed Design U-factor shall be the lower of the Standard Design U-factor or the NFRC rated U-factor for the greenhouse window or skylight

Standard Design. The addition alone is modeled the same as newly constructed building as described throughout the ACM manual.

3.8.3 Existing + Addition + Alteration Approach

The proposed building, including all additions and/or alterations, is modeled with tags that describe each energy feature as part of the existing building or the addition or the alteration. The ACM uses the tags to create an existing + addition + alteration (abbreviated e+ad+al) standard design in accordance with the rules in this section that takes into account whether altered components meet or exceed the prescriptive alteration levels. The energy use of the e+ad+al Proposed Design shall use equal or less energy than the e+ad+al Standard Design.

Valid tags include:

- Existing - building features that currently exist and will not be altered
- Altered – building features that are being altered from existing conditions but are not part of an addition
- Added - building features that are being added as part of an addition
- Deleted – existing building features that are being deleted as part of an addition or alteration

This section describes the case where the information about the e+ad+al is contained in a single input file using tags as needed for each zone, opaque surface, fenestration surface, mass surface, etc. Alternate input approaches that provide the information necessary to calculate and provide compliance documentation consistent with the descriptions in this section are allowed with approval from the Commission.

Proposed Design. The user shall indicate that an e+ad+al is being modeled and shall enter the appropriate tags for surfaces or systems. Features that are being altered will need to be paired by the ACM with the existing feature it replaces. The ACM shall clearly indicate each of the tags on the compliance documentation. To generate the proposed design, the ACM shall run the calculations using the surfaces and systems that represent the building when the additions and/or alterations are complete. This includes building features that are tagged as existing, altered and added. Features that are being deleted are not included in the proposed design.

When modeling an existing building, the ACM shall allow the use of the default assumptions specified in Table R3-11 for modeling the existing structure according to the vintage of the existing building. If the user enters higher U-factors, higher F-factors, higher SHGCs, lower efficiencies, or lower energy factors than the vintage defaults from Table R3-11 for the existing building's *Proposed Design*, the ACM shall report such values as special features in the *Special Features and Modeling Assumptions* listings.

Standard Design. Establishing the standard design for e+ad+al approach requires use of the tags entered by the user and, in some circumstances if there are alterations that involve fenestration, a simulation to determine if prescriptive shading requirements are met or exceeded. The resulting e+ad+al Standard Design is very different from the Standard Design for newly constructed buildings because it accounts for the energy use of the existing building and for altered features, and is dependent on whether altered features meet the prescriptive alteration requirements. The Standard Design is determined using the following rules:

- Existing features are included in the standard design
- Deleted features are included in the standard design
- Added features are assigned standard design values in the same manner as for an addition alone, as described above
- Altered features are modeled in the standard design as follows:

  General Approach. Each altered feature is compared to the prescriptive requirements in Section 152(b)1. Fenestration shading and area have additional modeling requirements described below:

- o If the altered feature meets or exceeds the prescriptive alteration requirements the Standard Design is the unaltered existing feature (note that the prescriptive alteration requirements are the mandatory requirements for all altered components plus additional prescriptive requirements for altered fenestration, HVAC equipment (refrigerant charge measurement or TXV), and ducts);
- o Otherwise, the Standard Design is the prescriptive alteration requirement (i.e., the mandatory requirement for altered components other than altered fenestration, HVAC equipment and ducts, which have additional prescriptive requirements beyond the mandatory requirements)

Fenestration Shading. Determining whether the prescriptive alteration requirement for fenestration shading is met may require an annual TDV energy simulation as follows:

- o For climate zones with an SHGC requirement, where the annual TDV energy for the combination of the proposed altered fenestration and the shading of that altered fenestration by existing overhangs or sidefins is less than or equal to the annual TDV energy due to the prescriptive alteration fenestration shading requirement with no shading from overhangs or sidefins, the Standard Design is the unaltered existing feature (existing fenestration products plus existing shading). Otherwise, the Standard Design is the prescriptive alteration requirement.
- o For climate zones without an SHGC requirement, the Standard Design is the unaltered existing feature (existing fenestration products plus existing shading).

