California Energy Commission

STAFF REPORT

CBECC-Res USER MANUAL

FOR CALIFORNIA BUILDING ENERGY CODE COMPLIANCE (CBECC-RES) PUBLIC DOMAIN SOFTWARE

Computer Performance Compliance with
the 2013 California Building Energy Efficiency Standards

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CALIFORNIA ENERGY COMMISSION

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ACKNOWLEDGMENTS

The Building Energy Efficiency Standards (standards) were first adopted and put into effect in 1978 and have been updated periodically in the intervening years. The standards are a unique California asset and have benefitted from the conscientious involvement and enduring commitment to the public good of many persons and organizations along the way. The 2013 standards development and adoption process continued that long-standing practice of maintaining the standards with technical rigor, challenging but achievable design and construction practices, public engagement and full consideration of the views of stakeholders.

The revisions in the 2013 standards were conceptualized, evaluated and justified through the excellent work of Energy Commission staff and consultants. This document was created with the assistance of Energy Commission staff including Martha Brook, PE, Doug Herr, Jeff Miller, PE, Dee Anne Ross, and Danny Tam.

Other key technical staff contributors included Payam Bozorgchami, Tav Commins, Todd Ferris, Gary Flamm, Rob Hudler, Alan Marshall, Nelson Peña, Bill Pennington, Maziar Shirakh, PE, and the Energy Commission’s Web Team. Dave Ashuckian, Deputy Director of the Efficiency and Renewable Energy Division, provided policy guidance to the Staff. Pippin Brehler and Michael Levy provided legal counsel to the staff.

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ABSTRACT

The 2013 Building Energy Efficiency Standards for Low-Rise Residential Buildings allow compliance by either a prescriptive or performance method. Performance compliance uses computer modeling software to trade off efficiency measures. For example, to allow more windows, the designer will specify more efficient windows, or to allow more west-facing windows they will install a more efficient cooling system. Computer performance compliance is typically the most popular compliance method because of the flexibility it provides in the building design.

The Energy Commission is required by the Warren-Alquist Act to provide a public domain compliance program. The California Building Energy Code Compliance (CBECC-Res) software is the public domain software that will be certified by the Energy Commission in conformance with the *Residential Alternative Calculation Methods (ACM) Approval Manual*, which contains the process for approving compliance software. CBECC-Res must also comply with the modeling requirements of the *Residential Alternative Calculation Methods (ACM) Reference Manual*, which establishes the rules for the how the proposed design (energy use) is defined, how the standard design (energy budget) is established, and what is reported on the Certificate of Compliance (CF1R).

CBECC-Res is the 2013 Compliance Manager, which is the simulation and compliance rule implementation software. CBECC-Res is used to model all components that affect the energy performance of the building, as required for complying with the 2013 Building Energy Efficiency Standards. A Certificate of Compliance (CF1R), signed by a documentation author and a responsible party (either the building owner or designer), reports all of the energy features for verification by the building enforcement agency.

Keywords: ACM, Alternative Calculation Method, Building Energy Efficiency Standards, California Energy Commission, California Building Energy Code Compliance, CBECC, CBECC-Res, Certificate of Compliance, CF1R, compliance manager, computer compliance, energy budget, energy standards, energy use, performance compliance, public domain, Title 24, Title 24 compliance software

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Chapter 1. Overview

1.1 Approval for Compliance

California Building Energy Code Compliance (*CBECC-Res 2013*) is an open-source software program developed by the California Energy Commission for demonstrating compliance with the low-rise residential 2013 *Building Energy Efficiency Standards* ("standards"). The standards become effective for new construction on July 1, 2014.

CBECC-Res was originally approved on September 11, 2013 (see Appendix A for the most recent resolution from the Energy Commission). The low-rise residential standards apply to single family dwellings (R-3 occupancy group) and to multi-family buildings (R-1 or R-2) with 3 stories or less. Hotels, motels, and multi-family buildings with 4 or more stories are outside the scope of the low-rise standards.

The 2013 compliance manager is the simulation and compliance rule implementation software specified by the Energy Commission. The compliance manager, called CBECC-Res, models all features that affect the energy performance of the building. Mandatory requirements, as specified in Sections 110.0 through 110.10 and 150.0 of the standards, are not always modeled. An exception, for example, is insulation values. Section 150.0 includes mandatory minimum insulation levels for framed walls, floors and ceilings. It is the responsibility of the program's user to be aware of the requirements of the Building Energy Efficiency Standards.

This manual is a guide to the program's use. It provides a description of software inputs and a guide to using the software. Knowledge of the standards is a pre-requisite. As the documentation author, you are responsible for the content of the compliance documents produced by CBECC-Res, which are submitted to the enforcement agency as proof of compliance with the standards.

1.2 Background

The standards allow compliance using either a prescriptive or performance method. The prescriptive method is found in the *Residential Compliance Manual* (see Section 1.12, Related Publications for information on obtaining this document). Performance compliance uses building modeling software to demonstrate compliance with the standards. CBECC-Res is the public domain compliance manager, meaning it is the simulation and compliance rule implementation software specified by the Energy Commission.

The document *Residential Alternative Calculation Methods (ACM) Reference Manual* (see Section 1.12 Related Publications) explains how the proposed and standard designs are determined. If you have questions about how the software models a building feature refer to this *Reference Manual*.

1.3 Program Updates

For software updates and valid version numbers check link to the the project website, accessible from www.energy.ca.gov/title24/2013standards/2013_computer_prog_list.html.

NOTE: Be sure to check for updates regularly and/or get notifications from the Energy Commission because submittals with outdated software will be rejected by the building department. Sign up for e-mail notifications at http://www.energy.ca.gov/efficiency/listservers.html.

1.4 Software Capabilities

Chapter 7 of this User Manual describes ~~what~~ features of the opaque envelope ~~may be modeled~~ and how they are modeled. Chapter 8 addresses the same for mechanical systems and Chapter 9 covers water heating systems. Chapter 10 discusses addition and alteration modeling. For a complete discussion of how the standard design is established, see the *2013 Residential ACM Reference Manual*.

1.5 Fixed and Restricted Inputs

When the specified analysis type is compliance, fixed and restricted inputs cannot be changed by the user. Since sample files may include assumptions that are not standard in a given climate zone, to determine the standard assumption for a given input, consult either Section 150.1, Package A, of the Building Energy Efficiency Standards, or the 2013 Residential ACM Reference Manual.

1.6 Preparing Basic Input

The software includes several sample files, and the user manual provides a tutorial as well as a guide through program inputs. Required inputs include:

1. Building address, climate zone, front orientation, and availability of natural gas,
2. Conditioned floor area and average ceiling height,
3. Attic/roof details, roof pitch, roofing material, solar reflectance and emittance,
4. Ceilings below attic and vaulted ceiling R-values,
5. Wall areas, orientation, and construction details,
6. Door areas and orientation,
7. Slab or raised floor area and construction details,
8. Window and skylight areas, orientation, U-factor, Solar Heat Gain Coefficient,
9. Building overhang and side fin shading,
10. Mechanical heating and cooling equipment type and efficiency,
11. Distribution system location and construction details,
12. Method for providing mechanical ventilation, and
13. Domestic water heating system details, including type of water heating equipment, fuel type, efficiency, distribution system details.

1.7 Documentation

CBECC creates a CF1R when you check the PDF box under the Analysis tab (accessible by double-clicking on Project). The CF1R will have a watermark that the CF1R is not yet registered (see Section 1.8) if using valid software with the CF1R generated as part of the compliance calculations. During the registration process the documentation author and responsible person fields will be completed. There fields are not program inputs ~~for these fields~~.

Another option for generating a CF1R is to~~After an analysis is performed, you can also produce a CF1R by~~ select~~ing~~ Generate Draft T-24 Compliance Report from the tools menu. Note: the watermark will display "not useable for compliance" (for a full explanation of the security features that results in the different watermarks, see the frequently asked questions from November 20, 2013 and March 18, 2014, accessible from Help/Quick Start Guide). See Appendix B for a sample of the CF1R.

The Energy Commission no longer produces a Mandatory Measures (MF-1R) form. Mandatory measures documentation is found on the installation certificates (CF2R). You can see a list of forms in Appendix A of the 2013 Residential Manual and you can access/print forms at the Energy Commission's web site: http://www.energy.ca.gov/title24/2013standards/.

1.8 Registered CF1R

When compliance requires HERS verification (some of which are mandatory requirements), the compliance documents must be registered with a HERS provider before applying for *a building permit (see Residential Compliance Manual*, Section 2.1.1). The primary document, which is produced by CBECC-Res, is the Certificate of Compliance (CF1R). Additionally, as construction progresses, follow-up documentation (certificates of installation (CF2R) and certificates of verification (CF3R)) are required to confirm that the required measures are installed.

The file needed to upload a project to a HERS provider is created only when you check the box labeled "Full (XML)" on the Analysis tab. When uploading to the HERS provider, the file is found in the projects folder and is entitled: "[filename] - AnalysisResults-BEES.xml" found in a location such as My Documents/CBECC-Res 2013 Projects folder.

1.9 Special Features and Modeling Assumptions

The 2013 Residential ACM Reference Manual identifies the features that are to be shown as a Special Feature and Modeling Assumption on the CF1R.

1.10 Field Verification

Appendix C of the 2013 Residential ACM Reference Manual identifies the specific measures that require HERS verification or diagnostic testing. The CF1R produced by CBECC-Res identifies if a building includes any measures requiring field testing or verification by a HERS rater as part of the compliance results on the first page. Additionally, as part of the component details, any specific measures requiring testing or verification are identified. See also Section 1.8 and Section 1.13.7.

1.11 Checklist for Compliance Submittal

The forms and documentation needed for a compliance submittal includes an electronic version of the CF1R, registered with a HERS provider.

Supporting documentation that ~~may~~ could also be required is the roofing material rating from the Cool Roof Rating Council, solar water heating documentation to support a modeled solar fraction, AHRI certified efficiency of cooling, heating and/or water heating equipment, NFRC certified U-factor and Solar Heat Gain Coefficient for windows and skylights. Any supporting documentation requested by the building department to verify modeled features.

1.12 Related Publications

In addition to this manual, users of the software need to have the following documents as a resource during the compliance process:

- *2013 Building Energy Efficiency Standards* (P400-2012-004-CMF, May 2012) contains the official standards adopted by the Energy Commission.
- *Residential Compliance Manual* (P400-2013-001-SD, June 2013) is the interpretive manual for complying with the standards (also contains sample compliance forms).
- *Reference Appendices for the 2013 Building Energy Efficiency Standards* (P400-2012-005-CMF, May 2012) is the source document for climate zones, HERS protocols for measures requiring verification by a HERS rater, as well as eligibility and installation criteria for energy efficiency measures.
- *Residential Alternative Calculation Methods (ACM) Reference Manual* contains the rules that the software follows to establish the standard and proposed designs for a proposed building.

These documents can be ~~obtained~~downloaded from the Energy Commission website (www.energy.ca.gov/title24) or purchased from:

California Energy Commission
Publications Office
1516 9th Street
Sacramento, CA 95814
(916) 654-5200

1.13 Terminology

1.13.1 Compliance Manager

The compliance manager is the simulation and compliance rule implementation software specified by the Energy Commission, otherwise known as the public domain compliance software. The compliance manager is named CBECC-Res and it models the features of the building as specified in the standards, Section 150.1(c) and Table 150.1-A (Package A) to establish the energy budget for the building.

1.13.2 Report Manager

The report manager is a separate program used to generate the Certificate of Compliance (CF1R). This is a web based application, which enables registering the CF1R, which is required any time there are HERS measures in a building. For more on CF1R registration, see *Residential Compliance Manual*, Section 2.1.1.

1.13.3 Proposed Design

The user-defined proposed building modeled in CBECC-Res is called the proposed design. The proposed design energy use is compared to the standard design to determine if the building complies with the standards.

The building configuration is defined by the user through entries for floors, walls, roofs and ceilings, windows, and doors. The areas are defined along with performance characteristics such as insulation R-values, U-factors, SHGC, etc. The entries for all of these building elements must be consistent with the actual building design and configuration.

1.13.4 Standard Design

CBECC-Res creates a version of the proposed building that has the features of Section 150.1(c) and Table 150.1-A (Package A) in the specified climate zone to establish the allowed energy budget or standard design. The standard design is compared to the proposed design, and if it complies a Certificate of Compliance (CF1R) can be produced.

For newly constructed buildings, the standard design building is in the same location and has the same floor area, volume, and configuration as the proposed design, except that wall and window areas are distributed equally between the four main compass points, North, East, South and West. For additions and alterations, the standard design has the same wall and window areas and orientations as the proposed building.

The basis of the standard design is prescriptive Package A (from Section 150.1(c) of the standards, Table 150.1-A). Package A requirements (not repeated here) vary by climate zone. *Reference Appendices for the 2013 Building Energy Efficiency Standards* (*Reference Appendices*), Joint Appendix JA2,

Table 2-1, contains the 16 California climate zones and their representative city. The climate zone can be found by city, county and zip code in JA2.1.1.

Detailed information about how the standard design is established can be found in the *Reference Manual* (see Section 1.12).

1.13.5 Mandatory Requirements

Mandatory requirements are found in Sections 100.0 through 110.10 and 150.0 of the standards. Any requirement that is mandatory (some are modeled, some are not) cannot be removed from the proposed building. For example, a building in climate zone 10 may be built without a whole house fan as long as it complies without that feature, because the whole house fan is a feature of Package A in Section 150.1. While the standard design building has all of the features of Package A, measures that are more efficient or less efficient can be modeled in the proposed design as long as it meets the mandatory minimum requirements and meets the energy budget.

A partial list of the changes affecting the building envelope is a minimum of R-30 ceiling/roof insulation, R-19 raised floor insulation, and a maximum of 0.58 U-factor for window (see Section 150.0(q) for exceptions). Space conditioning system mandatory requirements include ducts with R-6 insulation that are sealed and have tested duct leakage, air-handler fan efficacy of 0.58 W/CFM or less, and cooling airflow of greater than 350 CFM/ton. These measures require a Home Energy Rating System (HERS) rater.

1.13.6 Climate Zone

California has 16 climate zones. The climate zone can be found in the *Reference Appendices*, Joint Appendix JA2.1.1, by looking up the city, county, or zip code. The climate zone determines the measures that are part of the building's standard design (see Section 150.1, Table 150.1-A in the standards).

1.13.7 HERS Verification

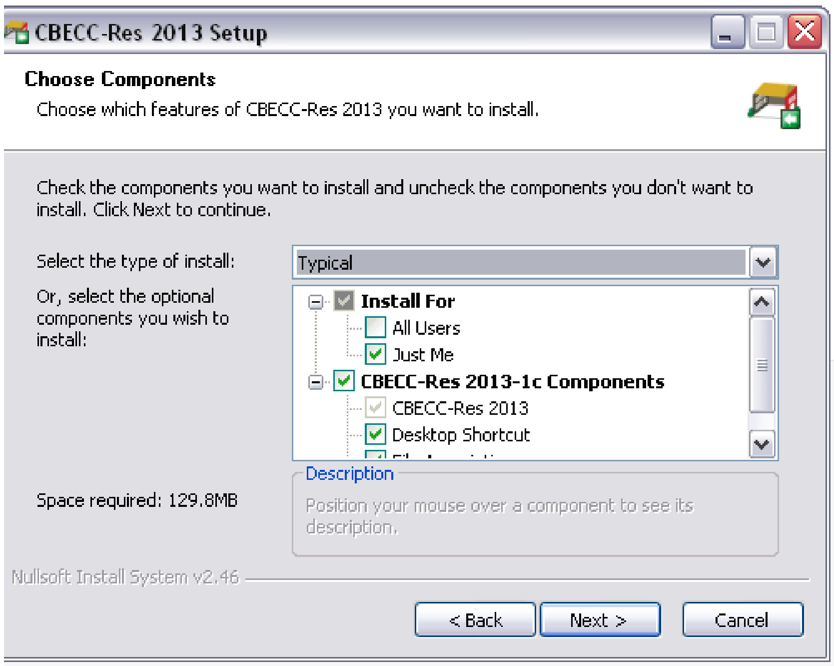
Some mandatory requirements and other optional compliance features require a Home Energy Rating Systems (HERS) rater to perform diagnostic testing or verify the installation. HERS raters are trained and certified by one of the HERS Providers. For a list of currently approved providers see www.energy.ca.gov/HERS/providers.html~~, which currently includes California Certified Energy Rating and Testing (CalCERTS) and ConSol Home Energy Efficiency Rating Services, Inc. (CHEERS)~~. HERS raters are trained and certified by the provider to perform ~~duct leakage testing, quality insulation installation inspections, refrigerant charge testing, and any~~verification and testing requirements as specified in the *Reference Appendices*, Residential Appendices RA1 – RA4.

Chapter 2. Getting Started

2.1 Installing CBECC-Res

Click on the hyperlink for CBECC-Res or copy the link into your browser's address box. Follow the prompts and read/accept the license agreement. You can direct the software to a different drive, but do not change the names of the file folders. The software will create a desktop icon.

Figure 2-1: Setup



2.2 Menu Bar

The menu bar at the top of the screen (see Figure 2-1) allows you to access many of the program's features.

Figure 2-2: Menu and Tool Bar

2.2.1 File

The file menu contains the standard functions for file management, opening and saving files, save as (to rename a file), and exiting the program.

2.2.2 Edit

In addition to the standard cut, copy, and paste commands, the edit menu contains several commands for editing building descriptions. They are:

- Edit component
- Create component
- Delete component

These menus allow you to edit all building components, including components that are not displayed on the tree control. Use this method to edit components like schedules and performance curves.

2.2.3 Ruleset

CBECC-Res 2013 is designed to support multiple rulesets that implement the requirements in different codes. When enabled, the ruleset menu will allow switching to a different compliance ruleset. Typically, changing to a different code requires changes to inputs. Users will need to pay special attention to instructions for performing accurate analysis under a different ruleset.

2.2.4 View

The view menu enables you to toggle on and off the display of the tool bar at the top of the screen and the status bar at the bottom of the screen.

2.2.5 Tools

The tools menu contains the following options:

- Check Building Database
- Generate HVAC Equipment Report Records / *documentation for installer and HERS Rater*
- Generate DHW Equipment Report Records / *documentation for installer and HERS Rater*
- Generate IAQ Ventilation Report Records / *documentation for installer and HERS Rater*
- Building Summary Report (input model) / *opens a .csv file in Excel*
- Building Summary Report (proposed/standard) / *opens two .csv files in Excel (one standard and one proposed)*
- Perform Analysis [same as short-cut key] / *runs file to determine if it passes or fails compliance*

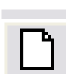
- Review Analysis Results / *displays compliance results, if available*
- Generate T-24 Compliance Report / *generates a CF1R with a watermark that it is not useable for compliance (for a "not registered" watermark see Section 1.7)*

2.2.6 Help

- Help Topics (*not yet enabled*)
- Quick Start Guide (opens an overview of the software and frequently asked questions)
- User Manual (opens this document)
- Mandatory Requirements for Assemblies (opens a list of requirements for construction assemblies; for example, a steel framed wall with no rigid insulation does not comply with the minimum requirement of Section 150.0)
- About . . . (to determine the version of CBECC-Res)

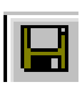
2.3 Tool Bar

This section explains the program features accessed by clicking the icons on the tool bar at the top of the screen (see Figure 2-2).

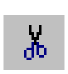


New File
This button closes the current file (if one is open) and opens a new file.

Open Existing File
This button launches the open dialog box to enable opening an existing file. If another file is open, a prompt to save that file before proceeding will appear.



Save File
This button saves the file under its current name or launches the *save as* dialog to enable a new file name.

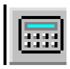


Cut Selected Item
This button is not currently enabled in *CBECC-Res 2013*.

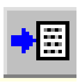
Copy Selected Item
This button enables you to copy the selected item on the tree control (along with any child components) to the clipboard. If the *copy* button is not available from within program dialogs use the keyboard equivalent (Ctrl+C) to copy selected text.

Paste Contents of Clipboard
This button enables pasting components copied from the tree control to the selected location in the tree control (provided that location is compatible with the stored component). The *Paste* button is not available from within program dialogs, but you can use the keyboard equivalent, Ctrl+V, to paste text from the Windows clipboard to the selected input field.

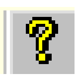
Print
This button is inactive in CBECC-Res. Once a CF1R is produced (see Section 1.7), it is printed via Adobe Acrobat print options.



Perform Analysis
This button enables launching a compliance analysis using the currently loaded building description. You must save the current building description before performing the analysis.



Compliance Reports
This icon launches the *CBECC-Res 2013 Report Viewer* when there is a report available to view.

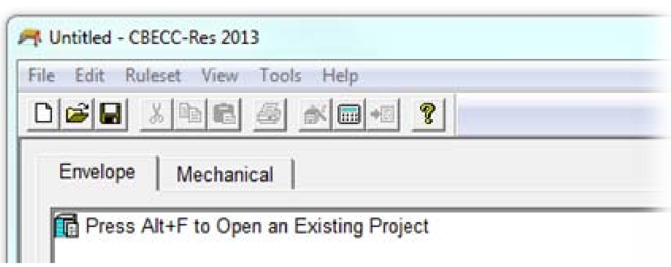


About CBECC-Res 2013
View program license and version information. To access the Quick Start Guide, Frequently Asked Questions or the User Manual, select Help from the file menu.

2.4 Main Screen

The main screen (see Figure 2-3) is used for editing building descriptions. There are two folder tabs at the top of the main screen—Envelope and Mechanical. These tabs provide different views of the building description and provide access to two different subsets of building description data.

Figure 2-3: Main Screen



2.5 Right-Click Menu Options

CBECC-Res makes extensive use of menus accessible by right-clicking the mouse button. The functions available through these menus depend on whether you are on the main screen or in an input dialog window.

Main Screen—Right-Click Menu. When clicked over a building component, the following choices are available:

- *Edit* – Opens the input dialog window for the selected component
- *Rename* – Enables renaming the selected component
- *Delete* – Deletes the selected component
- *Copy* – Copies the selected component with all of its associated ("children") components
- *Paste* – Adds copied components and children to the selected component
- *Expand/Contract* – Expands or contracts the list of children components (shortcut key is to use the + or – signs)
- *Create* – Enables you to create new child components for the selected component

Input Dialog—Right Mouse Menu. When clicked over an input value in the window, the following choices are available:

- *Item Help* – Accesses help information applicable to the selected input field (feature currently not available)
- *Topic Help* – Accesses help information applicable to the selected component (feature currently not available)
- *Restore Default* – Returns the value of the field to its default value (if applicable)
- *Critical Default Comment* – Opens a dialog enabling you to enter a justification for overriding values designated by the standards as critical defaults, i.e., a value that should only be overridden with special justification (feature currently not available)

2.5.1 Analysis Types

Proposed Only: Simulates the proposed building's energy use using the 2013 compliance rules without establishing the standard design.

Proposed and Standard: In addition to simulating the proposed design, simulates the standard design building (one that complies with the 2013 prescriptive standards) to establish the energy budget for compliance.

Research: Not yet implemented. Simulates the building input by the user but does not apply the 2013 compliance rules.

2.5.2 Building Tree Controls (Parent/Child Relationships)

In order to analyze a building's energy use, it is necessary to track relationships among building components. CBECC-Res displays these relationships using the familiar tree control found in Windows™ Explorer and many other applications. For example, under the envelope tab, exterior walls are shown as parents to windows. Windows are connected to exterior walls and appear under walls as children to spaces. The tree controls vary in the components they display depending on which folder is selected.

2.5.3 Rapid Editing

The tree control can be used to move and copy components or groups of components. To move a component, just drag and drop. If an association is not allowed, the program will prevent the move. To copy a component, select the component, copy, and paste. It is advisable to rename copied components to maintain readability. Whenever parents components are moved, copied, or deleted, child components are included.

Components shown on the tree can be moved using a drag-and-drop technique provided it results in a compatible parent-child relationship. For example, you can drag a window onto a different wall, but not vice versa.

A set of right-click edit commands can be used with the tree control. These are described above in Section 2.5. Double-clicking on any component on the tree opens its input dialog window.

2.6 Input Dialog Windows

The attributes of each building component can be edited by opening the input dialog window for the component. The dialog can be opened by double-clicking on the component on the tree control, using the edit option on the right mouse menu, or using the edit component option on the edit menu. (The tree control does not appear until you have created a project description or loaded an existing project file [Ctrl+O]).

2.7 Background Colors

The following background color convention is used in displaying data on the dialogs:

- White background = available for user input
- Gray background = not user editable

2.8 Status Bar

The status bar at the bottom of the screen provides useful information about each input field. There are three panes on the status bar that provide context-sensitive information. This same information is displayed in the tool tips if you allow the mouse to linger over an input field.

1. Input Description Pane – Concise descriptions of the selected input field are displayed at the far left of the status bar.
2. Input Classification Pane – The next pane to the right on the status bar displays a set of labels that indicates whether an input is required, optional, or unavailable for input (see Table 2-1).
3. Data Source Pane – The pane at the far right of the status bar displays a set of labels that identify the source of the information (if any) contained in the field. This distinguishes

between information that is dictated by the compliance checking process and the information entered, for which you are responsible. The data source labels are explained in Table 2-2.

Table 2-1: Input Classification Explanations

TEXT DISPLAYED	EXPLANATION
No field selected	No building data field is currently selected.
Input is compulsory	Data is required; the program cannot perform a compliance analysis without this input.
Input is required	Data is required if the field is applicable to your project.
Input is optional	If applicable to your project, you may enter a value; a default value is always acceptable.
Input is Critical Default	You may overwrite the data with a more appropriate entry. You must be prepared to provide documentation substantiating the input value.
Field is not editable	The data in this field cannot be edited either because it is defined by the compliance ruleset, is not applicable to the selected compliance ruleset, or is an intermediate calculated parameter.
Navigation input	The purpose of the selected field is to enable you to select a component for editing without having to exit the current component and choose the next component from the tree

Table 2-2: Data Source Explanations

TEXT DISPLAYED	EXPLANATION
No field selected	No building data field is currently selected.
Value from user	The data shown is defined by the user either by direct input or through a wizard selection.
Value from simulation	The data shown is defined by an energy simulation.
Value undefined	No data is defined for the field.
Value from program	The data in this field is defined by the program either to implement requirements and procedures specified in the standards or to conform to building energy modeling conventions.

2.9 Defining New Components

From the main program screen or at any point where you would like to create a component under (a child to the parent component):

- Right-click on the component to which you want to add the new component.
- Select *Create*, then select the type of object you want to add (only applicable component types will appear on the list).
- Accept the defaults or edit the name, parent, and existing component from which to copy, and click OK.
- Edit the input fields with white backgrounds to describe the new component, and click OK.

2.10 Managing Project Files

By default, project files are stored at C:\Users\<your username>\My Documents\CBECC-Res-2013-0\Projects, although this depends on where you installed the program.

To retain a project in the most efficient manner, keep the file name with extension ".ribd" (residential input building design). Additionally, the file name with the extension ".log" is useful for troubleshooting. The other project files are recreated when an analysis is performed.

2.11 Error Messages

If a file will not run and you receive no clear error message a file stored in the projects folder contains the entire record of what occurred with the file. Find a file in the Projects folder with the same name as your input file, with the extension ".log," and open this text file in notepad:

```
2013-Jun-06 11:51:52 - Opening Project 'jones1.ribd'...
2013-Jun-06 12:03:20 - Project Saved
2013-Jun-06 12:03:23 - Performing Building Database check...
2013-Jun-06 12:03:23 - Building Database check completed, 0 error(s)
found.
2013-Jun-06 12:03:23 - Error:  Garage 'Garage' has too few child and/or
adjacent surfaces (5, minimum is 6) to be simulated. evaluating rule: Rule
130, 37, Line 10660: Check for sufficient Garage:SurfaceCount
2013-Jun-06 12:03:23 - ERROR:  Error encountered evaluating rulelist
'ProposedModelSimulationCheck'
2013-Jun-06 12:03:27 - Opening Project 'jones1.ribd'...
2013-Jun-06 12:04:16 - Project Saved
```

This identifies a problem with the garage model, which does not have enough surfaces modeled. After adding a slab floor and a ceiling below attic, the file runs.

If you still find no obvious errors, look for a field in your input file that is blank, such as an area or a U-factor. This type of error does not always produce an error message. If it is necessary to send an e-mail to cbecc-res@gmail.com, include the *.ribd file with your name and contact information.

Following is a list of potential error messages:

1 : pszCSEEXEPath doesn't exist
2 : pszCSEWeatherPath doesn't exist
3 : pszDHWDLLPath doesn't exist
4 : One or more missing files (CSE, ASHWAT or T24*(DHW/ASM32/TDV/UNZIP/WTHR) DLLs)
5 : pszBEMBasePathFile doesn't exist
6 : pszRulesetPathFile doesn't exist
7 : Error initializing BEMProc (database & rules processor module)
8 : Error initializing compliance ruleset
9 : Invalid project log file name (too long)

10 : Error writing to project log file
11 : Building model input/project file not found
12 : Error reading/initializing model input/project file
13 : Error evaluating ProposedInput rules
14 : Error retrieving CSE weather file name (from Proj:WeatherFileName)
15 : Energy (CSE) simulation weather file not found
16 : Error retrieving DHW weather file name (from Proj:DHWWthrFileName)
17 : DHW simulation weather file not found
18 : Error retrieving required data: Proj:RunID and/or Proj:RunAbbrev
19 : Analysis processing path too long
20 : Error evaluating ProposedInput rules
21 : Error evaluating PostProposedInput rules
22 : Error evaluating BudgetConversion rules
23 : Error evaluating ProposedModelCodeCheck rules
24 : Unable to create or access analysis processing directory
25 : Unable to open/delete/write simulation output file (.csv or .rep)
26 : Unable to open/delete/write simulation weather file
27 : Error copying simulation weather file to processing directory
28 : Unable to open/delete/write simulation input (.cse) file
29 : Error writing simulation input (.cse) file
30 : CSE simulation not successful - error code returned
31 : DHW simulation not successful
32 : Error encountered loading CSE DLL(s)
33 : Error evaluating ProposedModelCodeCheck rules
34 : Error evaluating ProposedModelSimulationCheck rules
35 : Error evaluating ProposedModelCodeAdditions rules
36 : User aborted analysis via progress dialog 'Cancel' button
37 : Error evaluating ProposedInput rules
38 : Error performing range and/or error checks on building model
39 : Error evaluating CSE_SimulationCleanUp rules
40 : Error generating model report
41 : Error evaluating ProcessResults rules
42 : Error evaluating ProposedCompliance rules
43 : Error(s) encountered reading building model (project) file
44 : Error(s) encountered evaluating rules required analysis to abort
45 : Unable to write compliance report file (.pdf or .xml)
46 : Error(s) encountered generating compliance report file (.pdf or .xml)
47 : Error setting up check of weather file hash
48 : Error evaluating CheckFileHash rules
49 : Weather file hash failed consistency check

Chapter 3. Tutorial

Note: This tutorial is specific to CBECC-Res 2013 version 2.

3.1 Sample Files

This is a step-by-step tutorial for modeling a simple single-family residence in *CBECC-Res 2013 1f.* Although this tutorial will begin with a blank project, it is helpful to note that in the CBECC-Res "Projects" directory are several sample input files, including:

1. **1StoryExample13.ribd.** Based on the Energy Commission's 2100 ft^2 single floor prototype with slab-on-grade floors, a tile roof, an attached garage, window dimension inputs, overhangs, with the garage modeled as a fin (providing shading to windows).
2. **1StoryExample13Crawl.ribd.** Same as above with a crawl space.
3. **2StoryExample13.ribd.** Based on the CEC 2700 ft^2 two-story prototype with asphalt shingle roof, this file has window dimension inputs, Compliance 2015, and a Photovoltaic power compliance credit.
4. **2Story2ZoneExample13.ribd.** Same as above but zoned 1st and 2nd story each with its own HVAC system.
5. **MFexample13.ribd.** An eight-unit two-story multi-family 6960 ft^2 two-story building with each story as a separate zone with four dwelling units in each zone, served by individual water heaters.

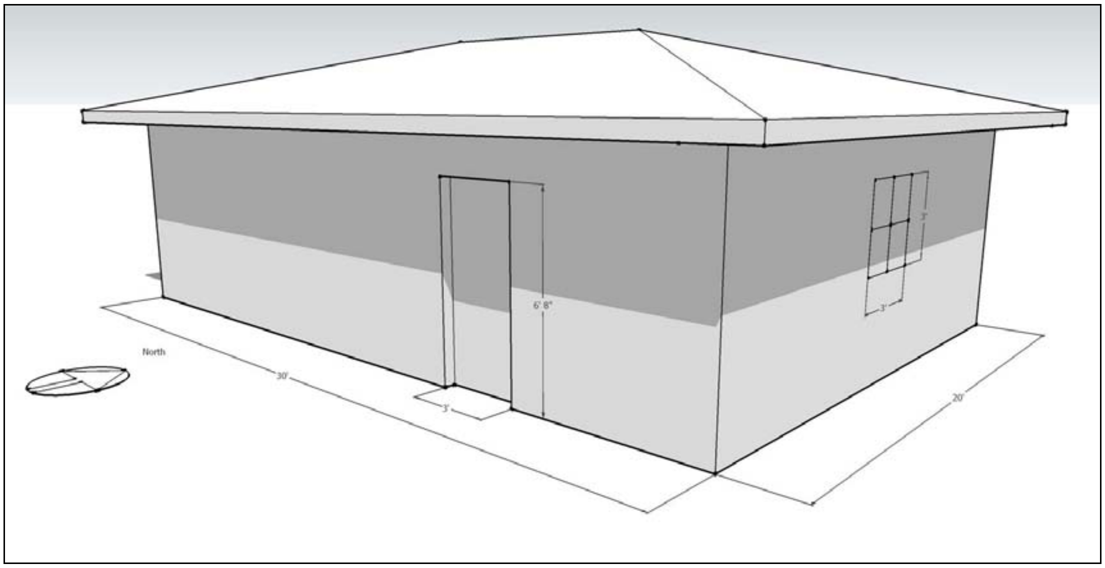
Not every input field will be discussed in this tutorial, but every input has a description in the appropriate chapter. Use the Table of Contents or the Index to find specific information. Additional information may also be found in the 2013 Residential Alternative Calculation Method (ACM) Reference Manual which discusses how the standard design is determined which may provide insight on the compliance results.

TIP: As you are progress through the tutorial, look around each of the screens and fields so you get an idea where changes can be made when you are working on a project.

3.2 Simple House Example

The house pictured in Figure 3-1 has a 30 ft by 20 ft living area, 8-ft ceilings with an attic above, and a slab-on-grade floor.

Figure 3-1: Simple House Example



On the south façade (front) is a single 3'-0" x 6'-8" front door. The east (right) has a 3'0" 3'0"window and north (back) facades has two 3'0" 3'0"windows and a 5'0" 6'8" sliding glass door with insulated glazing.

To model this home:

1. Download, install and start the CBECC-Res program. (The program can be downloaded from www.bwilcox.com/BEES/BEES.html). At the opening (main) screen dialog box, activate the button "Start with a Blank Project" and click <OK>.

2. Right click on the "Press Alt+F…" text line. Choose create project from the drop-down menu, and enter the project name "Simple House" and click <OK>.

3. Next you will pick the climate zone. Select Zone 12 (Sacramento). You can select any climate zone, however program defaults are based on Package A so your results for this tutorial may be different.

4. You will now be at the ***Project*** tab of the building model data. The name "Simple House" is filled in, and becomes the default name for the input file. Enter the address:

   1450 20th St
   Sacramento, CA
   95811
   <Select> CZ12 (Sacramento)

5. Rather than clicking OK (which will take you out of the building model data) click the ***Analysis*** tab to enter a run title, which is a field for your own notes or project information such as a compliance variable (e.g., w/ tankless water heater). The information will appear on the CF1R as "Calculation Description."

6. Check the box to Generate Report(s), ☑ PDF (note: the Full (XML) box generates the file that will get uploaded to the HERS provider). Keep the run scope as Newly Constructed.

7. Click on ***Building*** and enter a description such as "Single Family Residence," enter the front orientation as "180" (see North arrow in above figure) and number of bedrooms as "2." For this example, we will assume the building has natural gas and we will not model an attached garage.

8. For now we will leave the Indoor Air Quality and Cool Vent tabs alone. IAQ will model an appropriately sized default exhaust fan. Cool vent (for example, a whole house fan) will be set for you based on the climate zone and the presence of an attic.

9. Click "OK". Either click on the save button or Select <File>, <Save As> and name the file Simple House.ribd.

10. Some getting around tips are that the project is called Simple House (so that is the default name for the input file). This name appears at the head of the project tree of the main CBECC-Res screen. Next we will add child components to the parent component.

    To add components, right click on the parent component and choose <create> and pick the type of component you wish to add.

    To edit an existing component, either double click, or right click and pick <edit>.

    If you need to edit or check a project component (address, climate zone, front orientation, IAQ ventilation, etc.) double click on the word project and it brings up the initial screen with the project tabs running across the top of the screen.

    Items in the project tree ***Construction Assemblies*** and ***Material Layers*** are not project components, but are a library of assemblies and materials. At this point some of the folders are empty but will be populated by the time the input file is fully created.

11. To continue, right click on the ***Project*** title. From the drop-down menu choose <create> then choose <zone>. Enter the zone name "House" and click <OK>.

12. At the next dialog box, the ***zone type*** is "Conditioned" and you will enter "600" square feet for the floor area and "8" feet for the average ceiling height. Click <OK>. You have created a child component to the project component, which can now be described more fully.

13. You are at the ***Zone Data*** tab of the building model data dialog box, where you will add an HVAC system to the conditioned zone.

    a. Click the drop-down menu arrow at the ***HVAC System*** box and choose to <Create new HVAC System>. At the next dialog box accept the default name by clicking <OK>.

    b. At the ***HVAC System Type***, pick from the drop down menu "Other Heating and Cooling System" and click <OK>.

c. This opens the ***HVAC System Data*** fields where you will define the system, starting with the ***Heating Unit***. From the drop down box where it has "–none-" pick <create new heating system>. For now keep the default name Heating System 1 and click <OK>. Pick the equipment type as "CntrlFurnace" and keep the default 78 AFUE and click <OK>.

d. Now move to ***Cooling Unit*** and follow the same process – picking SplitAirCond and keeping the default efficiencies and refrigerant charge settings (since this sample is in a hot climate, we will keep the verified refrigerant charge, which is a HERS verification test, to avoid an energy penalty in this climate zone. The 11.3 default EER does not require HERS verification. A value higher than 11.3 does require verification as explained in Section 8.3.1. Click <OK>.

e. In the ***Distribution*** field follow the same procedure—selecting ducts in an unconditioned attic and accepting the default values (a check box sets the default values based on the climate zone). Click <OK>.

f. Next create the ***Fan*** data. Pick the Single speed furnace fan and click <OK>. Accept the W/CFM cooling value of "0.58" and click <OK>.

g. You are now back at the ***HVAC System Data*** tab. Click <OK> to return to the ***Zone Data***. Although in this exercise we will not further edit the HVAC system, to do so you would access it by clicking on the ***Mechanical*** tab at the CBECC-Res main screen where a tree similar to the ***Envelope*** tree appears.

h. Next click on the drop-down menu arrow at ***DHW System*** to begin defining the domestic hot water system components. Pick "create new DHW System" and keep the default system name. Keep the Distribution as "Standard". Pick from the drop-down menu for ***Water Heater(s) 1*** "create new Water Heater" and keep the default name. Click <OK> to accept the default characteristics for the water heating system. Click <OK>. We will keep the water heater count as 1. Click <OK> again to accept the building details for floor area, stories, HVAC and DHW systems.

NOTE: In this tutorial we often accept the default names. But you may wish to name your components something more descriptive since you will likely use a previous project to begin a new project and the names will help you identify the characteristics of that component.

14. Next we will add components from the top down, beginning with a 600 square foot ceiling. Right click on the ***House*** zone and choose <create> and then "Ceiling (below attic)." Accept the default name and click <OK>. Then follow the prompts to create a 600 square feet and create a new construction assembly. Set the cavity insulation to R-38 ceiling below attic. Click <OK> three times. Notice that in addition to the ceiling, the program has created an attic zone with 600 square feet.

15. Next add exterior walls.

a. Right click on the ***House*** zone again. Choose <create> and then pick <exterior wall>. Change the Exterior Wall Name to "Front Wall" and click <OK>.

b. Enter a gross area of 240 square feet of wall area, and for the construction assembly create a new construction. Call it Wall R15/4." Pick R-15 cavity insulation and an Exterior Finish of R4 Synthetic Stucco (this is the appropriate method for modeling 1-coat stucco). Since the rest of the inputs are correct, click <OK> twice.

c. Set the ***Orientation*** to front (Note: if you like to model an orientation value rather than front, left, etc., please read section 7.1 and check the CF1R before printing because whatever number you enter is added to the front orientation). Leave the wall ***tilt*** as 90. And click <OK>.

d. From the ***House***, repeat step b. three more times for a "Left Wall," "Back Wall" and "Right Wall" remembering to enter the correct gross wall area (160 for left and right walls, 240 for back wall) and change the orientation to <Left>, <Back> or <Right>. The program will let you copy data from any of the previous ***Exterior Walls*** or you can choose "none" at the <Copy Data From> dialog box. Return to the main screen by clicking <OK> after entering the last wall. The walls are child components to the parent ***House*** zone.

16. Before creating any windows, first set up the ***Window Types*** library in a manner that works for your projects. For example, if you use certain brands of windows, on the row Window Types, Right Click, and pick <Create>. Give it a name such as Operable.BrandX (0.32, 0.23), Picture.BrandY (0.31, 0.20), SGD.BrandX (0.28, 0.24) and set the U-factor and SHGC values only (NOTE: even if you wish to accept the default values, type the value in so that the field turns red). This set up allows you to change only the U-factor and SHGC values on a project in the Window Types list without having to go back and edit every window entry (see also 6.9.4). When adding the windows to the given walls, the fields will be blue indicating they are connected to the Window Type library correctly.

17. Now add the door and windows to the envelope description. The door and windows will be child components of the respective walls in which they are located. Begin with the front door.

    a. Right click on the ***Front Wall***, choose <create> and then click on <InputDoor>.

    b. Follow the prompts. The door is 20 square feet. Use the default U-factor (0.50). Return to the main screen.

18. Now move back up to the walls, right click on the ***Back Wall*** to <create> a window. Name it B1 and click <OK>.

19. The next dialog box asks you to choose between ***window dimensions*** and ***overall window area***. Choose ***window*** dimension so an overhang can be modeled and click <OK>.

20. You are now at the ***Window Data*** tab. Select the ***Window Type*** from the library types just added (e.g., Operable) and enter the window height "3" and width "3" and set the multiplier to 2 since we will model identical overhangs for the two windows.

21. Notice that it has picked up the U-factor and SHGC from the window Type. Leave the remaining values as defaults.

22. To add an overhang, click on the ***Window Overhang*** tab at the top of the screen. You will see an illustration of the inputs. Enter a ***Depth*** of "2" feet, a ***Dist Up*** of "1" foot, and an ***Extends Left*** and ***Extends Right*** of "7" feet each. Leave the ***Flap Height*** as "0." Complete the overhang by clicking <OK>.

23. Still on the back wall, create a 5'x6'8" sliding glass door by right-clicking, picking <create> a window named SGD, copy window B1. Pick SGD from the window type library and enter the width as 5 and a height of 6.67. Change the overhang to have a left distance of 3 and a right distance of 22.

24. Finally, right click the ***Right Wall*** using the same method to create a window. Tell the program to copy the data from the first window, changing the multiplier to 1. Change the overhang ***Extends Left*** and ***Extends Right*** values to "10.5" each. All other data remain the same. Click <OK>.

25. Next add a slab floor by moving back up to ***House***. Right click and choose <create> and then pick <Slab on Grade.> Enter an area of 600 square feet, a floor elevation of 0.67 (or the level of the surface of the floor above grade) and a perimeter equal to the length of the four sides exposed to the exterior (100). Note: If there was a garage, the edge no longer includes the length of the edge adjacent to the garage, but only adjacent to the exterior. Keep the surface set to default (80% covered, 20% exposed).

26. The model is now complete. You can edit envelope components by right clicking on them and choosing <edit>. You can add components by right clicking on a parent component and choosing <create> and then clicking on a component type. By choosing the ***Mechanical*** tab at the main screen you can similarly edit components of the mechanical systems.

27. To perform an analysis, save your input file using the ***Save*** shortcut key, and the ***Perform Analysis*** shortcut key (see page 2-3) (also accessible under the menu for ***Tools***). This will perform the simulation of the current model, which takes from 3-5 minutes. For comparison, Figure 3-2 shows the output screen for the model built in this tutorial. You will be able to view the CF1R since we checked the box to create the PDF. The PDF is generated using a web-based application.

Figure 3-2: Output for Simple House in Climate Zone 12

Energy Use Details | Summary

End Use	Standard Design Site (kWh)	Standard Design Site (therms)	Standard Design (kTDV/ft²-yr)	Proposed Design Site (kWh)	Proposed Design Site (therms)	Proposed Design (kTDV/ft²-yr)	Compliance Margin (kTDV/ft²-yr)
Space Heating	54	62.6	20.74	55	63.9	21.11	-0.37
Space Cooling	405		38.91	384		37.04	1.87
IAQ Ventilation	62		2.21	62		2.21	0.00
Other HVAC			0.00			0.00	0.00
Water Heating		145.5	38.85		145.5	38.85	0.00
PV Credit						0.00	0.00
Compliance Total			100.71			99.21	1.50
Inside Lighting	407		15.21	407		15.21	Result:
Appl. & Cooking	796	32.9	37.14	796	32.9	37.14	PASS
Plug Loads	1,147		41.36	1,147		41.36	
Exterior	5		0.17	5		0.17	
TOTAL	2,876	241.0	194.59	2,856	242.2	193.09	

28. The project complies. Note that due to the defaulting built into the program it is assumed to have a whole house fan, and a radiant barrier, which may not be desired. As part of this tutorial, we will try trading off some features. If you notice the above compliance margin is in compliance on cooling, so trading away some of the measures that help cooling is feasible.

29. Double click on Attic. This is where the Reflectance and Emittance values for a cool roof product are changed. The roof has a roof rise (pitch) of 5:12. The ***Construction*** is where the radiant barrier and above deck (not typical ceiling) insulation and the roofing material is modeled. Click <OK> and move down to the Construction Assemblies (click on the + sign) and double click on Asphalt Shingle Roof. Because Package A in climate zone 12 has a radiant barrier the program included that feature. Uncheck the radiant barrier box. Click <OK> again.

30. Double click on ***Project*** and pick the Cool Vent tab (off to the right). If no whole house fan is desired, change the default prescriptive whole house fan to none and click <OK>.

31. Click on the **Mechanical** tab and double click on the Heating or Cooling System to change the efficiencies. Change the heating system to 80% (not 0.80).

32. Double click on ***Water Heater 1***. Change the Energy Factor to 0.62. Click <OK>. At this point either save the input file with a new name or close the PDF of the CF1R. Save the file and perform the analysis to see if it still complies.

Figure 3-3: Updated Output for Simple House

Energy Use Details | Summary

End Use	Standard Design Site (kWh)	Standard Design Site (therms)	Standard Design (kTDV/ft²-yr)	Proposed Design Site (kWh)	Proposed Design Site (therms)	Proposed Design (kTDV/ft²-yr)	Compliance Margin (kTDV/ft²-yr)
Space Heating	54	62.6	20.74	55	62.8	20.80	-0.06
Space Cooling	405		38.91	398		39.72	-0.81
IAQ Ventilation	62		2.21	62		2.21	0.00
Other HVAC			0.00			0.00	0.00
Water Heating		145.5	38.85		127.1	33.99	4.86
PV Credit			0.00			0.00	0.00
Compliance Total			100.71			96.72	3.99
Inside Lighting	407		15.21	407		15.21	Result:
Appl. & Cooking	796	32.9	37.14	796	32.9	37.14	PASS
Plug Loads	1,147		41.36	1,147		41.36	
Exterior	5		0.17	5		0.17	
TOTAL	2,876	241.0	194.59	2,871	222.8	190.60	

(results may vary slightly)

Chapter 4. Project

It is often best to start with an existing input file for a similar project, which will have the structure of the building set up. However, you have the option of starting with a blank project. The sample files included with the software are one-story (slab or crawl space), two-story buildings (one or two zones), and a multi-family building.

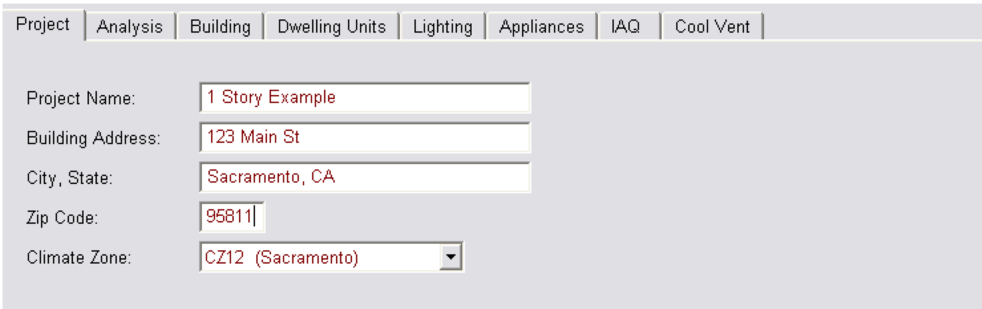
Once familiar with the program, you can set up a file template for projects that have a library of assemblies and equipment common to your projects. For example, R-30 cathedral ceilings; R-30 and R-38 ceilings below attic; tile roofs and asphalt/comp roofs, with or without radiant barriers; typical 2x4 and 2x6 wall construction assemblies; furnaces with 80% and 92% AFUE; and various water heater types and efficiencies typical for your clients.

4.1 Tool Tips/Automated Features

- **Tool Tips**. Some fields have tool tips that are activated by hovering over the field.
- **File Save**. If a file was not saved before you choose to perform an analysis, you are prompted to save it before running. If you select the default save, the file will be saved over the existing file. Thus, if your intention is to create a new version of the file, be sure to pick <cancel> and select <file> and <save as> from the file menu.
- **Cooling Efficiencies**. When minimum cooling equipment efficiencies are specified, these will be updated to the new minimum efficiencies when you switch from 2014 analysis to 2015 (see Section 4.3.1.4).
- **Duct R-value**. When the "defaults" for ducts are used, if you change the climate zone and the new zone has a different Package A basis, the minimum will be updated (e.g., zone 12 is based on R-6 while zone 11 is based on R-8).
- **Automated Defaults Based on Climate Zone**. When a field such as duct R-value, window U-factor or SHGC is blue rather than red the value will update based on the default for the selected climate zone. If the field is red and you wish to enable this feature, swipe the cursor across the field, right-click and select "Restore Default." The field will change from red to blue to indicate that it will change if a climate zone with a different standard design assumption is selected. To prevent unintended changes on window efficiencies, see also Window Types in Section 7.3.1.4.

4.2 Project Information

Figure 4-1: Project Information



4.2.1.1 Project Name

The project name is user-defined project information that will appear as the first piece of general information on the CF1R.

4.2.1.2 Building Address

Enter a building address, APN or legal description to identify the location of the proposed building project.

4.2.1.3 City, State

Enter the city or town in which the proposed building is located.

4.2.1.4 Zip Code

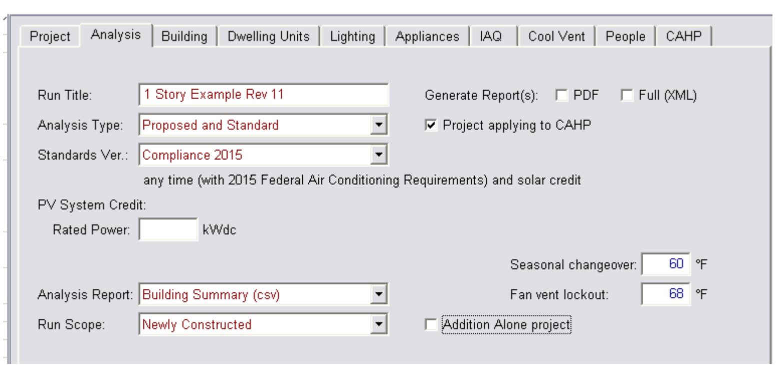
The zip code is used to establish the correct climate zone.

4.2.1.5 Climate Zone

Use the zip code and *Reference Appendices*, JA2.1.1. to determine the correct climate zone.

4.3 Analysis

Figure 4-2 Analysis Information



4.3.1.1 Run Title

Run title is a field for the software user's own notes or project information. The information will not appear on the CF1R. It can be used to identify information such as a compliance variable being considered (e.g., "w/ tankless water heater").

4.3.1.2 Analysis Type

The two types of analysis are ***proposed and standard design*** (typical for compliance), and ***proposed only***.

4.3.1.3 Generate Report(s)

Two options are provided to generate (1) a PDF of the compliance report for review purposes, and (2) the full (XML) once the project is ready to produce the compliance documentation for upload/submittal. The PDF automatically generated by having the PDF option checked will have a watermark that it has not been registered. Projects that require HERS verification will need to be uploaded to a HERS provider to obtain a registered CF1R before applying for a building permit.

4.3.1.4 Standards Version

Default Compliance 2015.

Compliance 2014 is valid only for permit applications through December 31, 2014 (at which time federal air conditioning efficiency requirements change).

Compliance 2015 is valid any time and required for permit applications made on or after January 1, 2015. At that time new federal cooling equipment standards of 14 SEER and an EER requirement based on equipment capacity of 11.7 EER or higher take effect (for simplification, CBECC assumes 11.7 as the standard minimum EER for all equipment). Compliance 2015 also allows credit for photovoltaic systems in some climate zones (see 4.3.1.5 below). New standards for water heating also take effect.

NOTE: When switching between Compliance 2014 and 2015, the minimum cooling efficiency values will change if you used default appliance efficiency levels. The standard design for Compliance 2014 is based on 13 SEER, and is 14 SEER and 11.7 EER for Compliance 2015.

4.3.1.5 PV System Credit

Optional photovoltaic system (PV) credit is available only when Compliance 2015 is selected, and only in climate zones 9-15 for single family and town house projects. Compliance 2015 may be used voluntarily at any time if credit for a PV system is desired. A minimum of 2 kWdc is required for the compliance credit.

The credit assumes updated federal cooling equipment appliance standards and is the smaller of:

PV Generation Rate (kTDV/kWdc) * kWdc

Max PV Cooling Credit * Standard Design Cooling Energy (kTDV)

Where the factors are shown in Table 4-1.

Table 4-1: PV Credit Calculation Factors

Climate Zone	PV Generation Rate (kTDV/kWdc)	Max PV Cooling Credits ($ of Standard Design Cooling kTDV/ft2)
09	30269	13%
10	30342	15%
11	29791	18%
12	29556	17%
13	29676	17%
14	31969	16%
15	29536	19%

The software calculates the solar credit, which is reported as a *Special Feature* on the CF1R. Systems must meet the eligibility criteria specified in Residential Appendix RA4.6.1.

4.3.1.6 Analysis Report

The default report type is Building Summary (csv).

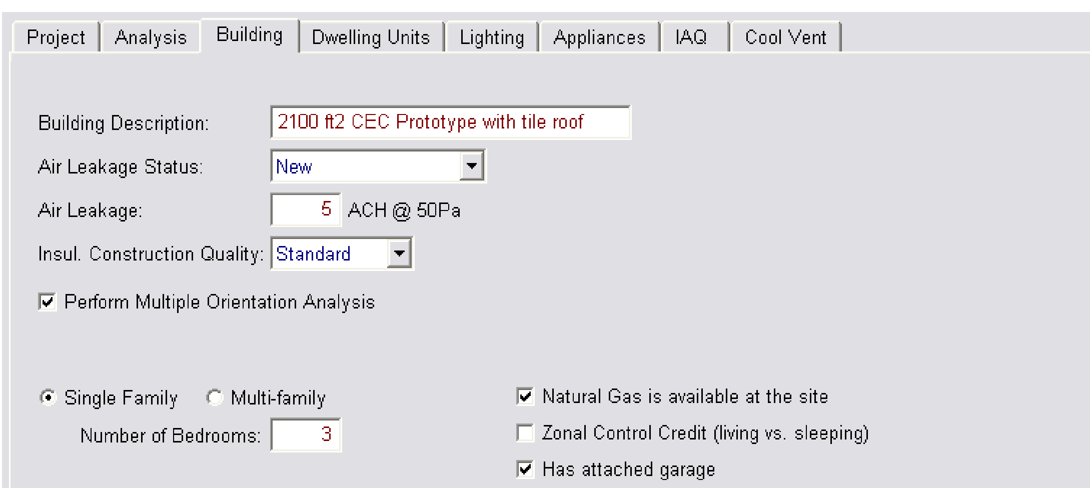
4.3.1.7 Run Scope

The two types of projects are ***Newly Constructed*** or ***Addition and/or Alteration*** [NOTE: for addition alone analysis, select Newly Constructed, check Addition Alone, and enter the Fraction of a dwelling unit (Addition Area / (Existing + Addition) = Fraction)].

4.4 Building

The ***Building*** tab (see Figure 4-3) is used to provide basic information about the building.

Figure 4-3: Building Information



4.4.1 Building Information

4.4.1.1 Building Description

The building description will appear as the second line of general project information on the CF1R. It is a user-defined label and is different from the project name.

4.4.1.2 Air Leakage

Default value (no blower door test) for buildings with space conditioning ducts in unconditioned space (and the default condition for no cooling) is 5 for single family and 7 for other buildings. When there are no heating and/or cooling system ducts in unconditioned space, the default is 4.4 for single-family buildings and townhomes and 6.2 for all others buildings.

If a single family or town home will have HERS verified infiltration testing (blower door test), model an achievable target leakage area value. For multi-family buildings there is no compliance option for infiltration testing.

When a value lower than default is modeled, diagnostic testing for reduced infiltration, with the details and target values modeled, is reported as a HERS Required Verification on the CF1R.

This input represents the air flow through a blower door at 50 pascals (Pa) of pressure measured in cubic feet per minute, called CFM50 or ACH50. CFM50 x 60 minutes divided by the volume of conditioned space is the air changes per hour at 50 Pa, called ACH50.

4.4.1.3 Insulation Construction Quality

The presence of improved/verified high quality insulation installation certified by the installer and field verified to comply with RA3.5. Default value is "standard." Specify either standard (unverified) or improved, which means verified high quality insulation installation. Also called Quality Insulation Installation (QII), improved requires HERS verification. Credit for verified quality insulation installation is applicable to all insulated assemblies in the building—ceilings/attics, knee walls, exterior walls and exterior floors. See *Reference Appendices*, Residential Appendix RA3.5.

4.4.1.4 Front Orientation

This field defines the front orientation in degrees and must be accurate within 5 degrees. This value is from the site plan, and differs from the window and wall orientation (see Section 7.1). While this input is typically the side of the building where the front door is located, if the front door, front façade, or the side of the building facing the street are different, any choice is acceptable as long as the end result is a CF1R with windows facing the correct ~~orientation~~actual azimuth.

The front orientation or actual azimuth is used to establish the orientation of walls and windows, which are modeled using either labels such as "front" or "left," or the orientation with respect to the front and ~~plan azimuth,~~ not the actual orientation (see Orientation in Section 7.1).

Multiple orientation (or cardinal compliance) is a valid selection for subdivisions where homes may be built in any orientation. The building must comply with the same energy features in all orientations. A single CF1R will display the compliance for the four cardinal orientations—north, east, south and west.

4.4.1.5 Single Family or Multi-family

Use the check box to indicate if the building is a single-family dwelling (R-3 occupancy group), or is a multi-family building (R-1 or R-2 occupancy group) with three stories or less. When multi-family is selected, the dwelling unit information is defined under the separate ***dwelling unit*** tab. This structure allows for modeling different dwelling unit configurations within a single building with unique HVAC, ventilation and water heating conditions.

Multi-family buildings can be modeled with each dwelling unit as a separate zone (the most detailed and complex) or with each floor as a separate zone. A 2-story, two zone sample file is included with CBECC-Res. This structure requires the dwelling units be defined separately for each floor. For example, if there are 1-bedroom and 2-bedroom configurations on both the first floor and second floor, they must be identified separately under the dwelling unit tab (see Section 4.4.1.10). For additional guidance, see Section 5.4.1.10 for structuring the HVAC system inputs, and Section 5.5 for information about defining the garage zone in a multi-family building. Party walls or a party floor must be modeled as an interior surface, with the box checked to indicate a different dwelling unit is on the other side of the surface being modeled.

4.4.1.6 Number of Bedrooms

The number of bedrooms in a building is used to establish mechanical ventilation requirements and to determine if a building qualifies as a compact building for purposes of incentive programs. For single family dwellings, indicate the number of bedrooms under the ***building*** tab and for multi-family dwellings under the ***dwelling unit*** tab.

4.4.1.7 Natural Gas Availability

Check the box if natural gas is available at the building site. The field does not indicate what fuel type is being used in the building for heating, cooling or water heating. Whether natural gas is available determines the fuel type used as the basis for time dependent value (TDV) in the standard design (see *Reference Appendices*, Joint Appendix JA3).

4.4.1.8 Zonal Control

Checking this box enables modeling a building that meets zonal control requirements of the heating system. Zonal control credit requires compliance with several eligibility criteria (see *Residential Compliance Manual*, Chapter 4, Section 4.5.2 for the complete list). The living and sleeping areas are modeled and conditioned separately, with either zonally-controlled equipment or separate space conditioning equipment, and with living and sleeping schedules for the thermostat settings.

Some of the requirements for this compliance option include each habitable room must have a source of space conditioning, the sleeping and living zones must be separately controlled, a non-closeable opening between the zones cannot exceed 40 ft^2, each zone must have a temperature sensor and a setback thermostat, and the return air for the zone must be located within the zone.

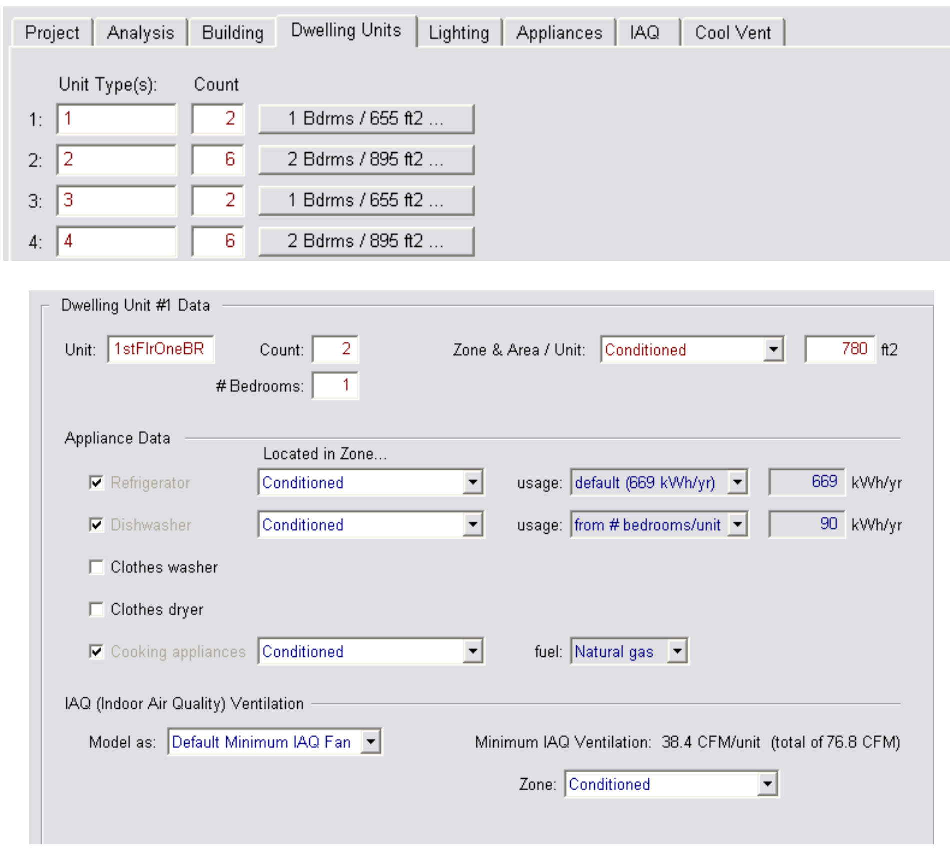
4.4.1.9 Has Attached Garage

This check box is used to indicate if there is an attached garage, which must be modeled. While there are no minimum requirements for the garage construction, it is modeled to accurately represent the building to be constructed and typically improves compliance due to the buffering effects of an enclosed attached space.

4.4.1.10 Dwelling Units

In a multi-family building, the dwelling unit information is identified under this tab (see Figure 4-4). For single family dwelling units the characteristics are defined under the ***Building*** tab.

Figure 4-4: Multi-Family Dwelling Unit Details



Each dwelling unit type must be separately identified. A dwelling unit type will have the same floor area, number of bedrooms, appliances (only the presence of clothes washer and dryer can be shut off), the same IAQ ventilation system type, and be located on the same floor. Identify each dwelling unit type and the number of that dwelling unit type that is included in the building or zone (see Figure 4-4).

4.4.2 Dwelling Unit Details, Multi Family

4.4.2.1 Unit

This is a short distinguishing piece of information to describe the dwelling unit.

4.4.2.2 Count

This input is to specify how many of this dwelling unit type are included in this zone. In the above figure, the bottom floor has 780 x 4 = 3120 ft^2.

4.4.2.3 # Bedrooms

Number of bedrooms in the dwelling unit used to establish the minimum ventilation requirements.

4.4.2.4 Zone & Area/Unit

The zone name is entered here. Multi-family buildings that have floors between dwelling units, must either define each floor as a separate zone or each dwelling unit as a separate zone. In this example, each floor is defined as a separate zone, with four dwelling units per zone.

4.4.2.5 Ft^2

The number of square feet in the one dwelling unit type being defined.

4.4.2.6 IAQ (Indoor Air Quality) Ventilation

Used to identify that a default minimum IAQ fan is being used or another method of meeting the mandatory ventilation requirement.

4.4.2.7 Zone

The zone in which the dwelling unit is modeled.

4.5 Lighting/Appliances

The inputs under these tabs are for project types other than energy compliance for new construction.

4.6 IAQ Ventilation

For single-family dwelling units, the mandatory indoor air quality (IAQ) ventilation is specified here. The minimum required ventilation rate is provided based on the conditioned floor area and number of bedrooms in the dwelling unit. See Section 8.6 for more information on the specific IAQ fan details. For more information on this mandatory requirement, see *Residential Compliance Manual*, Section 4.6.

4.6.1.1 Model as

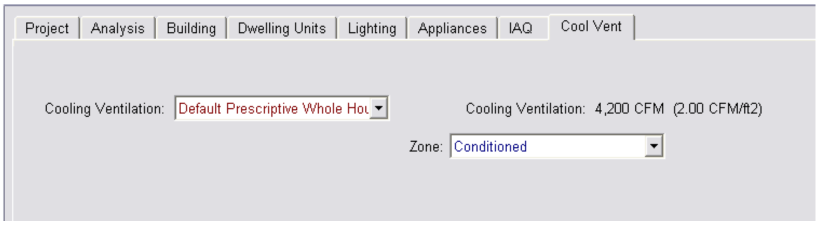
Select method of ventilation as either default minimum IAQ fan or specify individual fans (as described in Section 8.6).

4.6.1.2 Zone

Assign to one of the conditioned zones.

4.7 Cooling Ventilation

Figure 4-5: Cooling Ventilation



Cooling ventilation systems use fans to bring in outside air to cool the house when this could reduce cooling loads and save energy. The simplest approach is a whole house fan, which is the basis of the standard design in climate zones 8-14 where the evenings may cool down enough to be an effective means of cooling the house. The types of cooling ventilation are shown in Table 4-2. Additional inputs are discussed in Section 8.7.

4.7.1.1 Cooling Ventilation

Default value is none. Other options are a default prescriptive whole house fan (will set to exactly 2 CFM/ft^2), specify individual fans, or a central fan integrated system which uses the space conditioning duct system to provide outside air for cooling (additional inputs are discussed in Chapter 8). Whole house fan operation requires that the building have an attic.

Table 4-2: Ventilation Cooling Fans

Measure	**Description**
Whole House Fan	Traditional whole house fan is mounted in the ceiling to exhaust air from the house to the attic, inducing outside air in through open windows. Whole house fans are assumed to operate between dawn and 11 PM only at 25% of rated CFM to reflect manual operation of fan and windows by occupant. Fans must be listed in the California Energy Commission’s Whole House Fan directory. If multiple fans are used, enter the total CFM.
CFI (Central Fan Integrated) cool vent	These systems use the furnace or air handler fan to deliver outdoor air to conditioned space. With an automated damper, outside air duct, temperature sensors and controls, these systems can automatically deliver filtered outdoor air to occupant set comfort levels when outdoor conditions warrant the use of ventilation.

4.7.1.2 Zone

Assign to any conditioned zone that has a ceiling below an attic. Since a whole house fan uses attic venting to exhaust the hot air, an attic is required for this measure.

Chapter 5. Zones

5.1 Multiple Conditioned Zones

Decide in advance how many zones are needed to adequately define a building. A zone is typically an area with specific details that require it to be modeled separately from another area (a more complex building model does not necessarily yield better compliance results).

Some cases where multiple zones are required are:

- When taking credit for zonal control (with at least one living and one sleeping zone).
- Spaces are served by different types of heating/cooling equipment (such as a heat pump and a gas furnace)
- Different duct conditions or locations.
- A radiant barrier in part of an attic, and not in another part.

The simplest approach is to model the worst case in a single zone, but a more detailed model may be needed to achieve compliance.

NOTE: Different types of water heating can be modeled within the same zone.

In addition to the conditioned zones, attics, garages, attached unconditioned spaces and crawl spaces zones must be modeled.

5.2 Attic

The compliance software models attics as a separate thermal zone and includes the interaction with the air distribution ducts, infiltration exchange between the attic and the house, the solar gains on the roof deck and other factors. These interactions are illustrated in Figure 5-1.

5.2.1 Attic Zone Data

The software automatically creates an attic zone once you define a ceiling below an attic as part of the conditioned space or garage (see Figure 5-2).

Figure 5-1: Attic Model Components

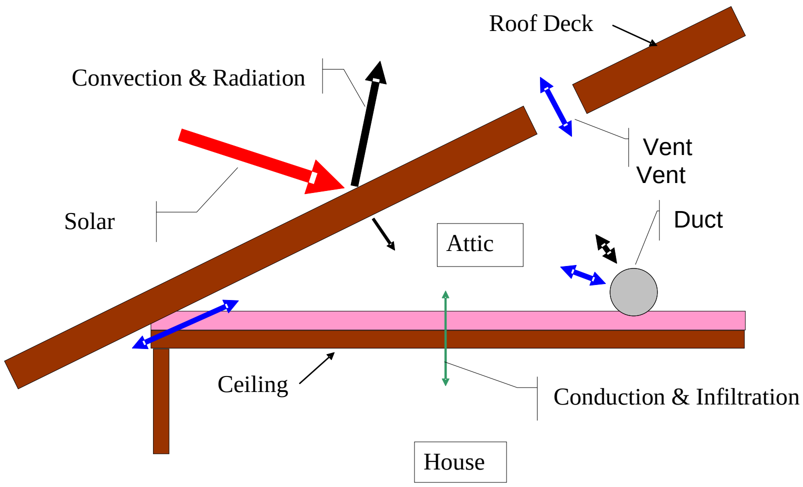
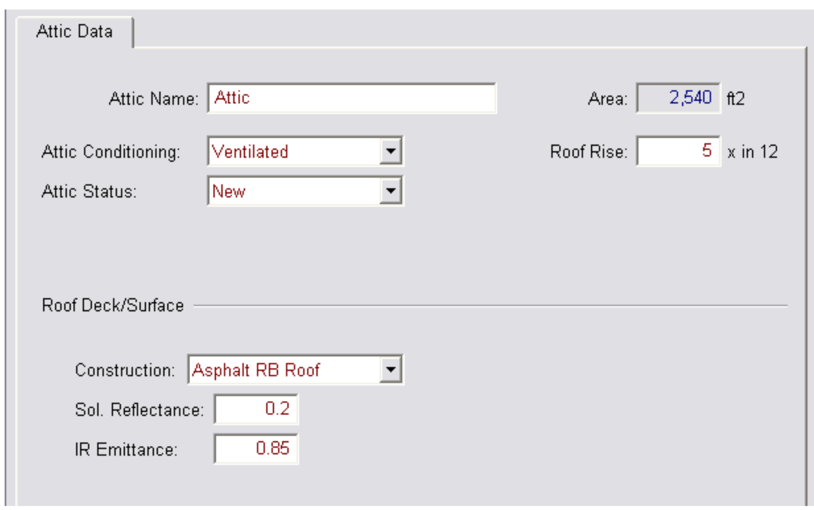


Figure 5-2: Attic Zone Data



5.2.1.1 Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

5.2.1.2 Attic Conditioning

The conditioning is either ventilated (typical attic) or conditioned (unvented), which is not yet implemented.

5.2.1.3 Roof Rise

Specify the roof rise or roof pitch, which is the number of feet the roof rises in a span of 12 feet (shown on elevations as 4:12 or 4 in 12). If there are multiple pitches you can enter the roof rise of the largest area of roof.

5.2.1.4 Area

The area is not a user input. The area is derived from the combination of ceilings below attic modeled as part of the conditioned and unconditioned zones.

5.2.1.5 Attic Status

Default is new. Other options include altered and existing for Existing+Addition+Alteration analysis.

5.2.1.6 Construction

The roof construction is the connection to an assembly that contains the roofing material (such as tile or asphalt shingles), radiant barrier, and other construction details (see more in Chapter 6, Construction Assemblies).