Fenestration Area. The Standard Design surfaces and areas for the existing plus alteration (fenestration area in an addition is not included in this section) is determined as follows:

- o If no fenestration area is being added, then the fenestration surfaces in the Standard Design are the existing fenestration surfaces.
- o If fenestration area is being added and the existing fenestration area is less than or equal to 20% of the existing floor area and the combination of the existing plus added fenestration is less than or equal to 20% of the existing floor area, then the fenestration surfaces in the Standard Design are the existing fenestration surfaces plus the added fenestration surfaces.
- o If fenestration area is being added and the existing fenestration area is less than or equal to 20% of the existing floor area and the combination of the existing plus added fenestration is greater than 20% of the existing floor area, then the fenestration area in the Standard Design is 20% of the existing floor area. The fenestration surfaces in the Standard Design are the existing fenestration surfaces plus the added fenestration surfaces with the added surface areas scaled so that the total area of existing plus added fenestration surfaces equals 20% of the existing floor area. For example, if the existing floor area is 2,000 square feet, the existing fenestration is 300 square feet, and the added fenestration is 200 square feet, the scaling factor applied to each added fenestration surface would be:

Equation R3-2

$$\text{ScalingFactor} = \frac{(0.20 x \text{ExistingCFA}) - (\text{ExistingFenArea})}{\text{AddedFenArea}}$$

$$= \frac{(0.20 \times 2000) - 300}{200} = 0.50$$

Thus, the square footage of each of the new fenestration surfaces would be scaled by a factor of 0.50 to determine the Standard Design.

- o Otherwise, if fenestration area is being added and the existing fenestration area is greater than 20% of the existing floor area, then the fenestration surfaces in the Standard Design are the existing fenestration surfaces.

The resulting Standard Design inputs are run as a single simulation and the results are compared to the Proposed Design. The energy use of the e+ad+al Proposed Design shall use equal or less energy than the e+ad+al Standard Design.

Conceptually, the e+ad+al approach can be described as follows where the right hand side term is calculated in a single simulation:

Equation R3-3 $$EU_{e+ad+al} \leq EU_{e} + EB_{ad} + EB_{al}$$

Where

$EU_{e+ad+al}$ = the Proposed Design energy use of the existing building with all additions and alterations completed

EU_{e} = the energy use for the unaltered portion of the existing building

EB_{ad} = the Standard Design energy use for the addition alone

EB_{al} = the Standard Design energy use of the altered features (= energy use of the unaltered existing feature when the prescriptive alteration requirements, including mandatory requirements, are met or energy use of the prescriptive alteration requirements when the prescriptive alteration requirements are not met).

3.8.4 Duct Sealing in Additions and Alterations

Section 152(a)1 establishes prescriptive requirements for duct sealing in additions and Sections 152(b)1.D. and 152(b)1.E. establish prescriptive requirements for duct sealing and duct insulation for installation of new and replacement duct systems and duct sealing for installation of new and replacement space conditioning equipment. Table R4-13 provides Duct Leakage Factors for modeling of sealed and tested new duct systems, sealed and tested existing duct systems, and untested duct systems built prior to and after June 1, 2001. Appendix RC provides procedures for duct leakage testing and Table RC-2 provides duct leakage tests and leakage criteria for sealed and tested new duct systems and sealed and tested existing duct systems. These requirements, factors, procedures, tests and criteria apply to performance compliance for duct sealing in Additions and Alterations.