5.2.1.7 Solar Reflectance

The default aged solar reflectance is 0.10 for all roof types. The aged solar reflectance for a roof product~~, as~~ published by the Cool Roof Rating Council (CRRC) (www.coolroofs.org)~~,~~ or calculated from the initial value using the equation in 3.7.1 of the 2013 Residential Compliance Manual. The aged solar reflectance measures the roofing product's ability to reflect solar heat. A higher value is better for warmer climates, so if a specific product color is unknown use a lower value among options to avoid having to recalculate compliance during construction.

If the roof membrane has a mass of at least 25 lb/ft^3 or any roof area that incorporates integrated solar collectors, the roof may assume the Package A solar reflectance value (see Section 5.2.2).

If the roof is a cathedral ceiling or rafter roof, the solar reflectance is defined as part of the ceiling (see Chapter 7, Building Envelope).

The roofing material and roof structure is specified via the ***Roof Deck/Surface: Construction***, which is accessed under ***construction assemblies*** or by creating a new ***roof construction assembly*** as discussed in Chapter 6, Construction Assemblies.

5.2.1.8 IR Emittance

The default infrared or thermal emittance (or emissivity) for all roofing materials is 0.85. Otherwise, enter the emittance value published by the Cool Roof Rating Council (CRRC) (www.coolroofs.org).

If the roof membrane has a mass of at least 25 lb/ft^3 or for any roof area that incorporates integrated solar collectors, the roof may assume the Package A emittance value (see Section 5.2.2).

If the roof is a cathedral ceiling or rafter roof, the emittance is defined as part of the ceiling (see Chapter 7, Building Envelope).

The roofing material and roof structure is specified via the ***Roof Deck/Surface: Construction*** which is accessed under ***construction assemblies*** or by creating a new ***roof construction assembly*** which is discussed in Chapter 6, Construction Assemblies.

5.2.2 Cool Roof

Cool roof is a term that refers to the ability of roofing materials to both reflect and absorb solar heat. It typically means a high solar reflectance and a high emittance, but can also be a low emittance and a very high solar reflectance.

Although specific values are not mandatory, Package A (the basis of the standard design) contains a minimum requirement for solar reflectance and emittance that varies by climate zone and roof slope. A low slope roof has a ratio of rise to run (or pitch) of 2 in 12 or less (≤9.5 degrees from the horizontal). In climate zones 13 and 15 a low slope roof is compared to a roof with 0.63 aged solar reflectance and 0.75 emittance. A steep slope roof has a ratio of rise to run of greater than 2:12 (>9.5 degrees from the horizontal). In climate zones 10 through 15 a steep slope roof is compared to a roof with 0.20 aged solar reflectance and 0.75 emittance.

The CF1R reflects that a cool roof is modeled when a reflectance of greater than 0.20 is modeled. If a reflectance value greater than 0.10 but less than or equal to 0.20 is modeled, the CF1R reflects a special features message that the building contains a non-standard roof reflectance.

5.2.3 Low Slope Aggregate Roof

Although more common in nonresidential applications, aggregate is a roofing product made up of stone or gravel material that is used as a finish surface for low-sloped roofing. A compliance option (see Publication CEC-400-2012-018-SF) allows for default efficiencies when the material is tested to the initial solar reflectance value shown in Table 5-1. The compliance option allows compliance using the default values for aged solar reflectance and emittance values shown in the table.

Table 5-1: Solar Reflectance and Emittance for Aggregate Materials

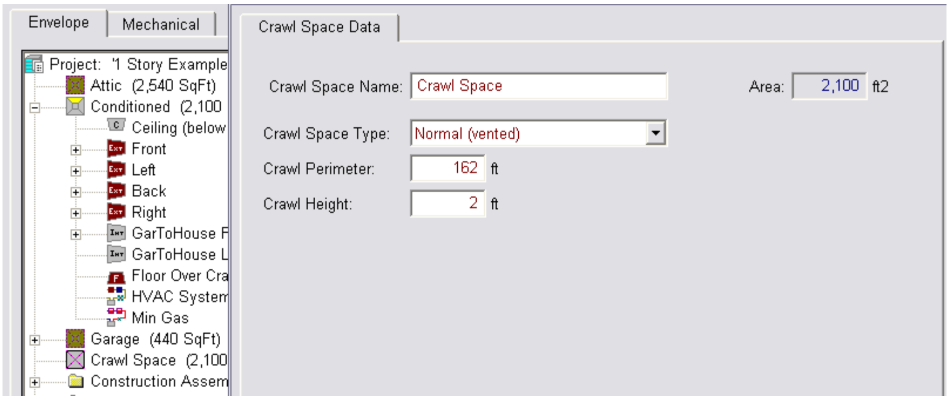
Aggregate Size	Tested Initial Solar Reflectance	Default Aged Solar Reflectance	Default Emittance
Built-Up Roofs Size 6-8 confirming to ASTM D448 and D1863	0.50	0.48	0.85
Ballasted Roofs Size 2-4 confirming to ASTM D448	0.45	0.40	0.85

5.3 Crawl Space

The software automatically creates a crawl space zone when a floor over crawl space is defined. The floor characteristics are more fully discussed in Chapter 6, Construction Assemblies).

The crawl space zone (see Figure 5-3) is created using the area specified for the raised floor above the crawl space and the floor elevation to set the area and height of the crawl space.

Figure 5-3: Crawl Space Zone



5.3.1 Crawl Space Zone Data

5.3.1.1 *Crawl Space Name*

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

5.3.1.2 *Crawl Space Type*

The default type is a vented crawl space. The three available types are (1) normal vented crawl space (has a conditioned space above with raised floor insulation), (2) insulated with reduced ventilation [as used in the Building Code], or (3) sealed and mechanically ventilated crawl space (also called a controlled ventilation crawl space or CVC). For CVC credit installation requirements see *Reference Appendices*, Residential Appendix RA 4.5.1.

5.3.1.3 *Crawl Perimeter*

The length (in feet) of the perimeter (similar to the slab edge length for a slab on grade floor).

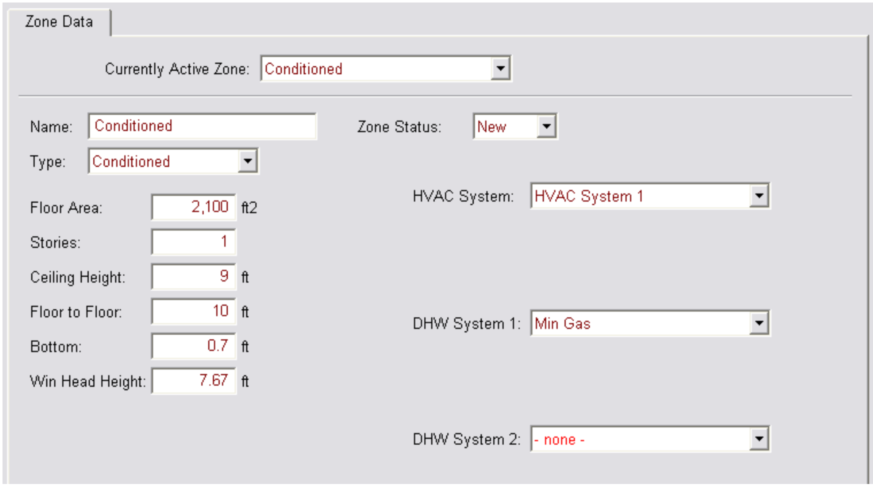
5.3.1.4 *Crawl Height*

The depth of the crawl space, in feet.

5.4 Conditioned Zone

To create the house or dwelling unit, right-click on project or edit an existing conditioned zone (see Figure 5-4).

Figure 5-4: Conditioned Zone Data



5.4.1 Conditioned Zone Data

5.4.1.1 Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

5.4.1.2 Zone Status

The default is new for new construction or the added floor area of an addition. Other options include altered and existing.

5.4.1.3 Type

The default zone type is conditioned. If the building is designated as meeting the zonal control criteria (under the ***building*** tab), the type is defined as living or sleeping. For more information on zonal control see Section 8.1.2.

5.4.1.4 Floor Area

Specify the floor area and the number of stories in the zone (not the building) and the average ceiling height.

5.4.1.5 Number of Stories

The number of stories in the zone. If each floor of a 2-story home is modeled as a separate zone, the number of stories is 1 for each zone. If the home is modeled as a single zone, then this value is 2.

5.4.1.6 Ceiling Height

Average ceiling height, in feet.

5.4.1.7 Floor to Floor

Distance between the floor being modeled and any floor above. Default value is average ceiling height plus one foot.

5.4.1.8 Bottom

Distance above grade of the surface of the floor (in feet). Slab floor will be the height from the grade to the top of the slab. Raised floor will be the height from grade to the top of the raised floor.

For multi-story buildings where the second or third floors are modeled as a separate zone, the bottom must be the total distance from grade to the bottom of the floor (e.g., if the first floor is at 0.7 feet, with 9 foot ceilings, and 10 feet as the floor to floor height, the second floor bottom is 10.7).

5.4.1.9 Window Head Height

Default value is based on the average ceiling height.

5.4.1.10 HVAC System

Identify the name of the heating, ventilating and air conditioning (HVAC) system by picking a defined system or creating a new system. The system is made up of the heating, cooling and distribution systems, and a furnace fan. See more in Chapter 8, Mechanical Systems.

In a multi-family building each floor must have at least one HVAC system (if the system characteristics are the same, use the copy/paste feature).

5.4.1.11 DHW System 1

Identify the name of the domestic water heating (DHW) system by picking a defined system or creating a new system. See more in Chapter 9, Domestic Hot Water.

5.4.1.12 DHW System 2

Identify a second DHW system or none.

5.5 Garage

An attached unconditioned space is modeled as a separate unconditioned zone. When the project was defined as having an attached garage, the software created an unconditioned zone (see Figure 5-5). The buffering effect of this zone is modeled to accurately represent the building.

The walls between the house and garage are modeled as part of the conditioned space as an interior wall. For details on modeling the walls, ceiling, slab floor and garage door, see Chapter 6, Construction Assemblies and Chapter 7, Building Envelope.

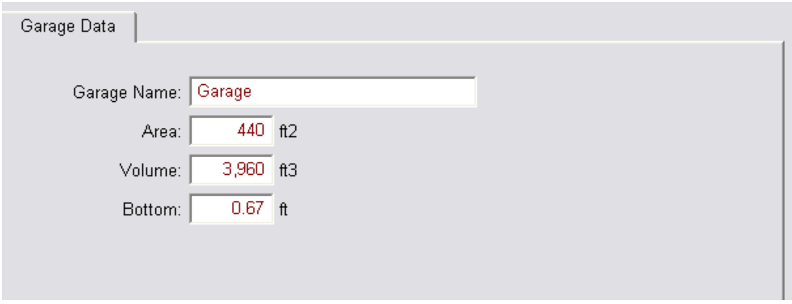
When a multi-family building is modeled as having an attached garage, the software creates only one unconditioned garage zone. To represent a garage attached to each unit increase the size of the single garage zone to have the area and all the surfaces of all the garages combined.

5.5.1.1 Party Walls

For multi-family building party walls between conditioned zones you need to check the "Different Dwelling Unit on Other Side" for each of those walls (and floors).

5.5.2 Garage Zone Data

Figure 5-5: Garage Zone Data



5.5.2.1 Garage Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

5.5.2.2 Area

The area of the garage or unconditioned space, in square feet (ft^2).

5.5.2.3 Volume

Volume of the space in cubic feet (ft^3) .The program defaults the volume based on the average ceiling height defined for the conditioned zone.

5.5.2.4 Bottom

Floor elevation or distance above grade of the surface of the floor (in feet).

Chapter 6. Construction Assemblies

CBECC-Res does not use the assembly U-factors from the *Reference Appendices*, Joint Appendix 4. Instead, assemblies are created inside the program. As you build an assembly, the screen displays a U-factor and R-value only as a guide for the user to see how the assembly compares to the standard design assembly (Section 150.1(c), Table 150.1-A, Package A). Model the closest insulation R-value without exceeding the product's R-value. The U-factor is not reported on the CF1R. Only the insulation R-values and construction details are reported.

In addition to typical wood-frame construction, CBECC-Res can model wood framed walls with advanced wall framing (AWF), steel-frame construction, concrete, masonry, insulated concrete form (ICF), brick, log, strawbale, and structurally insulated panels (SIPs).

6.1 Cavity R-Value

When completing assemblies, use the compressed product R-value for the cavity space (Table 6-1).

Table 6-1: Compressed Insulation R-values

Nominal Lumber Size	Cavity Depth	Compressed R-value Inside Cavity for Product Rated as…										
		R-38	R-38C	R-30	R-30C	R-25	R-22	R-21C	R-19	R-15C	R-13	R-11
2x12	11-1/4"	37	38	30								
2x10	9-1/4"	32	35	30	30	25						
2x8	7-1/4"	27	30	25	27	24	22	21	19			
2x6	5-1/2"			21	22	20	19	21	18			
2x4	3-1/2"						14	15	13	15	13	11
2x3	2-1/2"									11	10	8.9
2x2	1-1/2"										6.6	6.2
2x1	3/4"											
Standard Product Thickness		12"	10-1/4"	9-1/2"	8-1/4"	8"	6-3/4"	5-1/2"	6-1/4"	3-1/2"	3-1/2"	3-1/2"

6.2 Assembly Types

The types of assemblies that can be created in the program are:

Exterior wall
Interior wall (also used for demising walls or walls between house and garage)
Attic roof
Cathedral roof
Ceiling below attic
Interior floor

Exterior floor
Floor over crawl space

Also included are some typical assemblies:

T24-2013 exterior wall wood 2x4
T24-2013 R38 ceiling below attic
T24-2013 R30 ceiling below attic
T24-2013 R19 exterior floor
T24-2013 R19 floor over crawl
T24-2013 R15 interior wall
T24-2013 R19 interior floor

6.3 Mandatory Envelope Requirements

The mandatory roof insulation requirement in new construction is a wood-framed ceiling or rafter roof with R-30 (Section 150.0(a)), or a weighted average U-factor of 0.031 (formerly R-19).

The mandatory floor insulation requirement is a wood-framed raised floor (Section 150.0(d)) with R-19, or a weighted average U-factor of 0.037 (formerly R-13).

Under the Help button is a summary of the minimum mandatory requirements for opaque surfaces.

6.4 Spray Foam Insulation (SPF)

The R-values for spray applied polyurethane foam insulation differ depending on whether the product is closed cell (default R-5.8/inch) or open cell (default R-3.6/inch). When completing a construction assembly for the roof/ceiling, walls, or floor, use the values shown in Table 6-2 to determine the default R-value for the cavity size. Alternatively, with HERS verification and additional documentation requirements, a higher than default value may be used, as indicated by checking the box for non-standard spray foam in cavity as part of the construction assembly (see *Reference Appendices*, Residential Appendix RA3.5.6).

Table 6-2: Required Thickness Spray Foam Insulation

Required R-values for SPF insulation	R-11	R-13	R-15	R-19	R-21	R-22	R-25	R-30	R-38
Required thickness closed cell @ R5.8/inch	2.00 inches	2.25 inches	2.75 inches	3.50 inches	3.75 inches	4.00 inches	4.50 inches	5.25 inches	6.75 inches
Required thickness open cell @ R3.6/inch	3.0 inches	3.5 inches	4.2 inches	5.3 inches	5.8 inches	6.1 inches	6.9 inches	8.3 inches	10.6 inches

To receive the most credit, spray foam insulation may be combined with improved construction quality, which is modeled at the project level (see Section 4.4.1.3) and requires HERS verification (*Reference Appendices*, Residential Appendix RA3.5).

6.4.1 Medium Density Closed-Cell SPF Insulation

The default R-value for spray foam insulation with a closed cellular structure is R-5.8 per inch, based on the installed nominal thickness of insulation. Closed cell insulation has an installed nominal density of 1.5 to less than 2.5 pcf.

6.4.2 Low Density Open-Cell SPF Insulation

The default R-value for spray foam insulation with an open cellular structure is calculated as an R-3.6 per inch, calculated based on the nominal required thickness of insulation. Open cell insulation has an installed nominal density of 0.4 to 1.5 pounds per cubic foot (pcf).

6.4.3 Advanced Wall Framing

Advanced wall framing (AWF) is applicable to wood framed walls that meet the installation criteria from *Reference Appendices*, Joint Appendix JA 4.1.6 to reduce the amount of wood used for framing.. The construction technique, also referred to as an advanced wall system, incorporates the following construction techniques: 24-inch on center framing, eliminates intermediate framing for cripple and king studs, uses single top plates, double stud corners, and in-line (i.e., stack) framing to maintain continuity of transferring live loads of roof framing to wall framing (which allows roof sheathing and exterior siding to be installed at full widths), reduces framing for connections at interior partition walls (i.e., T-walls), and reduces window and door header sizes.

6.5 Attic Roof Terminology

6.5.1 Attic

Attic is an enclosed space directly below the roof deck and above the ceiling beams. The attic component of the building contains the roof and attic, and any insulation that occurs at the roof deck. In CBECC-Res, the attic is a separate zone. A typical attic does not include the ceiling or ceiling insulation which is modeled as part of the ceiling below attic.

6.5.2 Cathedral Ceiling

A cathedral ceiling or rafter roof is modeled when there is no attic above with a ceiling below. A cathedral ceiling typically has insulation installed between the rafters and may be flat or sloped. The insulation is in contact with the ceiling and there is typically a one-inch air gap above the insulation so that moisture can be vented. Whether there is an air space required above the insulation, or the entire cavity is filled with insulation with no venting, is up to the local building official.

6.5.3 Ceiling Below Attic

The ceiling is defined as the interior upper surface of a space separating it from an attic, plenum, indirectly or directly conditioned space or the roof assembly, which has a slope less than 60 degrees from horizontal (definition from *Reference Appendices*).

6.5.4 Knee Wall

A knee wall is a sidewall separating conditioned space from attic space under a pitched roof. Knee walls are modeled in CBECC-Res as an interior wall (although actually a demising surface) and are insulated as an exterior wall.

6.5.5 Low Slope Roof

A low slope roof has a ratio of rise to run (or pitch) of 2 in 12 or less (≤9.5 degrees from the horizontal). Although a specific value is not mandatory, the standard design for a low slope roof in climate zones 13 and 15 is a 0.63 aged solar reflectance.

If the roof membrane has a mass of at least 25 lb/ft^3 or the roof area incorporates integrated solar collectors, the roof may assume the standard design value for solar reflectance (exceptions to Section 150.1(c)11).

6.5.6 Radiant Barrier

A radiant barrier installed below the roof decking reduces radiant heat to any ducts and insulation below. While not a mandatory requirement, the standard design used to establish a building's energy budget has a radiant barrier in climate zones 2-15. Installation requirements for a radiant barrier (see CF2R form) require the radiant barrier in the garage/unconditioned space if a radiant barrier is installed in the attic over conditioned space and that same attic is over the unconditioned space.

6.5.7 Roof

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

When Package A (the basis of the standard design) contains a minimum requirement for solar reflectance and emittance, the values vary by roof slope. A low slope roof has a ratio of rise to run (or pitch) of 2 in 12 or less (≤9.5 degrees from the horizontal). A steep slope roof has a ratio of rise to run of greater than 2:12 (>9.5 degrees from the horizontal). Although there is no mandatory cool roof requirement, these are the characteristics used to establish the standard design, so there will be an energy penalty when default roof values are used.

6.5.8 Steep Slope Roof

A steep slope roof has a ratio of rise to run of greater than 2:12 (>9.5 degrees from the horizontal). Although a specific value is not mandatory, the standard design for climate zones 10 through 15 is an aged solar reflectance of 0.20.

If the roof membrane has a mass of at least 25 lb/ft^3 or the roof area incorporates integrated solar collectors, the roof may assume the standard design value for solar reflectance (exceptions to Section 150.1(c)11).

6.6 Attic Construction

Attic constructions are accessed by creating a new attic roof construction, or modifying an existing assembly in the list of ***Construction Assemblies***.

6.6.1 Attic Construction Data

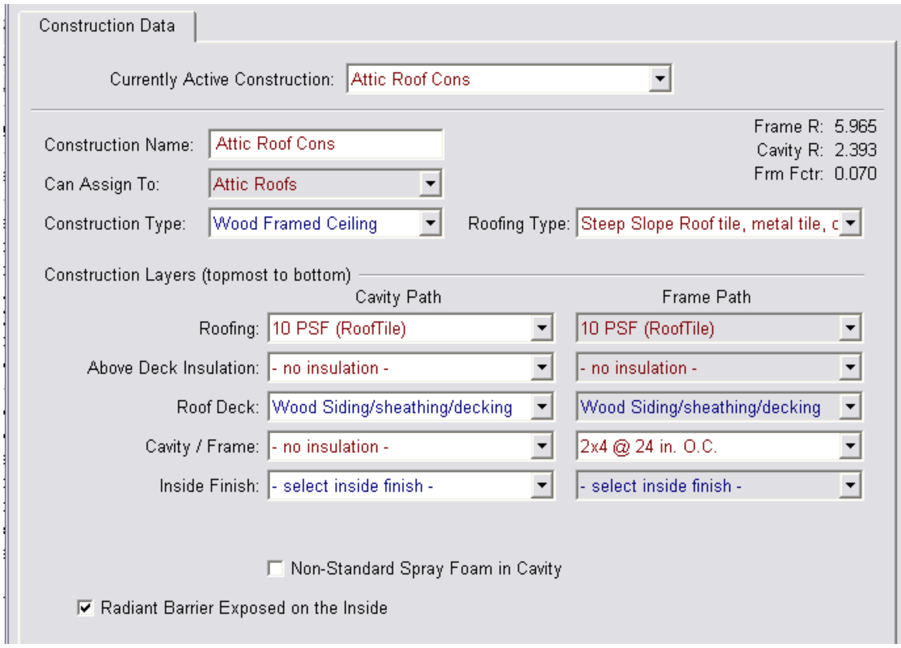
6.6.1.1 Construction Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

6.6.1.2 Can Assign To

This is a fixed field. To create a new assembly type, at the zone level, select <create> and pick the appropriate construction assembly type.

Figure 6-1: Attic Construction Data



6.6.1.3 Construction Type

Options are wood framed, ~~or~~ built up roof, steel framed, and SIPs.

6.6.1.4 Roofing Type

Pick the appropriate roof type as either (1) steep slope roof tile, metal tile, or wood shakes, or (2) all other.

6.6.2 Construction Layers

Working from the top to the bottom of the construction layers:

6.6.2.1 Roofing

The available types will depend on the roofing type specified. Types include light roof, roof tile, asphalt, gravel, tile, heavy ballast or pavers, and very heavy ballast or pavers.

6.6.2.2 Above Deck Insulation

If above deck insulation is shown as part of the attic details, model the R1 ~~through R8~~to R60 insulation.

6.6.2.3 Roof Deck

The default is wood siding/sheathing/decking.

6.6.2.4 Cavity/Frame

List the compressed R-value of cavity insulation (see Section 6.1) in the cavity column. This is the insulation that is installed at the roof. Typical insulation is modeled as part of the ceiling below attic. The framing column is to indicate the size and spacing of the framing. Options are 2x4 to 2x12 with 16- or ~~(e.g., 2x4 with~~ 24-inch on center framing).

6.6.2.5 Inside Finish

This is the inside finish (if any), of the attic space, and does not include the ceiling below the attic. A layer of gypsum is not typically included.

6.6.2.6 Non-Standard Spray Foam in Cavity

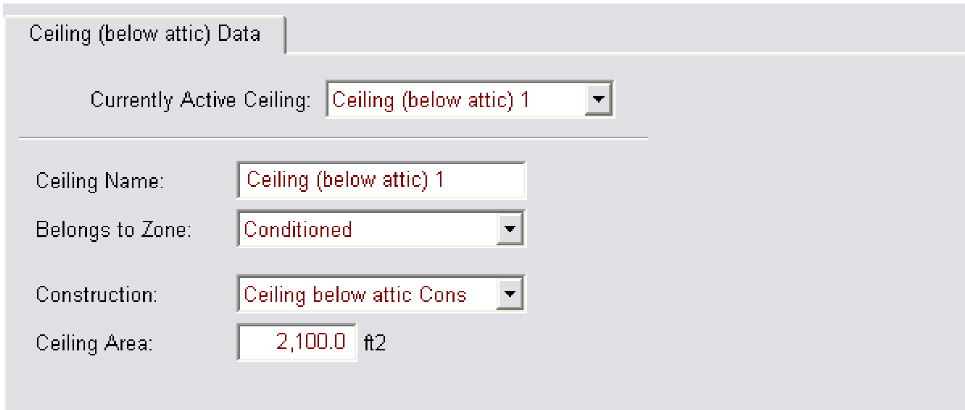
This check box identifies additional documentation and HERS verification requirements due a claimed R-value that exceeds the default assumption of R-5.8 per inch for closed cell and R-3.6 per inch for open cell (see Section 6.4).

6.6.2.7 Radiant Barrier Exposed on the Inside

This check box identifies whether a radiant barrier is being installed in the attic.

6.7 Ceiling Below Attic and Interior Ceilings

Figure 6-2: Ceiling Below Attic Data



The ***Construction*** called "Ceiling below attic cons" in Figure 6-2 is accessing the construction assembly shown in Figure 6-3.

6.7.1 Ceiling Below Attic Construction Data

6.7.1.1 Construction Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

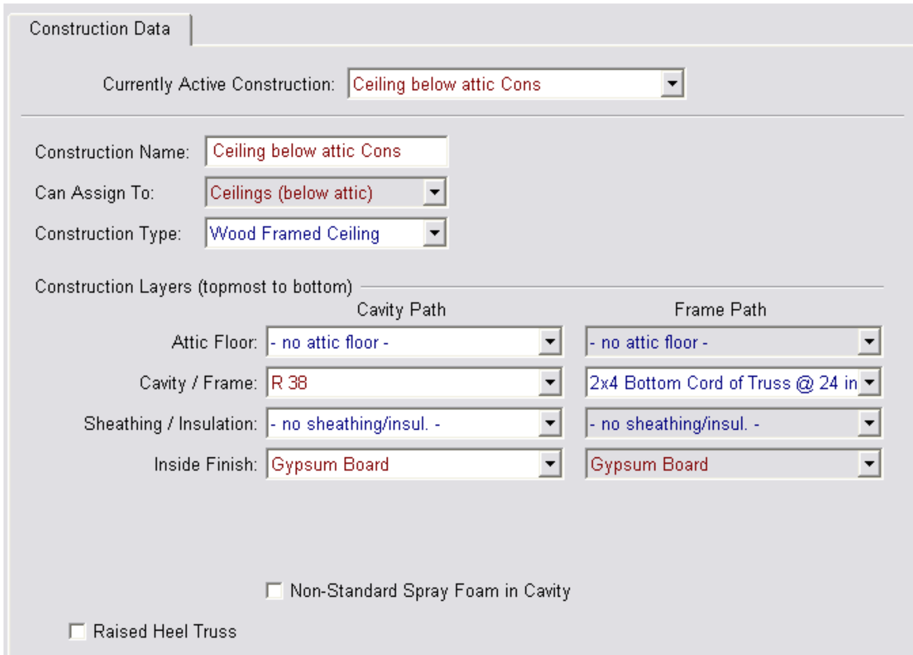
6.7.1.2 Can Assign To

This is a fixed field. To create a new assembly type, at the zone level, pick create and make the appropriate construction assembly type.

6.7.1.3 Construction Type

Options are wood or steel framed and SIPs~~or built up roof~~.

Figure 6-3: Ceiling Below Attic Assembly



6.7.2 Construction Layers

6.7.2.1 Attic Floor

The available types include no attic floor and wood siding/sheathing/decking.

6.7.2.2 Cavity/Frame

List the compressed R-value of cavity insulation (see Section 6.1) in the cavity column. In the framing column select the size of the framing and the spacing, such as 2x12 with 24-inch on center framing, or 2x4 roof truss at 24-inches on center.

6.7.2.3 Sheathing/Insulation

List the sheathing or insulation layer. Options are none, gypsum board, wood sheathing, and R1 ~~through R12~~to R60 insulation.

6.7.2.4 Inside Finish

This is the inside finish (if any), of the attic space, and does not include the ceiling below the attic. A layer of gypsum is not typically included.

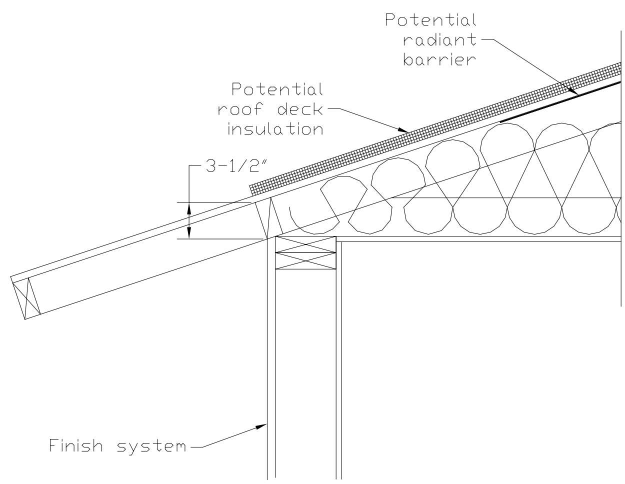
6.7.2.5 Non-Standard Spray Foam in Cavity

This check box identifies additional documentation and HERS verification requirements due a claimed R-value that exceeds the default assumption of R-5.8 per inch for closed cell and R-3.6 per inch for open cell (see Section 6.4).

6.7.2.6 Raised Heel Truss

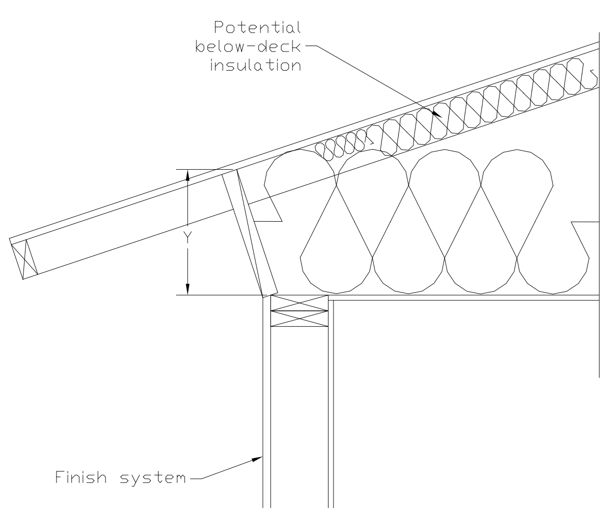
Check box to indicate if there is a raised heel truss and its height (in inches). With a standard roof truss (Figure 6-4) the depth of the ceiling insulation is restricted to the space left between the roof deck and the wall top plate for the insulation path and the space between the bottom and top chord of the truss in the framing path. If the modeled insulation completely fills this space, there is no attic air space at the edge of the roof. Heat flow through the ceiling in this attic edge area is directly to the outside both horizontally and vertically, instead of to the attic space.

Figure 6-4: Section at Attic Edge with Standard Truss



A raised heel truss (Figure 6-5) provides additional height at the attic edge that, depending on the height and the ceiling insulation, can either reduce or eliminate the attic edge area and its thermal impact.

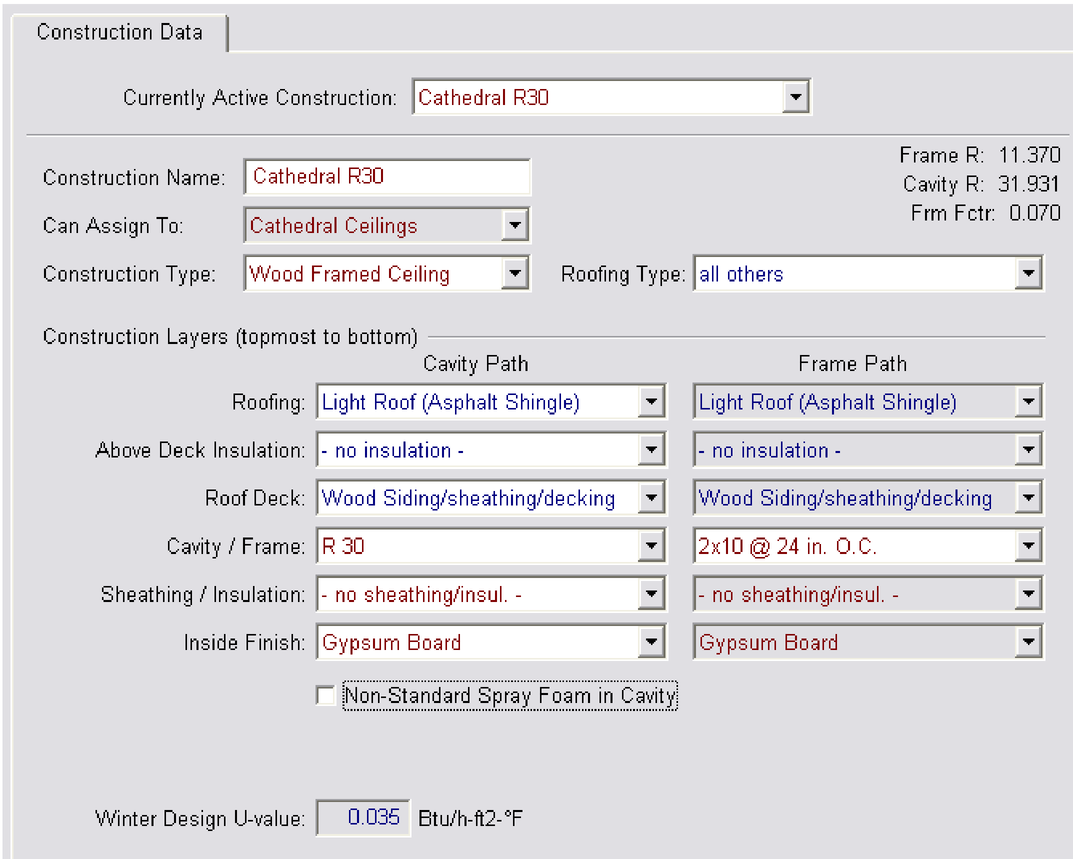
Figure 6-5: Section at Attic Edge with a Raised Heel Truss



6.7.3 Cathedral Ceiling Construction Data

Each surface facing a different orientation will be modeled as a separate surface (see Figure 6-7 and Section 6.7.5).

Figure 6-6: Cathedral Ceiling



6.7.3.1 Construction Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

6.7.3.2 Can Assign To

This is a fixed field. To create a new assembly type, at the zone level, pick create and make the appropriate construction assembly type.

6.7.3.3 Construction Type

Options are wood framed, ~~or~~ built up roof, steel framed, and SIPs.

6.7.3.4 Roofing Type

Pick the appropriate roof type as either (1) steep slope roof tile, metal tile, or wood shakes, or (2) all other.

6.7.4 Construction Layers

6.7.4.1 Roofing

The available types include no attic floor and wood siding/sheathing/decking.

6.7.4.2 Above Deck Insulation

If above deck insulation is shown as part of the attic details, model the R1 to R~~8~~60 insulation.

6.7.4.3 Roof Deck

The default is wood siding/sheathing/decking.

6.7.4.4 Cavity/Frame

List the compressed R-value of cavity insulation (see Section 6.1) in the cavity column. The framing column is to indicate the size of the framing and the spacing (e.g., 2x12 with 24-inch on center framing). Also included is an option for a 2x4 bottom chord of truss at 24-inches on center.

6.7.4.5 Sheathing/Insulation

List the sheathing or insulation layer. Options are none, gypsum board, wood sheathing, and R1 to R~~8~~60 insulation.

6.7.4.6 Inside Finish

This is the inside finish (if any), of the roof. A layer of gypsum is typically included.

6.7.4.7 Non-Standard Spray Foam in Cavity

This check box identifies additional documentation and HERS verification requirements due a claimed R-value that exceeds the default assumption of R-5.8 per inch for closed cell and R-3.6 per inch for open cell (see Section 6.4).

6.7.5 Cathedral Ceiling Data

Once you have an assembly to match your building and select <OK>, the screen shown in Figure 6-7 appears allowing you to complete the data for the roof assembly. Each surface facing a different orientation is modeled as a separate surface.

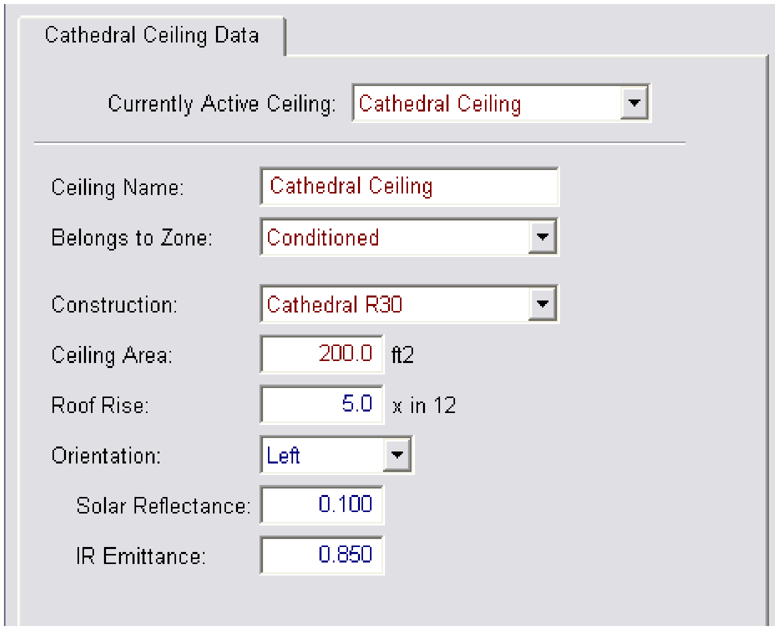
6.7.5.1 Ceiling Area

The area of the ceiling (in square feet) that meets all the same specified criteria. If parts of the roof face different orientations, they must be modeled separately.

6.7.5.2 Roof Rise

Specify the roof rise or roof pitch, which is the number of feet the roof rises in a span of 12 feet (may be shown as 4:12 for a roof rise of 4 feet in 12 feet). If there are multiple pitches you can enter the roof rise of the largest area of roof.

Figure 6-7: Cathedral Ceiling Data



6.7.5.3 Orientation

The plan view using labels front, left back and right or specify a value based on front = 0, left = 90, back = 180, and right = 270. If the cathedral ceiling is on a part of the building facing an angle, match the orientation of the walls. For more on orientation and plan azimuth, see Section 7.1.

6.7.5.4 Solar Reflectance

The default aged solar reflectance is 0.10 for all roof types. Alternatively, enter the aged solar reflectance for a roof product as published by the Cool Roof Rating Council (CRRC) (www.coolroofs.org). If only an initial value is available, calculate the aged value using the equation in 3.7.1 of the 2013 Residential Compliance Manual. A higher value is better, so if a specific product color is unknown use a lower value among options to avoid having to regenerate compliance during construction. See also Section 5.2.1.7.

6.7.5.5 IR Emittance

The default infrared or thermal emittance (or emissivity) for all roofing materials is 0.85. Alternatively, enter the emittance is the value published by the Cool Roof Rating Council (CRRC) (www.coolroofs.org). See also Section 5.2.1.8.

6.8 Walls

Wall constructions are accessed by creating a new wall inside the conditioned zone or modifying an existing assembly in the list of ***Construction Assemblies***. Walls (Figure 6-8) are defined from the inside surface to the outside. Interior walls are modeled the same as exterior walls. For a description of when a wall is modeled as interior (for example, demising or walls separating the house from the garage), see Section 6.8.5.

6.8.1 Interior and Exterior Wall Construction Data

6.8.1.1 Construction Name

User-defined name.

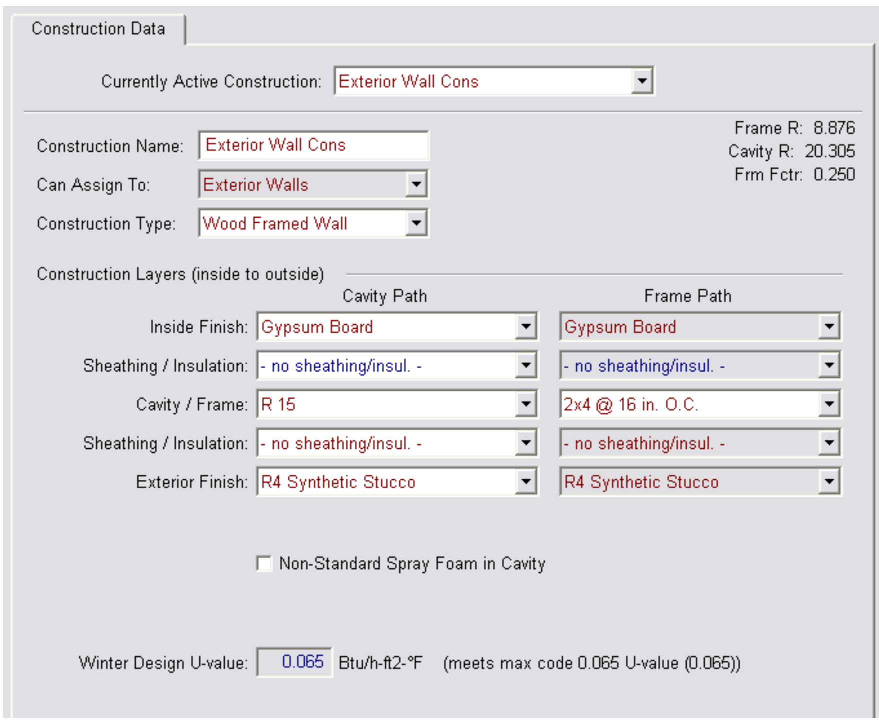
6.8.1.2 Can Assign To

This is a fixed field. To create a new assembly type, at the zone level pick <create> and select the appropriate construction assembly type.

6.8.1.3 Construction Type

Options available include wood framed~~,~~ andsteel framed (section 6.8.2), unframed wall types are concrete, Insulated Concrete Form (ICF), brick, hollow unit masonry, adobe, strawbale, log (section 6.8.3), and structurally insulated panels (SIPs) (section 6.8.4). ~~[Limited during program development to wood frame.]~~

Figure 6-8: Wood-Framed Wall Construction Data



6.8.2 Framed Wall Construction Layers (inside to outside)

6.8.2.1 Inside Finish

Default value gypsum board.

6.8.2.2 Sheathing/Insulation

List the sheathing or insulation layer in a wall on the inside surface (conditioned space side) of the ~~framing~~framed wall, or the size and material of furring on the inside surface. Options are none, gypsum board, wood sheathing, and R 1to R~~12~~ 60 insulation.

6.8.2.3 Cavity/Frame

List the compressed R-value of cavity insulation (see Section 6.1) in the cavity column. The framing column is to indicate the size of the framing and the spacing (e.g., 2x6 with 16-inch on center framing), or advanced wall framing (AWF), see Section 6.4.3.

6.8.2.4 Sheathing/Insulation

List the sheathing or insulation layer on the outside of the framing. Do not enter 1-coat stucco here. Options are none, gypsum board, wood sheathing, and R 1to R~~12~~ 60 insulation.

6.8.2.5 Exterior Finish

Exterior finish options are wood siding, 3 coat stucco, or R4 synthetic stucco (also known as 1-coat stucco).

6.8.2.6 Non-Standard Spray Foam in Cavity

This check box identifies that additional documentation and HERS verification requirements apply because the claimed R-value exceeds the default assumption of R-5.8 per inch for closed cell and R-3.6 per inch for open cell (see Section 6.4).

6.8.3 Mass or Other Unframed Walls

6.8.3.1 Inside Finish

Default value gypsum board.

6.8.3.2 Insulation/Furring

List the insulation installed if the walls are furred on the inside. Select the thickness and type of furring which is 0.5-inch to 5.5-inch thick wood or metal.

6.8.3.3 Mass Layer

List the material which varies based on the construction type and includes concrete, brick, light weight (LW), medium weight (MW) or normal weight (NW) concrete masonry units (CMU) with solid grout, insulated cores, or empty cores. Select the thickness.

6.8.3.4 Insulation/Furring

List the insulation installed if the walls are furred on the outside. Select the thickness and type of furring which is 0.5-inch to 5.5-inch thick wood or metal.

6.8.3.5 Exterior Finish

Exterior finish options are wood siding, 3 coat stucco, or R4 synthetic stucco (also known as 1-coat stucco) and wood siding/sheathing/decking.

6.8.3.6 Non-Standard Spray Foam in Cavity

This check box identifies that additional documentation and HERS verification requirements apply because the claimed R-value exceeds the default assumption of R-5.8 per inch for closed cell and R-3.6 per inch for open cell (see Section 6.4).

6.8.4 Structurally Insulated Panels (SIPs)

6.8.4.1 Inside Finish

Default value gypsum board.

6.8.4.2 Sheathing/Insulation

List the continuous insulation layer on the inside surface (conditioned space side) of the SIP wall. Options are R1 to R60 insulation.

6.8.4.3 Panel Rated R (@ 75 F)

Specify the panel's rated R-value at 75 degrees in the cavity path (R14 to R55). In the frame path list the thickness of the panel and whether it is or is not OSB.

6.8.4.4 Sheathing/Insulation

List the continuous insulation layer on the outside surface of the SIP wall. Options are R1 to R60 insulation.

6.8.4.5 Exterior Finish

Exterior finish options are wood siding, 3 coat stucco, or R4 synthetic stucco (also known as 1-coat stucco) and wood siding/sheathing/decking.

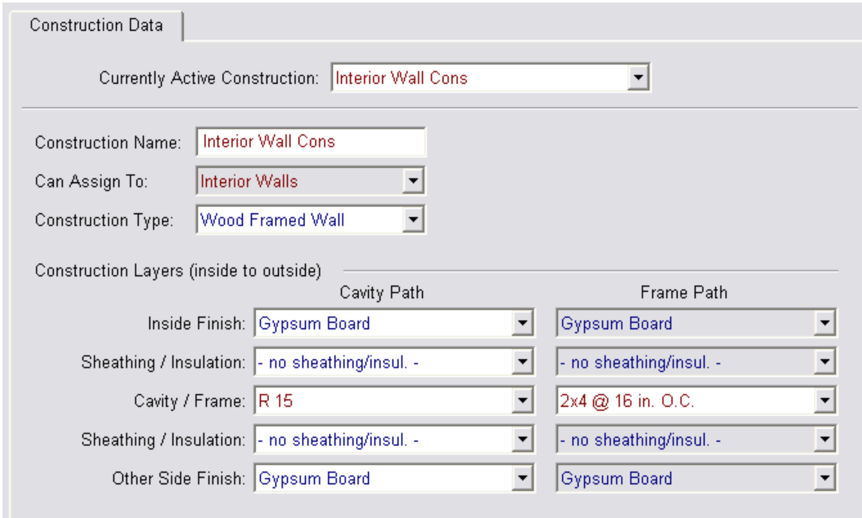
6.8.5 Demising and Interior Walls

Walls separating conditioned space from unconditioned space (e.g., from house to garage, knee walls) are modeled in the conditioned space as interior, although actually demising walls. In creating the building envelope, the wall will have conditioned space on one side and unconditioned space or zone on the other side.

When defining multi-family buildings, party walls separating zones are defined as part of both zones in which they occur. The box indicating that there is a dwelling unit on the other side is checked.

When the wall is an interior or demising wall, both the inside and outside surfaces are gypsum board, and there will be no solar gains on the unconditioned side. Knee walls are insulated as a wall.

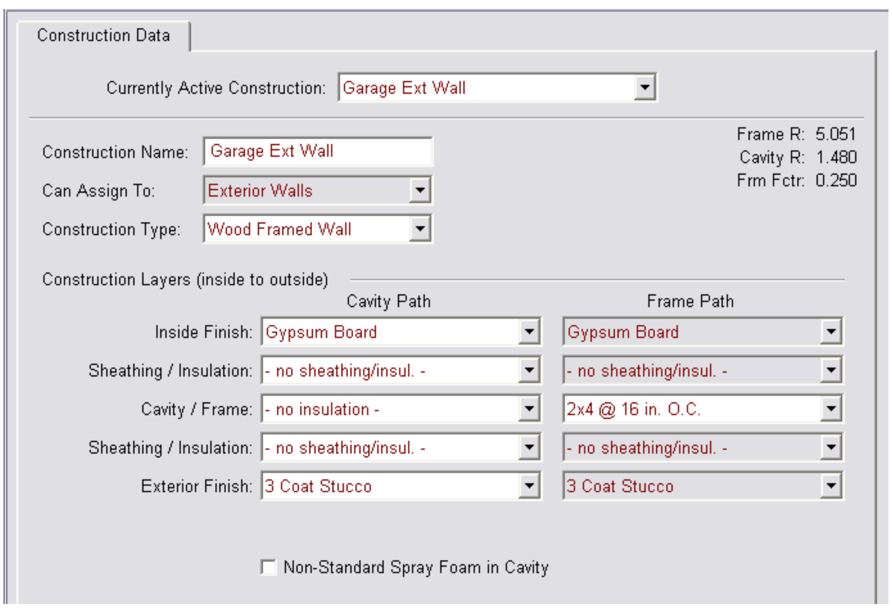
Figure 6-9: Interior Walls



6.8.6 Garage Exterior Walls

The outermost walls of the garage wall or unconditioned storage space, which are modeled as part of an unconditioned zone, typically do not have insulation (see Figure 6-10).

Figure 6-10: Uninsulated Exterior Wall



6.9 Floors

Raised floor types that can be created include wood framed, steel framed, and SIPs over a crawl space (with a crawl space zone associated with the building), over exterior (no crawl space), or interior floor (which includes a floor over garage (although actually a demising surface)). See Figure 6-11 through Figure 6-13.

Figure 6-11: Floor over crawl space

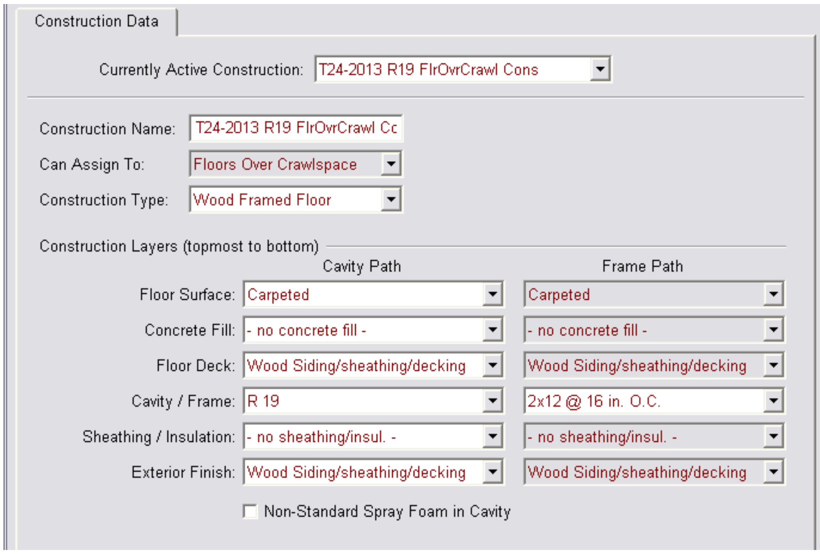
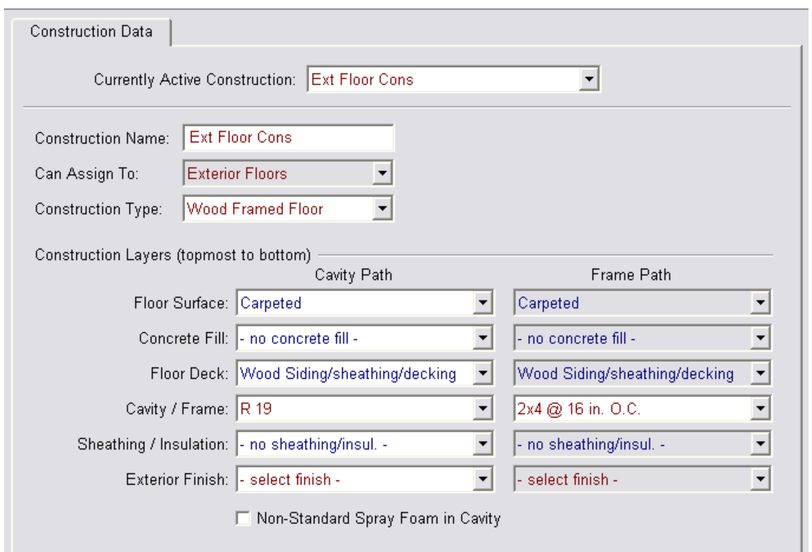


Figure 6-12: Floor over exterior



6.9.1 Raised Floor Construction Data

6.9.1.1 Construction Name

User-defined name.

6.9.1.2 Can Assign To

This is a fixed field. To create a new assembly type, at the zone level, pick create and make the appropriate construction assembly type.

6.9.1.3 Construction Type

Options include~~Default is~~ wood and steel frame construction, or SIPs.

6.9.2 Raised Floor Construction Layers (top to bottom)

6.9.2.1 Floor Surface

The available floor surface types ~~is~~are carpeted, hardwood, tile, and vinyl.

6.9.2.2 Concrete Fill

Default is no concrete fill. Select no concrete fill, or concrete fill.

6.9.2.3 Floor Deck

Select (1) no floor deck or (2) wood siding, sheathing, decking

6.9.2.4 Cavity/Frame

List the compressed R-value of cavity insulation (see Section 6.1) in the cavity column. The framing column is to indicate the size of the framing and the spacing (e.g., 2x6 with 16-inch on center framing) or panel size for SIPs.

6.9.2.5 Sheathing/Insulation

List the sheathing or insulation layer on the outside of the framing. Options are none, gypsum board, and R1 to R~~12~~60 insulation.

6.9.2.6 Exterior Finish or Ceiling Below Finish

Optional input. ~~Select either (1) wood siding, or (2) – select finish for exterior floors or gypsum board for an interior floor or floor over garage.~~

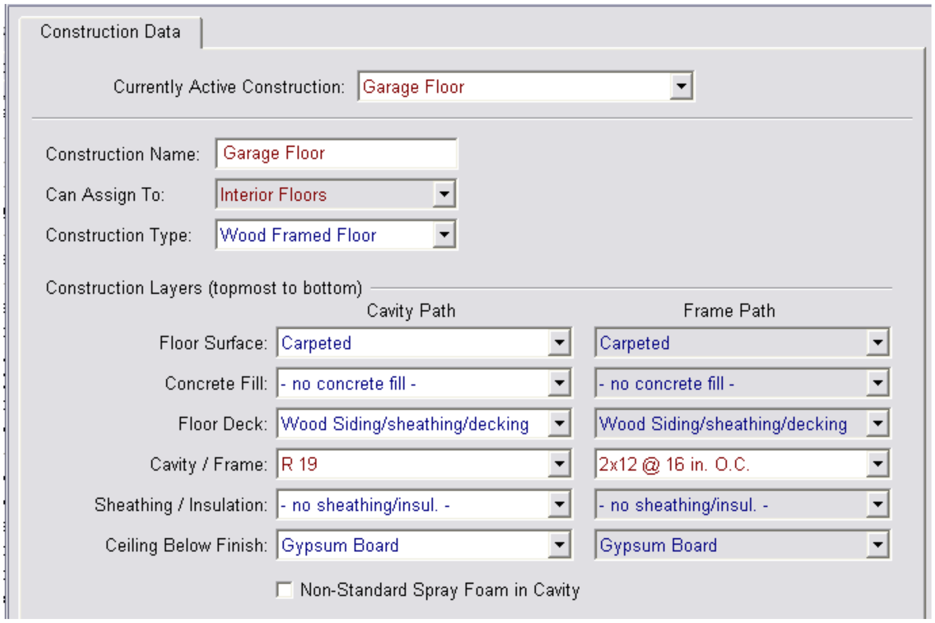
6.9.2.7 Non-Standard Spray Foam in Cavity

This check box identifies additional documentation and HERS verification requirements due a claimed R-value that exceeds the default assumption of R-5.8 per inch for closed cell and R-3.6 per inch for open cell (see Section 6.4).

6.9.3 Floor Over Garage

A floor over a garage is modeled as an interior floor. When defining the building envelope, the outside surface will be set to garage rather than another conditioned zone. By modeling it as an interior floor, the ceiling below can be set to gypsum board or be left undefined ("- select inside finish –").

Figure 6-13: Interior Floor

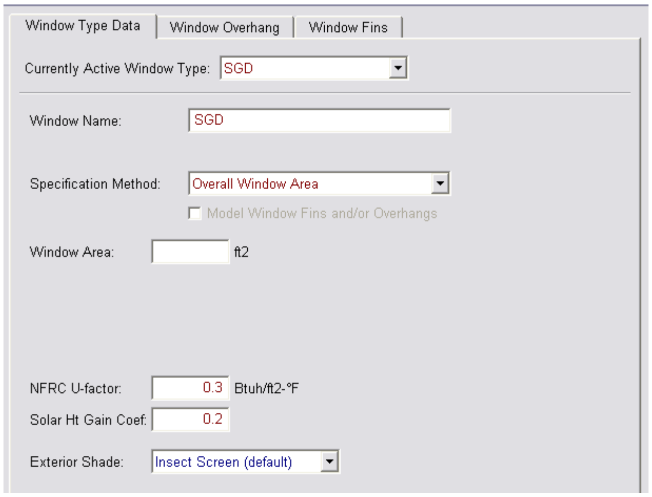


6.9.4 Window Types

Create a library of window types using product specific values for U-factor and SHGCs. Even if you wish to keep the default values, be sure to retype them. You may notice the text change from blue to red. This ensures the values will not change (if you change to a climate zone with different window requirements). For the greatest flexibility, leave size, overhang or fin fields blank and create values for products with different values, such as operable, fixed, glass block, doors, existing single pane windows, or a specific brand of windows.

If you wish to take advantage of the defaulting system, leave the fields blue (or swipe the cursor across the field, right-click and pick "restore default"). This will change the SHGC value to 0.50 if you pick climate zone 1, 3 or ~~16~~5, or to 0.25 in climate zones 2, 4, or 6-16~~-15~~.

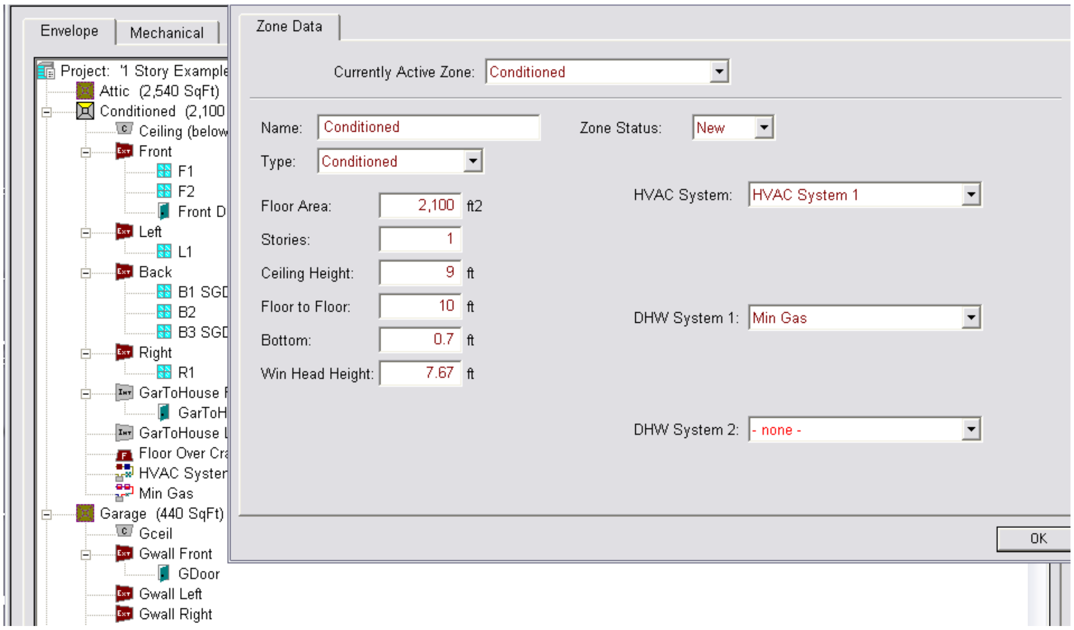
Figure 6-14: Window Type



Chapter 7. Building Envelope

Once the conditioned zone is defined (see Figure 7-1) the different components of the building envelope can be created or modified.

Figure 7-1: Conditioned Zone

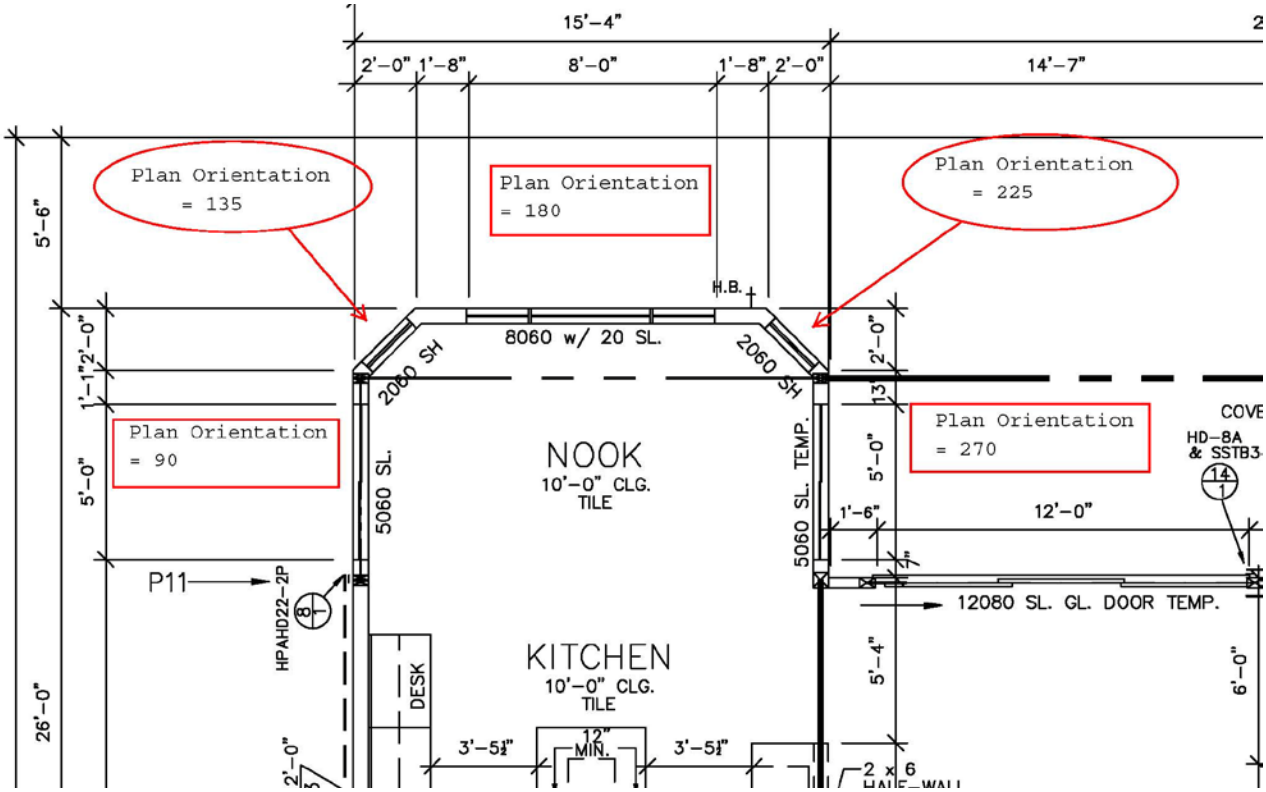


7.1 Orientation

The orientation of walls, windows, and any orientation other than front orientation is the plan ~~azimuth~~orientation or plan view. It is the view looking at the plans (front, left, back, right) or as if standing outside and looking at the front of the building. The numeric value for the plan view of walls and windows is the same for every building—front is 0, left is 90, back is 180, and right is 270. When defining surfaces use the labels front, left, back and right, and only specify a value when the walls are at an angle, such as a bay or corner wall, in which case you will specify the orientation "relative to the front." If there is a bay off the back of a building (see Figure 7-2) the back angled walls are entered as 135 and 225. If the bay is off the front, the angled walls are at 315 and 45. The software adjusts these for the energy use and as reported on the CF1R based on the front orientation entered for ***Building, Front Orientation***, and will report the actual azimuth.

NOTE: if you enter the actual orientation of walls, the software models the value entered plus the building front orientation, and the output will not match the proposed building. If you enter the actual orientation of the walls, the only way for the output to be correct would be to define the front orientation as 0 and most plan checkers will not understand why the site plan and your building front do not match. Additionally, to assist inspectors, the CF1R report was modified to include the side of the building or plan orientation.

Figure 7-2: Plan ~~Azimuth~~Orientation



7.2 Opaque Surfaces

Working from top down, add any ceilings below attic as well as any cathedral ceilings.

7.2.1 Ceiling below attic

7.2.1.1 Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

7.2.1.2 Belongs to Zone

Select any appropriate zone already included in the building model. When copying components of one zone to another, this field automatically changes.

7.2.1.3 Construction

If no appropriate construction assembly is available, right-click and pick create (discussed in depth in Chapter 6, Construction Assemblies).

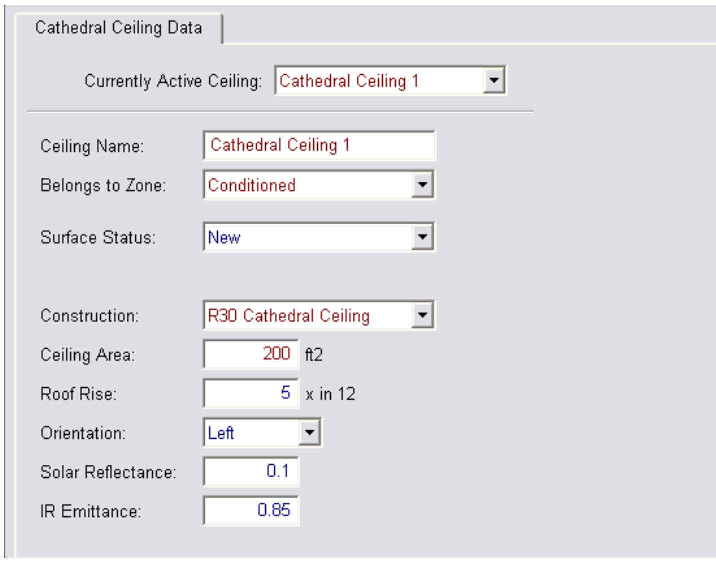
7.2.1.4 Ceiling Area

Area of the ceiling, in square feet.

7.2.2 Cathedral Ceiling

The information needed to define a cathedral ceiling is shown in Figure 7-3). Because the orientation is entered for cathedral ceilings, the ceiling will be modeled in multiple entries, with a typical cathedral ceiling having two or more parts (e.g., left and right).

Figure 7-3: Cathedral Ceiling



7.2.2.1 Ceiling Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

7.2.2.2 Belongs to Zone

Select any appropriate zone already included in the building model. When copying components of one zone to another, this field automatically changes.

7.2.2.3 Construction

If no appropriate construction assembly is available, right-click and pick create (discussed in depth in Chapter 6, Construction Assemblies).

7.2.2.4 Ceiling Area

Area of the ceiling, in square feet.

7.2.2.5 Roof Rise

Specify the roof rise or roof pitch, which is the number of feet the roof rises in a span of 12 feet (e.g., shown on plans as 4:12 or 4 feet in 12 feet). If there are multiple pitches you can enter the roof rise of the largest area of roof

7.2.2.6 Orientation

The plan view using labels front, left back and right. If specifying a value, it is based on front = 0, left = 90, back = 180, and right = 270. If the cathedral ceiling is on a part of the building facing an angle, match the orientation of the walls. See Section 7.1.

7.2.2.7 Solar Reflectance

The default aged solar reflectance is 0.10 for all roof types. Alternatively, enter the aged solar reflectance for a roof product, as published by the Cool Roof Rating Council (CRRC) (www.coolroofs.org). A higher value is better, so if a specific product color is unknown use a lower value among options to avoid having to regenerate compliance documentation during construction. See also Section 5.2.1.7.

7.2.2.8 IR Emittance

The default thermal emittance (or emissivity) for all roofing materials is 0.85. Alternatively, enter the emittance value published by the Cool Roof Rating Council (CRRC) (www.coolroofs.org). See also Section 5.2.1.8.

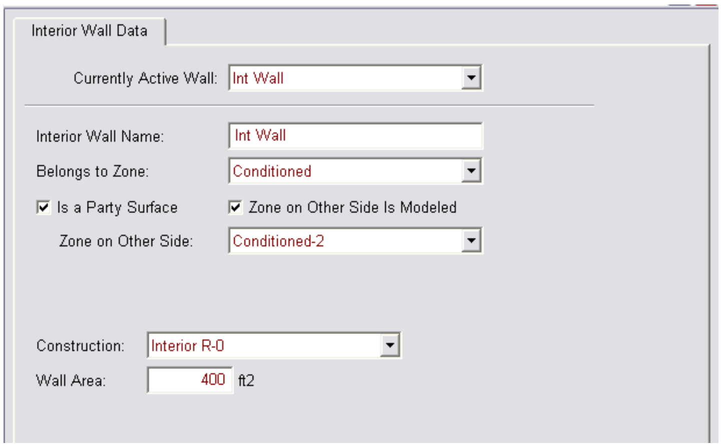
7.2.3 Knee Walls

Model any knee walls (a sidewall separating conditioned space from attic space under a pitched roof or where ceiling heights change), as an interior wall with the outside surface as attic, with insulation value typical for a wall.

7.2.4 Party Walls in Multi-Family

If each dwelling unit in a multi-family building is modeled as a separate zone, model any interior walls separating one dwelling unit from another as part of both dwelling units. Both zones are identified, as well as checking the box that the zone on the other side is modeled (see Figure 7-4).

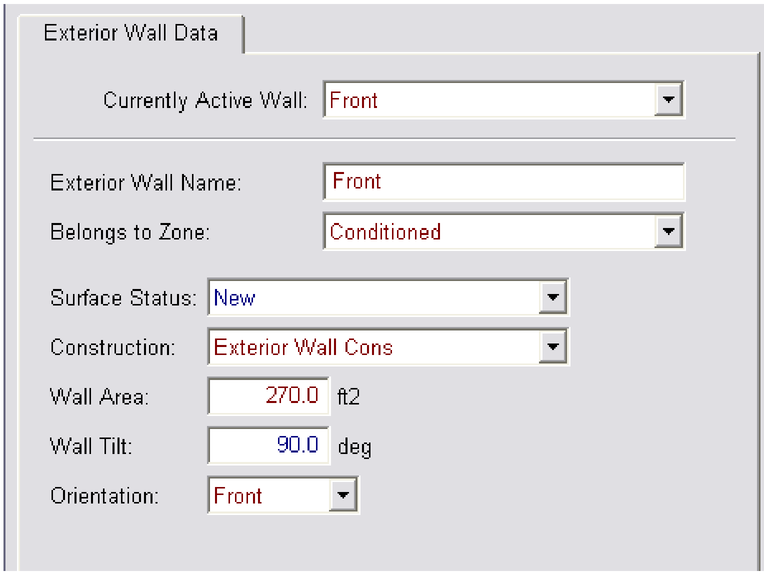
Figure 7-4: Party Wall



7.2.5 Walls

Add the walls in a clockwise or counter-clockwise direction and in the order you would like them to appear because it is not possible to change the order. See Figure 7-5.

Figure 7-5: Exterior Wall



7.2.5.1 Exterior Wall Name

If the building plans use a unique tag or ID, use that for the name, otherwise a simple name such as front or front wall is sufficient. Each name within a zone or on a surface must be unique.

7.2.5.2 Belongs to Zone

The name of the zone in which the wall is being modeled.

7.2.5.3 Surface Status

Surface status is used to identify an existing, altered or new wall. Any surfaces that are part of a new building or addition are new.

7.2.5.4 Construction

Pick one of the construction assemblies or create a new construction assembly (see Section 6.8)

7.2.5.5 Wall Area

Gross wall area, in square feet (the area of windows and doors associated with the wall will be subtracted).

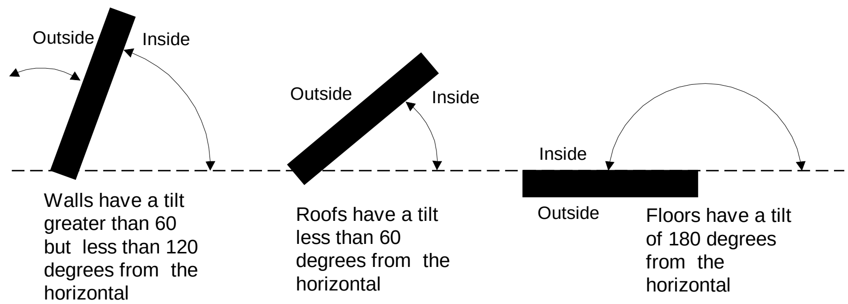
7.2.5.6 Wall Tilt

A wall typically has a tilt of 90 degrees but may range from greater than 60 degrees to less than 120 degrees (see Figure 7-6).

7.2.5.7 Orientation

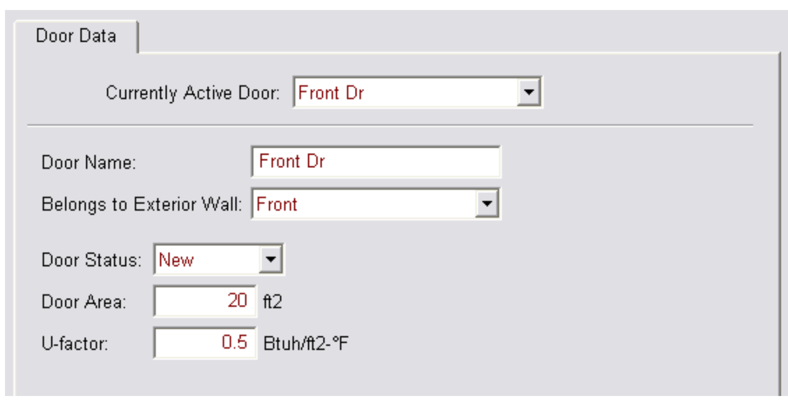
The plan view orientation. Use front, left, back and right. If specifying a value, it is based on front being equal to 0, left is 90, back is 180, and right is 270, rather than the actual building orientation. The software will add the front orientation and this plan orientation to determine the actual orientation of the modeled surface. See Section 7.1.