Condition	*Proposed Design*	*Standard Design*
Additions Served by Entirely New Duct Systems	The Proposed Design shall be either sealed and tested new duct systems or untested duct systems.	The Standard Design shall be sealed and tested new duct systems.
Additions Served by Extensions of Existing Duct Systems	The Proposed Design shall be either 1) sealed and tested new duct systems, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed new duct systems; 2) sealed and tested existing duct systems, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed existing duct systems; 3) untested duct systems in homes built after June 1, 2001; or 4) untested duct systems in homes built prior to June 1, 2001.	The Standard Design shall be sealed and tested existing duct systems.
Alterations with Prescriptive Duct Sealing Requirements when Entirely New Duct Systems are Installed	The Proposed Design shall be either 1) sealed and tested new duct systems; 2) untested duct systems built after June 1, 2001; or 3) untested duct systems in homes built prior to June 1, 2001.	The Prescriptive Alteration Requirement is sealed and tested new duct systems. Determine the Standard Design by the Standard Design rules in Section 3.8.3.

Condition	*Proposed Design*	*Standard Design*
Alterations with Prescriptive Duct Sealing Requirements when Existing Duct Systems are extended or replaced or when new or replacement air conditioners are installed	The Proposed Design shall be either 1) sealed and tested new duct systems, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed new duct systems; 2) sealed and tested existing duct systems, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed existing duct systems; 3) untested duct systems built after June 1, 2001; or 3) untested duct systems in homes built prior to June 1, 2001.	Prescriptive Alteration Requirement is sealed and tested existing duct systems. Determine the Standard Design by the Standard Design rules in Section 3.8.3.
Alterations for which Prescriptive Duct Sealing Requirements do not apply	The Proposed Design shall be either 1) sealed and tested new duct systems, if the new duct system or the total combined existing plus new duct system meets the leakage requirements for tested and sealed new duct systems; 2) sealed and tested existing duct systems, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed existing duct systems; 3) untested duct systems built after June 1, 2001; or 3) untested duct systems in homes built prior to June 1, 2001.	The Standard Design shall be either 1) untested duct systems built after June 1, 2001; or 3) untested duct systems in homes built prior to June 1, 2001.

Table R3-11 – Default Assumptions for Existing Buildings

	Default Assumptions for Year Built (Vintage)							
Conservation Measure	**Before 1978**	**1978 to 1983**	**1984 to 1991**	**1992 to 1998**	**1999 - 2000**	**2001-2003**	**2004-2005**	**2006 and Later**
INSULATION U-FACTOR								
Roof	0.079	0.049	0.049	0.049	0.049	0.049	0.049	0.049
Wall	0.356	0.110	0.110	0.102	0.102	0.102	0.102	0.102
Raised Floor –CrawlSp	0.099	0.099	0.099	0.046	0.046	0.046	0.046	0.046
Raised Floor-No CrawlSp	0.238	0.238	0.238	0.064	0.064	0.064	0.064	0.064
Slab Edge F-factor =	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
Ducts	R-2.1	R-2.1	R-2.1	R-4.2	R-4.2	R-4.2	R-4.2	R-4.2
LEAKAGE								
Building (SLA)	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Duct Leakage Factor (See Table 4-13)	0.86	0.86	0.86	0.86	0.86	0.89	0.89	0.89
FENESTRATION								
U-factor	Use Table 116-A - Title 24, Part 6, Section 116 for all Vintages							
SHGC	Use Table 116-B - Title 24, Part 6, Section 116 for all Vintages							
Shading Dev.	Use Table R3-7 for all Vintages							
SPACE HEATING EFFICIENCY								
Gas Furnace (Central) AFUE	0.75	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Gas Heater (Room) AFUE	0.65	0.65	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	6.8	7.4
Electric Resistance HSPF	3.413	3.413	3.413	3.413	3.413	3.413	3.413	3.413
SPACE COOLING EFFICIENCY								
All Types, SEER	8.0	8.0	8.9	9.7	9.7	9.7	9.7	12.0
WATER HEATING								
Energy Factor	0.525	0.525	0.525	0.525	0.58	0.58	0.575	0.575
Rated Input, MBH	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0