Figure 7-6: Surface Tilt



7.2.6 Opaque Doors

Figure 7-7: Opaque Door



Doors and windows (fenestration) are modeled separately. For doors with glass, first determine if only part of the door or the entire door is a window. When a door is less than 50 percent glass, calculate the glass area plus two inches on all sides (to account for a frame) and model that as window (see Section 7.3.1). The opaque area of the door is the total door area minus the calculated glass area. For doors with 50 percent or more glass area see Section 7.3.4. The standard design building has the same area of opaque door as the proposed design building.

7.2.6.1 Door Name

User defined name. If the plans use a door schedule or unique identifier, that identifier can be used for the door name. Each surface must have a unique name.

7.2.6.2 Belongs to Exterior Wall

Default is the existing wall. When copying window data to another zone, the program changes this to the new exterior wall.

7.2.6.3 Door Status

The default is new for new construction or if part of an addition. Other options include altered and existing.

7.2.6.4 Door Area

Enter the door area, in square feet.

7.2.6.5 U-factor

Default value is 0.50 for opaque doors, 1.00 for the large garage doors (roll-up or wood). Other values allowed are from Joint Appendix 4, Table 4.5.1, only.

7.2.7 Garage Door

When modeling a garage zone, the large garage doors (metal roll-up or wood) are modeled with a 1.00 U-factor.

7.3 Windows

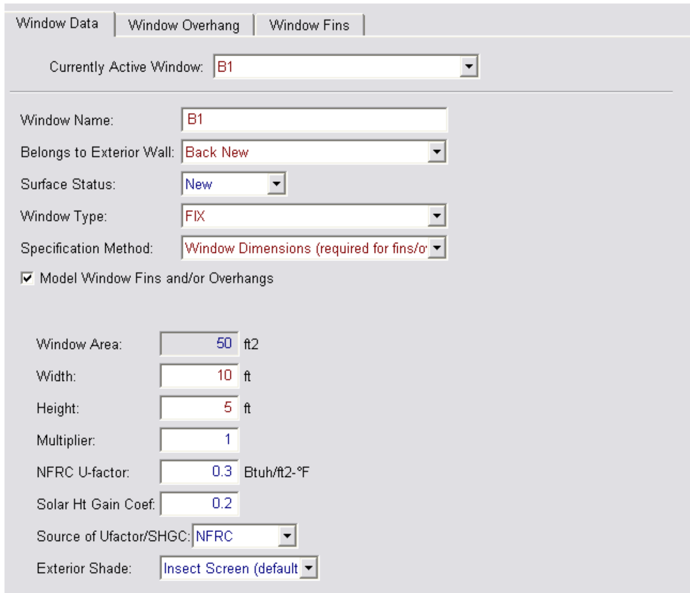
The 2013 standards establish a maximum weighted average U-factor of 0.58 (Section 150.0(q)) for fenestration, including skylights. The exception allows the greatest of 10 ft^2 or 0.5 percent of the conditioned floor area to exceed the maximum 0.58 U-factor.

Create a library of window types using either default values or product specific values for U-factor and SHGCs (see 6.9.4). Since you must model each window individually, this gives you the greatest flexibility by allowing you to update the window efficiencies with the least amount of effort. When you create a new window type, even if you wish to keep the default values, be sure to retype them so the values on the window type screen are red. Then when you pick the window type the window data screen picks up the values (in blue) from the window type fields.

7.3.1 Windows Data

Right-click on the wall to which you will add windows and pick <create> and select window. The screen shown in Figure 7-8 is displayed.

Figure 7-8: Window Data



7.3.1.1 Window Name

User defined name. If the plans use a window schedule or unique identifier, that identifier can be used for the window name. Each window on a given surface must have a unique name.

7.3.1.2 Belongs to Exterior Wall

Defaults to the wall on which the window was created. When copying window data to another zone, the program changes this to the new exterior wall.

7.3.1.3 Surface Status

Select new, altered or existing.

7.3.1.4 Window Type

If using a window type from the library you created, select from the valid options. This field can also be left as "none."

7.3.1.5 Specification Method

Select either Window Dimensions (required for fins and overhangs) or Overall Window Area.

7.3.1.6 Model Window Fins and/or Overhangs

Check box is available only when Section 7.3.1.4 is set to window dimensions.

7.3.1.7 Window Area

If using the overall window area, enter the area of a window (in square feet) and the multiplier. For example, if there are three 3^05^0 windows, enter window area "15" ft^2 and multiplier "3."

7.3.1.8 Width

If using the window dimensions method, enter the window width (in feet).

7.3.1.9 Height

If using the window dimensions method, enter the window height (in feet).

7.3.1.10 Multiplier

The number of identical windows (NOTE: must also have identical overhang and fin conditions, if modeled).

7.3.1.11 NFRC U-factor

U-factor from National Fenestration Rating Council (NFRC) for the window product (not the center of glass value) (www.nfrc.org). Alternatively, enter the default value from standards Section 110.6, Table 110.6-A.

7.3.1.12 Solar Heat Gain Coefficient

Solar Heat Gain Coefficient (SHGC) from NFRC for the fenestration product (www.nfrc.org). Alternatively, enter the default value from standards Section 110.6, Table 110.6-B.

7.3.1.13 Source of U-factor/SHGC

The three valid sources are NFRC, default, or Alternate Default Fenestration Procedure (ADFP). A rarely used provision in the standards is for unrated site-built fenestration, which requires use of Reference Appendix NA6 to calculate both the U-factor and SHGC. Whichever source is used, the standards require a temporary label on every window. See References Appendices (CEC-400-20012-005), p. NA6-1 through 6-5 for further information and responsibilities associated with this calculation procedure.

7.3.1.14 Exterior Shade

Default bug screens for windows, none for skylights.

7.3.2 Window Overhang

Under the Window Overhang tab (see Figure 7-9) enter the overhang dimensions and position.

7.3.2.1 Depth

Distance the overhang projects out from the wall (in feet).

7.3.2.2 Distance Up

The distance (as viewed from elevations) from the top of the window to the bottom of the overhang (in feet).

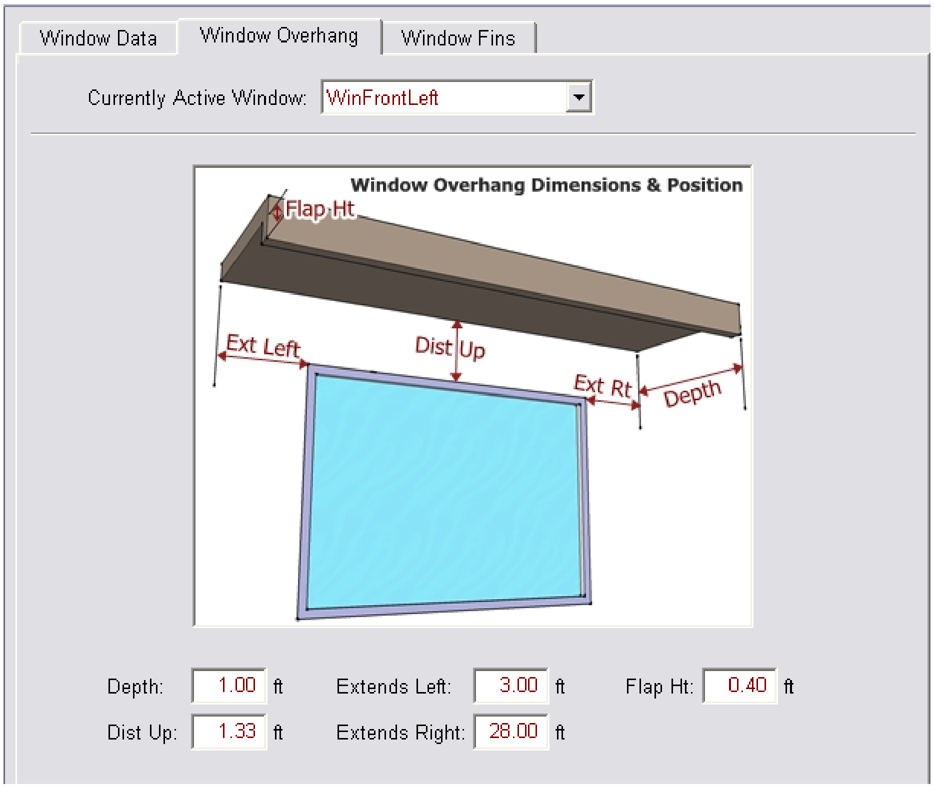
7.3.2.3 Extends Left

Distance (in feet) the overhang extends from the left edge of the window to the end of the overhang.

7.3.2.4 Extends Right

Distance (in feet) the overhang extends from the right edge of the window to the end of the overhang.

Figure 7-9: Overhang



7.3.2.5 Flap Height

Default 0 feet. If the overhang has a flap that extends lower than the bottom of the overhang, thereby increasing the potential shading of the overhang, this added length is modeled as the flap height.

7.3.3 Window Fins

A window fin is a building feature that provides shading benefit to a window (for example, a recessed entry area). Figure 7-10 shows inputs found in the Window Fins tab.

7.3.3.1 Left Fin Depth

Depth (in feet) of the wall (fin) to the left of the window that provides shading to the window.

7.3.3.2 Distance Left

Distance (in feet) from the left edge of the window to the left fin.

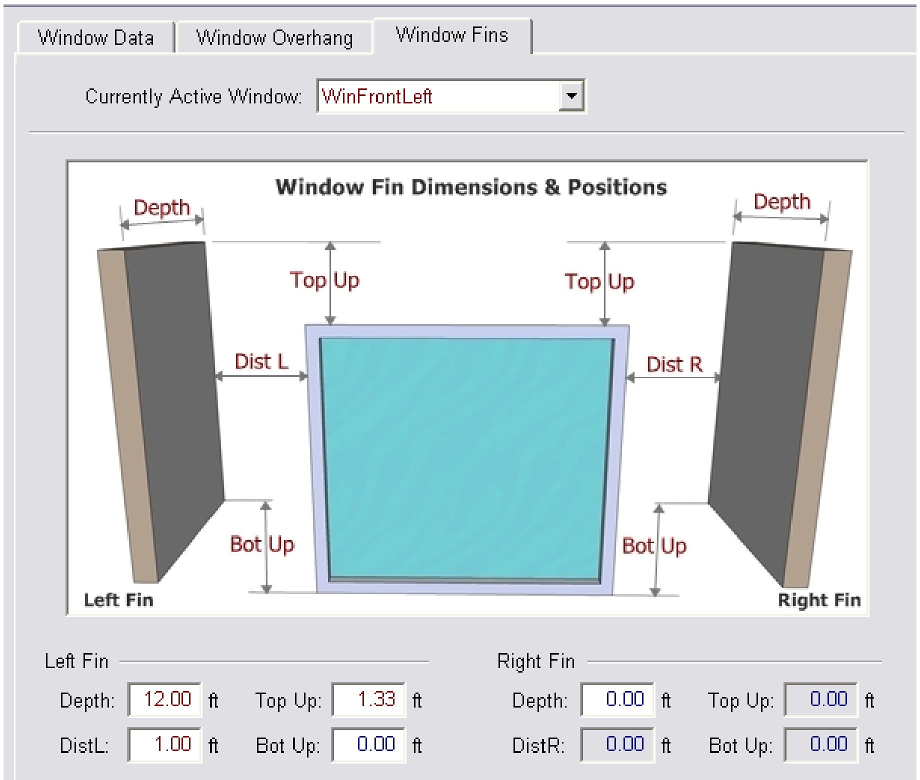
7.3.3.3 Top Up

Distance (in feet) from the top of the window to the top of the wall (fin).

7.3.3.4 Bottom Up

Distance (in feet) from the bottom of the window to the bottom of the left fin.

Figure 7-10: Window Fin



7.3.3.5 Right Fin Depth

Depth (in feet) of the wall (fin) to the right of the window that provides shading to the window.

7.3.3.6 Distance Right

Distance (in feet) from the right edge of the window to the right fin.

7.3.3.7 Top Up

Distance (in feet) from the top of the window to the top of the wall (fin).

7.3.3.8 Bottom Up

Distance (in feet) from the bottom of the window to the bottom of the right fin.

7.3.4 Glass Doors

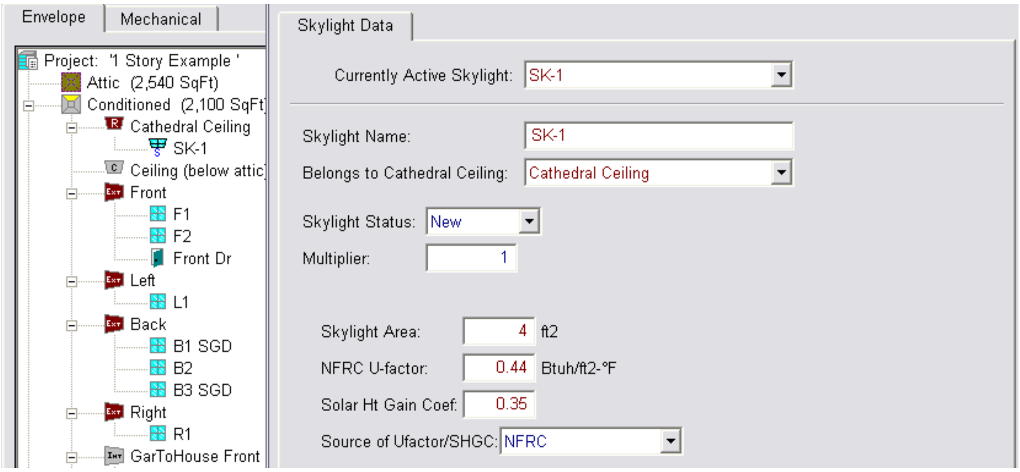
For a door with 50 percent or more glass area, or a door with an NFRC rating, the entire door area is modeled as a window.

The glass area (in square feet) of a door with less than 50 percent glass is the sum of all glass surfaces plus two inches on all sides of the glass (to account for a frame). This area is modeled as a window. The remaining area of the door is modeled as opaque door (see Section 7.2.6).

7.4 Skylights

To create a skylight, a section of cathedral ceiling with an area slightly larger than the skylight must be created. Right-click on the cathedral ceiling surface and pick <create> and select skylight (see Figure 7-11).

Figure 7-11: Skylight



7.4.1.1 Skylight Name

User defined name. If the plans use a window schedule or unique identifier, that identifier can be used for the window name. Each skylight on a given surface must have a unique name.

7.4.1.2 Belongs to Cathedral Ceiling

Defaults to the cathedral ceiling on which you picked create.

7.4.1.3 Skylight Area

Area of the skylight (in square feet).

7.4.1.4 Skylight Status

Select New, Existing, or Altered.

7.4.1.5 Multiplier

The number of identical skylights.

7.4.1.6 NFRC U-factor

U-factor from National Fenestration Rating Council for the skylight (www.nfrc.org), or default from Section 110.6, Table 110.6-A.

7.4.1.7 Solar Heat Gain Coefficient

Solar Heat Gain Coefficient (SHGC) from National Fenestration Rating Council for the skylight (www.nfrc.org), or default from Section 110.6, Table 110.6-B.

7.4.1.8 Source of U-factor/SHGC

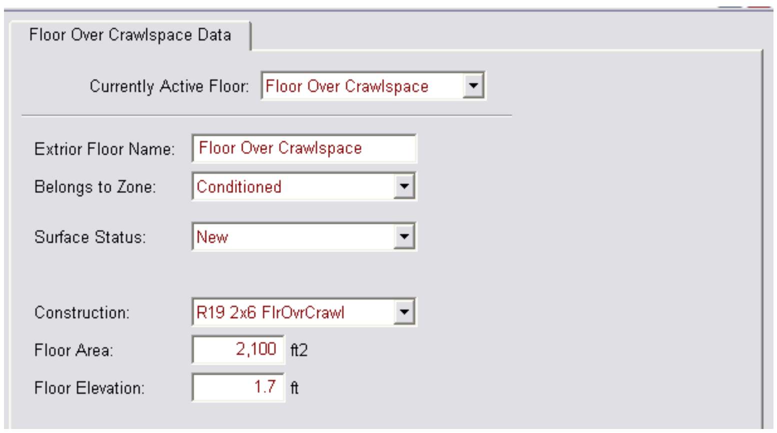
The three valid sources are NFRC, default, or Alternate Default Fenestration Procedure (ADFP). See Section 7.3.1.13.

7.5 Raised Floor

When a raised floor is over an unconditioned space, such as a garage, model this as an interior floor. CBECC recognizes that the outside condition is an unconditioned space. When creating a raised floor over a crawl space, the software will create the associated crawl space zone.

7.5.1 Floor over Crawl Space

Figure 7-12: Raised Floor



7.5.1.1 Exterior Floor Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

7.5.1.2 Belongs to Zone

Select any appropriate zone already included in the building model. When copying components of one zone to another, this field automatically changes.

7.5.1.3 Surface Status

Select New, Existing, or Altered.

7.5.1.4 Construction

Raised floor over crawl space, exterior floor, or interior floor. If an appropriate construction assembly is not available, right-click and pick <create> (discussed in depth in Chapter 6, Construction Assemblies).

7.5.1.5 Floor Area

Area of the floor, in square feet.

7.5.1.6 Floor Elevation

Height above grade or depth of crawl space, in feet. For multi-story buildings, this value must match the input "bottom" in modeled in the zone data.

7.5.2 Floor Over Garage

A raised floor over a garage or over another conditioned space is modeled as an interior floor, but with an unconditioned zone on the other side.

Figure 7-13: Garage or Interior Floor

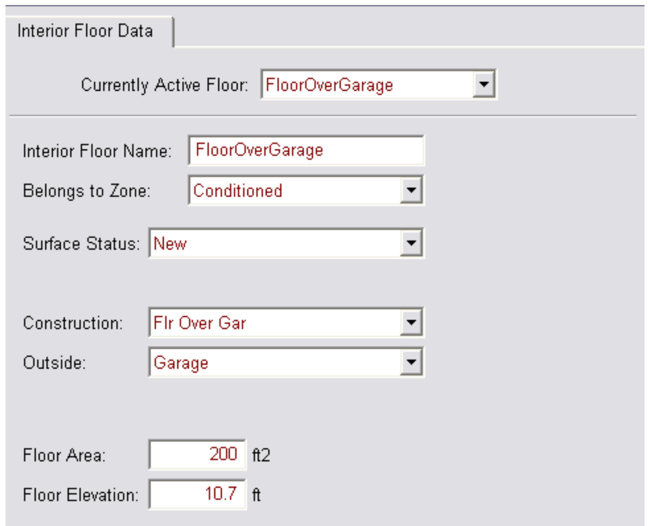
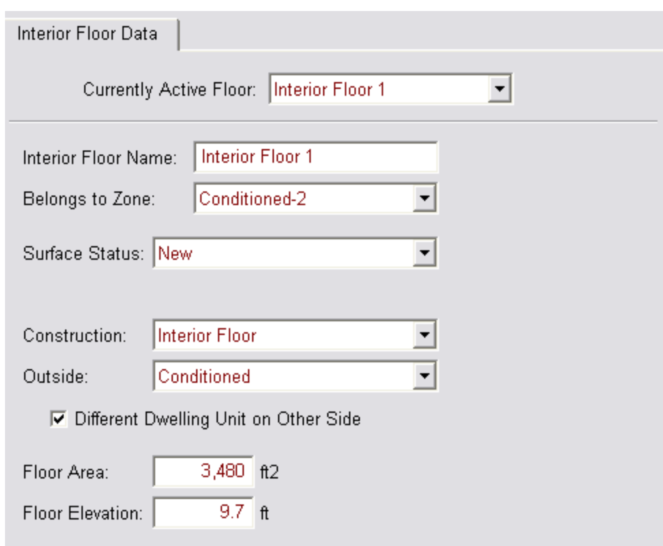


Figure 7-14: Multi-Family Interior Floor



7.5.2.1 Interior Floor Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

7.5.2.2 Belongs to Zone

Select any appropriate zone already included in the building model. When copying components of one zone to another, this field automatically changes.

7.5.2.3 Surface Status

Select New, Existing, or Altered.

7.5.2.4 Construction

Interior raised floor. If an appropriate construction assembly is not available, right-click and pick create (discussed in depth in Chapter 6, Construction Assemblies).

7.5.2.5 Outside

The outside condition or adjacent zone.

7.5.2.6 Different Dwelling Unit on Other Side

A checkbox(see Figure 7-14) is included when the project is identified as multi-family to indicate whether another dwelling unit is on the other side of the surface being modeled.

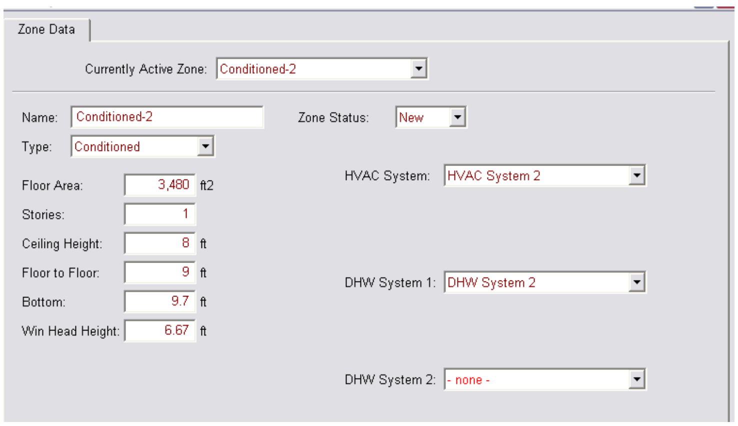
7.5.2.7 Floor Area

Area of the floor, in square feet.

7.5.2.8 Floor Elevation

Height above grade or depth of crawl space, in feet. For multi-story buildings modeled as multiple zones, this value must be consistent with the value input for "bottom" in zone data (see Figure 7-15).

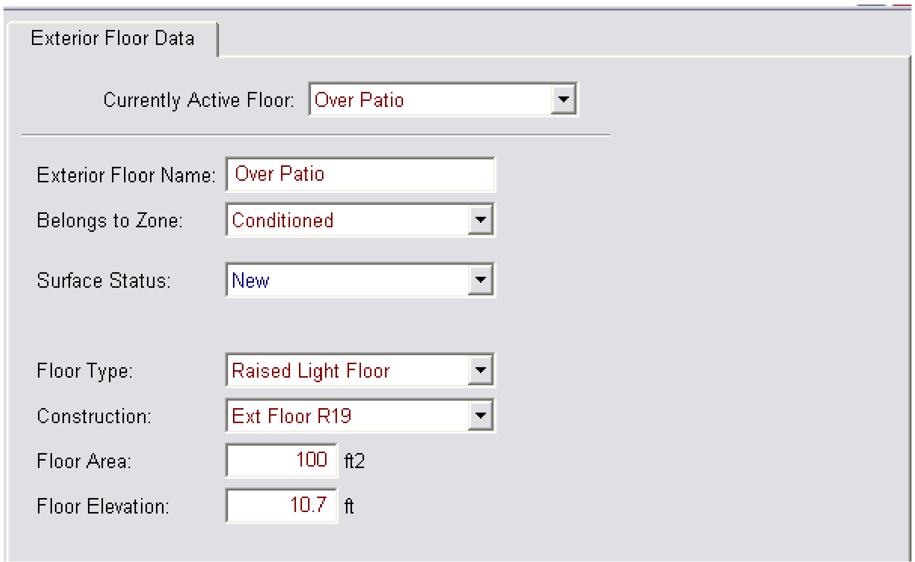
Figure 7-15: Zone Elevation Height



7.5.3 Floor Over Exterior

This type of floor is only used when there is no crawl space and no unconditioned space underneath the floor. Floors with a garage or unconditioned space underneath are modeled an interior floor (with the adjacent zone being unconditioned).

Figure 7-16: Exterior Floor



7.5.3.1 Exterior Floor Name

User-defined name. If the building plans have a unique identifier, that should be used here to assist in the plan checking and inspection processes.

7.5.3.2 Belongs to Zone

Select any appropriate zone already included in the building model. When copying components of one zone to another, this field automatically changes.

7.5.3.3 Surface Status

Select New, Existing, or Altered.

7.5.3.4 Floor Type

Raised light floor or other floor type available from the drop-down menu.

7.5.3.5 Construction

Raised floor over exterior. If an appropriate construction assembly is not available, right-click and pick create (discussed in depth in Chapter 6, Construction Assemblies).

7.5.3.6 Floor Area

Area of the floor, in square feet.

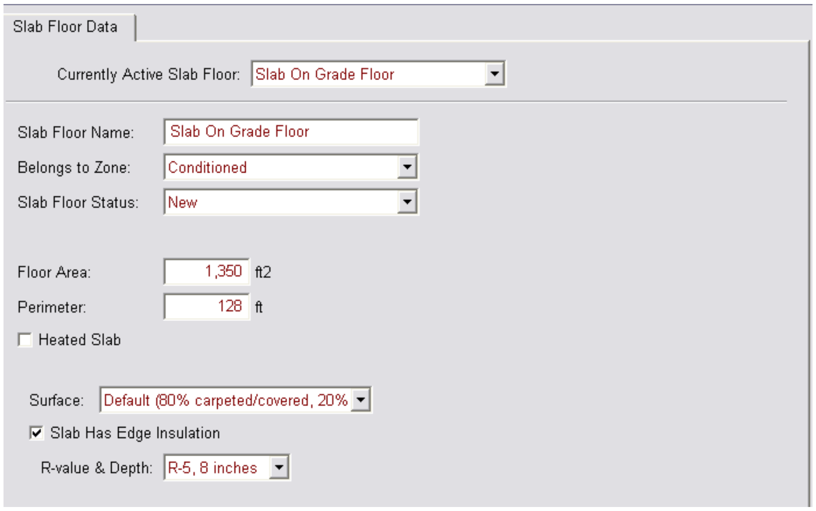
7.5.3.7 Floor Elevation

Height above grade or depth of crawl space, in feet. For multi-story buildings modeled as multiple zones, this value must be consistent with the value input for “bottom” in zone data (see Figure 7-15).

7.6 Slab Floor

Slab on grade floors are modeled in conditioned spaces, unconditioned spaces, heated slab floors, slab floors with mandatory or optional slab edge insulation, floors with 20% exposed and 80% covered, or some other combination of exposed and covered slab.

Figure 7-17: Slab Floor Data



7.6.1.1 Slab Floor Name

If the building plans use a unique tag or ID, use that for the name. Each name within a zone or on a surface must be unique.

7.6.1.2 Belongs to Zone

The name of the zone in which the slab is being modeled.

7.6.1.3 Slab Floor Status

Select New, Existing, or Altered.

7.6.1.4 Floor Area

Area in square feet measured from the outside of the exterior surface of the zone.

7.6.1.5 Perimeter

Length of slab edge (in feet) between the space modeled and exterior only. Do not include the length of edge that occurs between the house and garage (an area that cannot be insulated if the edge is being insulated).

7.6.1.6 Heated slab

Check box to indicate that the slab is heated, in which case mandatory insulation requirements apply. See Standards Section 110.8.

7.6.1.7 Surface

Default 20% exposed/80% covered, otherwise specify exposed or covered slab (modeled separately). Covered slab includes carpet, cabinets, and walls. No building has 100% exposed slab.

7.6.1.8 Slab Has Edge Insulation

Check box to indicate that the slab edge will be insulated.

7.6.1.9 R-value & Depth

When slab edge insulation is indicated in the check box, the R-value and depth of the proposed slab edge insulation is identified. Depth of insulation installed vertically is specified in inches. Depth of insulation installed horizontally is specified in feet.

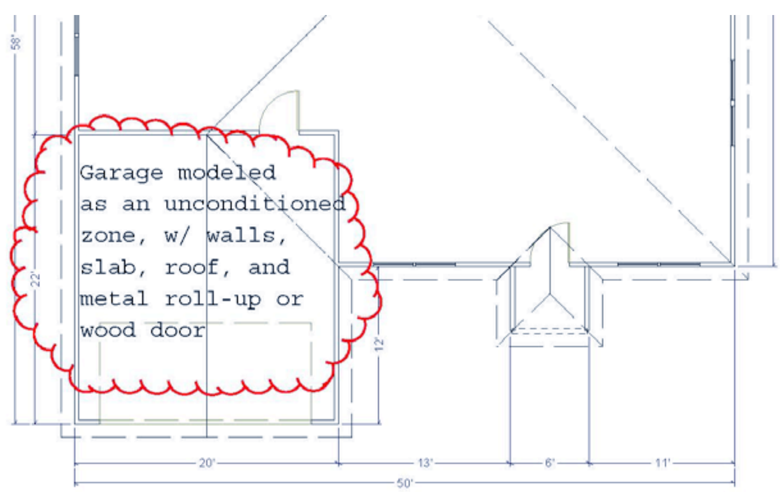
7.7 Exterior Garage Surfaces

In addition to the surfaces separating the house from the garage (which continue to be modeled as part of the conditioned zone), model attached unconditioned spaces (see Figure 7-18).

No surface is modeled more than once, so if the garage ceiling is a floor in the conditioned space zone, it is not modeled in the garage zone. The garage surfaces are typically not insulated and it is not necessary to model any windows. Model the area and type of ceiling, slab floor (perimeter length is only to exterior), any walls (typically with R-0 insulation) and the large metal roll-up or wood door (U-factor 1.00) and the door to outside. In a one-story building, the attic is typically shared with the conditioned space (NOTE: this is why the attic area (which cannot be edited) is bigger than the conditioned space).

The surfaces that separate the house or conditioned zone from the garage are modeled with the conditioned zone as interior walls and interior floors (see Sections 6.8.3 and 6.9.3).

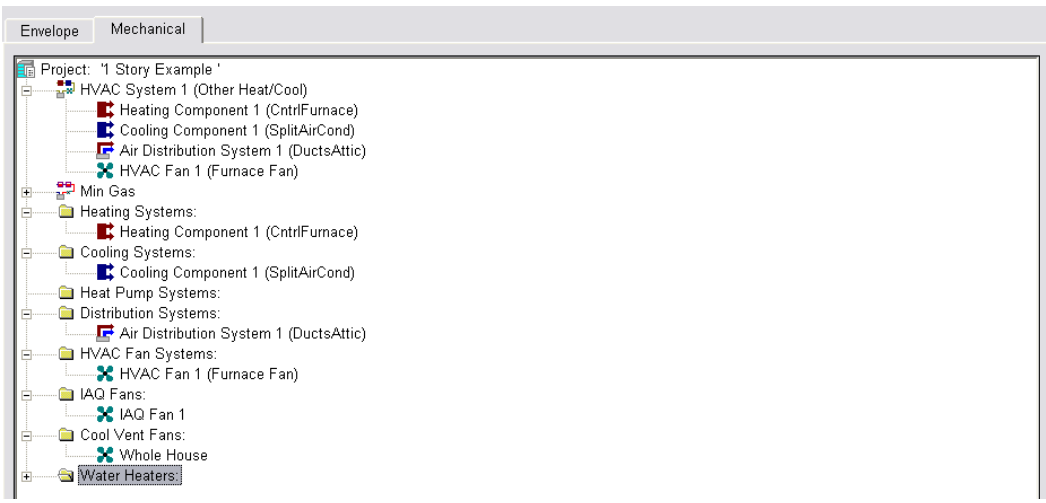
Figure 7-18: Attached Garage



Chapter 8. Mechanical Systems

The heating, cooling, duct/distribution system and space conditioning fans are defined at the zone level (see Section 5.4.1.10). The indoor air quality ventilation and cooling ventilation are defined at the project level (see Sections 4.6 and 4.7). The details of these systems are contained under the mechanical tab (see Figure 8-1). The information in this chapter is from the point of view of the mechanical tab.

Figure 8-1: Mechanical Tab



NOTE: Until an exceptional method is approved for mini-split, multi-split, evaporative cooling, room air conditioners, room heat pumps or ground source heat pumps systems, these systems are modeled as equivalent to a standard design system with no penalty and no credit.

8.1 HVAC System Data

The details of the HVAC system are shown in Figure 8-2.

8.1.1.1 System Name

User-defined name.

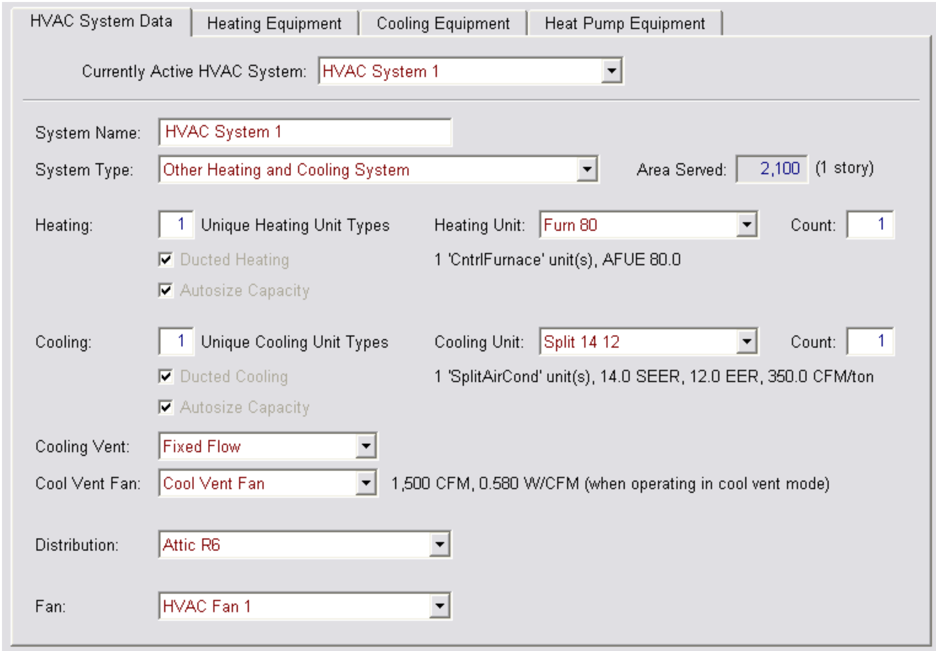
8.1.1.2 System Type

Select the correct system type as:

- Heat pump heating and cooling system,
- Variable outdoor air ventilation central heat/cool system for central fan integrated night ventilation cooling - *variable* speed (for example, NightBreeze~~Smart Vent~~™), or

- Other heating and cooling system for typical HVAC systems or for central fan integrated night ventilation cooling - *fixed* speed (for example, SmartVent~~Night Breeze~~™).

Figure 8-2: HVAC System Data



8.1.1.3 Unique Heating Unit Types

Indicate the number of unique system types. Not the same as "count" which is the number of systems.

8.1.1.4 Heating Unit

Name of the heating system, details of which are specified as shown in Section 8.2.

8.1.1.5 Count

Number of specified heating units to be installed.

8.1.1.6 Unique Cooling Unit Types

Indicate the number of unique system types. Not the same as "count" which is the number of systems.

8.1.1.7 Cooling Unit

Name of the cooling system, details of which are specified as shown in Section 8.3 (heat pump cooling is included with heating in Section 8.2.2).

8.1.1.8 Count

Number of specified cooling units to be installed.

8.1.1.9 Cooling Vent

When displayed for a central fan integrated night ventilation cooling system, select Fixed Flow.

8.1.1.10 Cool Vent Fan

When displayed for central fan integrated night ventilation cooling, specify the fan that circulates air for cooling ventilation, or create a new fan with CFM and W/CFM details. This system will require HERS verification.

8.1.1.11 Distribution

Name of the duct or distribution system, details of which are specified as shown in Section 8.4.

8.1.1.12 Fan

Name of the HVAC fan system, details of which are specified as shown in Section 8.5. If using central fan integrated night ventilation cooling, this is the furnace fan that operates in ventilation mode.

8.1.2 Zonal Control

With zonal control, the sleeping and living areas are modeled separately for space conditioning. Some of the requirements for this compliance option include each habitable room must have a source of space conditioning, the sleeping and living zones must be separately controlled, a non-closeable opening between the zones cannot exceed 40 ft^2, each zone must have a temperature sensor and a setback thermostat, and the return air for the zone must be located within the zone. Additionally, zonal control credit is not available if space heating is provided by a heat pump or combined hydronic system. A full list of eligibility criteria for this measure is presented in the *Residential Compliance Manual*, Section 4.5.2. Figure 8-3 and Figure 8-4 show where the ability to model zonal control is activated via a check box and the zone type. See also Sections 8.3.1.5 and 8.4.1.6 for information about the exception to the 350 CFM requirement for single-speed zoned systems.

Figure 8-3: Zonal Control from Section 4.4.1.8

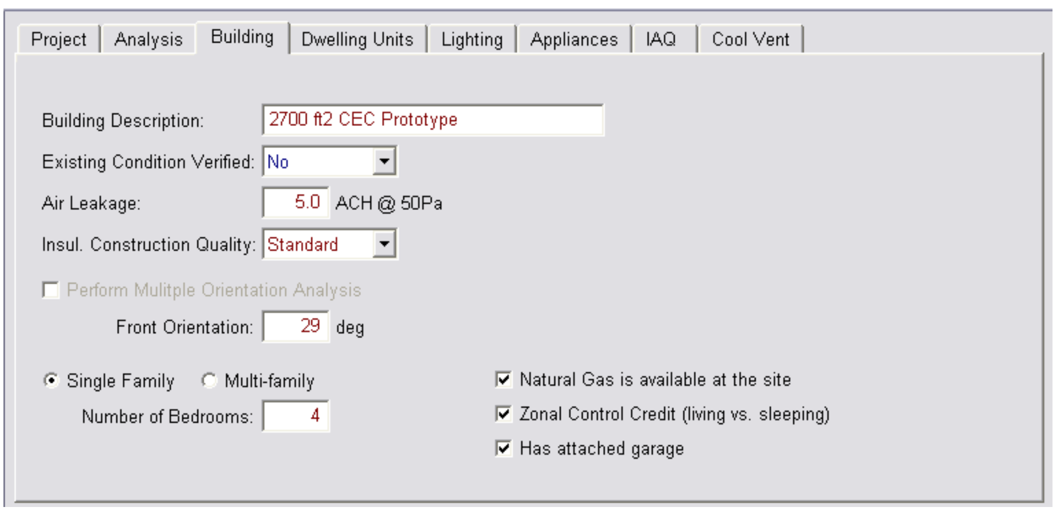
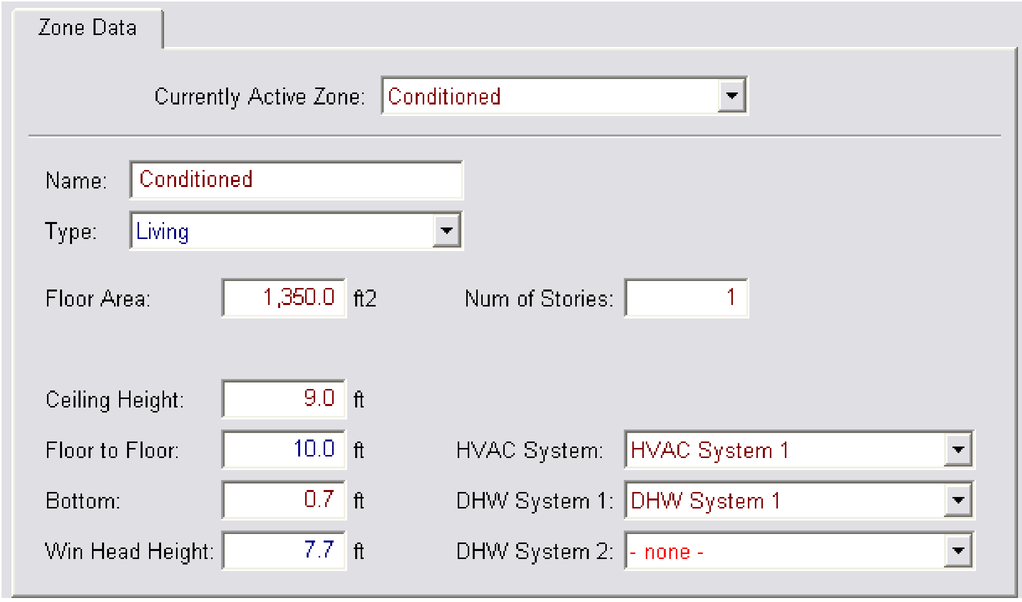


Figure 8-4: Type from Section 5.4.1



8.1.3 Multiple HVAC Systems

When multiple systems of the same type serve different areas of a building, it is the user's option to separately zone the systems. If modeled as one system, use either a weighted average efficiency or the lowest efficiency. For multi-family buildings modeled by floor rather than by dwelling unit, if the equipment efficiencies are different, the software will use the lowest efficiency unit.

When multiple systems of different equipment or fuel types serve the building, each type must be modeled as a separate zone to accommodate the different equipment types.

When multiple systems serve the same floor area, only one system can be modeled. The system modeled depends on the size and types of systems. If the capacity of the secondary system does not exceed 2 kW or 7,000 Btu/hr and is controlled by a time-limiting device of 30 minutes or less, the system is considered supplemental and may be ignored (*Residential Compliance Manual*, Section 8.7.3, and Section 150.1(c)6). If the system does not meet these criteria, the system that is modeled is the one that consumes the most TDV energy. For spaces with electric resistance heat in addition to another heating system, the electric resistance heat is the system that must be modeled.

8.2 Heating Systems

The heating system is the equipment that supplies heat to an HVAC System. Heating systems are categorized according to the types show in Table 8-1.

8.2.1 Heating System Data (other than heat pump)

See Figure 8-5 for the heating system data input screen, which varies slightly by equipment type. Not all system types are currently implemented.

8.2.1.1 Name

User-defined name for the heating system.

8.2.1.2 Type

Heating system type (see Table 8-1).

8.2.1.3 Efficiency

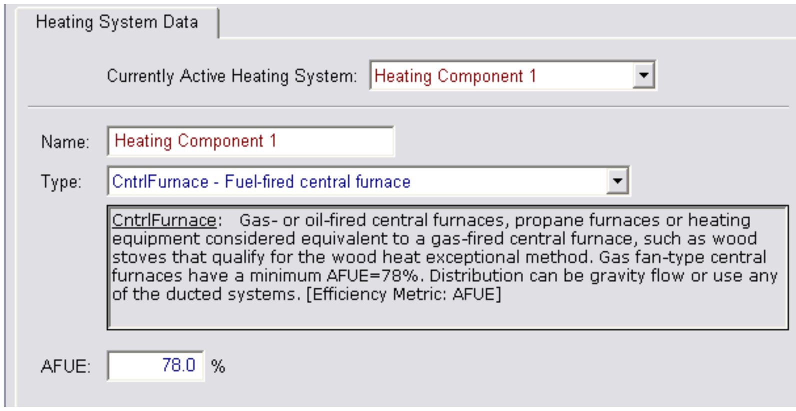
Enter an appropriate efficiency for the equipment type (e.g., 80.6 AFUE). The software will include the minimum efficiency for typical system types. Efficiency information for a specific model number of heating and cooling equipment is found by performing an "advanced search" in the Energy Commission's appliance directories (http://www.appliances.energy.ca.gov/) or from the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Certified Products Directory http://www.ahridirectory.org.

For more information on the default efficiency for wall furnaces, floor furnaces, and heaters, see Section 8.2.6.

Table 8-1: Heating Equipment

Descriptor	Heating Equipment Reference
Central Furnace	Fuel-fired central furnaces, propane furnaces or heating equipment considered equivalent to a gas-fired central furnace, such as wood stoves that qualify for the wood heat exceptional method. Gas fan-type central furnaces have a minimum AFUE=78%. Distribution is ducted. [Efficiency metric: AFUE]
Heater [wall, floor or space heater]	Non-central fuel-fired space heaters, such as wall heaters, floor heaters or unit heaters. Distribution is non-ducted. [Efficiency metric: AFUE]
Boiler	Gas or oil boiler. Boiler may be specified for dedicated hydronic systems or as part of a combined hydronic system (providing space and water heating). Distribution is non-ducted. [Efficiency metric: AFUE]
Electric	All electric heating systems (other than heat pumps), including electric resistance, electric boilers and storage electric water heaters. Distribution system is ducted or non-ducted. [Efficiency metric: HSPF]
Combined Hydronic	Water heating system can be storage gas, storage electric or heat pump water heater. Distribution systems can be ducted or non-ducted. [Efficiency metric AFUE, Recovery Efficiency or Thermal Efficiency]

Figure 8-5: Heating System Data



8.2.2 Heat Pumps (Air Source)

See Figure 8-6 for heat pump system data input screen, which varies slightly by equipment type.

8.2.2.1 Name

User-defined name for the system.

8.2.2.2 Type

Heat pump system type (see Table 8-2).

8.2.2.3 Heating Performance HSPF

Enter the heating seasonal performance Factor (HSPF). Efficiency information for a specific model number is found by performing an "advanced search" in the Energy Commission's appliance directories (http://www.appliances.energy.ca.gov/) or from the AHRI Certified Products Directory http://www.ahridirectory.org.

For systems rated with a COP only, which require an HSPF, convert the COP ~~to a Heating Seasonal Performance Factor (HSPF)~~ using Equation 8-1.

Equation 8-1: $HSPF = (3.2 \times COP) - 2.4$

8.2.2.4 Capacity @ 47 Degrees F

Required value from the AHRI Certified Products Directory http://www.ahridirectory.org. Capacity is used to determine the energy use of the backup electric resistance heat. In a multi-family building you will indicate the capacity for the defined system and specify the number of units of that given capacity assigned to the zone (see Section 8.1.1.5).

8.2.2.5 Capacity @ 17 Degrees F

Required value from the AHRI Certified Products Directory http://www.ahridirectory.org.

8.2.2.6 Cooling Performance - SEER

Cooling equipment Seasonal Energy Efficiency Ratio (SEER). For equipment tested only with an EER, enter the EER as the SEER. When a value higher than 13 SEER for "Compliance 2014" is modeled, it triggers a HERS Verification of High SEER. With "Compliance 2015" the minimum efficiency requirement of the Appliance Efficiency Standards changes to 14 SEER, and only when an SEER higher than 14 is modeled is a HERS Verification of High SEER triggered. Efficiency information can be obtained from an advanced search of the Energy Commission's appliance directories (http://www.appliances.energy.ca.gov/) or from the AHRI Certified Products Directory http://www.ahridirectory.org.

8.2.2.7 EER

Cooling equipment Energy Efficiency Ratio (EER). When an EER value of higher than 11.3 is modeled with "Compliance 2014" or an EER higher than 11.7 is modeled with "Compliance 2015", it triggers a HERS verification. For equipment with an EER rating only (e.g., room air conditioner), enter the EER as the SEER. Because the EER depends on the specific combination of coil and condenser model numbers, the EER ratings must be obtained from AHRI directory http://www.ahridirectory.org.

8.2.2.8 CFM per Ton

The mandatory requirement for cooling airflow is 350 CFM/ton for ducted cooling systems (also assumed for dwellings with no cooling), or 150 CFM/ton for Zonal Single Speed systems. Users may model a higher airflow. All systems other than no cooling require HERS verified system airflow using diagnostic testing procedures from *Reference Appendices*, Residential Appendix RA3.

8.2.2.9 AC Charge

Verified refrigerant charge. Select not verified, verified, or Charge Indicator Display (CID). There is no mandatory requirement for verified refrigerant charge, however, the standard design in climate zones 2 and 8-15 includes proper refrigerant charge in the standard design for most equipment types (see Standards Section 150.1(c)8.).

8.2.2.10 Refrigerant Type

Default R410A assumed for all refrigerant containing equipment.

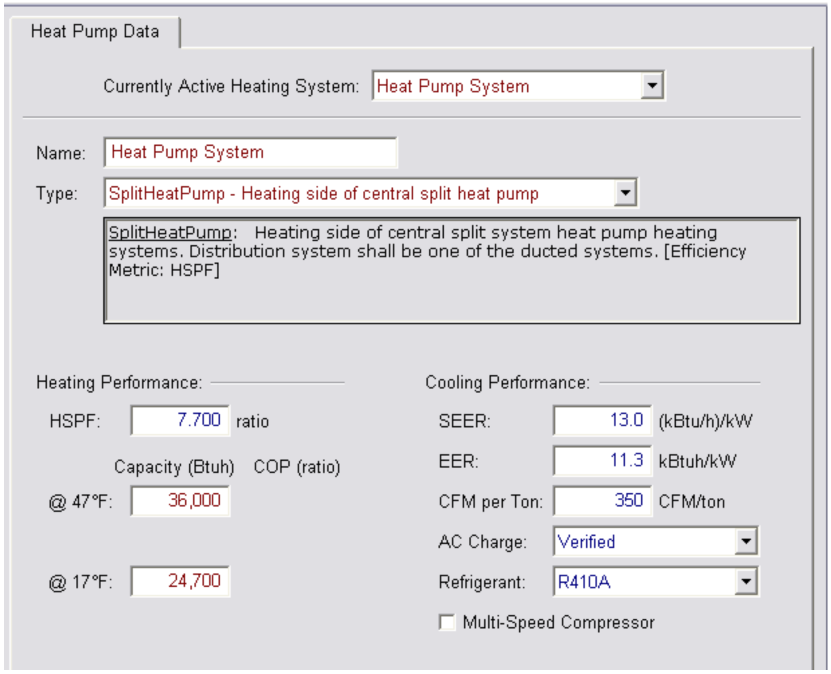
8.2.2.11 Multi-Speed Compressor

Use this field to indicate if the system is a zonally controlled multi-speed compressor. An exception for single speed compressors would leave this box unchecked and specify 150 CFM/ton (see Section 8.3.1.5).

Table 8-2: Heat Pump Equipment

Split Heat Pump	Split heat pump heating system that has one or more outdoor units supply heat to each habitable space in the dwelling unit. Distribution is ducted. [Efficiency metric: HSPF]
Ductless Heat Pump	One or more heat pump outdoor units that use refrigerant to transport heat to at least one terminal in each habitable space in the dwelling unit. These include small ductless mini-split and multiple-split heat pumps and packaged terminal (commonly called “through-the-wall”) units. Distribution is non-ducted. [Efficiency metric: HSPF, COP]
Package Heat Pump	Central packaged heat pump systems. Central packaged heat pumps are heat pumps in which the blower, coils and compressor are contained in a single package, powered by single phase electric current, air cooled, rated below 65,000 Btuh. Distribution system is ducted. [Efficiency metric: HSPF]
Large Package Heat Pump	Large packaged units rated at or above 65,000 Btu/hr (heating mode). Distribution system is ducted. These include water source and ground source heat pumps. [Efficiency metric: COP]
Room Heat Pump	A factory encased Same as Ductlesst heat pump that is designed as a unit for mounting in a window, through a wall, or as a consoleexcept that heat is not supplied to each habitable space in the dwelling unit. Distribution is non-ducted. [Efficiency metric: COP]
Air to Water Heat Pump	An indoor conditioning coil, a compressor, and a refrigerant-to-water heat exchanger that provides heating and cooling functions. Also able to heat domestic hot water. [Efficiency metric: COP and EER]
Ground Source Heat Pump	An indoor conditioning coil with air moving means, a compressor, and a refrigerant-to-ground heat exchanger that provides heating, cooling, or heating and cooling functions. Also able to heat domestic hot water. [Efficiency metric: HSPF, SEER, EER]

Figure 8-6: Heat Pump Data



8.2.3 Air to Water Source Heat Pump

See Figure 8-7 for air to water source heat pump input screens.

8.2.3.1 Name

User-defined name for the system.

8.2.3.2 Type

Heat pump system type (see Table 8-2).

8.2.3.3 Heating Performance

Enter the Coefficient of Performance (COP). Efficiency information for a specific model number is found by performing an “advanced search” in the Energy Commission’s appliance directories (http://www.appliances.energy.ca.gov/) or from the AHRI Certified Products Directory http://www.ahridirectory.org.

8.2.3.4 Capacity @ 47 Degrees F

Required value from the AHRI Certified Products Directory http://www.ahridirectory.org. Capacity is used to determine the energy use of the backup electric resistance heat. In a multi-family building you will indicate the capacity for the defined system and specify the number of units of that given capacity assigned to the zone (see Section 8.1.1.5).

8.2.3.5 Capacity @ 17 Degrees F

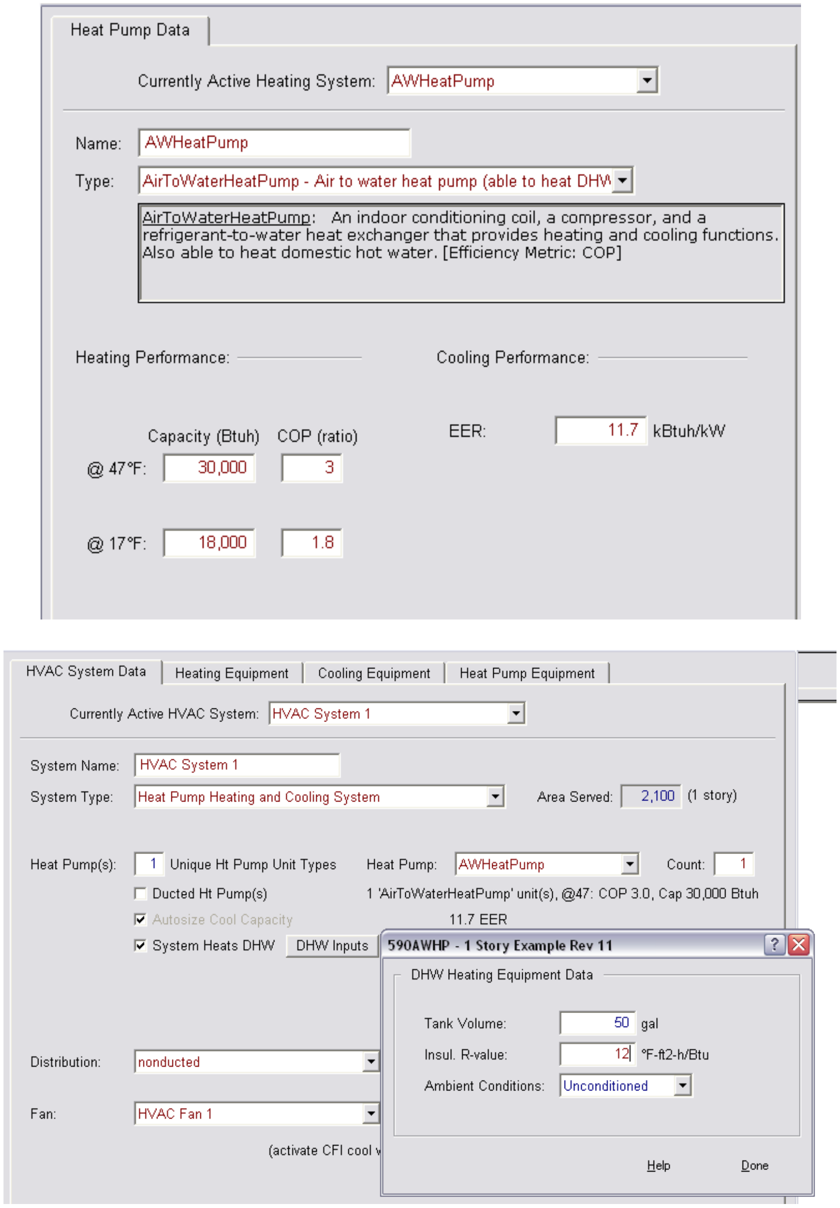
Required value from the AHRI Certified Products Directory http://www.ahridirectory.org.

8.2.3.6 EER

Cooling equipment Energy Efficiency Ratio (EER).

On the HVAC System Data screen, check the box "System Heats DHW" (see Figure 8-7) and enter the tank volume, insulation R-value and ambient conditions.

Figure 8-7: Air to Water Source Heat Pump



8.2.4 Ground Source Heat Pump

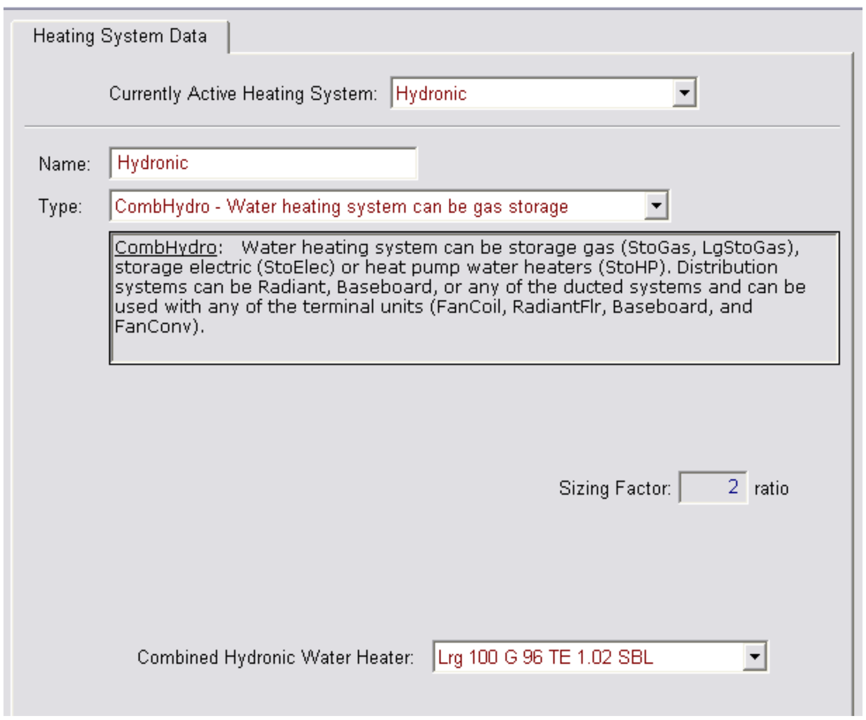
There is no current method for modeling ground source heat pumps to accurately represent this feature which uses the earth as a source of energy for heating and as a heat sink for energy when cooling. If this system type is being used, the ~~mandatory efficiencies for ground water source heat~~

~~pumps are a minimum~~ Coefficient of Performance (COP) for heating and EER for cooling are entered as well as the capacity. The system is simulated as a standard system. ~~The heating efficiency COP (from either Energy Commission or AHRI directory (see Section 8.2.1.3) is converted to an HSPF. For cooling efficiency, the EER may be modeled as the SEER, or the EER may be modeled as both the SEER and a HERS verified EER.~~

8.2.5 Hydronic Heating

Whether the heating system is hydronic or combined hydronic, define the system type from the drop down menu as 'CombHydro'. In the field labeled Combined Hydronic Water Heater, specify the device that is providing the space heating.

Figure 8-8: Hydronic Heating Data



8.2.6 Hydronic Distribution Systems and Terminals

The only combined hydronic systems currently implemented are those that have 10 feet or less of piping in unconditioned space.

When hydronic systems have more than 10 feet of piping (plan view) located in unconditioned space, additional information about the distribution system is needed.

Other information reported includes:

- *Piping Run Length (ft).* The length (plan view) of distribution pipe located in unconditioned space, in feet, between the primary heating/cooling source and the point of distribution.

- *Nominal Pipe Size (in.).* The nominal (as opposed to true) pipe diameter in inches.
- *Insulation Thickness (in.).* The thickness of the insulation in inches. Enter "none" if the pipe is uninsulated.
- *Insulation R-value (hr-ft^2- °F/Btu).* The installed R-value of the pipe insulation. Minimum pipe insulation for hydronic systems is as specified in Section 150.1(j).

8.2.7 Wood Heating

When all of the qualifications for the wood heat exceptional method are met (see *Residential Compliance Manual*, Section 4.7.7), the heating system (which includes any back-up heating system) receives neither a penalty nor a credit. A hypothetical heating system that meets Package A is modeled. The wood heater and its back-up system are modeled as a 78% AFUE central furnace, with sealed and tested ducts located in the attic with an R-value equivalent to Package A (select “Use all distribution system defaults”).

8.2.8 Electric Heat

~~Not yet implemented.~~ Electric resistance heat is modeled with a default efficiency of 3.413 ~~an~~ HSPF ~~of 3.413. Electric radiant heat is modeled with an HSPF of 3.55~~.

8.2.9 Non-central Heating

Because the minimum appliance efficiency standard for wall furnaces, floor furnaces and heaters is based on size and ranges from an AFUE of 59 to 74, it is important to specify an unachievable efficiency. ~~For systems such as wall furnaces, floor furnaces, and heaters, where the size of the equipment determines the minimum efficiency, the software will assume 34 Btu/hour per square foot of conditioned floor area in setting the standard design efficiency~~. If specific details about the proposed heating equipment are unknown, see *Residential Compliance Manual,* Section 4.2.1 for the minimum standard by type and capacity ~~so that an appropriate efficiency can be modeled~~. A default assumption of at least 34 Btu/hour per square foot of conditioned floor area can be used to determine an appropriate efficiency.

For the distribution system, model either “none” or a “distribution systems without ducts” as specified in Section 8.4.1.2.

For systems rated with a Coefficient of Performance (COP) only, convert the COP to a Heating Seasonal Performance Factor (HSPF) using Equation 8-1 above.

8.3 Cooling Systems

The cooling system is the equipment that supplies cooled air to an HVAC System (see Figure 8-7). Cooling systems are categorized according to the types shown in Table 8-3. See Table 8-4 for which measures (some of which are mandatory) require HERS verification.

Table 8-3: Cooling Equipment

Descriptor	Cooling Equipment Reference
Ductless Split Air Conditioner	Split air conditioning outdoor unit that uses refrigerant to transport cooling to at least one terminal in each habitable space in the dwelling unit. These include small ductless mini-split and multiple-split air conditioners and packaged terminal ("through-the-wall") units. Distribution is non-ducted. [Efficiency metric: EER]
Evaporative Direct	Direct evaporative cooling systems. Assume minimum efficiency air conditioner. The default distribution system is ducts in attic. [Efficiency metric: SEER]
Evaporative Indirect/Direct	Indirect-direct evaporative cooling systems. Assume energy efficiency ratio of 13 EER. Requires air flow and media saturation effectiveness from the Energy Commission appliance directory. Distribution is ducted or non-ducted. [Efficiency metric: EER]
Evaporative Indirect	Indirect cooling systems. The default distribution system is duct in attic; evaporative cooler duct insulation requirements are the same as those for air conditioner ducts. Assume energy efficiency ratio of 13 EER. Requires air flow and media saturation effectiveness from the Energy Commission directory. [Efficiency metric: EER]
~~Evaporatively Cooled Condenser~~	~~A split mechanical system, with a water-cooled condenser coil. Distribution is ducted. [Efficiency metric: EER]~~
~~Gas Cooling~~	~~Gas absorption cooling. Distribution is ducted. [Efficiency metrics: COP95 (the rated COP for the gas portion), CAP95 (the rated capacity), and PPC (the parasitic electric energy at rated conditions in Watts)]~~
Large Package Air Conditioner	Systems rated at or above 65,000 Btu/hr (cooling capacity). Distribution is ducted. [Efficiency metric: EER]
No Cooling	When the proposed building is not cooled or when cooling is optional (to be installed at some future date). Both the standard design and proposed design use the same default system. Distribution is ducted (either the same system as heating or default ducts in attic). (See also section 8.3.2). [Efficiency metric: SEER]
Package Air Conditioner	Central packaged air conditioning systems less than 65,000 Btu/hr cooling capacity. Distribution is ducted. [Efficiency metric: SEER and EER]
Room Air Conditioner	A factory encased ~~Same as Ductless Split~~ air conditioner that is designed as a unit for mounting in a window, through a wall, or as a console~~except that heat is not supplied to each habitable space in the dwelling unit~~. Distribution is non-ducted. [Efficiency metric: EER]
Split Air Conditioner	Split air conditioning systems. Distribution is ducted. [Efficiency metric: SEER and EER]

8.3.1 Cooling System Data

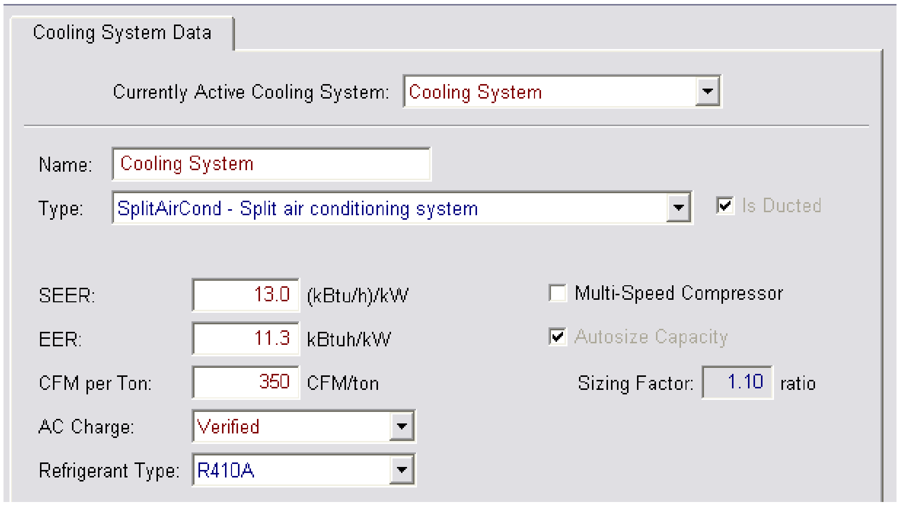
8.3.1.1 Name

User-defined name for the cooling system.

8.3.1.2 Type

Cooling system type (see Table 8-3).

Figure 8-9: Cooling System Data



8.3.1.3 SEER

Cooling equipment Seasonal Energy Efficiency Ratio (SEER). For equipment tested only with an EER, enter the EER as the SEER. When a value higher than 13 SEER for “Compliance 2014” is modeled, it triggers a HERS Verification of High SEER. With “Compliance 2015” the minimum efficiency requirement of the Appliance Efficiency Standards changes to 14 SEER, and only when an SEER higher than 14 is modeled is a HERS Verification of High SEER triggered. Efficiency information can be obtained from the Energy Commission’s appliance directories (http://www.appliances.energy.ca.gov/AdvancedSearch.aspx) or from the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Certified Products Directory http://www.ahridirectory.org.

8.3.1.4 EER

Cooling equipment Energy Efficiency Ratio (EER). When an EER value higher than 11.3 is modeled with “Compliance 2014” or an EER higher than 11.7 is modeled with “Compliance 2015”, it triggers a HERS verification. For equipment with an EER rating only (e.g., room air conditioner), enter the EER as the SEER. Because the EER depends on the specific combination of coil and condenser model numbers, the EER ratings must be obtained from AHRI directory http://www.ahridirectory.org.

8.3.1.5 CFM per Ton

The mandatory requirement for cooling airflow is 350 CFM/ton for ducted cooling systems (also assumed for dwellings with no cooling), or 150 CFM/ton for Zonal Single Speed systems. Users may model a higher airflow. All systems other than no cooling require HERS verified system airflow using diagnostic testing procedures from *Reference Appendices*, Residential Appendix RA3.

8.3.1.6 AC Charge

Verified refrigerant charge. Select not verified, verified, or Charge Indicator Display (CID). There is no mandatory requirement for verified refrigerant charge, however, the standard design in climate zones 2 and 8-15 includes proper refrigerant charge in the standard design for most equipment types (see Standards Section 150.1(c)8.).

Table 8-4: Air Conditioning Measures Requiring HERS Verification

Measure	Description
Refrigerant Charge	Air-cooled air conditioners and air-source heat pumps must be diagnostically tested to verify that the system has the correct refrigerant charge.
Charge Indicator Display	A Charge Indicator Display (CID), alternative to refrigerant charge testing.
System Airflow	Ducted systems require a verified system airflow greater than or equal to 350 CFM/ton (mandatory requirement) or another specified value.
Air-handling Unit Fan Efficacy	To verify that fan efficacy is less than or equal to 0.58 Watts/CFM (a mandatory requirement) or other specified criterion.
EER	Credit for higher than minimum EER by installation of specific air conditioner or heat pump models.
SEER	Credit for higher than minimum SEER.
Evaporatively Cooled Condensers	Must combine with duct leakage testing, refrigerant charge, and verified EER.

8.3.1.7 Refrigerant Type

Default R410A assumed for all refrigerant containing equipment.

8.3.1.8 Multi-Speed Compressor

Use this field to indicate if the system is a zonally controlled multi-speed compressor. An exception for single speed compressors would leave this box unchecked and specify 150 CFM/ton (see Section 8.3.1.5).

8.3.2 No Cooling

When no cooling system is installed in a dwelling, create a cooling system using the type NoCooling. The system is modeled in a way that results in no credit and no penalty. The software sets the default cooling system to a split system air conditioner that exactly meets Package A for the efficiency, airflow, and refrigerant charge. NOTE: The duct system should never be set to none or non-ducted. It is either the same as the heating system ducts (if any), or Package A, whichever is better.

8.3.3 Non-central Cooling

Until the manufacturers of non-typical cooling technologies pursue an exceptional method, the Energy Commission has determined that there is not enough data about how these systems perform in achieving comfort conditions to simulate their efficiency. Model the proposed system, however, the systems will be modeled as equivalent to the standard design, meaning there is no credit and no penalty. Non-ducted systems are modeled with the distribution system defined as a "distribution system without ducts".

8.3.4 Evaporative Cooling

[Not yet Implemented] Specify one of three types of evaporative cooling: (1) direct evaporative cooler, the most commonly available system type, (2) indirect, or (3) indirect-direct. Product specifications and other modeling details are found in the Energy Commission appliance directory for evaporative cooling. The default system type is evaporative direct, which is assigned an efficiency of 13 SEER (or the minimum appliance efficiency standard for split system cooling). For indirect or indirect-direct, select the appropriate type, based on the Energy Commission appliance directory as well as the air flow and media saturation effectiveness or cooling effectiveness from the Energy Commission appliance directory, and specify 13 EER (if required input 13 SEER as well).

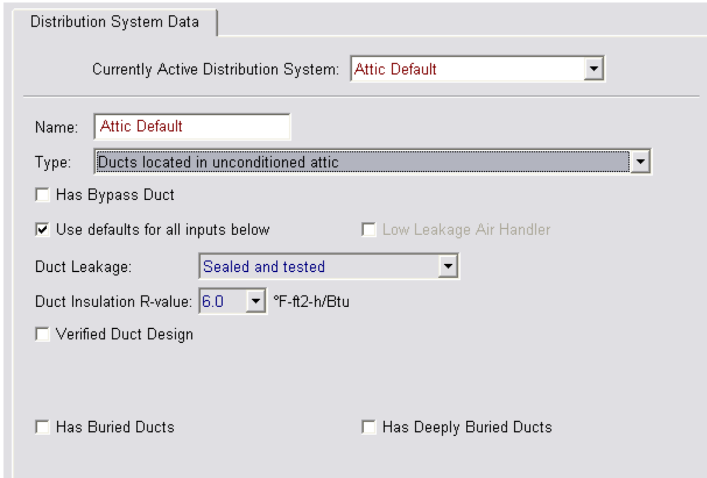
Direct evaporative coolers are assumed to be equivalent to a minimum split system air conditioner. The evaporative cooling modeling methodology addresses two performance issues: (1) rising indoor relative humidity during periods with extended cooler operation, and (2) evaporative cooler capacity limitations. Since modeling of indoor air moisture levels is beyond the capability of simulation models, a simplified algorithm is used to prohibit evaporative cooler operation during load hours when operation is expected to contribute to uncomfortable indoor conditions. The algorithm disallows cooler operation when outdoor wet bulb temperatures are 70°F, or above. As for the capacity limitations, since evaporative coolers are 100 percent outdoor air systems, their capacity is limited by the outdoor wet bulb temperature. Each hour with calculated cooling load, the algorithm will verify that the cooling capacity is greater than the calculated house cooling load.

8.4 Distribution System Data

When multiple distribution system details occur within a given zone, each system and the conditioned space it serves may be modeled in detail separately or the systems may be modeled as one large system. When modeled as one system, assume the worst case conditions.

When modeling a multi-story building, the computer model already assumes that some ductwork is between floors and inside the conditioned space.

Figure 8-10: Distribution System Data



8.4.1.1 Name

User-defined name.

8.4.1.2 Type

Indicate the type of duct system, location, or no ducts (see Table 8-5).

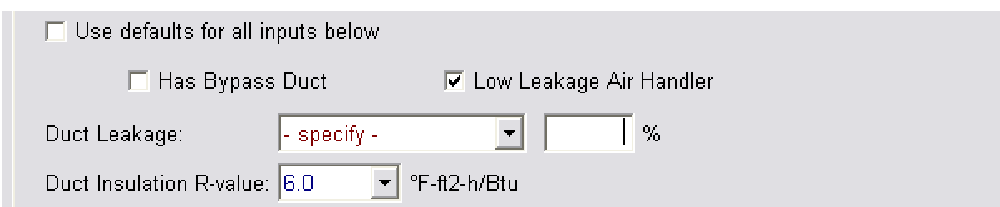
Table 8-6 summarizes the duct conditions that require HERS verification, including sealed and tested ducts, which are a mandatory requirement.

Proposed HVAC systems with ducts in the crawl space or a basement must have supply registers within two feet of the floor and show the appropriate locations for the ducts. Ducts in crawl space and basement can be verified by the local enforcement agency (no HERS verification or duct design).

8.4.1.3 Use all distribution system defaults

By checking this option, the detailed information about the supply and return ducts is completed based on other building inputs, including climate zone. NOTE: If you change the climate zone to one with a different Package A duct insulation value, the program will change to match Package A, which may not match the plans.

Figure 8-11: Duct Leakage



8.4.1.4 Duct Leakage

Selected sealed and tested. To specify a target leakage number, select Low Leakage Air Handler (see Figure 8-10). HERS verification is required for this mandatory measure.

8.4.1.5 Duct Insulation R-value

Specify the R-value of HVAC system ducts. The mandatory minimum R-value allowed is 6. Valid options are 0, 2.1, 4.2, 6.0, 8.0, 10.0 and 12.0.

Table 8-5: Distribution Type

Descriptor	Distribution Type and Location
Ducts located in unconditioned attic	Ducts located overhead in the unconditioned attic space (and default condition for no cooling).
Ducts located in a crawl space	Ducts located in an unconditioned crawl space.
Ducts located in a garage	Ducts located in an unconditioned garage space.
Ducts located within the conditioned space (except 12 lineal feet)	Less than 12 linear feet of duct is outside of the conditioned space.
Ducts located entirely in conditioned space	HVAC equipment and all HVAC ducts (supply and return), furnace cabinet and plenums, located within the conditioned floor space. Location of ducts in conditioned space eliminates conduction losses but does not change losses due to leakage. Leakage from either ducts that are not tested for leakage or from sealed ducts is modeled as leakage to outside the conditioned space.
Distribution system without ducts	Air distribution systems without ducts such as ~~ductless split system air conditioners and heat pumps,~~ window air conditioners, ~~through-the-wall heat pumps,~~ wall furnaces, floor furnaces, radiant electric panels or combined hydronic heating equipment.
Ducts located in outdoor locations	Ducts located in exposed locations outdoors.
Verified low-leakage ducts entirely in conditioned space	Verified Low Leakage Ducts in Conditioned Space - defined as duct systems for which air leakage to outside conditions is equal to or less than 25 CFM when measured in accordance with *Reference Appendices*, Residential Appendix RA3.1.
Ducts located in multiple places	Allows a different location for supply and return ducts.

8.4.1.6 Has Bypass Duct

If the system meets zonal control criteria, indicate if the system has or does not have a bypass duct. When specifying that there is no bypass duct, this credit requires HERS rater verification with *Reference Appendices*, Residential Appendix RA3.1.4.6.

8.4.1.7 Supply Ducts

If Section 8.4.1.3 is unchecked so that credit may be obtained for a verified duct design/reduced surface area (see *Reference Appendices*, Residential Appendix RA3.1), enter the supply duct details for area, diameter and location. The supply duct begins at the exit from the furnace or air handler cabinet.

The supply duct surface area for crawl space and basement applies only to buildings or zones with all supply ducts installed in the crawl space or basement. If the supply duct is installed in locations other than crawl space or basement, the default supply duct location is “Other.” Do not include the surface area of supply ducts completely inside conditioned space, or ducts in floor cavities or vertical chases when surrounded by conditioned space with draft stops.

The surface area of each supply duct system segment is calculated based on its inside dimensions and length. The total supply surface area in each unconditioned location (attic, attic with radiant barrier, crawl space, basement, other) is the sum of the area of all duct segments in that location.

Table 8-6: Summary of Verified Air Distribution Systems

Measure	Description
Duct Sealing	Mandatory measures require that space conditioning ducts be sealed. Field verification and diagnostic testing is required.
Supply Duct Location, Reduced Surface Area and R-value	Compliance credit for improved supply duct location, reduced surface area and R-value. Field verification that duct system was installed according to the duct design, including location, size and length of ducts, duct insulation R-value and installation of buried ducts. For buried ducts, this measure also requires improved construction quality or QII and duct sealing.
Low Leakage Ducts in Conditioned Space	When space conditioning ducts are located entirely in directly conditioned space, this is verified by diagnostic testing. Compliance credit can be taken for verified duct systems with low air leakage to the outside. Field Verification for ducts in conditioned space and duct sealing are required (*Reference Appendices*, Residential Appendix RA3.1.4.3.8).
Low Leakage Air-handling Units	Compliance credit can be taken for installation of a factory sealed air handling unit tested by the manufacturer and certified to the Commission to have met the requirements for a Low Leakage Air-Handling Unit achieved. Field verification of the air handler’s model number is required. Duct sealing is required.
Return Duct Design	Verification to confirm that the return duct design conforms to the criteria given in Table 150.0-C or Table 150.0-D. as an alternative to meeting 0.58 W/CFM fan efficacy of Section 150.0(m)12.
Air Filter Device Design	Verification to confirm that the air filter devices conform to the requirements given in Section 150.0(m)12.
Bypass Duct Condition	Verification to determine if system is zonally controlled, and confirm that bypass ducts condition modeled matches installation.

8.4.1.8 Return Ducts

Return duct surface area is not a compliance variable. If Section 8.4.1.3 is unchecked in order to take credit for a verified duct design, enter the return duct details for area, diameter and location. The calculations assume that the return duct is located entirely in the attic, unless (a) the return duct is located entirely in the basement, in which case the calculation shall assume basement conditions for the return duct efficiency calculation, or (b) the return duct is located entirely in conditioned space and the system meets the requirements for *Verified Low Leakage Ducts in Conditioned Space*, in which case the return duct is assumed to be in conditioned space.

8.4.2 Low Leakage Air Handlers

Credit can be taken for installation of a factory sealed air handling unit tested by the manufacturer and certified to the Energy Commission to meet the requirements for a Low Leakage Air-Handler. Field verification of the air handler's model number is required.

A Low Leakage Air Handler is reported on the compliance report and field verified in accordance with the procedures specified in *Reference Appendices*, Residential Appendix RA3.1.4.3.9.

8.4.3 Verified Low Leakage Ducts in Conditioned Space

For ducted systems the user may specify that all ducts are entirely in conditioned space and the software will model the duct system with no leakage and no conduction losses.

Systems that have all ducts entirely in conditioned space are reported on the compliance documents and this is verified by measurements showing duct leakage to outside conditions is equal to or less than 25 CFM when measured in accordance with *Reference Appendices*, Residential Appendix RA3.

8.4.4 Buried Ducts

Ducts partly or completely buried under blown attic insulation also meeting the requirements for verified quality insulation installation, verified duct design and duct leakage testing may take credit for increased effective duct insulation using the HERS verified credit for buried ducts. Additional details regarding the duct design and the inspection process can be found in *Reference Appendices*, Residential Appendix RA3.1.4 and the *Residential Compliance Manual* Section 4.4.3.

The duct design shall identify the segments of the duct that meet the requirements for ~~being~~ buried ducts on the ceiling ("buried ducts") and ducts that are enclosed in a lowered ceiling and completely covered by ceiling insulation ("deeply buried ducts"), and these are input separately from supply and return ducts that are not buried. ~~Ducts to be b~~Buried ducts shall have a minimum of R-4.2~~6.0~~ duct insulation prior to being buried. The ceiling must be level with at least 6 inches of space between the outer jacket of the installed duct and the roof sheathing above.

8.4.4.1 Buried Ducts

Select the check box for buried ducts (see Figure 8-11) and enter the return duct length (in feet) for the portion of duct runs directly on or within 3.5 inches of the ceiling gypsum board and surrounded with blown attic insulation of R-30 or greater. Determine the appropriate effective R-value ~~may take credit for increased effective duct insulation~~ as shown in Table 8-7 (assume the worst case where multiple conditions exist).

8.4.4.2 Deeply Buried Ducts

Select the check box for deeply buried ducts (see Figure 8-11) and enter the return duct length (in feet) for ducts installed in ~~Duct segments deeply buried in~~ lowered areas of ceiling and covered by at least 3.5 inches of insulation above the top of the duct insulation jacket. ~~may claim effective insulation of~~Model R-25 duct R-value for fiberglass ceiling insulation and R-31 duct R-value for cellulose ceiling insulation.

Figure 8-12: Buried Ducts

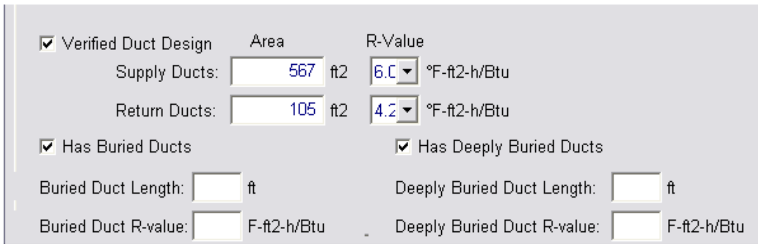


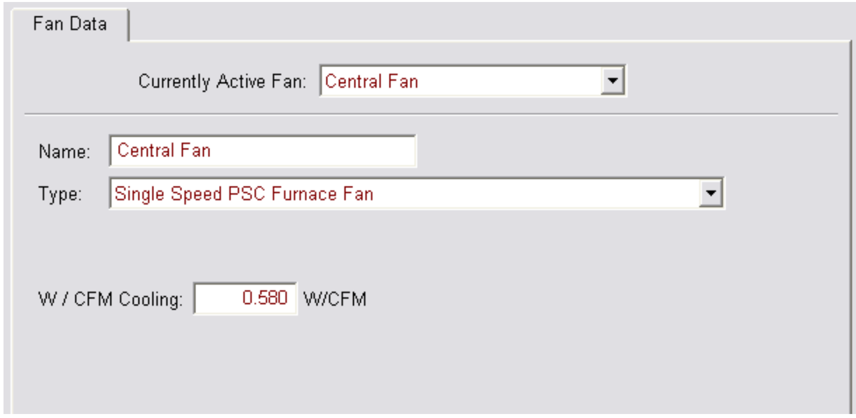
Table 8-7: Buried Duct Effective R-values

	Nominal Round Duct Diameter								
Attic Insulation	4"	5"	6"	7"	8"	10"	12"	14"	16"
	Effective Duct Insulation R-value for Blown Fiberglass Insulation								
R-30	R-13	R-13	R-13	R-9	R-9	R-4.2	R-4.2	R-4.2	R-4.2
R-38	R-25	R-25	R-25	R-13	R-13	R-9	R-9	R-4.2	R-4.2
R-40	R-25	R-25	R-25	R-25	R-13	R-13	R-9	R-9	R-4.2
R-43	R-25	R-25	R-25	R-25	R-25	R-13	R-9	R-9	R-4.2
R-49	R-25	R-25	R-25	R-25	R-25	R-25	R-13	R-13	R-9
R-60	R-25	R-25	R-25	R-25	R-25	R-25	R-25	R-25	R-13
	Effective Duct Insulation R-value for Blown Cellulose Insulation								
R-30	R-9	R-4.2	R-4.2	R-4.2	R-4.2	R-4.2	R-4.2	R-4.2	R-4.2
R-38	R-15	R-15	R-9	R-9	R-4.2	R-4.2	R-4.2	R-4.2	R-4.2
R-40	R-15	R-15	R-15	R-9	R-9	R-4.2	R-4.2	R-4.2	R-4.2
R-43	R-15	R-15	R-15	R-15	R-9	R-4.2	R-4.2	R-4.2	R-4.2
R-49	R-31	R-31	R-15	R-15	R-15	R-9	R-9	R-4.2	R-4.2
R-60	R-31	R-31	R-31	R-31	R-31	R-15	R-15	R-9	R-9

8.5 HVAC Fan System

The HVAC fan system moves air for the air conditioning and heating systems.

Figure 8-13: HVAC Fan



8.5.1.1 Name

User-defined name.

8.5.1.2 Type

Default single speed furnace fan.

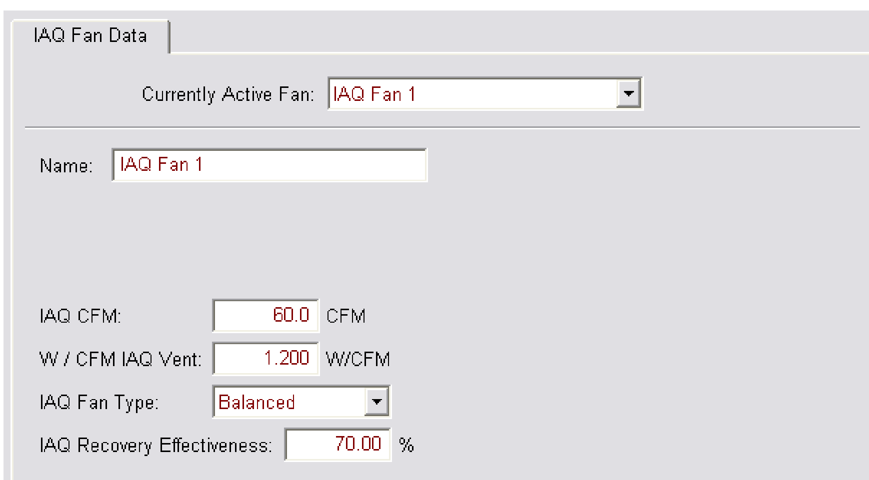
8.5.1.3 Watts/CFM Cooling

The mandatory requirement in Section 150.0(m)13 is for an air-handling unit fan efficacy less than or equal to 0.58 Watts/CFM as verified by a HERS rater. The alternative to HERS verification of 0.58 Watts/CFM is HERS verification of a return duct design that conforms to the specification given in Table 150.0-C or D. However, if a value less than 0.58 Watts/CFM is modeled for compliance credit, the fan efficacy value must be verified and the alternative is not allowed.

If no cooling system is installed, this value is assumed to be 0.58 W/CFM.

8.6 Indoor Air Quality (IAQ) Fan Data

Figure 8-14: IAQ Fan Data



Mechanical ventilation is required to meet minimum indoor air quality (IAQ) requirements of ASHRAE Standard 62.2 (see *Residential Compliance Manual*, Section 4.6). The IAQ system requires HERS verification meeting *Reference Appendices*, Residential Appendix RA3.3.

The simplest IAQ fan system is an exhaust fan, such as a bathroom fan that meets the criteria in ASHRAE Standard 62.2 for air delivery and low noise, and that operates continuously. More advanced IAQ fan systems have a supply or both supply and exhaust fans. In most cases, the energy impact of this mandatory requirement is neutral. The only system for which credit can accrue is a central fan integrated system with HERS verified W/CFM of less than 0.58.

8.6.1.1 Name

User-defined name (must be the same name as specified in Section 4.6).

8.6.1.2 IAQ CFM

Enter the size of fan being installed to meet the minimum CFM required to meet the mandatory ventilation requirements (found under Building in Section 4.4).

8.6.1.3 W/CFM IAQ Vent

The default value is 0.25 W/CFM. The standard design is set to the same value as proposed up to 1.2 W/CFM).

8.6.1.4 IAQ Fan Type

Select exhaust, supply, or balanced (both exhaust and supply).

8.6.1.5 IAQ Recovery Effectiveness

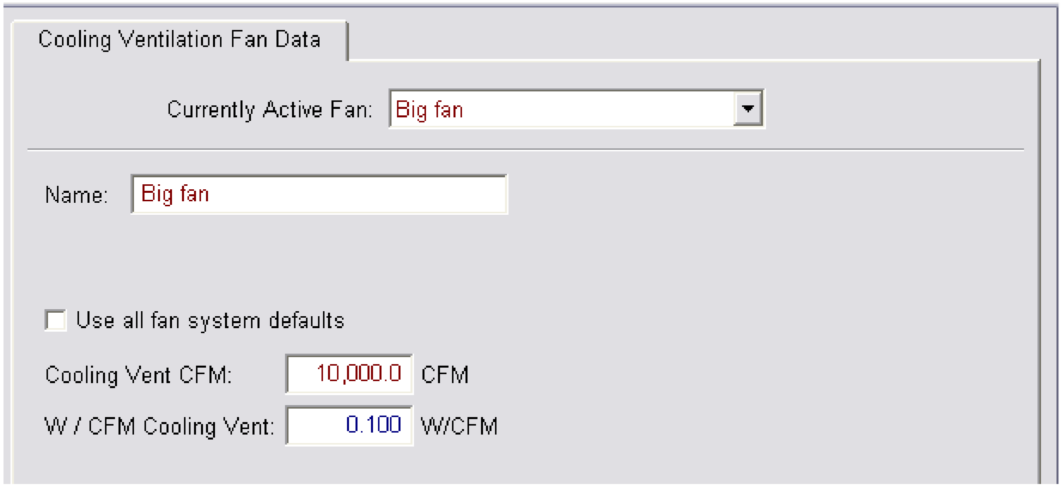
When the fan type is balanced, enter the IAQ Recovery Effectiveness.

8.7 Cooling Ventilation Fans

Ventilation cooling systems bring in outside air to cool the house when this can reduce cooling loads and save cooling energy. Whole house fans involve window operation and attic venting. Central fan integrated systems use the HVAC duct system to distribute ventilation air. Ventilation cooling systems that exhaust air through the attic require a minimum of 1 ft^2 of free attic ventilation area per 1000 CFM of rated capacity for relief (see Section 150.1(c)12 of the standards).

CBECC-Res can model system types shown in Table 4-2. If a “default prescriptive whole house fan” was specified in Section 4.7, there is no need to provide details about the fan. For central fan integrated (CFI) night ventilation, first make sure that the Cool Vent tab at the project level is set to CFI (see Section 4.7.1.1). For a fixed speed fan, set the HVAC system type to “Other Heating and Cooling System” or for a variable speed fan, set the HVAC system type to “Variable Outdoor Air Ventilation Central Heat/Cool System (see Section 8.1.1.2). Fixed Flow for the Cooling Vent drop-down menu. It is also necessary that the Cool Vent tab at the project level be set to CFI (see Section 4.7.1.1).

Figure 8-15: Cooling Ventilation



8.7.1.1 Name

User defined name, which must also be specified in Section 4.7.

8.7.1.2 Use all fan system defaults

Sets the default minimum to 2 CFM/ft^2.

8.7.1.3 Cooling Vent CFM

If system default is not checked, enter the actual CFM of the proposed ventilation fan.

8.7.1.4 W/CFM Cooling Vent

Enter the Watts/CFM of the proposed system.

Chapter 9. Domestic Hot Water (DHW)

The water heating system is defined at the zone level (see Section 5.4.1.11), while the details of the systems are contained under the mechanical tab. The information in this chapter is from the point of view of the mechanical tab.

9.1 Efficiency Information

Water heaters are required to be certified to the Energy Commission and the applicable efficiency values needed for modeling are found in the on-line certified appliance directory (http://www.appliances.energy.ca.gov/). From this site, an ***advanced search*** yields the most useful information, which can be exported to a spreadsheet format for sorting and searching.

Alternatively, data may be found in the Air-Conditioning, Heating and Refrigeration Institute (http://www.ahridirectory.org/ahridirectory). The AHRI directory does not contain the standby loss for large water heaters, which is a required input.

The federal minimum efficiency used to establish the standard design changes in 2015. When natural gas is used, the efficiency for small gas storage changes from an energy factor of 0.575 in 2014 to 0.60 in 2015. If the standard design is based on electric, the minimum energy factor for small electric storage changes from 0.904 in 2014 to 0.945 in 2015.

9.2 Water Heater Types

Tank types are based on the Appliance Efficiency Regulations definitions:

- Small storage has an input of less than or equal to 75,000 Btu gas/propane, less than or equal to 105,000 Btu/hr oil, less than or equal to 12 kW electric, or less than or equal to 24 amps heat pump.
- Small tankless has an input of less than or equal to 200,000 Btu per gas/propane, 210,000 Btu per hour or less oil-fired, or 12 kW or less electric. A tankless water heater is a water heater with an input rating of at least 4,000 Btu per hour per gallon of stored water.
- Large storage has an input greater than 75,000 Btu/hr gas or propane, greater than 105,000 Btu/hr oil-fired, or greater than 12 kW electric. Rated with thermal efficiency and standby loss.

- Large tankless has an input of greater than 200,000 Btu per hour gas/propane, greater than 210,000 Btu per hour oil-fired, or greater than 12 kW electric. Tankless water heater is a water heater with an input rating of at least 4,000 Btu per hour per gallon of stored water.
- Boiler is a space heater supplying steam or hot water for space heating.
- Indirect is a water heater consisting of a storage tank with no heating elements or combustion devices, connected via piping and recirculating pump to a heat source consisting of a boiler.

9.3 Distribution Types

9.3.1 Single Family Distribution Type

Distribution types (Figure 9-1) range from standard (distribution system multiplier 1.0) to recirculating with no control (distribution system multiplier 7.0) as options with no HERS verification requirement. Some systems are allow for a higher credit if the system will be verified by a HERS rater. See Table 9-1 for a comparison of the multiplier (lower number equals more efficient system). More information about distribution types can be found in *Residential Compliance Manual*, Section 5.3 and *Reference Appendices*, Residential Appendix RA3.6.

Figure 9-1: Single Family Distribution Systems

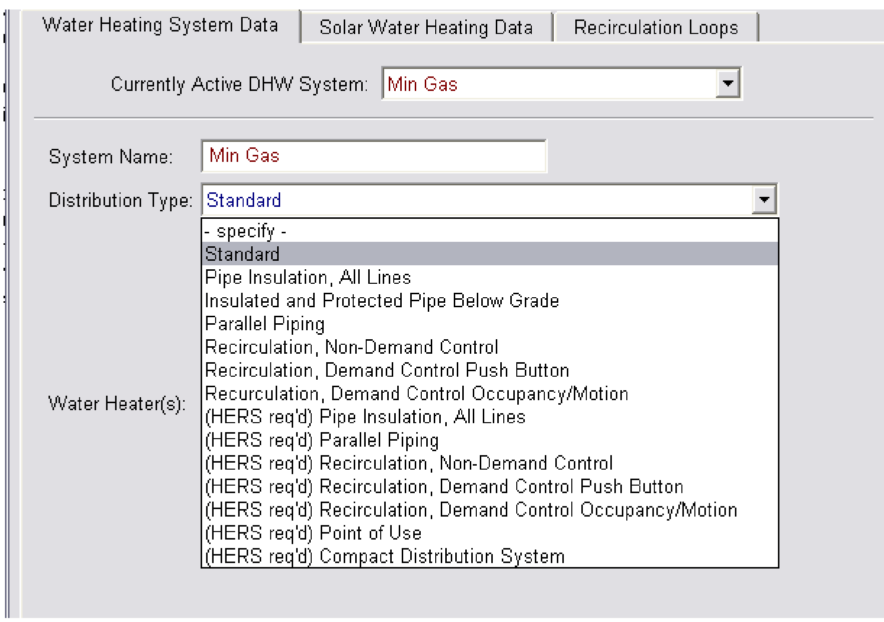


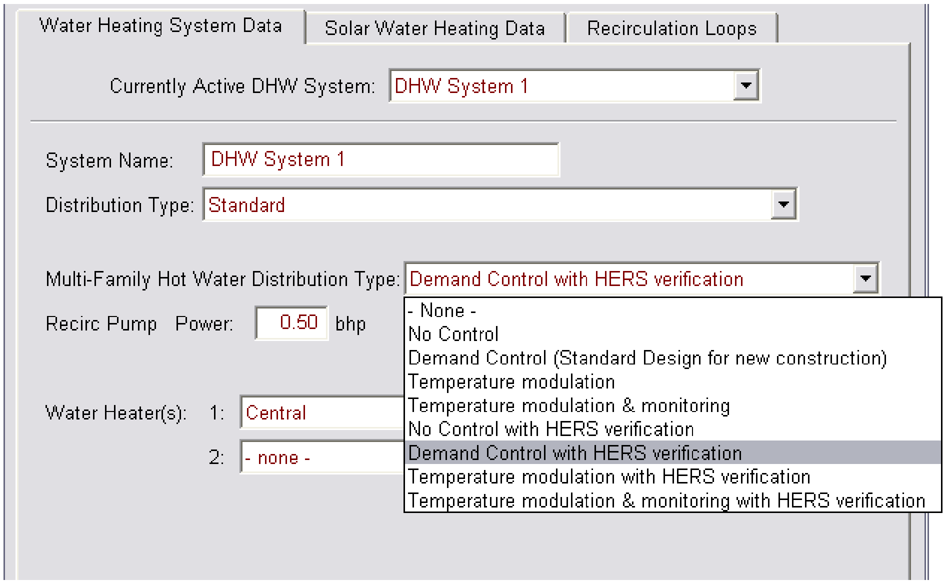
Table 9-1: Water Heater Distribution System Multipliers

Distribution System	Distribution System Multiplier
NO HERS INSPECTION REQUIRED	
Standard	1.00
Pipe Insulation, All Lines	0.90
Insulated and Protected Pipe Below Grade	1.40
Parallel Piping	1.05
Recirculation, Non-demand Control (no control, runs 24 hrs/day)	7.00
Recirculation, Manual Demand Control Push Button	1.15
Recirculation, Demand Control Occupancy/Motion	1.30
OPTIONAL CASES: HERS INSPECTION REQUIRED	
Pipe Insulation, All Lines	0.80
Parallel Piping	0.95
Compact Design	0.70
Point of Use	0.30
Recirculation, Demand Control Push Button	1.05
Recirculation, Demand Control Occupancy/Motion	1.20
Point of Use	0.30
Compact Distribution System	0.70
Non-Compliant Installation Distribution Multiplier	1.20

9.3.2 Multi-Family Distribution Type

When using central water heating in a multi-family building, the options for distribution systems are shown in Figure 9-2. More information about distribution types can be found in *Residential Compliance Manual*, Section 5.3 and *Reference Appendices*, Residential Appendix RA3.6.

Figure 9-2: Multi-Family Distribution Systems



9.4 Water Heating System Data

Under the Mechanical Tab, the water heating system details are defined (see Figure 9-2).

9.4.1.1 System Name

User defined name. This is the same name that was provided under the Zone Data tab (see Section 5.4.1.11).

9.4.1.2 Distribution type

Drop-down menu with options based on the building and water heater type being specified. See Section 9.3 and Table 9-1. For installation and compliance requirements see *Residential Compliance Manual* Chapter 5 and *Reference Appendices*, Residential Appendix RA3.6 and 4.4.

9.4.1.3 Multi-Family Hot Water Distribution Type

Drop-down menu with options for the level of control on the recirculating system serving the dwelling unit, based on the building and water heater type being specified. See Section 9.3.2 and Figure 9-2. An input for the recirculation loops is also required (see Figure 9-3).

9.4.1.4 Recirculation Pump Power (bhp)

Multi-family recirculation pump power (brakehorse power). Typical value less than 1.00.

9.4.1.5 Efficiency (fraction)

Multi-family recirculation motor efficiency (fraction). Typical value less than 1.00. See **Table 9-2** for default efficiencies.

Table 9-2: Default Recirculating Pump Motor Efficiency

Nameplate or Brake Horsepower	Standard Fan Motor Efficiency
0.050 (1/20)	0.40
0.083 (1/12)	0.49
0.125 (1/8)	0.55
0.167 (1/6)	0.60
0.250 (1/4)	0.64
0.333 (1/3)	0.66
0.500 (1/2)	0.70
0.750 (3/4)	0.72
Source: Reference Appendices, Nonresidential Appendix NA3	

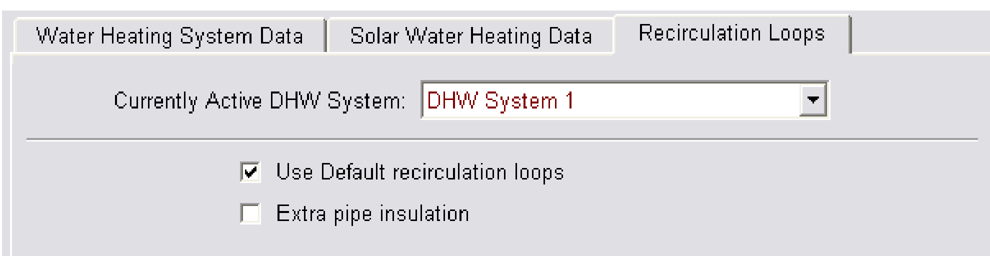
9.4.1.6 Water Heater(s)

The name of the water heater (which holds more information about the water heater, see Section 5.4.1.11).

9.4.1.7 Count

The number of water heaters named in the adjacent field that are in the system. Include different water heaters or different water heater efficiencies on a different line.

Figure 9-3: Recirculation Loops



9.5 Solar Water Heating Data

When a water heating system has a solar system to provide part of the water heating, the Solar Fraction (SF) is determined using an F-chart program, OG-100 or OG-300 calculation method (see www.gosolarcalifornia.org). The calculation methods require varying levels of detail about the solar system and the site of the installation. Calculations use published efficiency data for the solar water heating system.

Figure 9-4: Solar Water Heating Data, Annual

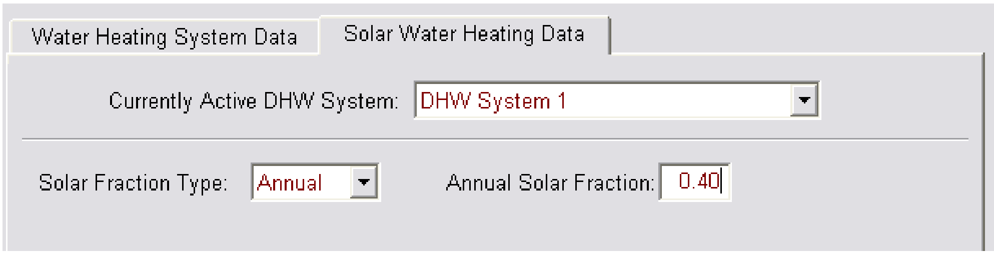
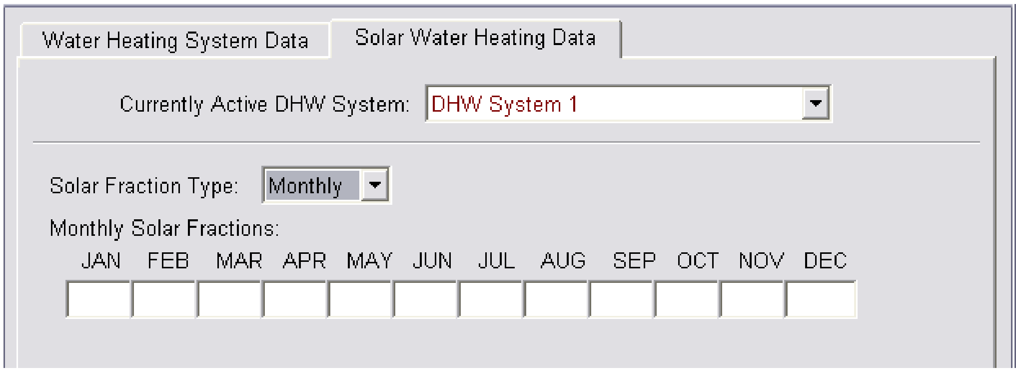


Figure 9-5: Solar Water Heating Data, Monthly



9.5.1.1 Solar Fraction Type

Select annual or monthly, based on the appropriate calculation method for the system type. See www.gosolarcalifornia.org.

9.5.1.2 Solar Fraction

Enter one annual solar fraction (see Figure 9-4) or 12 monthly solar fractions (see Figure 9-5), as calculated for the system type.

9.6 Water Heater Data

The specifications of the water heater accessed in Figure 9-3 are contained in the water heater data as shown in Figure 9-6. The fields will vary based on the tank type.

Figure 9-6: Water Heater Data Small Storage

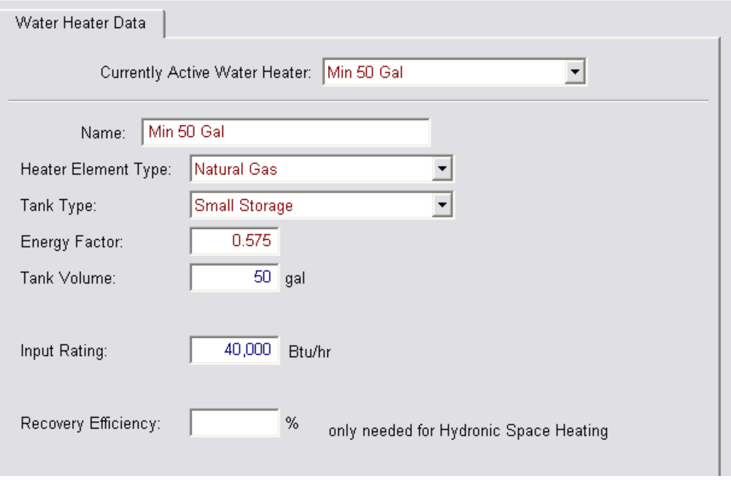
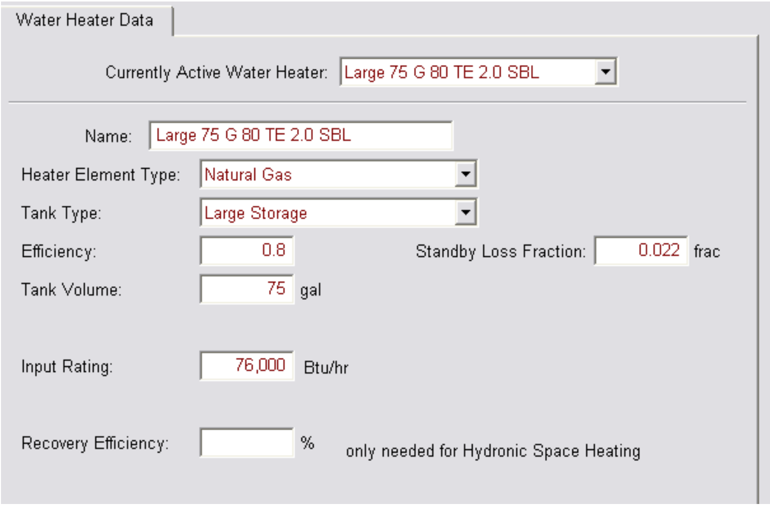


Figure 9-7: Large Storage Water Heater Data



9.6.1.1 Name

User-defined name that is specified in the water heating system data for the field water heater (see Section 9.4.1.6).

9.6.1.2 Heater Element Type

Choose electric resistance, natural gas, propane, heat pump, or oil.

9.6.1.3 Tank Type

Choose boiler, indirect, large instantaneous, large storage, small instantaneous, small storage, or unfired tank. Most instantaneous water heaters are small, based on the rated input (see Section 9.2 Water Heater Types).

9.6.1.4 Efficiency

Certified efficiency from one of the sources listed in Section 9.1. Based on the tank type, the efficiency is energy factor for small storage, small instantaneous, and small heat pump water heaters. For large storage, large instantaneous, large heat pump, or boilers the efficiency is thermal efficiency, recovery efficiency, or AFUE. Indirect water heater efficiency is based on the type of device being used to heat the water. Value entered as a decimal, such as 0.60 or 0.80.

9.6.1.5 Standby Loss ~~Fraction~~

Required input for large storage water heaters and mini tanks. For large storage, a standby loss of 3% is entered as 0.03. For mini tanks, enter the standby loss Watts. Find the standby loss by conducting an advanced search in the Energy Commission's appliance efficiency database of water heating equipment (see Section 9.1).

Some large storage water heaters are not required to report standby loss. This value can be calculated using equations from the 2012 Appliance Efficiency Regulations, Tables F2 and F3, as follows:

Standby loss Btu/hr = (rated input / 800) + (110 x (volume x 0.5)

Convert to Standby Loss Percent as:

Standby loss Btu/hr / (8.25 x Volume x 70)

9.6.1.6 Tank Volume

Enter the tank volume (in gallons). The rated input rather than the tank volume is used to determine if a tank type is large or small (see Section 9.2)

9.6.1.7 Exterior R-value

For indirect and unfired tanks.

9.6.1.8 Input Rating

The input rating (consistent with the tank type) from one of the listed sources in Section 9.1.

9.6.1.9 Ambient Conditions

For an indirect water heater, specify whether it is installed in unconditioned or conditioned space.

9.6.1.10 Recovery Efficiency

If the equipment is part of a hydronic system, enter the recovery efficiency, thermal efficiency or AFUE for appropriate water heating type. The value comes from one of the listed sources in Section 9.1 and is entered as a percent (e.g., 78, 80).

Chapter 10. Additions and Alterations

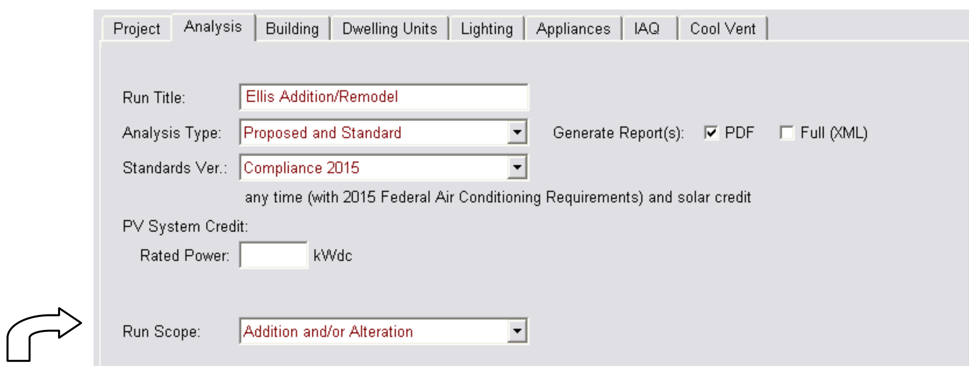
CBECC-Res can model addition alone, alteration alone, or existing plus addition/alteration. For alteration alone, the performance compliance approach can only be used if two or more components are altered. These components include the building's envelope insulation, fenestration, space conditioning (HVAC) equipment, duct system, water heating system, or roofing products.

Select the run scope on the Analysis tab (see Figure 10-1).

10.1 Addition Alone

To model an addition alone, (1) set the run scope to newly constructed, (2) check the box for Addition Alone, and (3) set the fraction of the dwelling unit that the addition represents (for example, a 500 ft^2 additon to a 1500 ft^2 house = 500/(1500+500) = 0.25.

Figure 10-1: Run Scope



10.2 Setting the Standard Design

The standard design against which alterations are compared will depend on whether (1) the existing conditions were verified by a HERS rater ***prior*** to creating the building model, and (2) the proposed alteration meets or exceeds a minimum efficiency threshold (which may be mandatory or prescriptive).

10.2.1 Third Party Verification

The standard design (energy budget) is not based on the vintage of the building, Instead, existing conditions are either set to actual conditions verified by a HERS Rater or default conditions for alterations meeting prescriptive requirements (see *Building Energy Efficiency Standards*, Section 150.2, Table 150.2-B).

For example, if windows that are single-pane, metal frame, with clear glass are replaced with dual-pane, wood frame, Low-E windows, the standard design without verification is based on the existing windows having a 0.40 U-factor and 0.35 SHGC (or 0.66 in zones with no SHGC requirement). If verified by a HERS rater, the standard design is set using the actual efficiency of the existing windows, which is 1.28 U-factor and 0.80 SHGC.

10.2.2 Efficiency Threshold

Another factor in determining the amount of credit that is achieved by an alteration is the proposed efficiency of the alteration. If an altered component does not meet the mandatory or prescriptive requirement set out in Section 150.2, the standard design will be based on the higher level. For example, if a ceiling has a verified insulation level of R-11, but the proposed alteration is to achieve R-19, the standard design is based on the standards' requirement of R-30, and the proposed ceiling insulation alteration will receive an energy penalty.

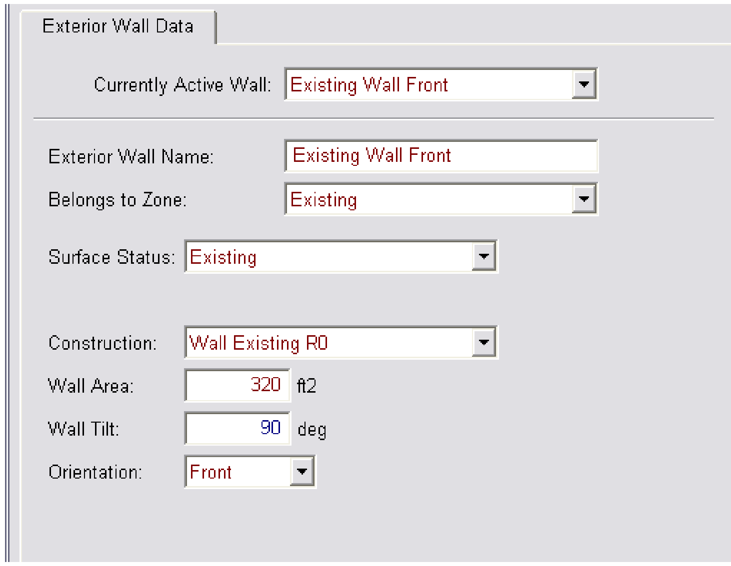
If more information is needed, the Reference Manual (Residential Alternative Calculation Method Reference Manual, P400-2013-003-SD), Section 2.11, contains detailed explanations of how each feature of the addition/alteration affects the standard design.

10.3 Existing Building

If the existing building will be modeled as part of an existing plus addition/alteration analysis, the user has the option of specifying the status of a component as existing, altered, or new. ***Deleted or removed surfaces are not modeled.*** Specify the characteristics of all existing, altered or new components (for example, a new window in an existing wall) associated with the existing part of the building. For altered components see Section 10.3.

If an existing garage is being converted to conditioned space, do not model the unconditioned garage.

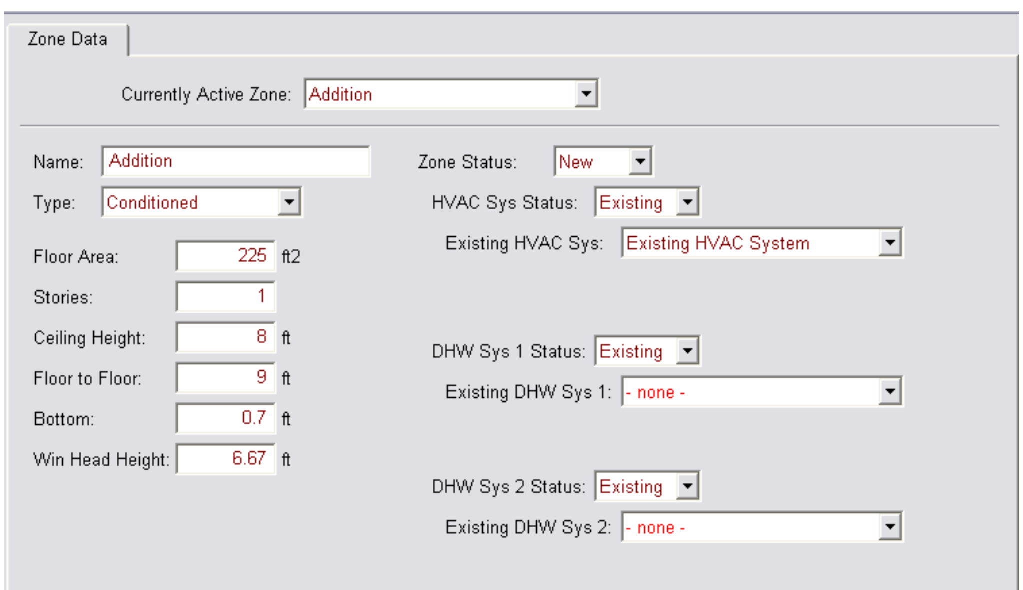
Figure 10-2: Existing Surface



10.4 Addition

The addition is modeled as a separate zone, identified by the Zone Status as new. Set the surface status to “new” for all envelope components in the addition including existing components in a previously unconditioned space.~~, including~~ The exception is an existing HVAC system ~~is~~ being extended for the addition (see Section 10.4.2 for an explanation of how to model various scenarios). It is not necessary to define a DHW system in either the existing or new zone, unless one is being altered or added.

Figure 10-3: Addition HVAC and DHW



10.5 Addition/Alteration

Model any components that will be altered with the surface status "altered" and the new characteristics. You will only specify the existing characteristics if the existing conditions were verified by a HERS rater (see Figure 10-4 and Figure 10-5). The "verified" check box opens additional fields to define the existing conditions and affect the standard design (see Section 10.1). If one component is verified, all components must be verified.

Since only one surface status can be used, separately model components that are being altered from those that will not be altered.

NOTE: Deleted or removed surfaces are not modeled.

Figure 10-4: Altered with Verified Existing Conditions

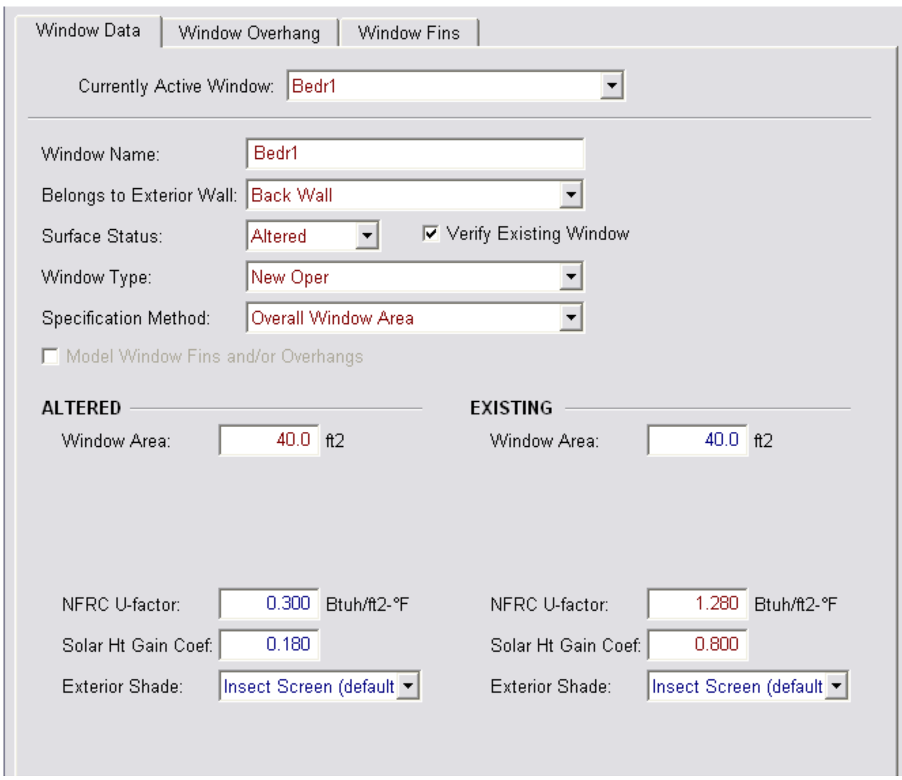
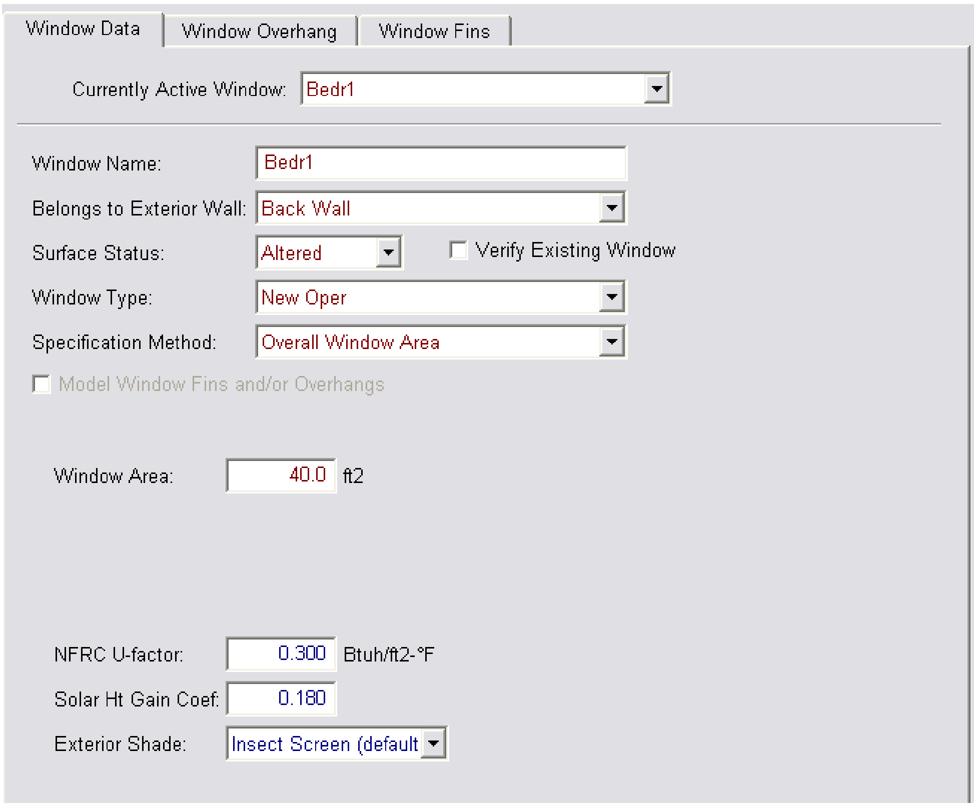


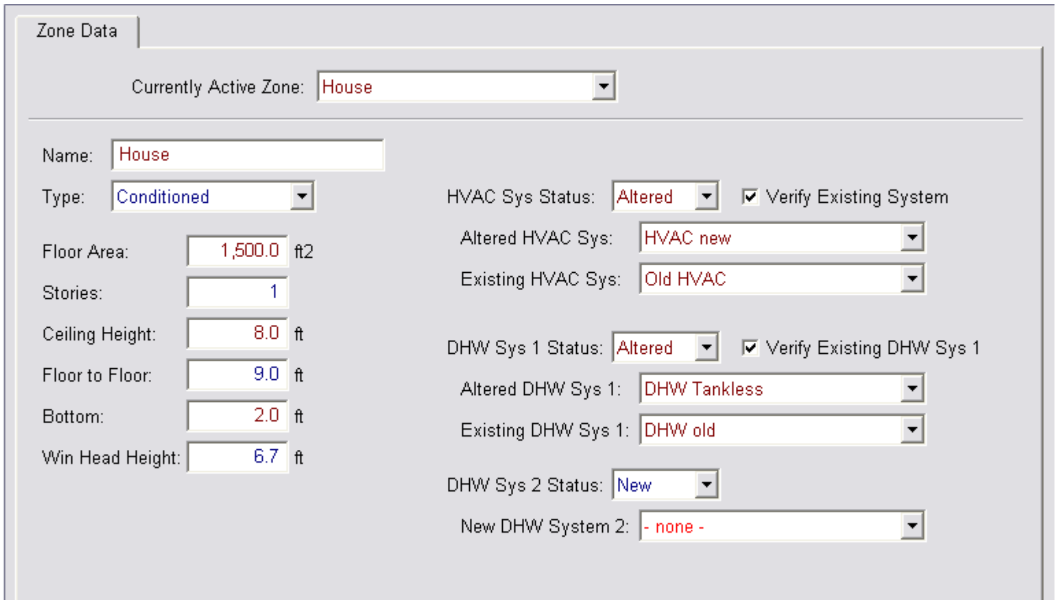
Figure 10-5: Altered Without Verified Existing Conditions



10.5.1 Radiant Barrier

Current software limitations do not allow modeling multiple radiant barrier conditions, such as a radiant barrier in an addition but not in the existing attic. radiant barrier that is only in an addition as part of an existing plus addition analysis. What can be modeled is a radiant barrier in an addition alone, or if an entire attic is being altered to include radiant barrier.

Figure 10-6: Altered HVAC and DHW



10.5.2 HVAC

First determine if an existing system will be extended to serve an addition, if a replacement system (including ducts) will be installed for the whole house, or if a supplemental system will be added for the addition only. Existing equipment does not need to meet current standards (Exception 4 to Section 150.2(a)).

Existing equipment to serve addition. For the existing and new zones, set the system status to "existing" and model the actual values for the existing system ~~and ducts~~ (the standard and proposed design will both have the same equipment) (Figure 10-7). ~~For the addition zone, define a separate system with the system status also "existing," but with prescriptive default system values (use an EER value of less than 11.3, such as 11.25, so that a HERS verified EER is not triggered).~~ The distribution system data will have both existing and new parts of the system defined (Figure 10-8). ~~Set the duct status to "new" and specify the actual proposed conditions.~~

Replacement system for whole house. For the existing and new zones, set the system status to "altered" and model the proposed system conditions for equipment ~~and ducts~~ (if verified, specify the existing conditions as verified by the HERS Rater). Model the appropriate conditions for the ducts, which may be new (if existing ducts are being replaced) or existing + new. ~~For the addition zone, define a separate system with the system status "new" with same proposed conditions for equipment and ducts.~~

Figure 10-7: Existing System ~~Existing Zone~~

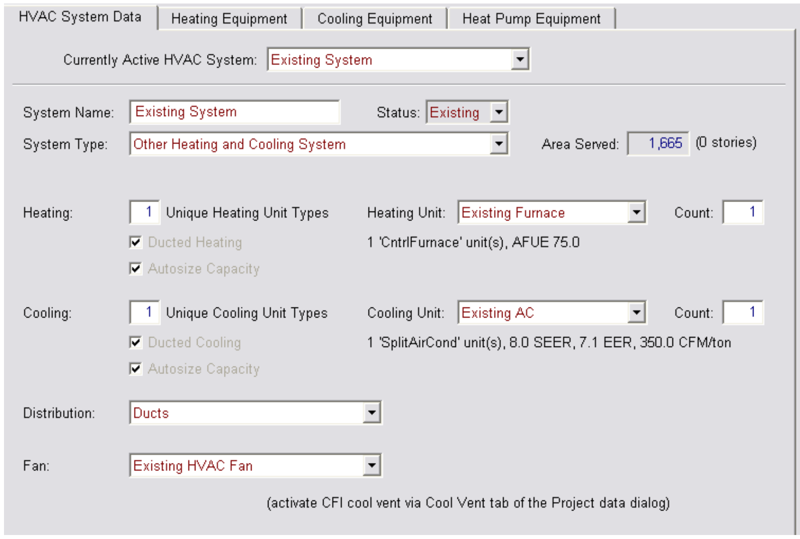
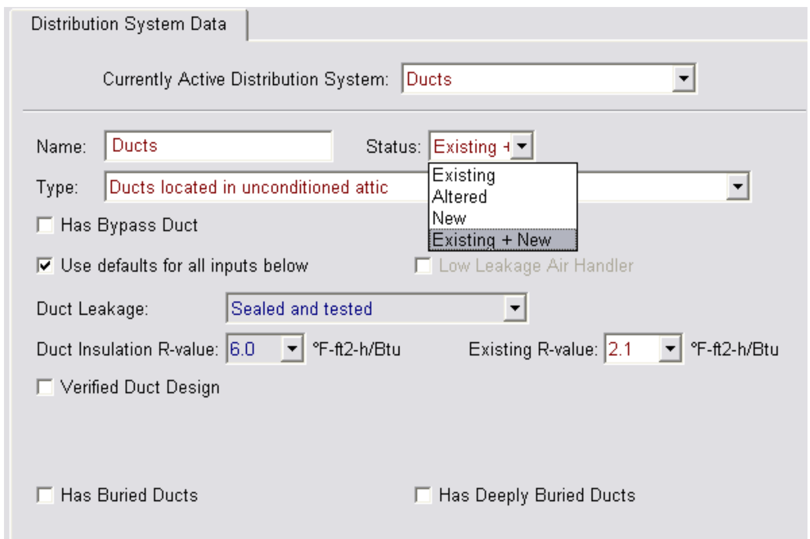


Figure 10-8: ~~Existing System Addition Zone~~Duct System



Adding a separate system for the addition. For the existing zone, set the system status to "existing" and model the actual values for the existing system and ducts. For the addition zone, define a separate system with the system status "new" with the proposed conditions of the new supplemental system and duct conditions.

10.5.3 Water heating

If altering a water heater, define the altered specifications. If existing conditions were verified, check the box and include the specifications of the existing equipment. If the distribution system is being altered, and the existing conditions are verified, set the dwelling unit distribution type to "non-compliant installation distribution multiplier" or other appropriate value (see Section 9.3).

If adding a water heater, define both the existing water heater in the existing zone, and the added water heater in the addition zone.

10.5.4 Mechanical Ventilation

Alterations and additions of 1,000 square feet or less are not required to meet the mechanical ventilation requirements of Section 150.0(o).

10.5.5 Ventilation Cooling/Whole House Fan

Alterations and additions of 1,000 square feet or less are not required to meet the requirements of 150.1(c)12, which is part of the standard design in climate zones 8-14. If the new conditioned floor area does not exceed 1,000 square feet, there will be no energy penalty for not installing a whole house fan or other ventilation cooling device.

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Appendix A – *Resolution approving CBECC-Res*

STATE OF CALIFORNIA

Energy Resources Conservation
And Development Commission

2013 Building Energy Efficiency Standards, California Code of Regulations, Title 24, Parts 1 and 6	**Docket No. 12-BSTD-01** **Resolution No. 14-0422-8**

RESOLUTION OF THE ENERGY COMMISSION APPROVING REVISIONS TO THE 2013 PUBLIC DOMAIN RESIDENTIAL COMPLIANCE SOFTWARE

WHEREAS, the Warren-Alquist State Energy Resources Conservation and Development Act, Public Resources Code sections 25000 et seq., 25402.1, subd. (b), requires the Energy Commission to, among other things, establish a process for certifying calculation methods for demonstrating compliance with its building energy efficiency standards; and

WHEREAS, on September 11, 2013, the Energy Commission approved the 2013 Public Domain California Building Energy Code Compliance – Residential (CBECC-Res) software, version 1.0, for estimating energy consumed by residential buildings under Public Resources Code section 25402.1, subdivision (a), and for demonstrating compliance with the performance- based residential provisions of the 2013 Building Energy Efficiency Standards, California Code of Regulations, Title 24, Parts 1 and 6; and

WHEREAS, the Energy Commission subsequently approved revisions to CBECC-Res, and revoked approval of previous versions, under California Code of Regulations, Title 24, Part 1, Chapter 10, sections 10-109 and 10-110; and

WHEREAS, CBECC-Res has been further revised as reflected in Version 2 to incorporate additional programming for additional envelope assemblies and heating, ventilating, and air-conditioning systems; and

WHEREAS, as described in the CBECC-Res 2 Summary of Residential ACM Tests presented to the Energy Commission along with this Resolution, staff of the Energy Commission has reviewed and tested CBECC-Res, Version 2, to ensure it meets the requirements, specifications, and criteria for building energy models set forth in the Residential Alternative Calculation Method Approval Manual, CEC-400-2012-007-CMF-REV (April 2014);

THEREFORE, the Energy Commission approves CBECC-Res, Version 2, for estimating energy consumed by residential buildings under Public Resources Code section 25402.1, subdivision (a), and for demonstrating compliance with the performance- based residential provisions of the 2013 Building Energy Efficiency Standards, California Code of Regulations, Title 24, Parts 1 and 6; and

THEREFORE, the Energy Commission rescinds its approval of previous versions of CBECC-Res for estimating energy consumed by residential buildings under Public Resources Code section 25402.1, subdivision (a), and demonstrating performance compliance with the performance- based residential provisions of the 2013 Standards for permit applications made on or after July 1, 2014;[1] and

THEREFORE, the Energy Commission directs the Executive Director to take, on behalf of the Energy Commission, all actions reasonably necessary to implement this resolution, including but not limited to:

(a) posting information on obtaining CBECC-Res, version 2, on the Energy Commission's publicly-accessible internet web site;
(b) ensuring CBECC-Res is maintained and revised as necessary to accurately estimate the energy use of residential buildings and demonstrate compliance with the 2013 Building Energy Efficiency Standards for buildings, including by
    (i) correcting functional and analytical errors, and
    (ii) incorporating software modules that address additional compliance options approved by the Energy Commission, and additional building systems, assemblies, and construction materials.

Date: April 22, 2014

CERTIFICATION

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly approved at a meeting of the California Energy Commission held on April 22, 2014.

AYE: Weisenmiller, Douglas, Hochschild, Scott
NAY: None
ABSENT: McAllister
ABSTAIN: None

Harriet Kallemeyn
Harriet Kallemeyn,
Secretariat

[1] This action was considered as item 11 on the agenda of the Business Meeting on April 22, 2014.

Appendix B – CF1R

CERTIFICATE OF COMPLIANCE - RESIDENTIAL PERFORMANCE COMPLIANCE METHOD

Project Name: 1 Story Example
Calculation Description: 1 Story Example Rev 12
Calculation Date/Time: 11:47, Wed, May 07, 2014
Input File Name: Exampl12.ribd

GENERAL INFORMATION					
01	Project Name	1 Story Example			
02	Calculation Description	2100 ft2 CEC Prototype with tile roof			
03	Project Location	1516 Ninth St			
04	A City	Sacramento, CA	05	Standards Version	Compliance 2015
06	Zip code	95814	07	Compliance Manager Version	BEMCmpMgr 2013-2 (590)
08	Climate Zone	CZ12	09	Software Version	CBECC-Res 2013-2 (592)
10	Building Type	Single Family	11	Front Orientation (deg/Cardinal)	90
12	Project Scope	Newly Constructed	13	Number of Dwelling Units	1
14	Total Cond. Floor Area (FT^2)	2100	15	Number of Zones	1
16	Slab Area (FT^2)	2100	17	Number of Stories	1
18	Addition Cond. Floor Area	NA	19	Natural Gas Available	Yes
20	Addition Slab Area (FT^2)	NA	21	Glazing Percentage (%)	20.0%

COMPLIANCE RESULTS	
01	Building Complies with Computer Performance
02	This building incorporates features that require field testing and/or verification by a certified HERS rater under the supervision of a CEC-approved HERS provider.
03	This building incorporates one or more Special Features shown below

Detailed help on using the CF-1R Certificate of Compliance is available via the Internet by either scanning the QR code or browsing to http://www.title24energycode.org/t24help/cf1r.aspx

ENERGY USE SUMMARY				
04	05	06	07	08
Energy Use (kTDV/ft)	Standard Design	Proposed Design	Compliance Margin	Percent Improvement
Space Heating	22.70	24.34	-1.64	-7.2%
Space Cooling	14.11	11.78	2.33	16.5%
IAQ Ventilation	1.13	1.13	0.00	0.0%
Water Heating	13.86	13.86	0.00	0.0%
Photovoltaic Offset	----	0.00	0.00	----
TOTAL	**51.80**	**51.11**	**0.69**	**1.3%**

REQUIRED SPECIAL FEATURES
The following are features that must be installed as condition for meeting the modeled energy performance for this computer analysis.
• **Window overhangs and/or fins**

HERS FEATURE SUMMARY
The following are features that must be installed as condition for meeting the modeled energy performance for this computer analysis.
• **Window overhangs and/or fins**

BUILDING - FEATURES INFORMATION

01	02	03	04	05	06	07
Project Name	**Conditioned Floor Area (sft)**	**Number of Dwelling Units**	**Number of Bedrooms**	**Number of Zones**	**Number of Ventilation Cooling Systems**	**Number of Water Heating Systems**
1 Story Example	2100	1	3	1	1	1

ZONE INFORMATION

01	02	03	04	05	06	07
Zone Name	**Zone Type**	**HVAC System Name**	**Zone Floor Area (ft^2)**	**Avg. Ceiling Height**	**Water Heating System 1**	**Water Heating System 2**
Conditioned	Conditioned	HVAC System 1	2100	9	Gas 60 EF	

OPAQUE SURFACES							
01	02	03	04	05	06	07	08
Name	**Zone**	**Construction**	**Azimuth**	**Orientation**	**Gross Area (ft^2)**	**Window Area (ft^2)**	**Tilt(deg)**
Front	Conditioned	R15 R4 Stucco Wall	90	Front	270	100	90
Left	Conditioned	R15 R4 Stucco Wall	180	Left	324	56.04	90
Back	Conditioned	R15 R4 Stucco Wall	270	Back	450	207.32	90
Right	Conditioned	R15 R4 Stucco Wall	0	Right	414	56.04	90
Ceiling (below attic) 1	Conditioned	R38 Ceiling below attic			2100		
GarToHouse Front	Conditioned>>Garage	Gar House R15			180		
GarToHouse Left	Conditioned>>Garage	Gar House R15			90		
Gwall Front	Garage	Garage Ext Wall	90	Front	180	0	90
Gwall Left	Garage	Garage Ext Wall	180	Left	198	0	90
Gwall Right	Garage	Garage Ext Wall	0	Right	108	0	90
Gceil	Garage	R0 ClgBlwAttic Cons			440		

ATTIC						
01	02	03	04	05	06	07
Name	**Construction**	**Roof Rise**	**Roof Reflectance**	**Roof Emittance**	**Radiant Barrier**	**Cool Roof**
Attic	Tile RB Roof	5	0.2	0.85	Yes	No

WINDOWS									
01	02	03	04	05	06	07	08	09	10
Name	**Type**	**Surface (Orientation-Azimuth)**	**Height (ft)**	**Width(ft)**	**Multiplie r**	**Area (ft^2)**	**U-factor**	**SHG C**	**Exterior Shading**
F1	Window	Front (Front-90)	5.0	10.0	1	50.0	0.32	0.25	
F2	Window	Front (Front-90)	5.0	10.0	1	50.0	0.32	0.25	
L1	Window	Left (Left-180)	4.7	6.0	2	56.0	0.32	0.25	
B1 SGD	Window	Back (Back-270)	7.7	8.0	1	61.4	0.32	0.25	
B2	Window	Back (Back-270)	4.7	6.0	3	84.6	0.32	0.25	
B3 SGD	Window	Back (Back-270)	7.7	8.0	1	61.4	0.32	0.25	
R1	Window	Right (Right-0)	4.7	6.0	2	56.0	0.32	0.25	

DOORS			
01	**02**	**03**	**04**
Name	**Side of Building**	**Area (ft^2)**	**U-factor**
Front Dr	Front	20.0	0.50
GarToHouse Dr	GarToHouse Front	20.0	0.50
GDoor	Gwall Front	108.0	1.00

OVERHANGS AND FINS													
01	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**
	Overhang	**Left Fin**				**Right Fin**							
Window	**Depth**	**Dist Up**	**Left Extent**	**Right Extent**	**Flap Ht.**	**Depth**	**Top Up**	**DistL**	**Bot Up**	**Depth**	**Top Up**	**Dist R**	**Bot Up**
F1	1	1.33	3	28	0.4	12	1.33	1	0	0	0	0	0
F2	1	1.33	28	3	0.4	0	0	0	0	0	0	0	0
L1	1	1.33	6	8	0.4	0	0	0	0	0	0	0	0
B1 SGD	6	1.33	4	40	0.4	0	0	0	0	0	0	0	0
B2	6	1.33	23	23	0.4	0	0	0	0	0	0	0	0
B3 SGD	6	1.33	40	4	0.4	0	0	0	0	0	0	0	0
R1	1	1.33	8	8	0.4	0	0	0	0	0	0	0	0

OPAQUE SURFACE CONSTRUCTIONS					
01	02	03	04	05	06
Construction Name	**Surface Type**	**Construction Type**	**Framing**	**Total Cavity R-value**	**Assembly Layers**
R0 ClgBlwAttic Cons	Ceilings (below attic)	Wood Framed Ceiling	2x4 Bottom Chord of Truss @ 24 in. O.C.		• *Attic Floor: - no attic floor -* • *Cavity: - no insulation -* • *SheathingInsulation - no sheathing/insul. -* • *Inside Finish: Gypsum Board*
Gar House R15	Interior Walls	Wood Framed Wall	2x4 @ 16 in. O.C.	R 15	• *Inside Finish: Gypsum Board* • *Sheathing/Insulation: - no sheathing/insul. -* • *Cavity: R 15* • *Sheathing/Insulation: - no sheathing/insul. -* • *Other Side FInish: Gypsum Board*
Tile RB Roof	Attic Roofs	Wood Framed Ceiling	2x4 @ 24 in. O.C.		• *Roofing: 10 PSF (RoofTile)* • *Above Deck Insulation - no insulation -* • *Roof Deck: Wood Siding/sheathing/decking* • *Cavity: - no insulation -* • *Inside Finish: - select inside finish -*
R38 Ceiling below attic	Ceilings (below attic)	Wood Framed Ceiling	2x4 Bottom Chord of Truss @ 24 in. O.C.	R 38	• *Attic Floor: - no attic floor -* • *Cavity: R 38* • *SheathingInsulation - no sheathing/insul. -* • *Inside Finish: Gypsum Board*
R15 R4 Stucco Wall	Exterior Walls	Wood Framed Wall	2x4 @ 16 in. O.C.	R 15	• *Inside Finish: Gypsum Board* • *Sheathing/Insulation: - no sheathing/insul. -* • *Cavity: R 15* • *Sheathing/Insulation: - no sheathing/insul. -* • *Exterior Finish: R4 Synthetic Stucco*
Garage Ext Wall	Exterior Walls	Wood Framed Wall	2x4 @ 16 in. O.C.	- no insulation (vertical) -	• *Inside Finish: Gypsum Board* • *Sheathing/Insulation: - no sheathing/insul. -* • *Cavity: - no insulation (vertical) -* • *Sheathing/Insulation: - no sheathing/insul. -* • *Exterior Finish: 3 Coat Stucco*

OPAQUE SURFACES – Cathedral Ceilings										
01	02	03	04	05	06	07	08	09	10	11
Name	**Zone**	**Type**	**Orientation**	**Area (ft^2)**	**Roof Risee (x in 12)**	**Roof Pitch**	**Roof Tilt(deg)**	**Roof Reflectance**	**Roof Emmittance**	**Framing Factor**

SLAB FLOORS

01	02	03	04	05	06	07
Name	**Zone**	**Area (ft^2)**	**Perimeter (ft)**	**Edge Insul. R-value& Depth**	**Carpeted Fraction**	**Heated**
Slab On Grade 2	Conditioned	2100	162	None	0.8	No
Gslab	Garage	440	44	None	0	No

BUILDING ENVELOPE - HERS VERIFICATION

01	02	03	04
Quality Insulation Installation(QII)	**Quality Installation of Spray Foam Insulation**	**Building Envelope Air Leakage**	**ACH @ 50 Pa**
NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	---

WATER HEATING SYSTEMS

01	02	03	04
Name	**Distribution Type**	**Number of Heaters**	**Solar Fraction (%)**
Gas 60 EF	Standard	1	NaN

WATER HEATERS

01	02	03	04	05	06	07	08
Name	**Heater Element Type**	**Tank Type**	**Tank Volume (gal)**	**Energy Factor or Efficiency**	**Input Rating**	**Tank Exterior Insulation R-value**	**Standby Loss (Fraction)**
50 Gal Gas	Natural Gas	Small Storage	50	0.6	40000-Btu/hr	0	0

WATER HEATING - HERS VERIFICATION

01	02	03	04	05	06	07
Name	**Pipe Insulation**	**Parallel Piping**	**Compact Distribution**	**Point-of Use**	**Recirculation with Manual Control**	**Recirculation with Sensor Control**
Gas 60 EF-hers-dhw	n/a	n/a	n/a	n/a		n/a

HVAC SYSTEMS

01	02	03		04		05	06	07
		Heating System		**Cooling System**				
Name	**System Type**	**Name**	**Ducted**	**Name**	**Ducted**	**Distribution System**	**Fan System**	**Floor Area Served**
HVAC System 1	Other Heating and Cooling System	Min Furn 78	Yes	Cooling Min	Yes	Attic Default	HVAC Fan 1	2100

HVAC - HEATING SYSTEMS

01	02	03
Name	Type	Efficiency
Min Furn 78	CntrlFurnace - Fuel-fired central furnace	78 AFUE

HVAC - COOLING SYSTEMS

01	02	03	04	05
		Efficiency		
Name	System Type	EER	SEER	HERS Verification
Cooling Min	SplitAirCond - Split air conditioning system	11.3	13	Cooling Min-hers-cool

HVAC COOLING - HERS VERIFICATION

01	02	03	04	05	06
Name	Verified Airflow	Airflow Target	Verified EER	Verified SEER	Verified Refrigerant Charge
Cooling Min-hers-cool	Required	350	Not Required	Not Required	Required

HVAC - DISTRIBUTION SYSTEMS

01	02	03	04	05	06	07	08
Name	Type	Duct Leakage	Insulation R-value	Supply Duct Location	Return Duct	Bypass Duct	HERS Verification
Attic Default	Ducts located in unconditioned attic	Sealed and tested	6	Attic	Attic	None	Attic Default-hers-dist

HVAC DISTRIBUTION - HERS VERIFICATION

01	02	03	04	05	06
				Verified Duct Design	
Name	Duct Leakage Verification	Duct Leakage Target (%)	Verified Duct Location	Return	Supply
Attic Default-hers-dist	Required	6.0	Not Required	Not Required	Not Required

HVAC - FAN SYSTEMS

01	02	03	04
Name	Type	Fan Power (Watts/CFM)	HERS Verification
HVAC Fan 1	Single Speed PSC Furnace Fan	0.58	Required

HVAC FAN SYSTEMS - HERS VERIFICATION		
01	02	03
Name	VerifiedFanWatt Draw	Required Fan Efficiency (Watts/CFM)
HVAC Fan 1-hers-fan	Required	0.58

IAQ (Indoor Air Quality) FANS				
01	02	03	04	05
Name	IAQ CFM	IAQ Fan Type	IAQ Recovery Effectiveness(%)	HERS Verification
IAQ Fan	51	Exhaust	0	Required

COOLING VENTILATION				
01	02	03	04	05
Name	Cooling Vent CFM	Cooling Vent Watts/CFM	Number of Fans	HERS Verification
Whole House Fan	4200	0.1	1	

DOCUMENTATION AUTHOR'S DECLARATION STATEMENT	
1. I certify that this Certificate of Compliance documentation is accurate and complete.	
Documentation Author Name:	Documentation Author Signature:
Company:	Signature Date:
Address:	CEA/HERS Certification Identification (If applicable):
City/State/Zip:	Phone:

RESPONSIBLE PERSON'S DECLARATION STATEMENT	
I certify the following under penalty of perjury, under the laws of the State of California: 1. I am eligible under Division 3 of the Business and Professions Code to accept responsibility for the building design identified on this Certificate of Compliance. 2. I certify that the energy features and performance specifications identified on this Certificate of Compliance conform to the requirements of Title 24, Part 1 and Part 6 of the California Code of Regulations. 3. The building design features or system design features identified on this Certificate of Compliance are consistent with the information provided on other applicable compliance documents, worksheets, calculations, plans and specifications submitted to the enforcement agency for approval with this building permit application.	
Responsible Designer Name:	ResponsibleDesigner Signature:
Company:	Date Signed:
Address:	License:
City/State/Zip:	Phone: