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

AUGUST 2014

CALIFORNIA ENERGY COMMISSION

Dee Anne Ross
Primary Author

Martha Brook
Project Manager

Eurlyne Geisler
Office Manager
Building Standards Office

David Ashuckian
Deputy Director
Efficiency Division

Robert P. Oglesby
Executive Director

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.

Special thanks to our key consultants, including Scott Criswell, Bruce Wilcox, Ken Nittler, Robert Scott, and Jennifer Roberts.

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

TABLE OF CONTENTS

Chapter 1. Overview ... 1-1

1.1 Approval for Compliance ... 1-1

1.2 Background ... 1-1

1.3 Program Updates ... 1-2

1.4 Software Capabilities ... 1-2

1.5 Fixed and Restricted Inputs ... 1-2

1.6 Preparing Basic Input ... 1-2

1.7 Documentation ... 1-3

1.8 Registered CF1R ... 1-3

1.9 Special Features and Modeling Assumptions ... 1-4

1.10 HERS Third-Party Verification ... 1-4

1.11 Checklist for Compliance Submittal ... 1-4

1.12 Related Publications ... 1-4

1.13 Terminology ... 1-5

1.13.1 Compliance Manager ... 1-5

1.13.2 Report Manager ... 1-5

1.13.3 Proposed Design ... 1-5

1.13.4 Standard Design ... 1-5

1.13.5 Mandatory Requirements ... 1-6

1.13.6 Climate Zone ... 1-6

1.13.7 HERS Verification ... 1-6

Chapter 2. Getting Started ... 2-1

2.1 Installing CBECC-Res ... 2-1

2.2 Menu Bar ... 2-1

2.2.1 File ... 2-1

2.2.2 Edit ... 2-2

2.2.3 Ruleset 2-2
2.2.4 View 2-2
2.2.5 Tools 2-2
2.2.6 Help 2-3
2.3 Tool Bar 2-3
2.4 Main Screen 2-4
2.5 Right-Click Menu Options 2-4
2.5.1 Analysis Types 2-5
2.5.2 Building Tree Controls (Parent/Child Relationships) 2-5
2.5.3 Rapid Editing 2-5
2.6 Defining New Components 2-6
2.7 Analysis Results 2-6
2.7.1 Energy Use Details 2-6
2.7.2 Summary 2-7
2.7.3 CAHP 2-7
2.8 Error Messages 2-8
2.9 Managing Project Files 2-10
2.10 Input Dialog Windows 2-10
2.11 Background Colors 2-10
2.12 Status Bar 2-10
Chapter 3. Tutorial 3-1
3.1 Example Files 3-1
3.2 Simple House Example 3-2
Chapter 4. Project 4-1
4.1 Tool Tips/Automated Features 4-1
4.2 Project Information 4-2
4.3 Analysis 4-3
4.4 Building 4-5

4.4.1 Building Information ... 4-6
4.4.2 Dwelling Units ... 4-8
4.5 Lighting/Appliances ... 4-8
4.6 IAQ Ventilation ... 4-8
4.7 Cooling Ventilation ... 4-9
4.8 CAHP ... 4-10
Chapter 5. Zones ... 5-1
5.1 Conditioned Zones ... 5-1
5.2 Multi-family Dwelling Unit Zone ... 5-1
5.3 Attic ... 5-2
5.3.1 Attic Zone Data ... 5-3
5.3.2 Name ... 5-3
5.3.3 Cool Roof ... 5-5
5.3.4 Low Slope Aggregate Roof ... 5-5
5.4 Crawl Space ... 5-6
5.4.1 Crawl Space Zone Data ... 5-6
5.5 Conditioned Zone ... 5-7
5.5.1 Conditioned Zone Data ... 5-7
5.6 Garage ... 5-8
5.6.2 Garage Zone Data ... 5-9
5.7 Dwelling Unit Types ... 5-9
Chapter 6. Construction Assemblies ... 6-1
6.1 Cavity R-Value ... 6-1
6.2 Assembly Types ... 6-1
6.3 Mandatory Envelope Requirements ... 6-2
6.4 Spray Foam Insulation (SPF) ... 6-2
6.4.1 Medium Density Closed-Cell SPF Insulation ... 6-3
6.4.2 Low Density Open-Cell SPF Insulation ... 6-3

6.5 Advanced Wall Framing 6-3
6.6 Attic Roof Terminology 6-3
6.6.1 Attic 6-3
6.6.2 Cathedral Ceiling 6-4
6.6.3 Ceiling Below Attic 6-4
6.6.4 Knee Wall 6-4
6.6.5 Low Slope Roof 6-4
6.6.6 Radiant Barrier 6-4
6.6.7 Roof 6-4
6.6.8 Steep Slope Roof 6-5
6.7 Attic Construction 6-5
6.7.1 Attic Construction Data 6-5
6.7.2 Attic Construction Layers 6-6
6.8 Ceiling Below Attic and Interior Ceilings 6-7
6.8.1 Ceiling Construction Data 6-7
6.8.2 Ceiling Construction Layers 6-8
6.9 Cathedral Ceiling 6-10
6.9.1 Cathedral Ceiling Construction Data 6-10
6.9.2 Cathedral Ceiling Construction Layers 6-11
6.10 Walls 6-11
6.10.1 Interior and Exterior Wall Construction Data 6-11
6.10.2 Framed Wall Construction Layers (inside to outside) 6-12
6.10.3 Mass or Other Unframed Walls 6-13
6.10.4 Structurally Insulated Panels (SIPs) 6-13
6.10.5 Demising and Interior Walls 6-14
6.10.6 Garage Exterior Walls 6-15
6.11 Floors 6-15
6.11.1 Raised Floor Construction Data 6-16

6.11.2 Raised Floor Construction Layers (top to bottom) ... 6-17
6.11.3 Floor Over Garage ... 6-17
6.12 Window Types ... 6-18
Chapter 7. Building Envelope ... 7-1
7.1 Orientation ... 7-1
7.2 Opaque Surfaces ... 7-2
7.2.1 Ceiling below attic ... 7-2
7.2.2 Cathedral Ceiling ... 7-3
7.2.3 Knee Walls ... 7-4
7.2.4 Exterior Walls ... 7-4
7.2.5 Party Walls and Surfaces ... 7-5
7.2.6 Garage Surfaces ... 7-6
7.2.7 Opaque Doors ... 7-7
7.2.8 Garage Door ... 7-8
7.3 Raised Floor ... 7-8
7.3.1 Floor over Exterior or Crawl Space ... 7-8
7.3.2 Interior Floor/Floor Over Garage ... 7-9
7.4 Slab Floor ... 7-11
7.5 Windows ... 7-12
7.5.1 Windows Data ... 7-12
7.5.2 Window Overhang ... 7-14
7.5.3 Window Fins ... 7-15
7.5.4 Glass Doors ... 7-16
7.6 Skylights ... 7-17
Chapter 8. Mechanical Systems ... 8-1
8.1 HVAC System Data ... 8-1
8.1.2 Multiple HVAC Systems ... 8-3
8.1.3 Zonal Control ... 8-3

8.2 Heating Systems 8-4
8.2.1 Heating System Data (other than heat pump) 8-5
8.2.2 Heat Pumps (Air Source) 8-6
8.2.3 Air to Water Source Heat Pump 8-9
8.2.4 Ground Source Heat Pump 8-11
8.2.5 Mini-Split Heat Pump 8-11
8.2.6 Hydronic Heating and Combined Hydronic Heating 8-12
8.2.7 Hydronic Distribution Systems and Terminals 8-14
8.2.8 Wood Heating 8-14
8.2.9 Electric Heat (other than heat pump) 8-14
8.2.10 Non-central Heating 8-14
8.3 Cooling Systems 8-14
8.3.1 Cooling System Data 8-15
8.3.2 No Cooling 8-17
8.3.3 Evaporatively Cooled Condensing 8-18
8.3.4 Non-central Cooling 8-18
8.3.5 Evaporative Cooling 8-19
8.4 Distribution System Data 8-19
8.4.2 Low Leakage Air Handlers 8-22
8.4.3 Verified Low Leakage Ducts in Conditioned Space 8-23
8.4.4 Buried Ducts 8-23
8.5 HVAC Fan System 8-24
8.6 Indoor Air Quality (IAQ) Fan Data 8-25
8.7 Cooling Ventilation Fans 8-26
Chapter 9. Domestic Hot Water (DHW) 9-1
9.1 Efficiency Information 9-1
9.2 Water Heater Types 9-1
9.3 Distribution Types 9-2

9.3.1 Single Family Distribution Type ... 9-2
9.3.2 Multi-Family Distribution Type ... 9-3
9.4 Water Heating System Data ... 9-4
9.5 Solar Water Heating Data ... 9-5
9.6 Water Heater Data ... 9-6
9.7 Hydronic and Combined Hydronic ... 9-9
9.8 Ground Source Heat Pump and Air to Water Heat Pump ... 9-9
Chapter 10. Additions and Alterations ... 10-1
10.1 How to Use the Status Fields ... 10-1
10.1.1 Zone Status ... 10-1
10.1.2 Surface Status ... 10-1
10.1.3 Space Conditioning Status ... 10-2
10.1.4 Duct Status ... 10-2
10.1.5 Water Heating Status ... 10-2
10.2 Setting the Standard Design ... 10-3
10.2.1 Third Party Verification ... 10-3
10.2.2 Efficiency Threshold ... 10-3
10.3 Existing Building ... 10-4
10.4 Addition ... 10-4
10.5 Addition/Alteration ... 10-5
10.5.1 Radiant Barrier ... 10-7
10.5.2 HVAC ... 10-7
10.5.3 Water heating ... 10-8
10.5.4 Mechanical Ventilation ... 10-9
10.5.5 Ventilation Cooling/Whole House Fan ... 10-9
10.1 Addition Alone ... 10-9
Appendix A: CBECC Approval ... A-1
Appendix B: Certificate of Compliance ... B-1

FIGURES

Figure 2-1: Setup ... 2-1

Figure 2-2: Menu and Tool Bar ... 2-1

Figure 2-3: Main Screen ... 2-4

Figure 2-4: Energy Use Detail Results ... 2-7

Figure 2-5: Summary Results ... 2-7

Figure 2-6: CAHP Results ... 2-7

Figure 3-1: Simple House Example ... 3-2

Figure 3-2: Output for Simple House in Climate Zone 12 ... 3-7

Figure 3-3: Updated Output for Simple House ... 3-8

Figure 4-1: Project Information ... 4-2

Figure 4-2 Analysis Information ... 4-3

Figure 4-3: Building Information ... 4-5

Figure 4-4: Cooling Ventilation ... 4-9

Figure 4-5: CAHP ... 4-10

Figure 4-6: CAHP Results ... 4-10

Figure 5-1: Dwelling Unit Data ... 5-2

Figure 5-2: Attic Model Components ... 5-3

Figure 5-3: Attic Zone Data ... 5-3

Figure 5-4: Crawl Space Zone ... 5-6

Figure 5-5: Conditioned Zone Data ... 5-7

Figure 5-6: Garage Zone Data ... 5-9

Figure 5-7: Dwelling Unit Type ... 5-10

Figure 6-1: Attic Construction Data ... 6-6

Figure 6-2: Ceiling Below Attic Assembly ... 6-8

Figure 6-3: Section at Attic Edge with Standard Truss ... 6-9

Figure 6-4: Section at Attic Edge with a Raised Heel Truss ... 6-9

Figure 6-5: Cathedral Ceiling 6-10

Figure 6-6: Wood-Framed Wall Construction Data 6-12

Figure 6-7: Interior Walls 6-14

Figure 6-8: Uninsulated Exterior Wall 6-15

Figure 6-9: Floor over crawl space 6-16

Figure 6-10: Floor over exterior 6-16

Figure 6-11: Interior Floor 6-18

Figure 6-12: Window Type 6-19

Figure 7-1: Conditioned Zone 7-1

Figure 7-2: Plan Orientation 7-2

Figure 7-3: Cathedral Ceiling 7-3

Figure 7-4: Exterior Wall 7-4

Figure 7-5: Surface Tilt 7-5

Figure 7-6: Party Wall 7-6

Figure 7-7: Attached Garage 7-7

Figure 7-8: Opaque Door 7-7

Figure 7-9: Raised Floor 7-8

Figure 7-10: Garage or Interior Floor 7-9

Figure 7-11: Multi-Family Interior Floor 7-10

Figure 7-12: Slab Floor Data 7-11

Figure 7-13: Window Data 7-13

Figure 7-14: Overhang 7-15

Figure 7-15: Window Fin 7-16

Figure 7-16: Skylight 7-17

Figure 8-1: Mechanical Tab 8-1

Figure 8-2: HVAC System Data 8-2

Figure 8-3: Zonal Control from Section 4.4.1.9 8-4

Figure 8-4: Type from Section 5.5.1 8-4

Figure 8-5: Heating System Data 8-6
Figure 8-6: Heat Pump Data 8-9
Figure 8-7: Air to Water Source Heat Pump 8-10
Figure 8-8: Mini-Split Heat Pump Data........ 8-12
Figure 8-9: Hydronic Heating Data 8-13
Figure 8-10: Hydronic Water Heating (Separate)........ 8-13
Figure 8-11: Cooling System Data 8-16
Figure 8-12: No Cooling System 8-18
Figure 8-13: Distribution System Data 8-19
Figure 8-14: Duct Leakage 8-20
Figure 8-15: Buried Ducts 8-24
Figure 8-16: HVAC Fan 8-25
Figure 8-17: IAQ Fan Data 8-25
Figure 8-18: Cooling Ventilation 8-27
Figure 9-1: Single Family Distribution Systems 9-2
Figure 9-2: Multi-Family Distribution Systems........ 9-4
Figure 9-3: Recirculation Loops 9-5
Figure 9-4: Solar Water Heating Data, Annual........ 9-6
Figure 9-5: Solar Water Heating Data, Monthly 9-6
Figure 9-6: Water Heater Data Small Storage 9-7
Figure 9-7: Large Storage Water Heater Data 9-7
Figure 9-8: Water Heater from an HVAC System 9-9
Figure 9-9: Water Heating Screen When from HVAC........ 9-10
Figure 10-1: Run Scope 10-1
Figure 10-2: Less than 40 feet of new duct........ 10-2
Figure 10-3: Existing Surface 10-4
Figure 10-4: Addition HVAC and DHW 10-5
Figure 10-5: Altered with Verified Existing Conditions 10-6

Figure 10-6: Altered Without Verified Existing Conditions 10-6

Figure 10-7: Altered HVAC and DHW 10-7

Figure 10-8: Existing System 10-8

Figure 10-9: Duct System 10-8

TABLES

Table 2-1: Input Classification Explanations.......... 2-11

Table 2-2: Data Source Explanations.......... 2-11

Table 4-1: PV Credit Calculation Factors.......... 4-5

Table 4-2: Ventilation Cooling Fans.......... 4-9

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

Table 6-1: Compressed Insulation R-values.......... 6-1

Table 6-2: Required Thickness Spray Foam Insulation.......... 6-3

Table 8-1: Heating Equipment.......... 8-5

Table 8-2: Heat Pump Equipment.......... 8-8

Table 8-3: Cooling Equipment.......... 8-15

Table 8-4: Air Conditioning Measures Requiring HERS Verification.......... 8-17

Table 8-5: Distribution Type.......... 8-21

Table 8-6: Summary of Verified Air Distribution Systems.......... 8-22

Table 8-7: Buried Duct Effective R-values.......... 8-24

Table 9-1: Water Heater Distribution System Multipliers.......... 9-3

Table 9-2: Default Recirculating Pump Motor Efficiency.......... 9-5

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. All hotels and 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 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 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 document produced by CBECC-Res, which is 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* ("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 the ACM Reference Manual.

1.3 Program Updates

For software updates and valid version numbers check the 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 and at the CBECC-Res software website.

1.4 Software Capabilities

CBECC-Res can model most typical new construction and addition/alteration features. For a list of capabilities not yet implemented consult the Quick Start Guide.

Chapter 7 of this User Manual describes features of the opaque envelope 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 example files may include assumptions that are not standard in a given climate zone, to determine the standard assumption for a given input, consult either Standards, Section 150.1, Package A, or the ACM Reference Manual.

1.6 Preparing Basic Input

The software includes several example 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 below) if using valid software with the CF1R generated as part of the compliance calculations. The documentation author and responsible person fields are completed during the registration processand. There fields are not program inputs.

Another option for generating a CF1R is to select Generate Draft T-24 Compliance Report from the tools menu. 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). 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). For a full list of forms, see Appendix A of the 2013 Residential Manual. 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 document, Certificate of Compliance (CF1R), produced by CBECC-Res must be registered with a HERS provider, such as CalCERTS, USERA or CHEERS, before applying for a building permit (see *Residential Compliance Manual*, Section 2.1.1). For a list of currently approved HERS providers, see www.energy.ca.gov/HERS/providers.html.

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 (see Section 4.3.1.3) before running compliance. When you access the HERS provider’s website to upload the xml file, you will find the file <input file name> - AnalysisResults-BEES.xml in the folder My Documents/CBECC-Res 2013 Projects.

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.

1.9 Special Features and Modeling Assumptions

The 2013 Residential ACM Reference Manual identifies the features that are Special Feature and Modeling Assumptions on the CF1R.

1.10 HERS Third-Party Verification

Appendix C of the 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. See also Section 1.8 and Section 1.13.7.

1.11 Checklist for Compliance Submittal

The form needed for a compliance submittal includes a CF1R which is registered with a HERS provider if HERS verification is required (all new construction requires one or more mandatory HERS verified requirements).

Supporting documentation that 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, or 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* (P400-2013-003, June 2013) contains the rules that the software follows to establish the standard and proposed designs for a proposed building.

These documents can be 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, also known as the public domain compliance software. It 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 generates 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 is compared to the standard design to determine if the building complies with the Standards. The standard design minus proposed design must have an overall zero or positive margin to comply, although individual features (for example, space cooling) may be negative.

The building configuration is defined by the user through entries for floors, walls, roofs and ceilings, windows, and doors. The areas and performance characteristics, such as insulation R-values, U-factors, SHGC, are defined by the program user. 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, however duct leakage testing requirements contained in Section 150.0(m) cannot be removed. 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. HERS raters are trained and certified by the provider to perform 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

Most users will use the right-click options to edit, rename, create and delete components which offer more control (see Section 2.5).

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

Use "delete component" carefully. The default condition is to delete the entire project.

2.2.3 Ruleset

Although not yet enabled, CBECC-Res 2013 is designed to support multiple rulesets that implement the requirements of 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:

- Program and Analysis Options / *Proxy Server Settings*
- View Project Log File / *contains file history, error messages*
- Delete Project Log File / *since this file contains the entire history of an input file, this tool deletes thelog file to start fresh*
- Check Building Database / *checks for major errors*
- 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)*

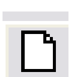
- Perform Analysis [same as short-cut key] / *runs file to determine if it passes or fails compliance*
- Review Analysis Results / *displays compliance results, if available*
- Generate Draft T-24 Compliance Report / *generates a CF1R with a watermark that it is not useable for compliance (for a "not registered" watermark see Section 1.7)*

2.2.6 Help

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

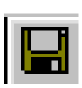
2.3 Tool Bar

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).

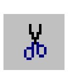


New File
This button closes the current file (if one is open) and opens a new file.

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.

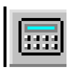


Cut Selected Item
Not enabled.

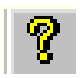
Copy Selected Item
This button enables you to copy the selected item on the tree control (along with any child components) to the clipboard. If the *copy* button is not available from within program dialogs use the keyboard equivalent (Ctrl+C) to copy selected text.

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
Inactive. 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.

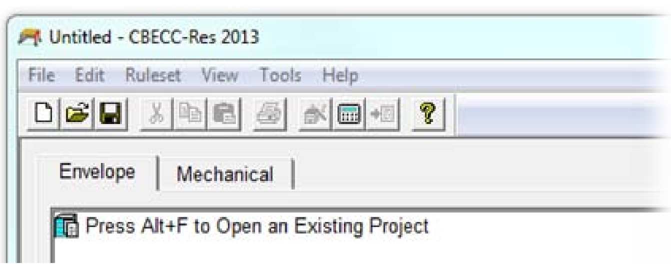


About CBECC-Res 2013
View program license and version information.

2.4 Main Screen

The main screen (see Figure 2-3) is used for editing building descriptions. There are two 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
- *Move Up in list* – Moves a component up in the list of the same component type
- *Move Down in list* – Moves a component down in the list of the same component type
- *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.

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 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 create. Only applicable component types will appear on the list. When starting with a new project, the only option is to create the project. Once that is defined, the components available will depend on where the cursor is placed. For example, a skylight can only be created under a cathedral roof.
- 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.

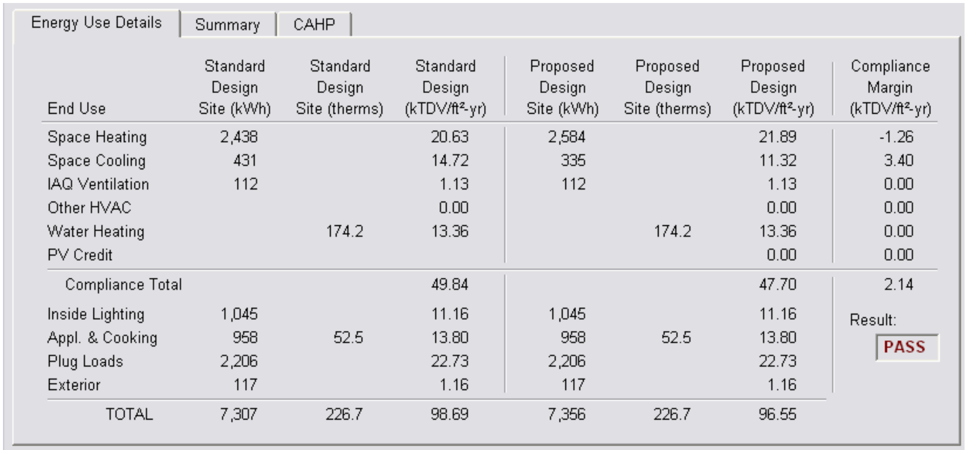
2.7 Analysis Results

Once an input file is created and the analysis performed (tools, perform analysis), the results can be viewed in several formats as shown below.

2.7.1 Energy Use Details

This is the typical results screen showing the detailed standard design and proposed design values in site energy and kTDV values (which are reported on the CF1R). The detailed breakdown of lighting, appliance, plug loads, and exterior lighting are also show (which are summarized on the CF1R).

Figure 2-4: Energy Use Detail Results

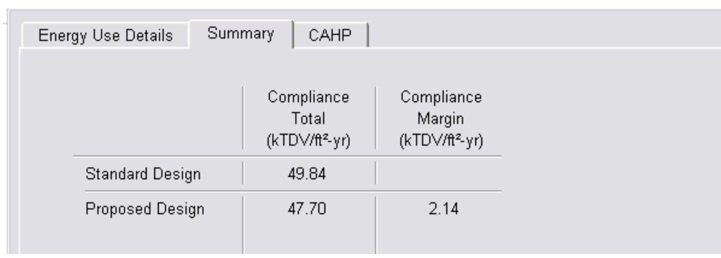


End Use	Standard Design Site (kWh)	Standard Design Site (therms)	Standard Design (kTDV/ft²-yr)	Proposed Design Site (kWh)	Proposed Design Site (therms)	Proposed Design (kTDV/ft²-yr)	Compliance Margin (kTDV/ft²-yr)
Space Heating	2,438		20.63	2,584		21.89	-1.26
Space Cooling	431		14.72	335		11.32	3.40
IAQ Ventilation	112		1.13	112		1.13	0.00
Other HVAC			0.00			0.00	0.00
Water Heating		174.2	13.36		174.2	13.36	0.00
PV Credit						0.00	0.00
Compliance Total			49.84			47.70	2.14
Inside Lighting	1,045		11.16	1,045		11.16	Result:
Appl. & Cooking	958	52.5	13.80	958	52.5	13.80	PASS
Plug Loads	2,206		22.73	2,206		22.73	
Exterior	117		1.16	117		1.16	
TOTAL	7,307	226.7	98.69	7,356	226.7	96.55	

2.7.2 Summary

To view only the total compliance results (versus the individual heating, cooling, water heating results), pick the summary tab.

Figure 2-5: Summary Results

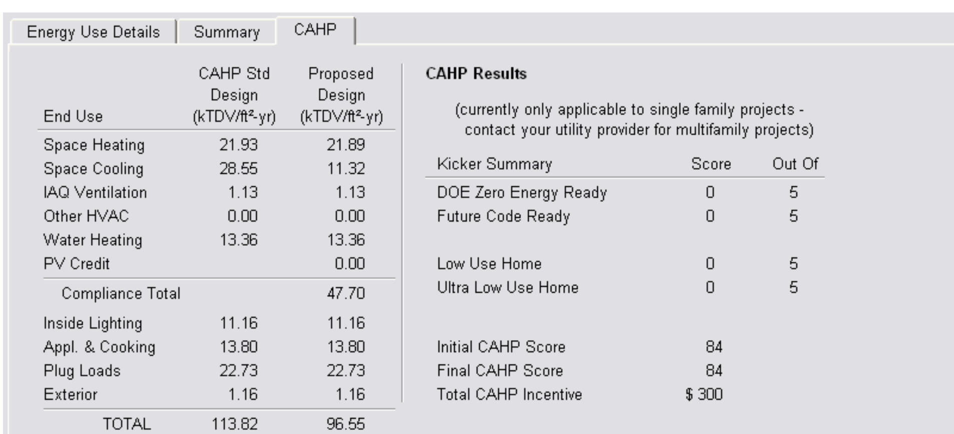


	Compliance Total (kTDV/ft²-yr)	Compliance Margin (kTDV/ft²-yr)
Standard Design	49.84	
Proposed Design	47.70	2.14

2.7.3 CAHP

The results of the CAHP analysis can be viewed by selecting the appropriate tab on the results screen. Results include the CAHP score and incentive amount.

Figure 2-6: CAHP Results



End Use	CAHP Std Design (kTDV/ft²-yr)	Proposed Design (kTDV/ft²-yr)
Space Heating	21.93	21.89
Space Cooling	28.55	11.32
IAQ Ventilation	1.13	1.13
Other HVAC	0.00	0.00
Water Heating	13.36	13.36
PV Credit		0.00
Compliance Total		47.70
Inside Lighting	11.16	11.16
Appl. & Cooking	13.80	13.80
Plug Loads	22.73	22.73
Exterior	1.16	1.16
TOTAL	113.82	96.55

Kicker Summary	Score	Out Of
DOE Zero Energy Ready	0	5
Future Code Ready	0	5
Low Use Home	0	5
Ultra Low Use Home	0	5
Initial CAHP Score	84	
Final CAHP Score	84	
Total CAHP Incentive	$ 300	

2.8 Error Messages

If a file will not run and you receive no clear error message, select Tools and pick the option “View Project Log File.” This file provides clues as to what is wrong. It contains a lot of repetitive information so you have to sift through a lot of data. Start at the bottom of the file and work up to find the word Error and look for a clue as to where the error may be located:

```
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. It does not always require six surfaces, but does need to be attached (by an interior wall or floor) to the house and have a floor. If the ceiling is really a floor above (modeled as an interior floor as part of the house zone), it does not need a ceiling. But if there is no floor above it needs a ceiling below attic or a cathedral ceiling.

Here is another example. This tells that something is wrong with window areas. These errors were listed several times, but by looking for the differences (Line *) it was clear there was something wrong in 4 different places:

```
2014-Aug-01 07:39:36 - ERROR:  Undefined data: left side of '*' evaluating
rule: Rule 1, 334, Line 1822: Set Win:TotAreaInclMult[1] - total
2014-Aug-01 07:39:36 - ERROR:  Undefined data: left side of '-' evaluating
rule: Rule 1, 336, Line 1824: Set Win:TotAreaInclMult[2] - new/altered
2014-Aug-01 07:39:36 - ERROR:  Undefined data: right side of '+'
evaluating rule: Rule 1, 601, Line 2992: Set Win:MaxArea
2014-Aug-01 07:39:36 - ERROR:  Undefined data: left side of '>' evaluating
rule: Rule 1, 604, Line 3001: Set Win:MaxMultiplier
```

If you still find no obvious errors, send your .ribd file (found in the CBECC-Res 2013 Projects folder) via e-mail to cbecc-res@gmail.com with your 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

2.9 Managing Project Files

By default, project files are stored at C:\Users\<your username>\My Documents\CBECC-Res-2013-*\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). The <input file name> - AnalysisResults-BEES.xml is the file needed for uploading to the HERS provider. The other project files are recreated when an analysis is performed.

2.10 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]).

2.11 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

2.12 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.

Chapter 3. Tutorial

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

3.1 Example Files

This is a step-by-step tutorial for modeling a simple single-family residence in *CBECC-Res 2013 2.* Although this tutorial will begin with a blank project, it is helpful to note that in the CBECC-Res “Projects” directory are several example input files, including:

1. **1StoryExample16.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. **1StoryExample16Cathedral.ribd.** Same as above with cathedral ceilings.
3. **1StoryExample16Crawl.ribd.** Same as above with a crawl space.
4. **1StoryExample16EvapCond.ribd.** Same as above with an evaporatively cooled condenser.
5. **1StoryHVACExample16.ribd.** Same as above with mini-split, ground source, and air to water heat pumps defined in the mechanical system library.
6. **2StoryExample16.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. The space conditioning system is a combined hydronic system with a boiler as the source of heating/water heating.
7. **2StoryExample16Crawl.ribd.** Same as above with a crawl space.
8. **2Story2ZoneExample16.ribd.** Same as above but zoned 1st and 2nd story each with its own HVAC system.
9. **EAAExample 16.ribd.** An existing plus addition input file.
10. **AAExample 16.ribd.** An addition alone input file.
11. **MFexample16.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.
12. **MFexample16Central.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 central water heating.

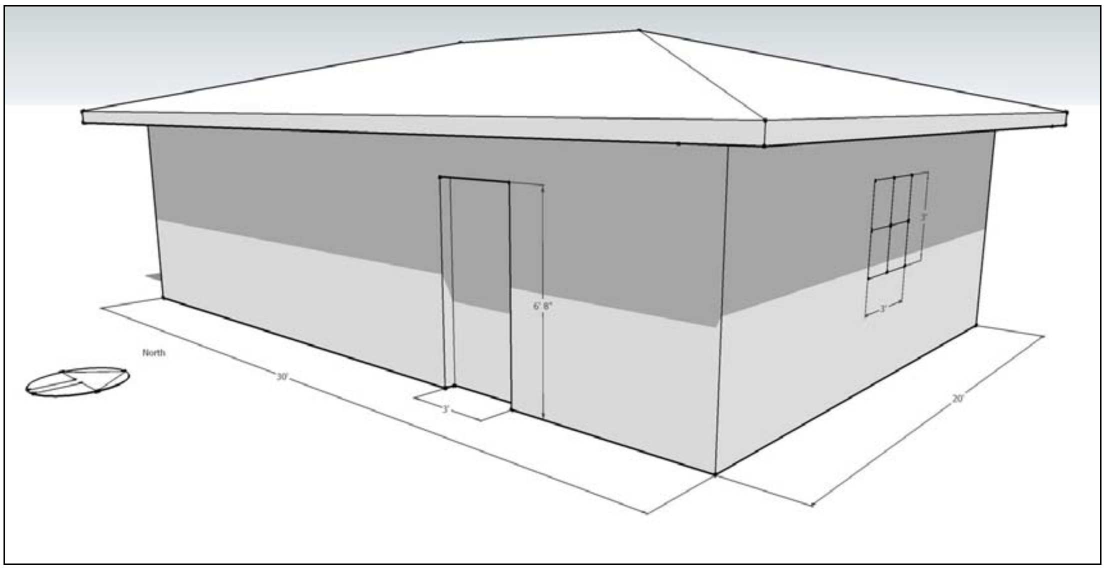
Not every input field will be discussed in this tutorial, but every input has a description in the appropriate chapter. Use the Table of Contents or the Index to find specific information. Additional information may also be found in the 2013 Residential Alternative Calculation Method (ACM) Reference 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 example 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 and checking the option to “☑ Use this EER in compliance analysis” requires verification as explained in Section 8.3.1.4. Click <OK>.

    e. In the ***Distribution*** field follow the same procedure—selecting ducts located in 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 6.12). 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.

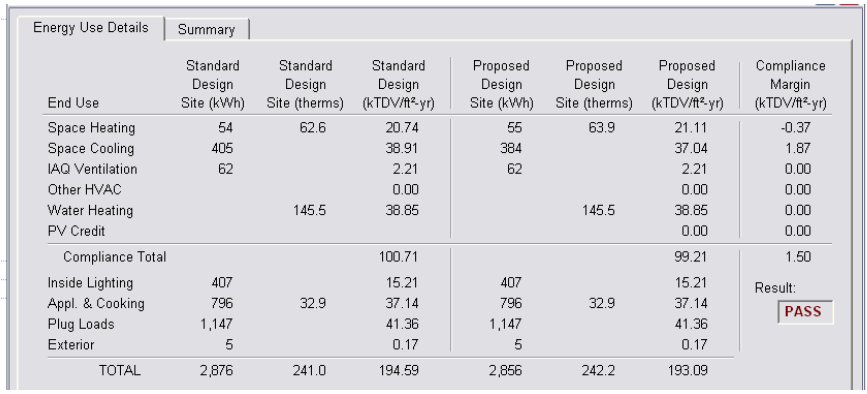
24. Finally, right click the ***Right Wall*** using the same method to create a window. Tell the program to copy the data from the first window, changing the multiplier to 1. Change the overhang ***Extends Left*** and ***Extends Right*** values to "10.5" each. All other data remain the same. Click <OK>.

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
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 example files included with the software are listed in Section 3.1.

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, as appropriate for your clients.

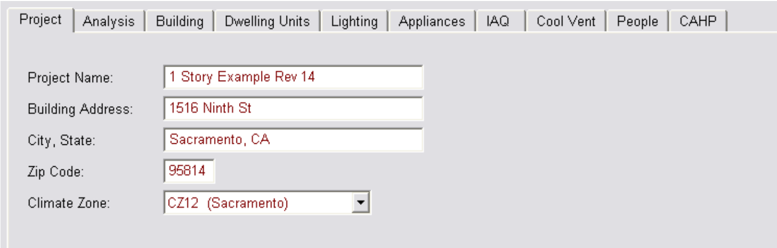
4.1 Tool Tips/Automated Features

- **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.
- **Window Types**. You can set up window types in such a way that you can easily upgrade all of the windows in a project with very few steps. By creating a list of window types and entering only the window U-factor and SHGC (or any other information that would be the same for all windows where this type is specified), if the project requires a change of brand or grade of windows, you can change the efficiencies in the types, and all windows entered in the building using that type will be revised. You may wish to read the explicit instructions so this flexibility is built in from the beginning (see Section 6.12)
- **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 4.3.1.5 and 8.3.1.3).
- **EER verified**. When modeling an EER for typical HVAC equipment, you can accept the default EER and no verification is required. If however, you wish to take credit for the verified EER or a higher than default EER, you will need to check the box directing the program to use the specified EER in the compliance analysis.
- **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 7.5.1.4.

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

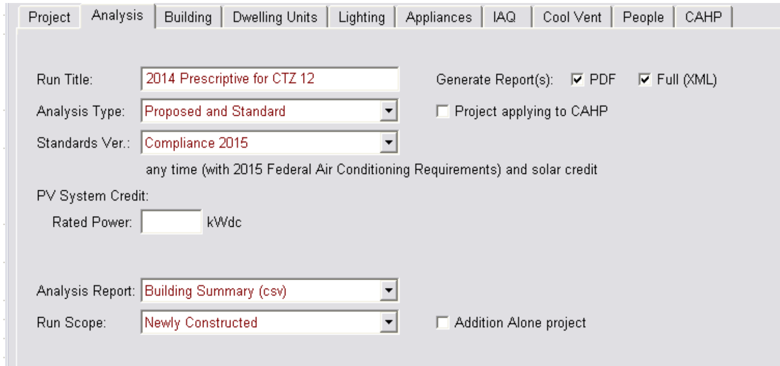
The zip code is used to establish the correct climate zone.

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 Standards Version

Default Compliance 2015.

Compliance 2014 is valid only for permit applications through December 31, 2014 (at which time federal appliance efficiency standards 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 4.3.1.7 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.

4.3.1.4 Generate Report CF1R

To generate a PDF of the Certificate of Compliance (CF1R) at the end of the analysis, check the PDF box. The PDF automatically generated when this box is checked will have a watermark identifying that the CF1R is not registered. This watermark cannot be removed. Once the project is uploaded to a

HERS provider and signed by the appropriate responsible persons, a CF1R with a registration number can be printed and submitted to the building department to obtain a building permit.

If the CF1R has a watermark stating that it is not useable for compliance, this is an indication of one of two situations (1) the CF1R was generated via the tools option “Generate Draft T-24 Compliance Report” rather than as part of the compliance run (as explained in the frequently asked questions, this is a security feature), or (2) the software is out of date.

To locate a previously generated CF1R, the file is located in the My Documents\CBECC-Res 2013 Projects folder <input file name> - AnalysisResults-BEES.pdf.

4.3.1.5 Generate Report HERS Upload File

An XML file gets uploaded to the HERS provider. Once a project is ready to complete, be sure to check the option to generate the full (XML) before running the compliance analysis. This will create a file located in the My Documents\CBECC-Res 2013 Projects folder named <input file name> - AnalysisResults-BEES.xml (the xml file without “BEES” cannot be uploaded).

Although XML files are easily modified, the HERS providers have in place security measures to reject files that are modified. You can read more about this in the frequently asked question.

4.3.1.6 Project applying to CAHP

Check to indicate if the project will apply for California Advanced Homes Program (CAHP) utility incentives (see Section 4.8).

4.3.1.7 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.

4.3.1.8 Analysis Report

The default report type is Building Summary (csv).

4.3.1.9 Run Scope

The two types of projects are ***Newly Constructed*** or ***Addition and/or Alteration***

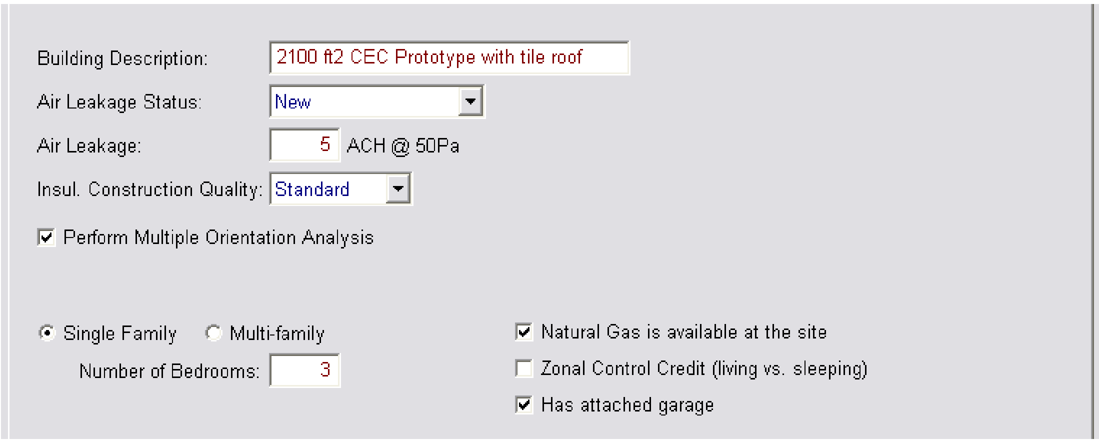
4.3.1.10 Addition Alone project

For an addition alone analysis, you must select Newly Constructed, check Addition Alone project 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 Status

Valid options are New and Altered. New construction is new. For an addition and/or alteration where infiltration testing will be performed for compliance credit, use altered.

4.4.1.3 Air Leakage

Input as Air Changes per Hour @ 50 Pascals (ACH50), the CF1R reports CFM50).

Default value (no blower door test) for single family buildings with space conditioning ducts in unconditioned space, and the default condition for no cooling, is 5 ACH50. When there are no heating and/or cooling system ducts in unconditioned space, the default is 4.4 for single-family buildings and townhomes. 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. The default value that is assumed by CBECC-Res is 7 ACH.

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. 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.

4.4.1.4 Insulation Construction Quality

Valid options are Standard and Improved. Default value is "standard." Improved means verified high quality insulation installation certified by the installer and field verified to comply with RA3.5 is modeled for compliance credit. , 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.

4.4.1.5 Front Orientation

This field defines the front orientation in degrees and must be accurate within 5 degrees. This value is from the site plan. 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 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 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 results for the four cardinal orientations—north, east, south and west.

4.4.1.6 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.

NOTE: A duplex or townhome must be modeled with each dwelling unit as a separate input file rather than the building.

For more on modeling a multi-family building, see Sections 5.2 and 5.7.

4.4.1.7 Number of Bedrooms

For single family dwellings, indicate the number of bedrooms to establish mechanical ventilation requirements and determine if a building qualifies as a compact building for purposes of incentive programs.

4.4.1.8 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).

4.4.1.9 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, with separate thermostat settings for living and sleeping zones.

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.

4.4.1.10 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.

4.4.1.11 Central Laundry

If modeling a multi-family building, indicate if the laundry facilities are in a central location rather than within each dwelling unit. If the laundry facilities are central, define the zone in which the facilities are located.

4.4.2 Dwelling Units

See Sections 5.2 and 5.7.

4.5 Lighting/Appliances

For compliance with the Standards, lighting is fixed.

The appliance information does not affect compliance with the Standards but does affect the “appliances and miscellaneous energy use" as reported on the CF1R.

For single family buildings, check the box to indicate if an appliance is located within a conditioned zone of the dwelling unit. The fuel type choices for the clothes dryer and cooking appliances will depend on whether natural gas is available at the site (as identified under the building tab).

For multi-family buildings, this information is provided as part of the dwelling unit type (see Section 5.7.1.4).

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 displayed 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.

For multi-family dwelling units, see Section 5.7.1.6.

4.6.1.1 Model as

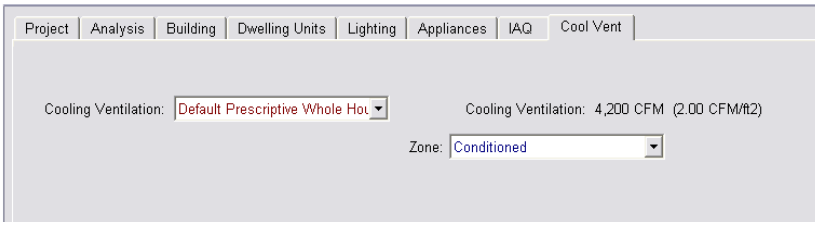
Select method of ventilation as either default minimum IAQ fan or specify individual fans (as described in Section 8.6).

4.6.1.2 Zone

Assign to one of the conditioned zones.

4.7 Cooling Ventilation

Figure 4-4: 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 provide 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 (set to exactly 2 CFM/ft^2), specify individual fans, or a central fan integrated system [not yet implemented] 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

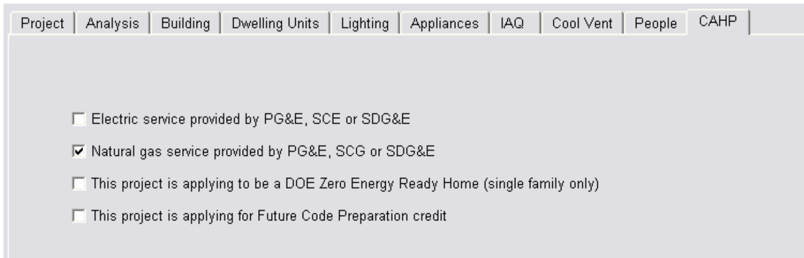
Measure	Description
Whole House Fan	Traditional whole house fan is mounted in the ceiling to exhaust air from the house to the attic, inducing outside air in through open windows. Whole house fans are assumed to operate between dawn and 11 PM only at 25% of rated CFM to reflect manual operation of fan 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.

4.8 CAHP

Figure 4-5: CAHP

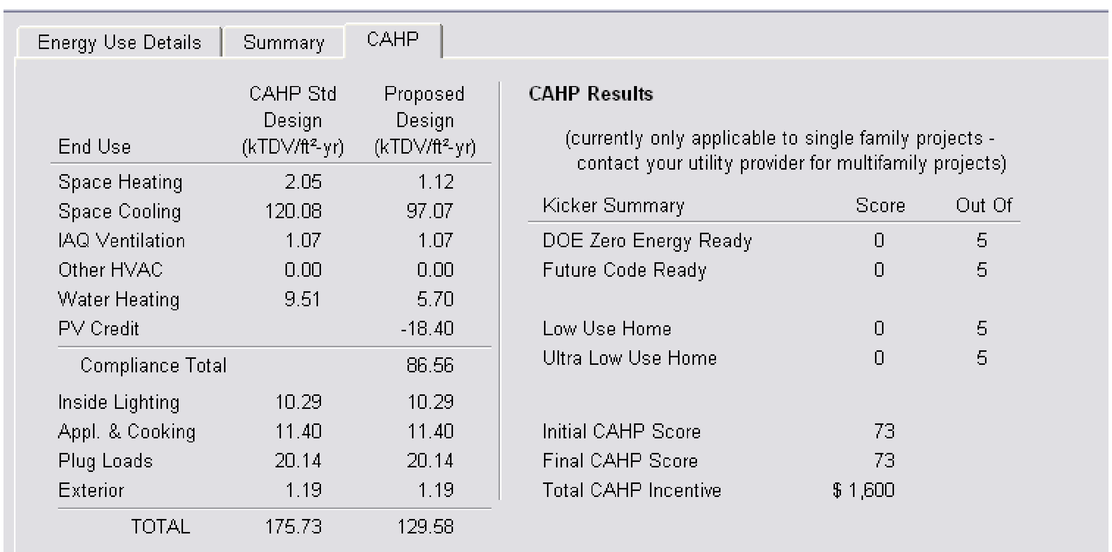


If the project will apply for California Advanced Homes Program (CAHP) utility incentives, check the appropriate incentive calculations options that apply to the project:

- Electric service provided by PG&E, SCE or SDG&E;
- Natural gas service provided by PG&E, SCE or SDG&E;
- This project is applying to be a DOE Zero Energy Ready Home (single family only); or
- This project is applying for Future Code Preparation credit.

The results of the analysis include the CAHP score and incentive amount.

Figure 4-6: CAHP Results



Chapter 5. Zones

5.1 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 must 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:

- Zonal control (with at least one living and one sleeping zone).
- Spaces served by different types of heating/cooling equipment (such as a heat pump and a gas furnace)
- Different duct conditions or locations.

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

The simplest approach is to model the worst case in a single zone.

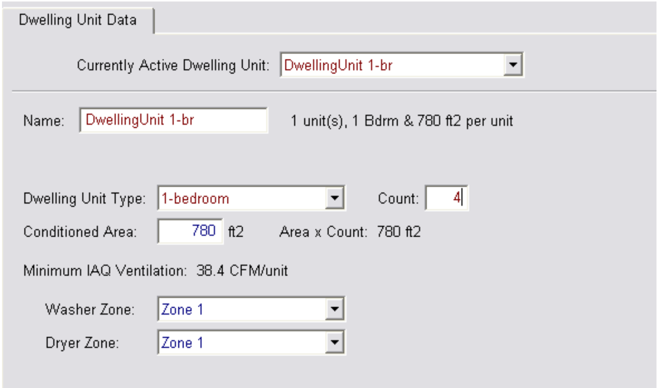
In addition to the conditioned zones, attics, crawl spaces, and garages/attached unconditioned spaces must be modeled. Attached unconditioned spaces should be modeled using the “attached garage” option (named as appropriate). The zone type “unconditioned” is not yet implemented.

5.2 Multi-family Dwelling Unit Zone

Multi-family buildings can be modeled with each floor as a separate zone or with each dwelling unit as a separate zone. Two multi-family example files are included with the program using the less detailed approach. Both have 4 dwelling units per zone/floor, and one has central water heating.

When multi-family is selected, the zone data for HVAC and DHW are defined by creating the dwelling unit types (see Section 5.7). The dwelling unit type is one of the inputs used to build the zone information (see ***Figure 5-1***).

Figure 5-1: Dwelling Unit Data



5.2.1.1 Name

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

5.2.1.2 Dwelling Unit Type

Indicate which dwelling unit type contains the appliance data, HVAC, water heating and indoor air quality (IAQ) information for these dwelling units.

5.2.1.3 Count

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

5.2.1.4 Conditioned Area

This data is captured from the dwelling unit type.

5.2.1.5 Washer Zone

This data is based on the input from the dwelling unit type indicating that this appliance is contained within the floor area of the dwelling unit.

5.2.1.6 Dryer Zone

This data is based on the input from the dwelling unit type indicating that this appliance is contained within the floor area of the dwelling unit.

5.3 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 5-2.

5.3.1 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 5-3).

Figure 5-2: Attic Model Components

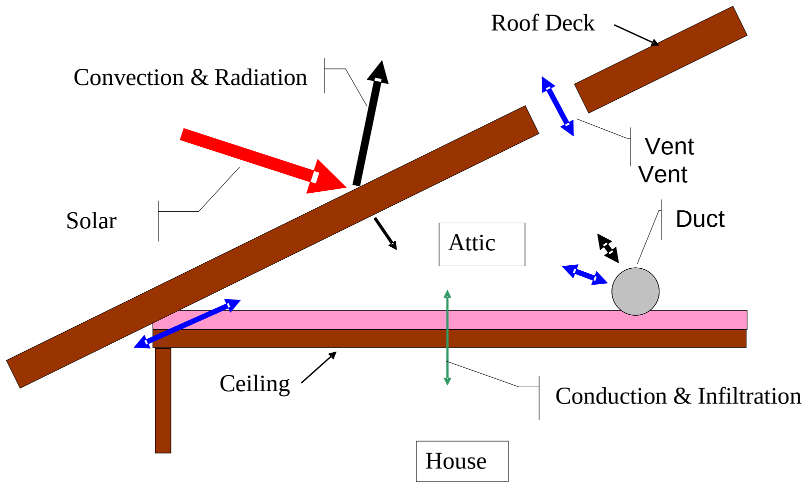
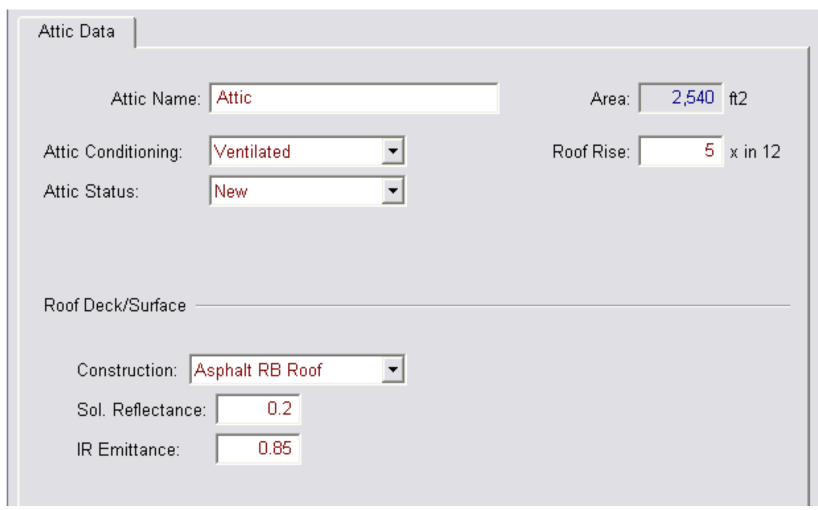


Figure 5-3: Attic Zone Data



5.3.2 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.

5.3.2.1 Attic Conditioning

The conditioning is either ventilated (typical attic) or conditioned (unvented).

5.3.2.2 Roof Rise

Specify the roof rise or roof pitch, which is the number of feet the roof rises in a span of 12 feet (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.

5.3.2.3 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.

5.3.2.4 Attic Status

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

5.3.2.5 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, though typically not insulation (see more in Chapter 6, Construction Assemblies).

5.3.2.6 Solar Reflectance

The default aged solar reflectance is 0.10 for all roof types. The aged solar reflectance for a roof product 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^2 or any roof area that incorporates integrated solar collectors, the roof may assume the Package A solar reflectance value (see Section 5.3.3).

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.

5.3.2.7 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^2 or for any roof area that incorporates integrated solar collectors, the roof may assume the Package A emittance value (see Section 5.3.3).

If the roof is a cathedral ceiling or rafter roof, the emittance is defined as part of the roof/ceiling rather than an attic (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.

5.3.3 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 0.85 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 0.85 emittance.

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

5.3.4 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

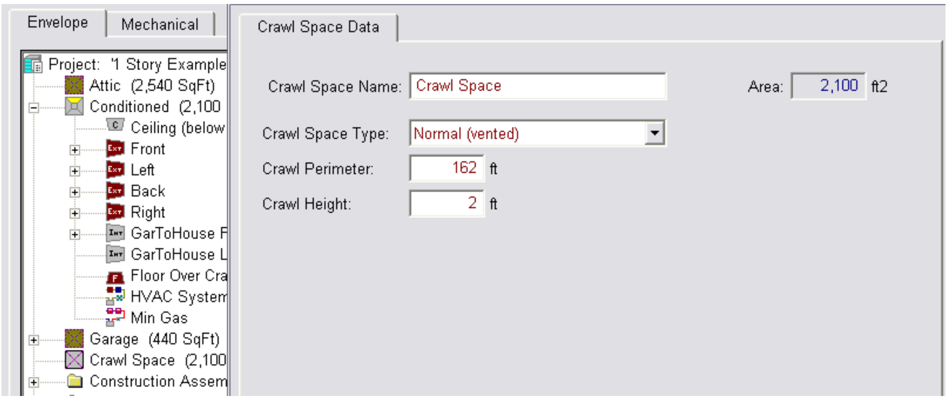
Aggregate Size	Tested Initial Solar Reflectance	Default Aged Solar Reflectance	Default Emittance
Built-Up Roofs Size 6-8 confirming to ASTM D448 and D1863	0.50	0.48	0.85
Ballasted Roofs Size 2-4 confirming to ASTM D448	0.45	0.40	0.85

5.4 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 5-4) 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 5-4: Crawl Space Zone



5.4.1 Crawl Space Zone Data

5.4.1.1 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.

5.4.1.2 Crawl Space Type

The default type (and only option implemented) is a vented crawl space. Of the three types: (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.

5.4.1.3 Crawl Perimeter

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

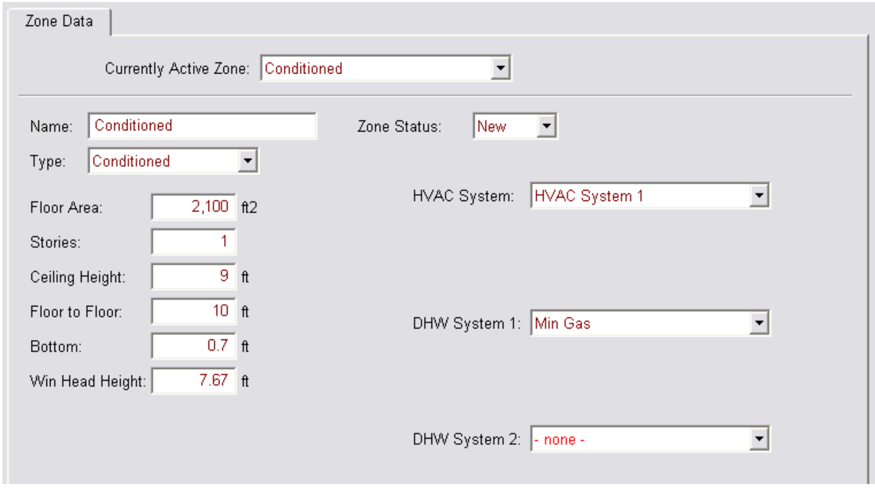
5.4.1.4 Crawl Height

The depth/height of the crawl space, in feet (minimum of 2 feet). The same value is used for the floor elevation and the zone bottom.

5.5 Conditioned Zone

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

Figure 5-5: Conditioned Zone Data



5.5.1 Conditioned Zone Data

5.5.1.1 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.

5.5.1.2 Zone Status

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

5.5.1.3 Type

The default zone type is conditioned. If the building specifies zonal control (under the ***building*** tab), the type is defined as living or sleeping. For more information on zonal control see Section 8.1.2. Unconditioned is not yet implemented as a valid zone type. Any unconditioned zones can be modeled as a garage or as part of the garage (see Section 5.6).

5.5.1.4 Floor Area

Specify the floor area of the zone.

5.5.1.5 Number of Stories

Enter the number of stories in the zone (not the building). 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.

5.5.1.6 Ceiling Height

Average ceiling height, in feet.

5.5.1.7 Floor to Floor

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

5.5.1.8 Bottom

The value input depends on how the building is zoned. It is the 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 (0.7). Raised floor will be the height from grade to the top of the raised floor (2 or more).

For multi-story buildings, if the upper 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 10 feet as the floor to floor height, the second floor bottom is 10.7).

5.5.1.9 Window Head Height

Default value is based on the average ceiling height.

5.5.1.10 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.

5.5.1.11 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.

5.5.1.12 DHW System 2

If a second water heater or water heating system has a different distribution system, identify that second DHW system, or enter.

5.6 Garage

An attached unconditioned space is modeled as a separate unconditioned zone. If the garage is not attached to the building, it is not modeled. When the project was defined as having an attached garage, the software created an unconditioned zone (see Figure 5-6). 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.

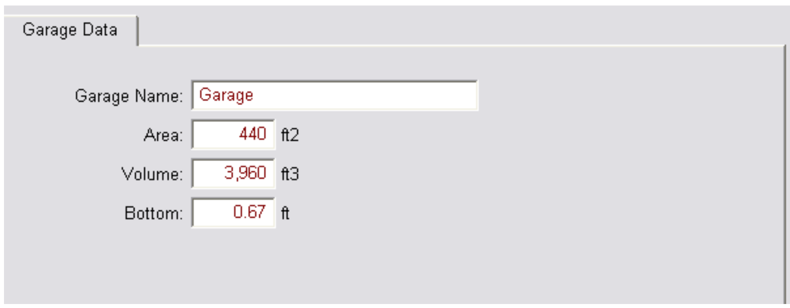
5.6.1.1 Party Walls

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

When modeling an interior surface adjacent to a space that is not being modeled (e.g., an addition alone), model the interior surface as a party wall.

5.6.2 Garage Zone Data

Figure 5-6: Garage Zone Data



5.6.2.1 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.

5.6.2.2 Area

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

5.6.2.3 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.

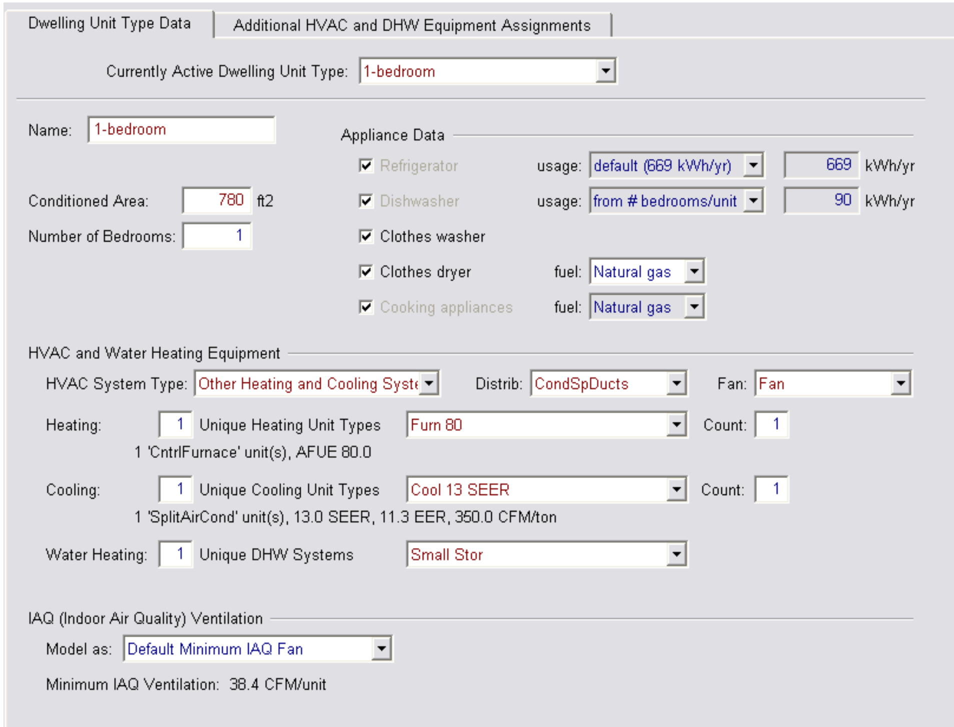
5.6.2.4 Bottom

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

5.7 Dwelling Unit Types

Each dwelling unit type is created based on its characteristics (see Figure 5-7). For example, 1-bedroom units with 780 ft^2, 2-bedroom units with 960 ft^2 are created defining the HVAC equipment, water heating conditions, and IAQ ventilation. Once created, the dwelling unit types are used in defining the zone (see Section 5.2).

Figure 5-7: Dwelling Unit Type



5.7.1.1 Name

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

5.7.1.2 Conditioned Area

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

5.7.1.3 # Bedrooms

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

5.7.1.4 Appliance Data

The appliance information does not affect compliance with the Standards but does affect the “appliances and miscellaneous energy use" as reported on the CF1R.

Check the box to indicate if an appliance is located within a conditioned zone of the dwelling unit. The fuel type choices for the clothes dryer and cooking appliances will depend on whether natural gas is available at the site (as identified under the building tab).

5.7.1.5 HVAC and Water Heating Equipment

Space conditioning and water heating equipment is entered as described in Chapter 8 and 9. If multiple pieces of equipment with identical characteristics are used, enter that in the “count” field. If multiple pieces of different equipment are modeled (the worst case will be assumed), enter that as “unique . . .” types or systems and enter the specifications under the tab called Additional HVAC and DHW Equipment Assignments.

5.7.1.6 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. Required minimum IAQ ventilation, in CFM/dwelling unit, is displayed based on conditioned floor area and number of bedrooms.

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 (Standards, 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)
Underground wall (not yet implemented)
Attic roof
Cathedral roof
Ceiling below attic
Interior ceiling (not yet implemented)

Slab on Grade
Exterior floor
Floor over crawl space
Interior floor
Underground floor (not yet implemented)

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 insulation requirements (Standards Section 150.0(a)-(d)) for new construction are based on a wood-framed assembly:

- Ceilings or rafter roofs with R-30, or a weighted average U-factor of 0.031 (formerly R-19).
- Raised floor insulation with R-19 or a weighted average U-factor of 0.037 (formerly R-13).
- Framed wall insulation is either (1) R-13 in a wood-framed 2x4 wall or an overall U-factor of 0.102, or (2) R-19 in a wood-framed 2x6 wall or an overall U-factor of 0.074.

Under the Help button is a summary of these minimum mandatory requirements which may be particularly helpful if building with steel framed walls. These walls require sheathing insulation in order to comply with the mandatory requirement.

Mass or unframed walls do not have a minimum mandatory insulation requirement.

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 4.4.1.4) 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).

6.5 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.

6.6 Attic Roof Terminology

6.6.1 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.

6.6.2 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.

6.6.3 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*).

6.6.4 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.

6.6.5 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^2 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).

6.6.6 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. The radiant barrier is modeled as part of the attic zone construction (see Section 6.7.2.7) Radiant barrier cannot be installed in a cathedral ceiling.

6.6.7 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.

6.6.8 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^2 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).

6.7 Attic Construction

Attic constructions are accessed by creating a new attic roof construction, or modifying an existing assembly in the list of ***Construction Assemblies***. The attic construction is the zone containing the roofing material (e.g., tile, asphalt), above or below deck insulation, and the radiant barrier. A typical attic does not include the ceiling or ceiling insulation modeled as the ceiling below attic. There is no orientation associated with an attic roof.

6.7.1 Attic Construction Data

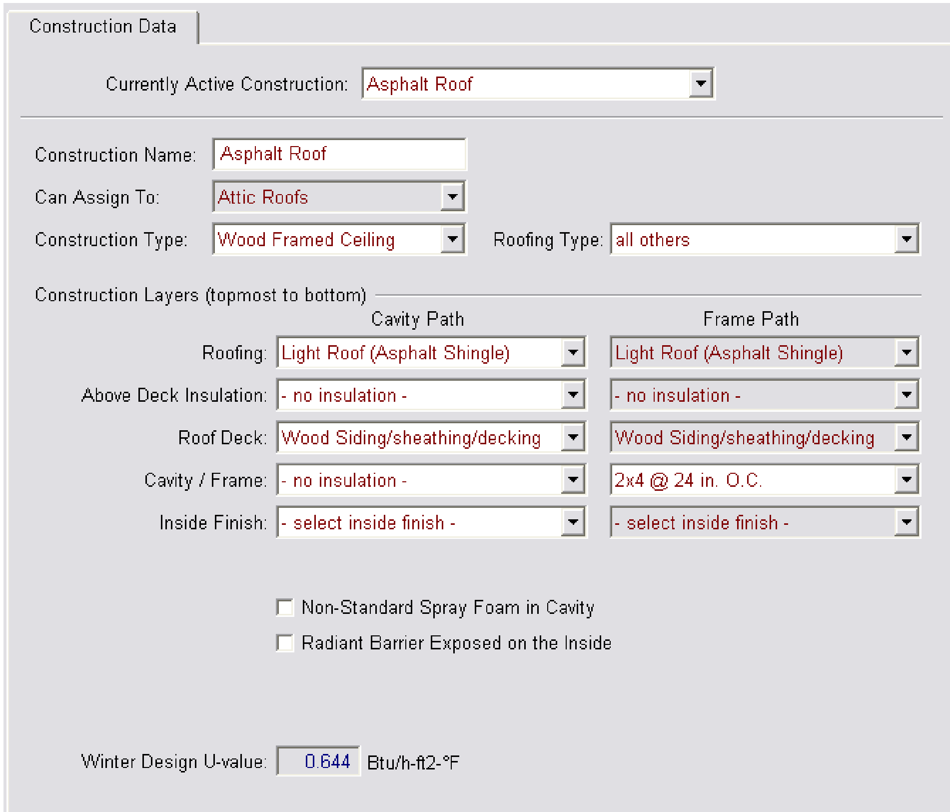
6.7.1.1 Construction Name

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, select <create> and pick the appropriate construction assembly type.

Figure 6-1: Attic Construction Data



6.7.1.3 Construction Type

Options are wood framed, built-up roof, steel framed ceiling, and SIP ceiling.

6.7.1.4 Roofing Type

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

6.7.2 Attic Construction Layers

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

6.7.2.1 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.

6.7.2.2 Above Deck Insulation

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

6.7.2.3 Roof Deck

The default is wood siding/sheathing/decking.

6.7.2.4 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 24-inch on center framing).

6.7.2.5 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.

6.7.2.6 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).

6.7.2.7 Radiant Barrier Exposed on the Inside

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

6.8 Ceiling Below Attic and Interior Ceilings

The ceiling below attic is typically where insulation is installed when it separates conditioned space from the attic zone (Figure 6-2).

6.8.1 Ceiling Construction Data

6.8.1.1 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.

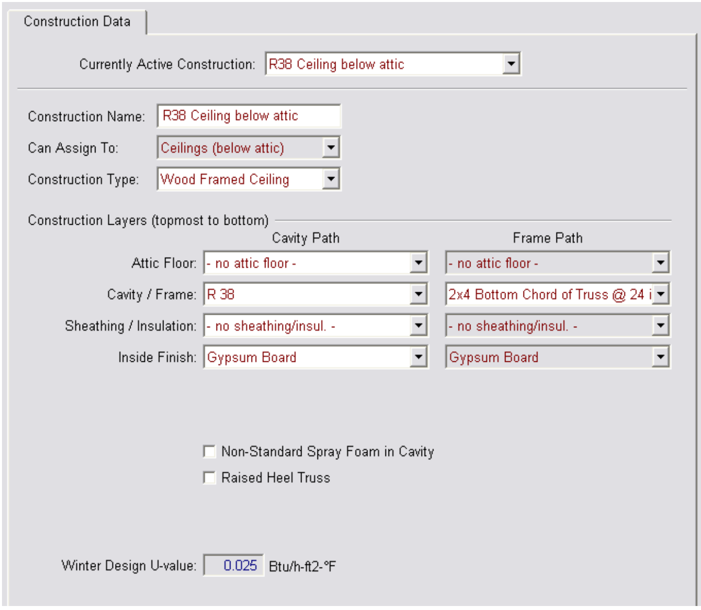
6.8.1.2 Can Assign To

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

6.8.1.3 Construction Type

Options are wood or steel framed.

Figure 6-2: Ceiling Below Attic Assembly



6.8.2 Ceiling Construction Layers

6.8.2.1 Attic Floor

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

6.8.2.2 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.

6.8.2.3 Sheathing/Insulation

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

6.8.2.4 Inside Finish

This is the inside finish (if any), of the attic space. A layer of gypsum is typical.

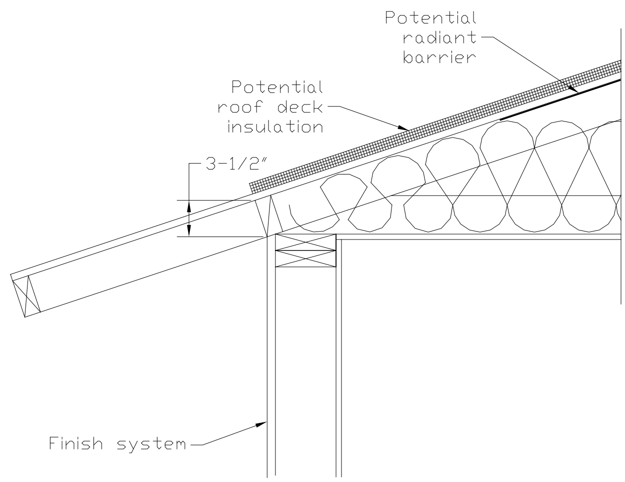
6.8.2.5 Non-Standard Spray Foam in Cavity

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).

6.8.2.6 Raised Heel Truss

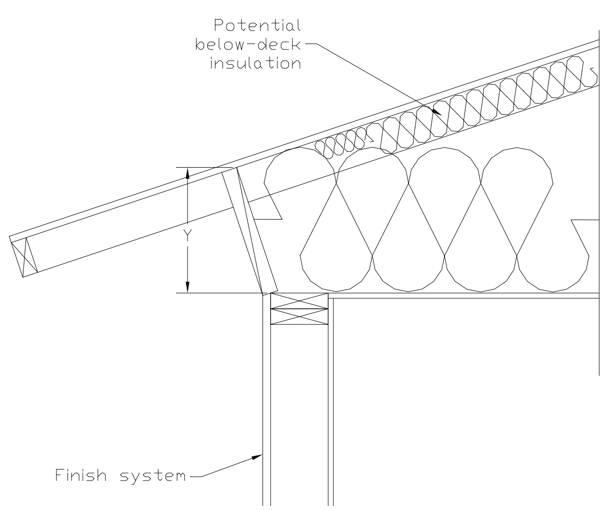
Check box to indicate if there is a raised heel truss and its height (in inches). With a standard roof truss (Figure 6-3) the depth of the ceiling insulation is restricted to the space left between the roof deck and the wall top plate for the insulation path and the space between the bottom and top chord 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 6-3: Section at Attic Edge with Standard Truss



A raised heel truss (Figure 6-4) 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 6-4: Section at Attic Edge with a Raised Heel Truss

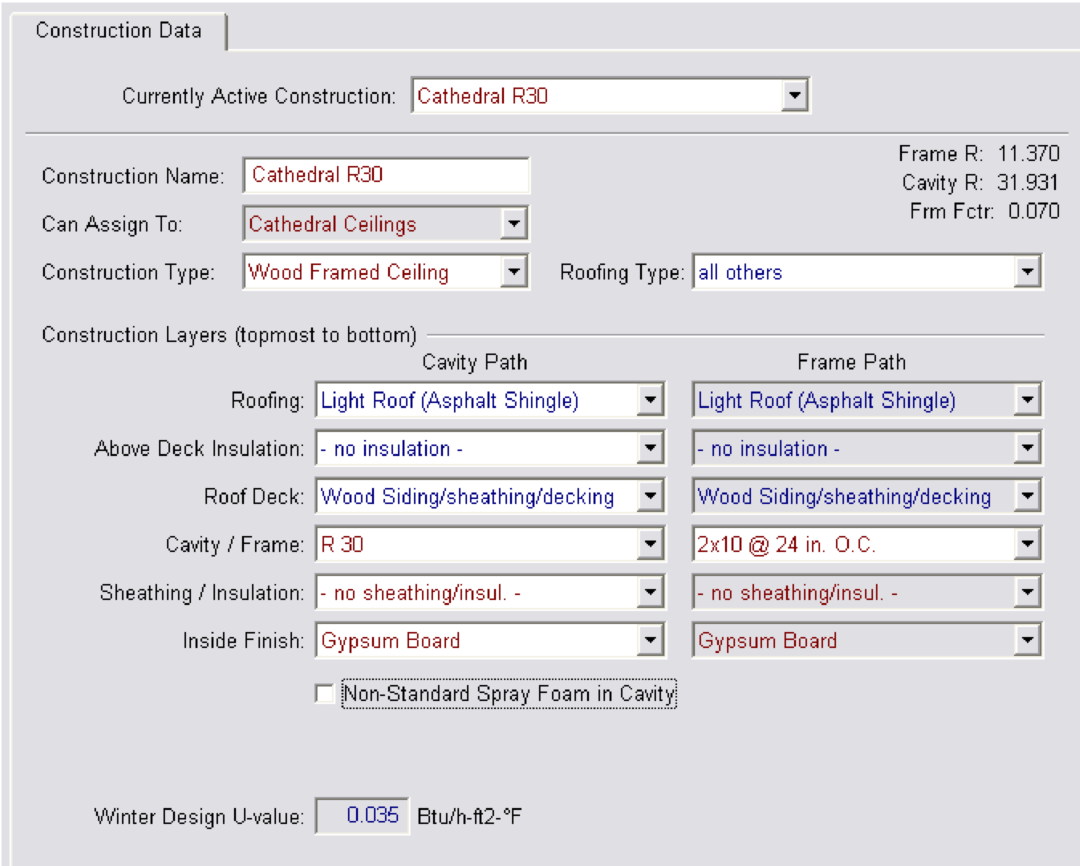


6.9 Cathedral Ceiling

6.9.1 Cathedral Ceiling Construction Data

Each surface facing a different orientation will be modeled as a separate surface (see **Error! Reference source not found.** and Section **Error! Reference source not found.**).

Figure 6-5: Cathedral Ceiling



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 select the appropriate construction assembly type.

6.9.1.3 Construction Type

Options are wood framed, built up roof, steel framed, and SIP ceiling.

6.9.1.4 Roofing Type

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

6.9.2 Cathedral Ceiling Construction Layers

6.9.2.1 Roofing

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

6.9.2.2 Above Deck Insulation

Options include no insulation, or R1 to R60.

6.9.2.3 Roof Deck

The default is 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., 2x12 with 24-inch on center framing). Also included is an option for a 2x4 bottom chord of truss at 24-inches on center.

6.9.2.5 Sheathing/Insulation

List the sheathing or insulation layer. Options are no sheathing/insulation, gypsum board, wood sheathing, and R1 to R60 insulation.

6.9.2.6 Inside Finish

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

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).

6.10 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 6-6) 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 6.10.5.

CBECC can currently model wood or steel-framed, SIP, mass, straw bale and log walls, as well as advanced wall framing.

6.10.1 Interior and Exterior Wall Construction Data

6.10.1.1 Construction Name

User-defined name.

6.10.1.2 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.

6.10.1.3 Construction Type

Options available include wood framed and steel framed (Section 6.10.2), unframed wall types are concrete, Insulated Concrete Form (ICF), brick, hollow unit masonry, adobe, strawbale, log (Section 6.10.3) and structurally insulated panels (SIPs) (Section 6.10.4).

Figure 6-6: Wood-Framed Wall Construction Data

6.10.2 Framed Wall Construction Layers (inside to outside)

6.10.2.1 Inside Finish

Default value gypsum board.

6.10.2.2 Sheathing/Insulation

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

6.10.2.3 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 6.5.

6.10.2.4 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 60 insulation.

6.10.2.5 Exterior Finish

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

6.10.2.6 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).

6.10.3 Mass or Other Unframed Walls

6.10.3.1 Inside Finish

Default value gypsum board.

6.10.3.2 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.

6.10.3.3 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.

6.10.3.4 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.

6.10.3.5 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.

6.10.3.6 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).

6.10.4 Structurally Insulated Panels (SIPs)

6.10.4.1 Inside Finish

Default value gypsum board.

6.10.4.2 Sheathing/Insulation

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

6.10.4.3 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.

6.10.4.4 Sheathing/Insulation

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

6.10.4.5 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.

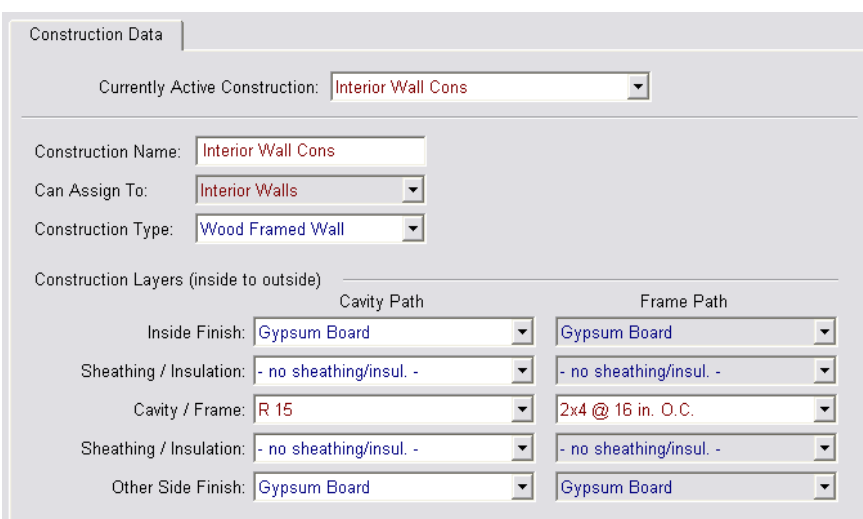
6.10.5 Demising and Interior Walls

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.

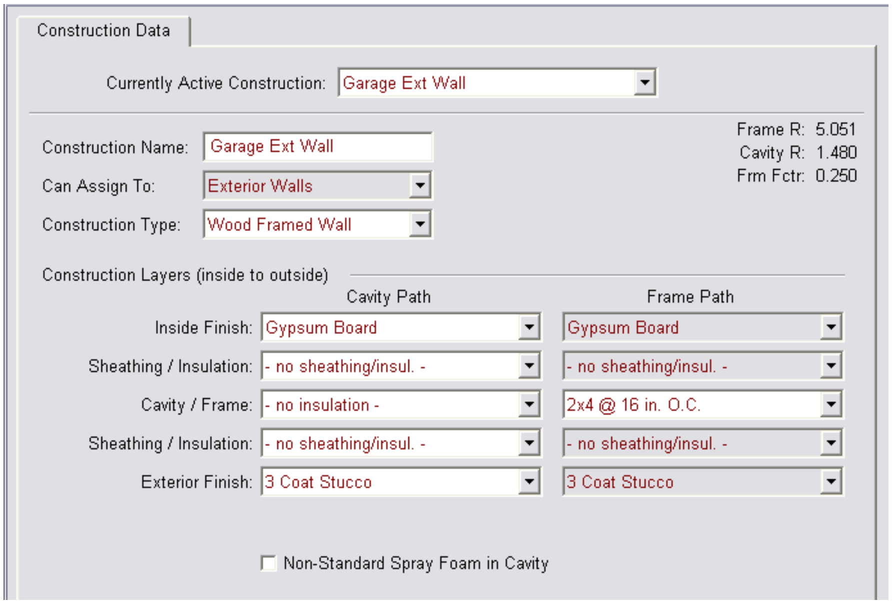
Figure 6-7: Interior Walls



6.10.6 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 6-8).

Figure 6-8: Uninsulated Exterior Wall



6.11 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 6-9 through Figure 6-11.

Figure 6-9: Floor over crawl space

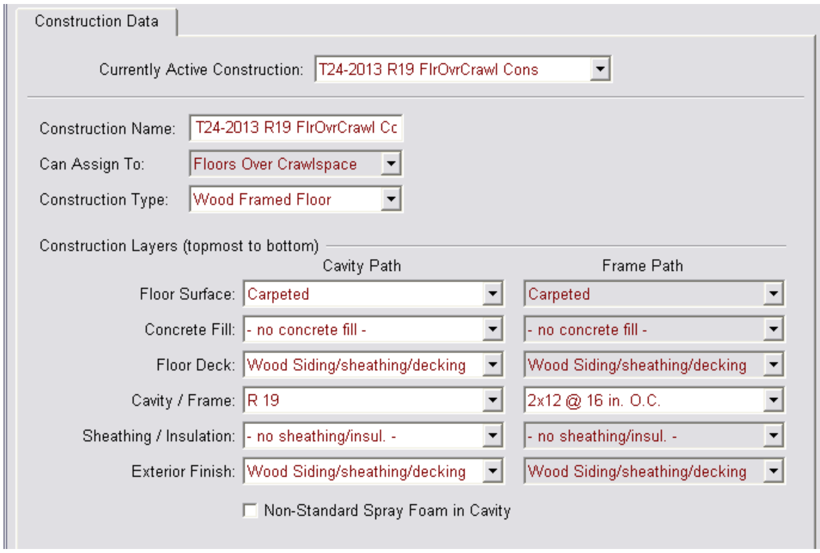
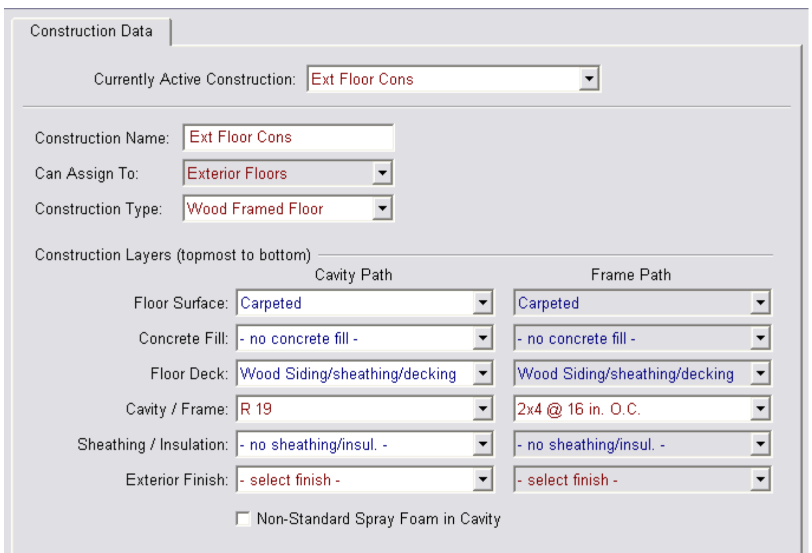


Figure 6-10: Floor over exterior



6.11.1 Raised Floor Construction Data

6.11.1.1 Construction Name

User-defined name.

6.11.1.2 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.

6.11.1.3 Construction Type

Options include wood and steel frame construction, or SIPs.

6.11.2 Raised Floor Construction Layers (top to bottom)

6.11.2.1 Floor Surface

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

6.11.2.2 Concrete Fill

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

6.11.2.3 Floor Deck

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

6.11.2.4 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.

6.11.2.5 Sheathing/Insulation

List the sheathing or insulation layer on the outside of the framing. Options are none, gypsum board, and R1 to R60 insulation.

6.11.2.6 Exterior Finish or Ceiling Below Finish

Optional input.

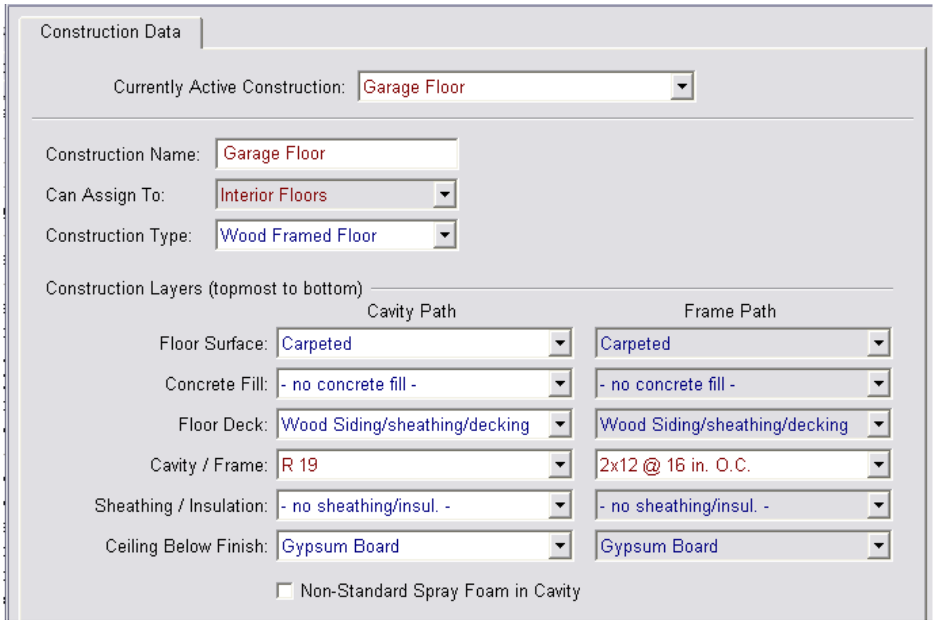
6.11.2.7 Non-Standard Spray Foam in Cavity

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).

6.11.3 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 6-11: Interior Floor



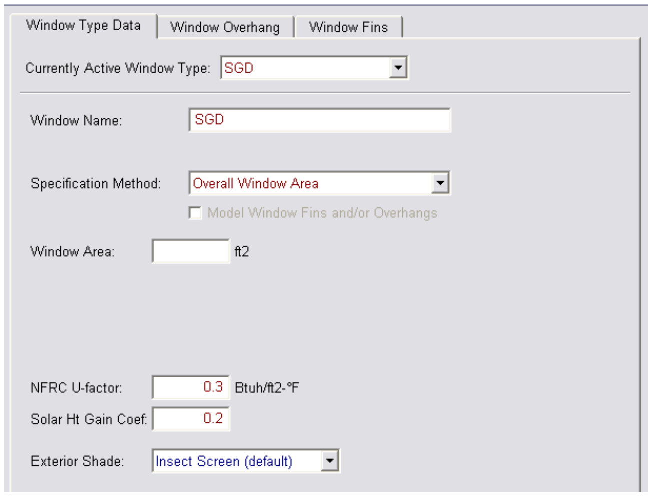
6.12 Window Types

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, casement, glass block, doors, and existing single pane windows.

When creating the windows on a given wall, specify the window types created.

To use this feature most productively, if the window brand or product specific efficiencies change, modify them at the window type level of input rather than in the specific windows defined. In this way, all of the windows using that window type will be updated.

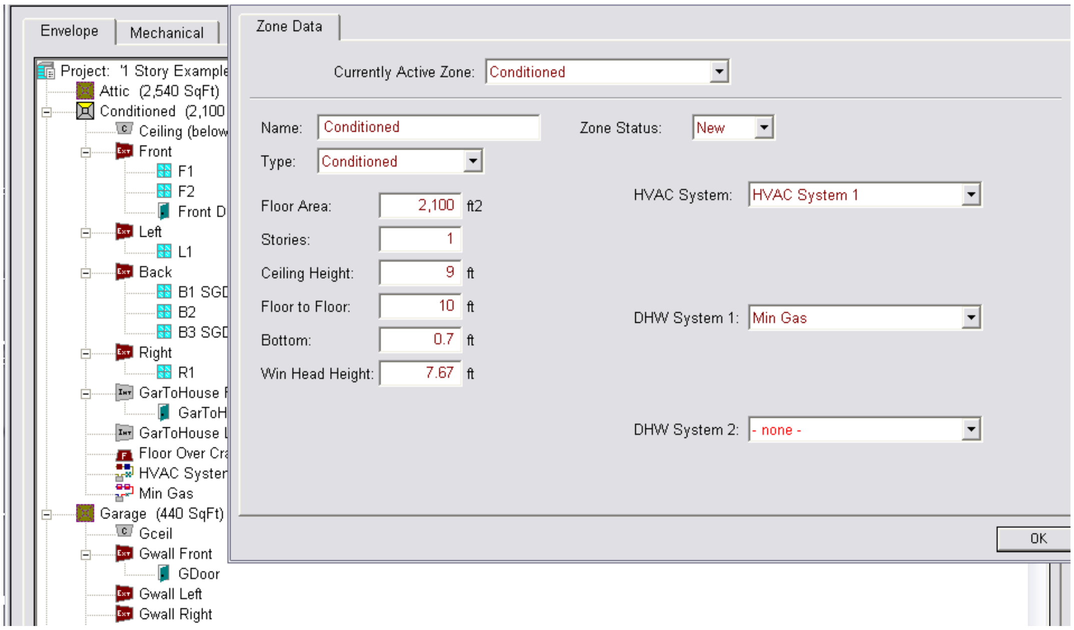
Figure 6-12: Window Type



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

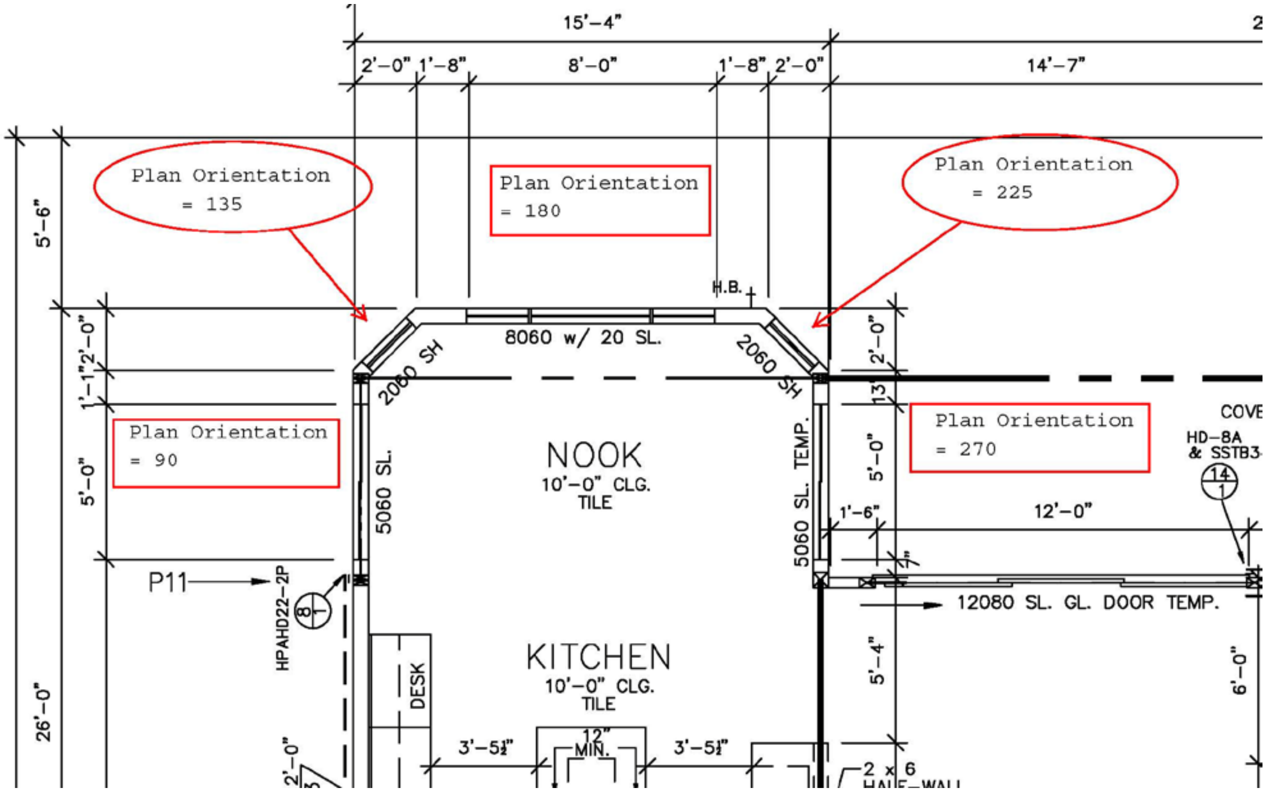


7.1 Orientation

The orientation of walls, windows, and any orientation other than front orientation is the plan 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 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).

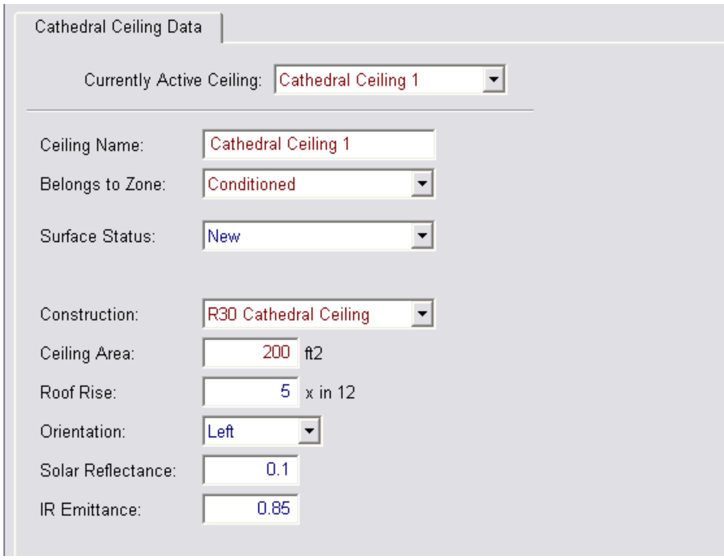
7.2.1.4 Ceiling Area

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 Surface Status

The default condition is new for new construction. Other options include existing and altered.

7.2.2.4 Construction

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

7.2.2.5 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.

7.2.2.6 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

7.2.2.7 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.

7.2.2.8 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 5.3.2.6.

7.2.2.9 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 5.3.2.7.

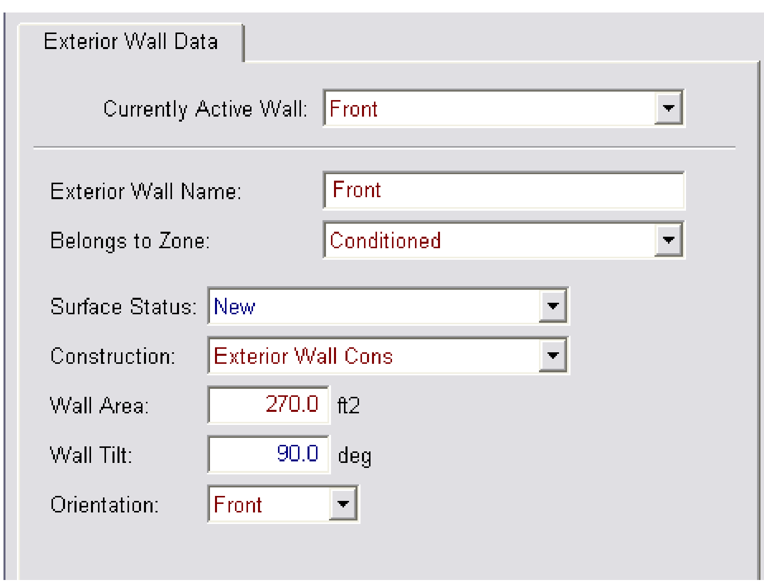
7.2.3 Knee Walls

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 Exterior 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 7-4.

Figure 7-4: Exterior Wall



7.2.4.1 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.

7.2.4.2 Belongs to Zone

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

7.2.4.3 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.

7.2.4.4 Construction

Pick one of the construction assemblies or create a new construction assembly (see Section 6.10)

7.2.4.5 Wall Area

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

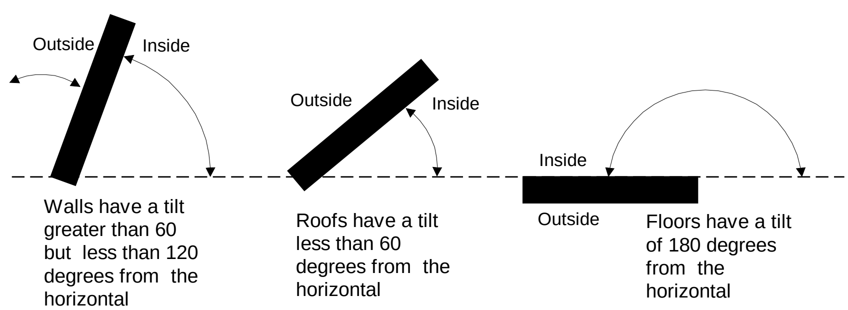
7.2.4.6 Wall Tilt

A wall typically has a tilt of 90 degrees but may range from greater than 60 degrees to less than 120 degrees (see Figure 7-5).

7.2.4.7 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.

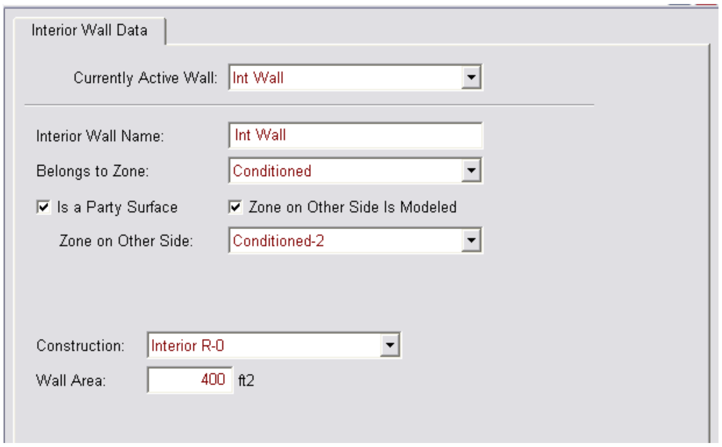
Figure 7-5: Surface Tilt



7.2.5 Party Walls and Surfaces

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 7-6).

Figure 7-6: Party Wall



When modeling an addition, the wall separating the addition from the house, garage, or other unconditioned space must be modeled. If the zone on the other side of the surface is not modeled (e.g., addition alone adjacent to garage), model the interior wall as a party surface.

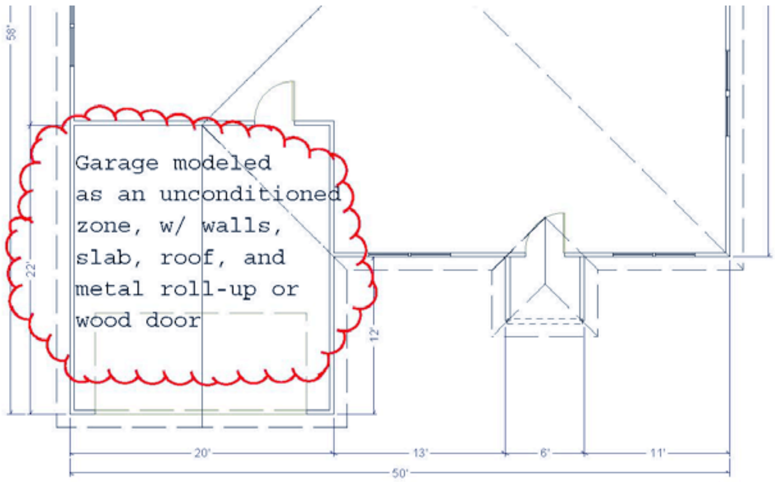
7.2.6 Garage Surfaces

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 7-7).

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).

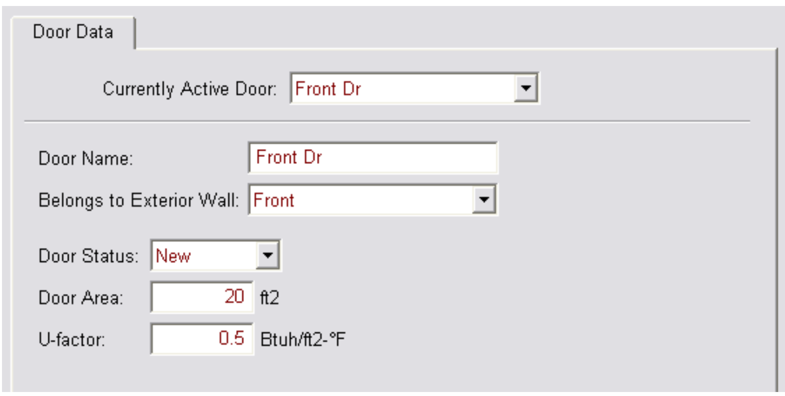
The surfaces that separate the house or conditioned zone from the garage are modeled with the conditioned zone as interior walls and interior floors (see Sections 6.10.3 and 6.11.3).

Figure 7-7: Attached Garage



7.2.7 Opaque Doors

Figure 7-8: 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 7.5.1). 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 7.5.4. The standard design building has the same area of opaque door as the proposed design building.

7.2.7.1 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.

7.2.7.2 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.

7.2.7.3 Door Status

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

7.2.7.4 Door Area

Enter the door area, in square feet.

7.2.7.5 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.

7.2.8 Garage Door

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

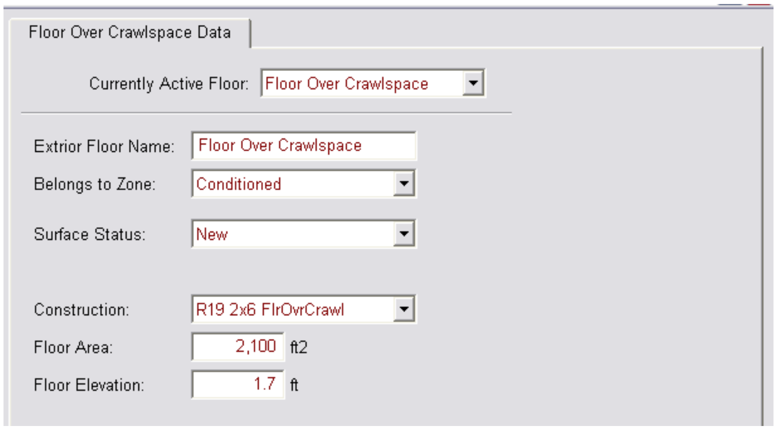
7.3 Raised Floor

When creating a raised floor over a crawl space, the software will create the associated crawl space zone. When a raised floor is over an unconditioned space, such as a garage, model this as an interior floor (with the adjacent zone being the garage).

A raised floor over exterior is when there is no crawl space and no unconditioned space underneath the floor (floor extends out beyond the first floor walls).

7.3.1 Floor over Exterior or Crawl Space

Figure 7-9: Raised Floor



7.3.1.1 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.

7.3.1.2 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.

7.3.1.3 Surface Status

Select New, Existing, or Altered.

7.3.1.4 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).

7.3.1.5 Floor Area

Area of the floor, in square feet.

7.3.1.6 Floor Elevation

Height above grade or the depth of crawl space, in feet. This value must be consistent with the zone information. If the crawlspace height is 2 feet, this value is also 2. If this is a second floor and the zone identifies the bottom of the zone as 2 with a floor to floor height of 10, this value is 12.

7.3.2 Interior Floor/Floor Over Garage

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

Figure 7-10: Garage or Interior Floor

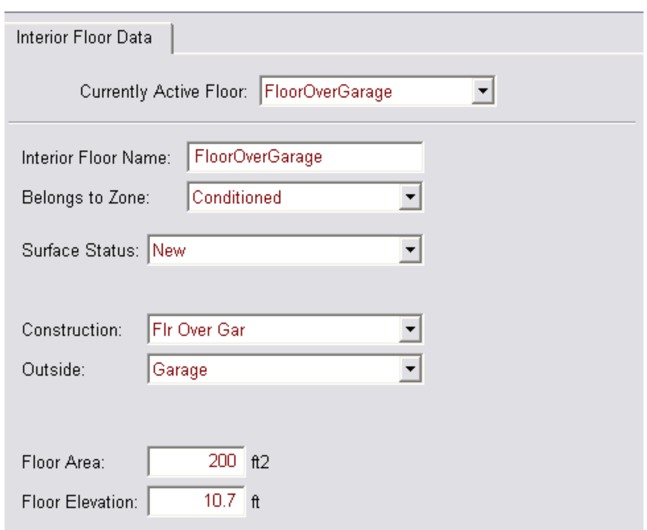
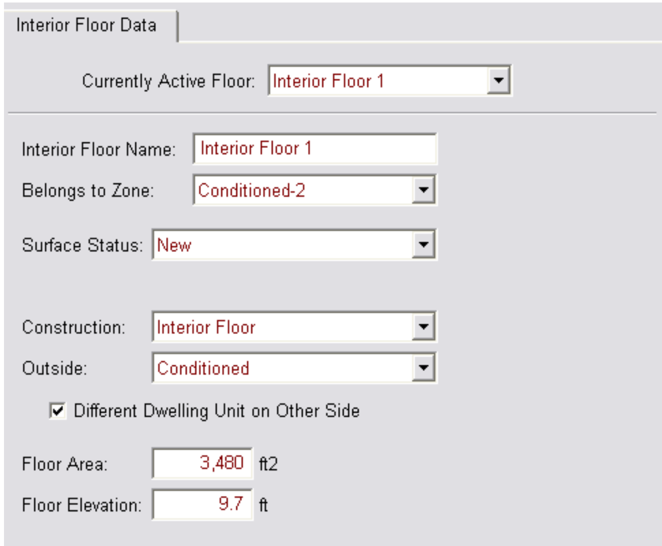


Figure 7-11: Multi-Family Interior Floor



7.3.2.1 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.

7.3.2.2 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.

7.3.2.3 Surface Status

Select New, Existing, or Altered.

7.3.2.4 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).

7.3.2.5 Outside

The outside condition or adjacent zone.

7.3.2.6 Different Dwelling Unit on Other Side

A checkbox(see Figure 7-11) 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.

7.3.2.7 Floor Area

Area of the floor, in square feet.

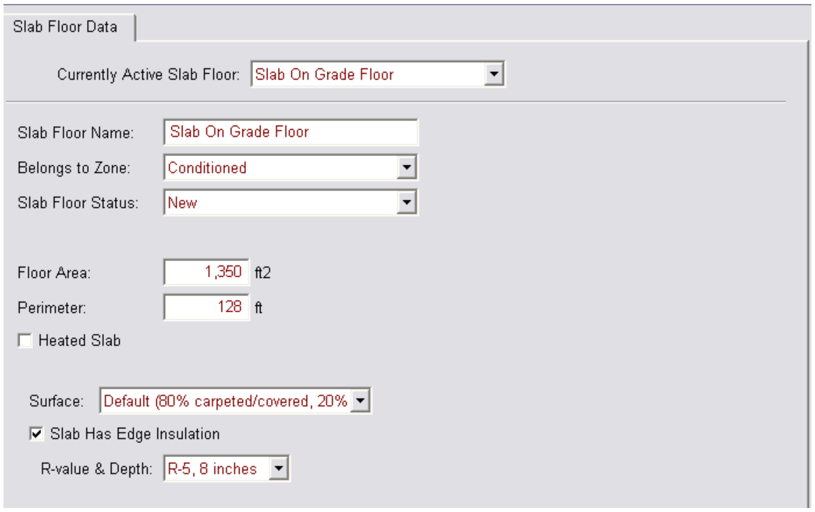
7.3.2.8 Floor Elevation

Height above grade, in feet. This value must be consistent with the zone information. If the bottom of the zone is 0.7 and the floor to floor height is 10, this value is 10.7.

7.4 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 7-12: Slab Floor Data



7.4.1.1 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.

7.4.1.2 Belongs to Zone

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

7.4.1.3 Slab Floor Status

Select New, Existing, or Altered.

7.4.1.4 Floor Area

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

7.4.1.5 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).

7.4.1.6 Heated slab

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

7.4.1.7 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.

7.4.1.8 Slab Has Edge Insulation

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

7.4.1.9 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.

7.5 Windows

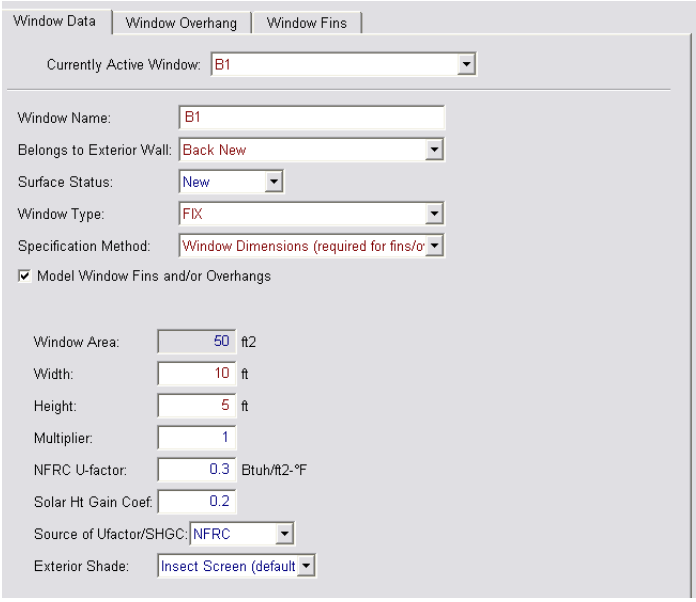
The 2013 Standards establish a maximum weighted average U-factor of 0.58 (Section 150.0(q)) for fenestration, including skylights. The exception allows the greatest of 10 ft^2 or 0.5 percent of the conditioned floor area to exceed the maximum 0.58 U-factor.

Create a library of window types using either default values or product specific values for U-factor and SHGCs (see 6.12). 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.

7.5.1 Windows Data

Right-click on the wall to which you will add windows and pick <create> and select window. The screen shown in Figure 7-13 is displayed.

Figure 7-13: Window Data



7.5.1.1 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.

7.5.1.2 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.

7.5.1.3 Surface Status

Select new, altered or existing.

7.5.1.4 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.”

7.5.1.5 Specification Method

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

7.5.1.6 Model Window Fins and/or Overhangs

Check box is available only when Section 7.5.1.4 is set to window dimensions.

7.5.1.7 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 $3^0 5^0$ windows, enter window area “15” ft^2 and multiplier “3.”

7.5.1.8 Width

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

7.5.1.9 Height

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

7.5.1.10 Multiplier

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

7.5.1.11 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.

7.5.1.12 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.

7.5.1.13 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.

7.5.1.14 Exterior Shade

Default bug screens for windows, none for skylights.

7.5.2 Window Overhang

Under the Window Overhang tab (see Figure 7-14) enter the overhang dimensions and position.

7.5.2.1 Depth

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

7.5.2.2 Distance Up

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

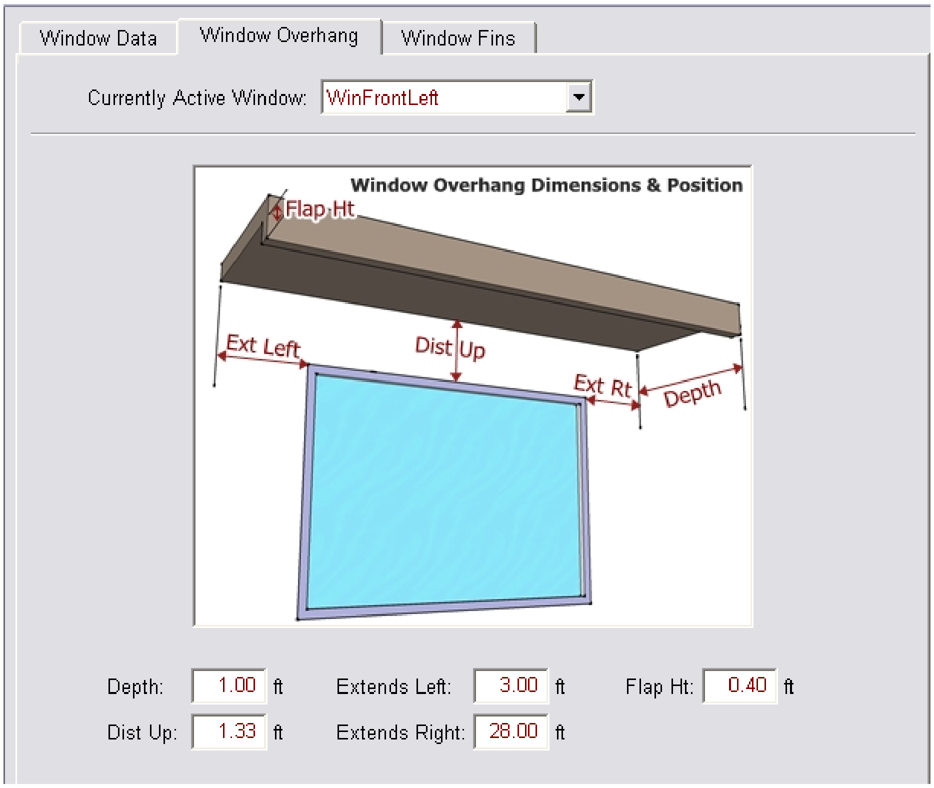
7.5.2.3 Extends Left

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

7.5.2.4 Extends Right

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

Figure 7-14: Overhang



7.5.2.5 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.

7.5.3 Window Fins

A window fin is a building feature that provides shading benefit to a window (for example, a recessed entry area). Figure 7-15 shows inputs found in the Window Fins tab.

7.5.3.1 Left Fin Depth

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

7.5.3.2 Distance Left

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

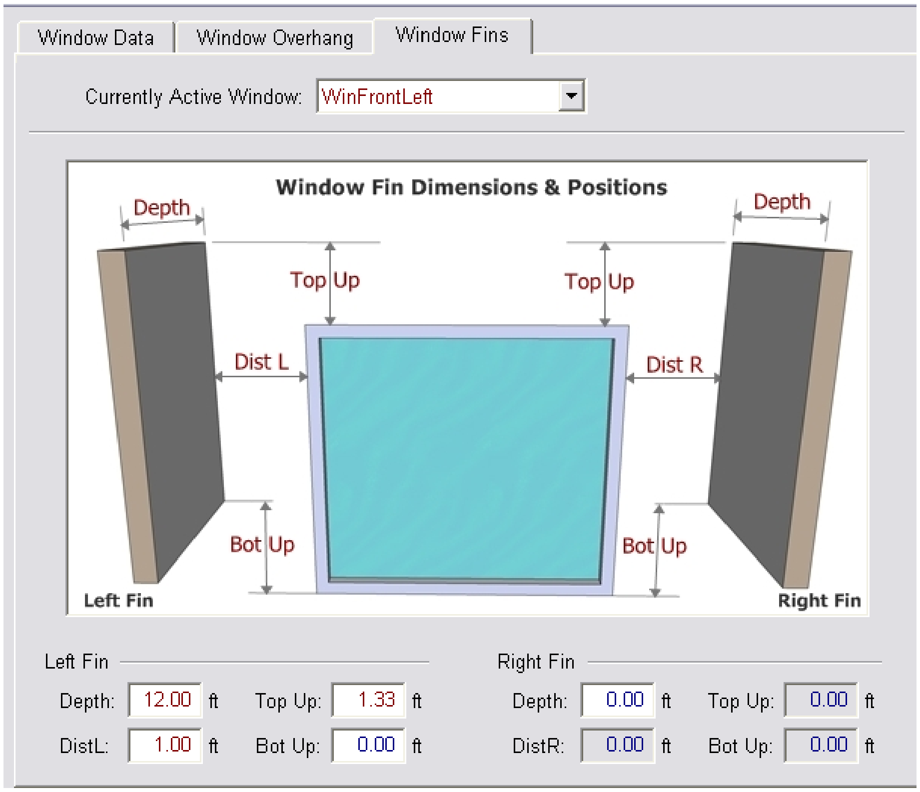
7.5.3.3 Top Up

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

7.5.3.4 Bottom Up

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

Figure 7-15: Window Fin



7.5.3.5 Right Fin Depth

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

7.5.3.6 Distance Right

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

7.5.3.7 Top Up

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

7.5.3.8 Bottom Up

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

7.5.4 Glass Doors

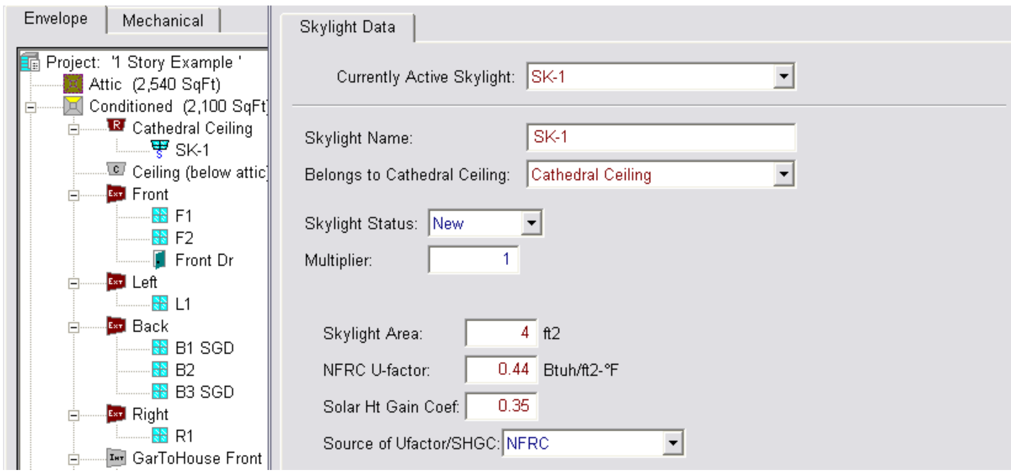
For a door with 50 percent or more glass area, or a door with an NFRC rating, the entire door area is modeled as a window.

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 7.2.5).

7.6 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 7-16).

Figure 7-16: Skylight



7.6.1.1 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.

7.6.1.2 Belongs to Cathedral Ceiling

Defaults to the cathedral ceiling on which you picked create.

7.6.1.3 Skylight Area

Area of the skylight (in square feet).

7.6.1.4 Skylight Status

Select New, Existing, or Altered.

7.6.1.5 Multiplier

The number of identical skylights.

7.6.1.6 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.

7.6.1.7 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.

7.6.1.8 Source of U-factor/SHGC

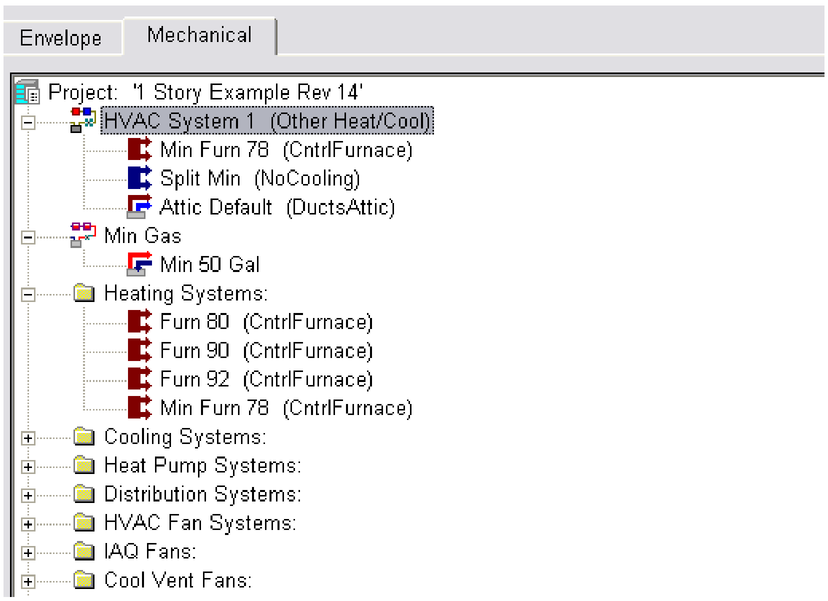
The three valid sources are NFRC, default, or Alternate Default Fenestration Procedure (ADFP). See Section 7.5.1.13.

Chapter 8. Mechanical Systems

The heating, cooling, duct/distribution system and space conditioning fans are defined at the zone level (see Section 5.5.1.10). 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.

Libraries of equipment can be added to an input file for any of the systems and fan types. In the figure below, the file has four furnaces with different efficiencies. A piece of equipment is only used when it is defined as part of the HVAC system data (see Figure 8-2).

Figure 8-1: Mechanical Tab



NOTE: Mini-split, multi-split, evaporative cooling, room air conditions, room heat pumps and ground source heat pumps—Until an exceptional method is approved, 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

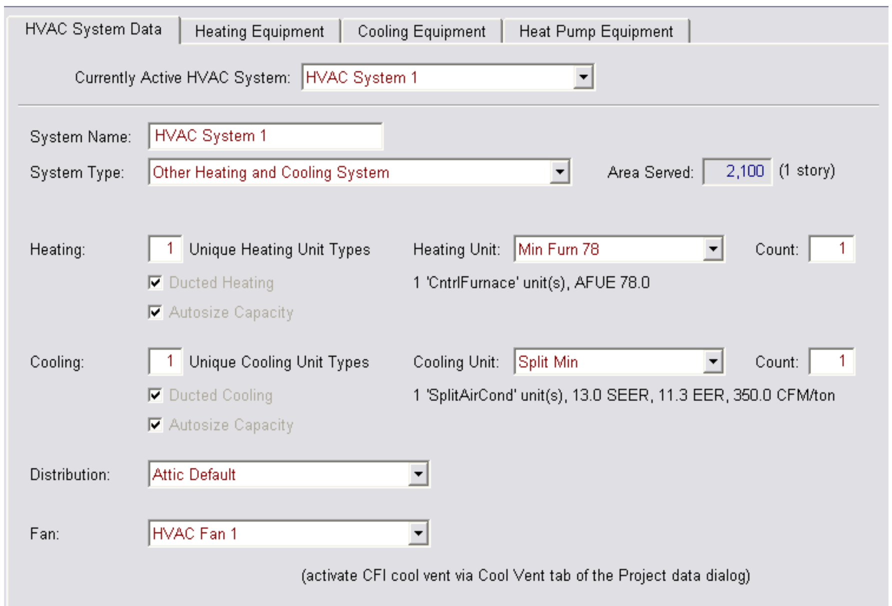
User-defined name.

8.1.1.2 System Type

Select the correct system type as:

- Heat pump heating and cooling system,
- [Not yet implemented] Variable outdoor air ventilation central heat/cool system for central fan integrated night ventilation cooling - *variable* speed (for example, NightBreeze™), or
- Other heating and cooling system for typical HVAC systems or for central fan integrated night ventilation [not yet implemented] cooling - *fixed* speed (for example, SmartVent™).

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 identical systems. When modeling multiple efficiencies in a single zone, the worst case efficiency is assumed in the compliance analysis.

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. When modeling multiple efficiencies in a single zone, the worst case efficiency is assumed in the compliance analysis.

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

{not yet implemented]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. In some cases “none” can be modeled. For example, where a default system with ducts is assumed (e.g., no cooling, mini-split heat pump), the software can simulate this with a user input of “none.”

8.1.1.12 Fan

Name of the HVAC fan system, details of which are specified in Section 8.5. If a system type does not have a fan (e.g., combined hydronic, wall furnace), or if there is no cooling system, a value of “none” may be modeled. If using central fan integrated night ventilation cooling, this is the furnace fan that operates in ventilation mode.

8.1.2 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, the compliance program will use the lowest efficiency.

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.

8.1.3 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 4.4.1.9

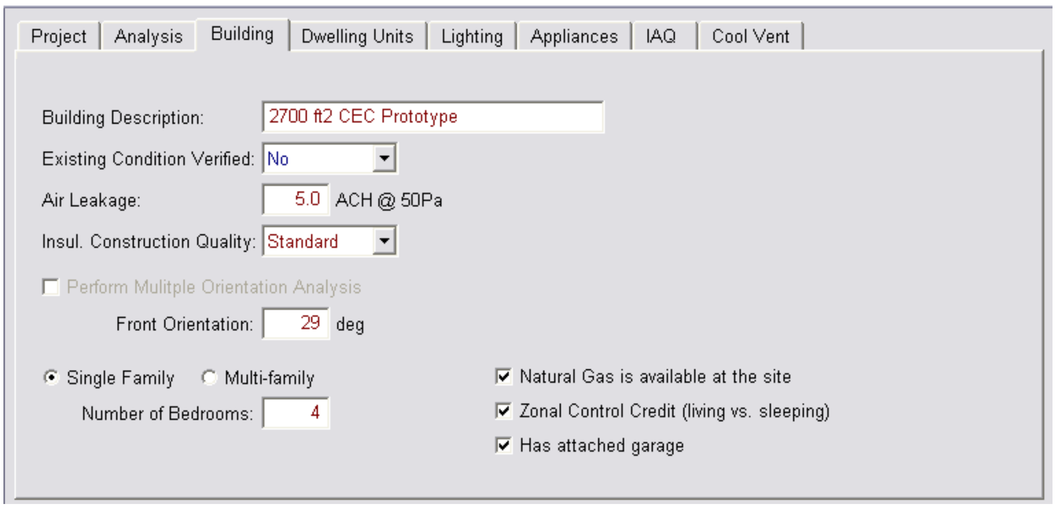
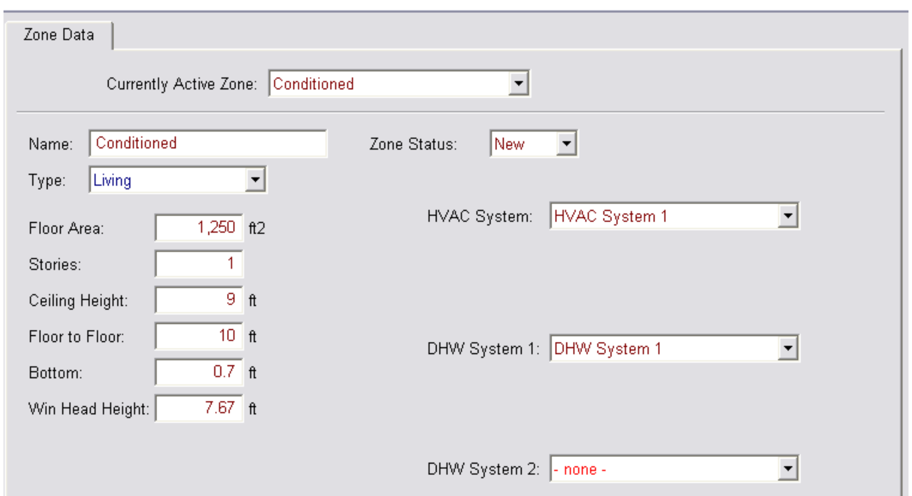


Figure 8-4: Type from Section 5.5.1



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). In version 3, all of the heating systems types are enabled.

8.2.1.3 Efficiency

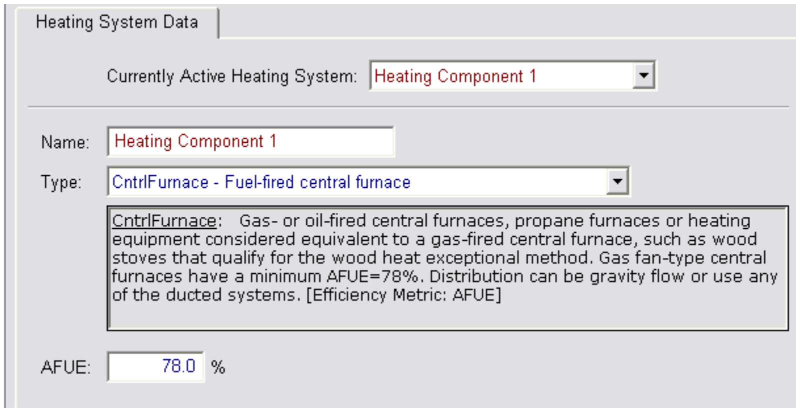
Enter an appropriate efficiency for the equipment type (e.g., 80.6 AFUE). The software will include the minimum efficiency for typical system types. Efficiency information for a specific model number of heating and cooling equipment is found by performing an “advanced search” in the Energy Commission’s 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 8.2.10.

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 using Equation 8-1.

Equation 8-1: HSPF = (3.2 x 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). CBECC has default values for the EER based on the SEER value modeled. Two conditions will result in a HERS verified EER. (a) An EER higher than the default of 11.3 for “Compliance 2014” or higher than 11.7 for “Compliance 2015”, and (b) checking the box “☑ Use this EER in compliance analysis.” Because the EER depends on the specific combination of coil and condenser model numbers, other than default EER ratings can 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.

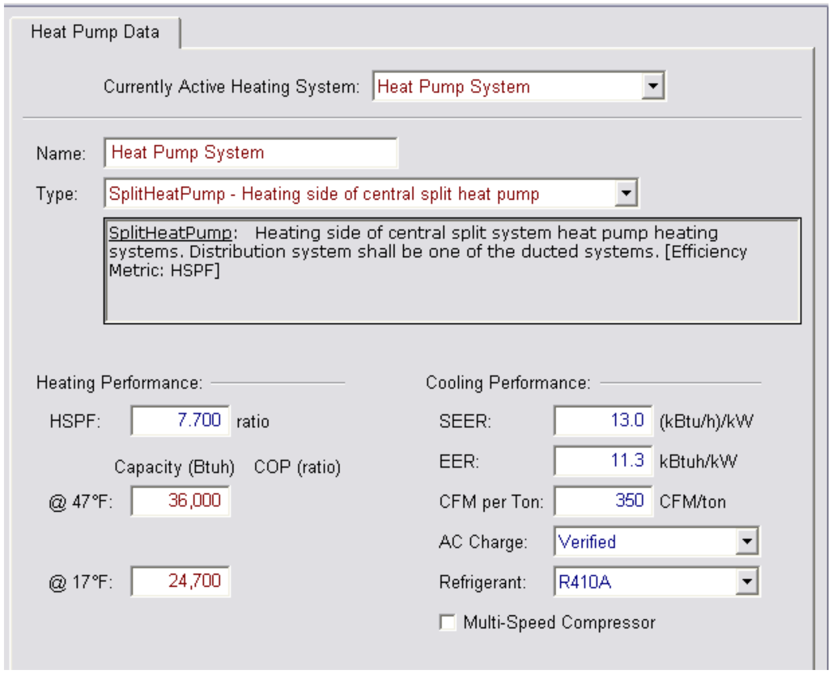
8.2.2.11 Multi-Speed Compressor

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. [Efficiency metric: COP]
Room Heat Pump	A factory encased heat pump that is designed as a unit for mounting in a window, through a wall, or as a console. 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: COP, 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.

An example file included with the program (1StoryHVACExample16.ribd) contains an air to water source heat pump system. If the system provides water heating, see Section 9.8.

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

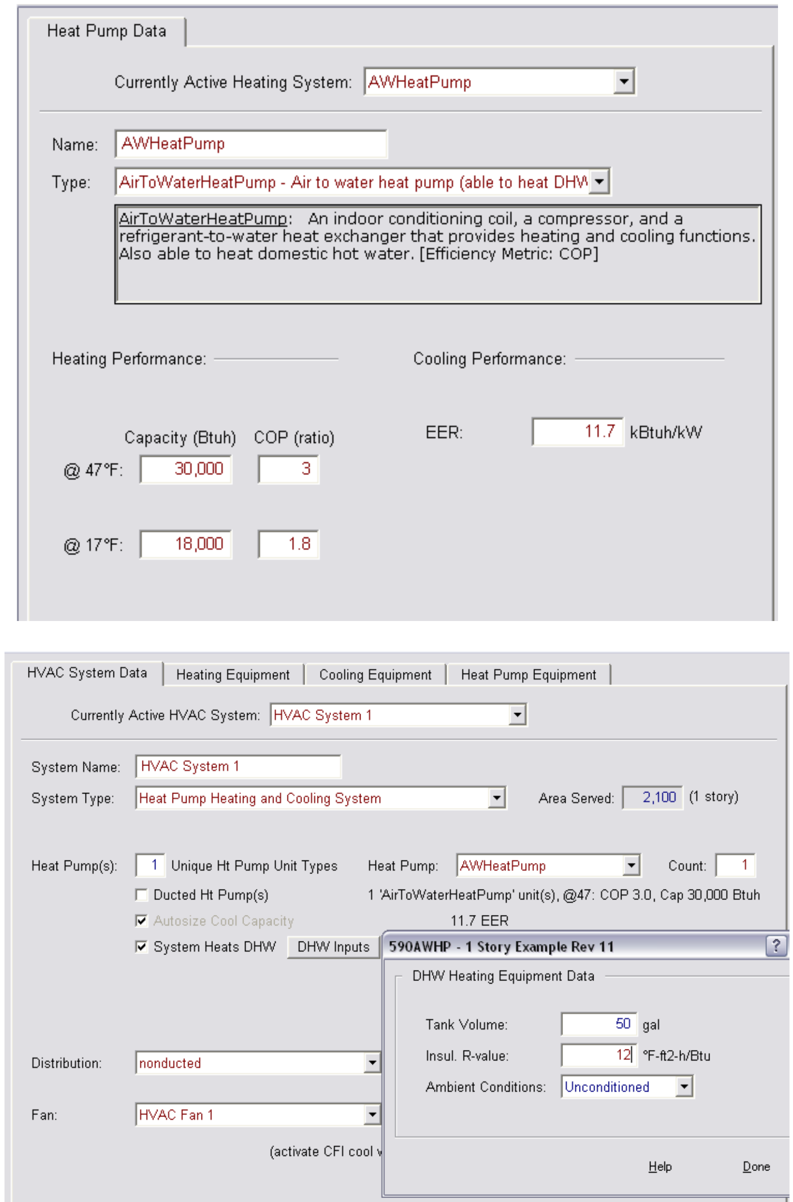
Required value from the AHRI Certified Products Directory http://www.ahridirectory.org.

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

Because there is no current method for simulating the performance of these systems, they are modeled as equivalent to a standard design ducted system (split system heat pump). The characteristics modeled are reported on the CF1R.

An example file included with the program (1StoryHVACExample16.ribd) contains a ground source heat pump system. If the system provides water heating, see Section 9.8.

8.2.4.1 Name

User-defined name for the system.

8.2.4.2 Type

Heat pump system type is Ground Source Heat Pump (as shown in Table 8-2).

8.2.4.3 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.

8.2.4.4 Capacity

Capacity of the proposed heat pump model.

8.2.4.5 . EER

Cooling equipment Energy Efficiency Ratio (EER).

8.2.5 Mini-Split Heat Pump

See Figure 8-8 for mini-split or multi-split heat pumps input screens. An example file (1StoryHVACExample16.ribd) is included in the projects folder. Distribution system and fan can be set to "none" on the HVAC System Data screen (see Figure 8-2).

8.2.5.1 Name

User-defined name for the system.

8.2.5.2 Type

Heat pump system type is ductless heat pump (from Table 8-2).

8.2.5.3 Heating Performance

Enter the Heating Seasonal Performance Factor (HSPF) for a specific model number from the AHRI Certified Products Directory http://www.ahridirectory.org.

8.2.5.4 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).

8.2.5.5 Capacity @ 17 Degrees F

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

8.2.5.6 SEER

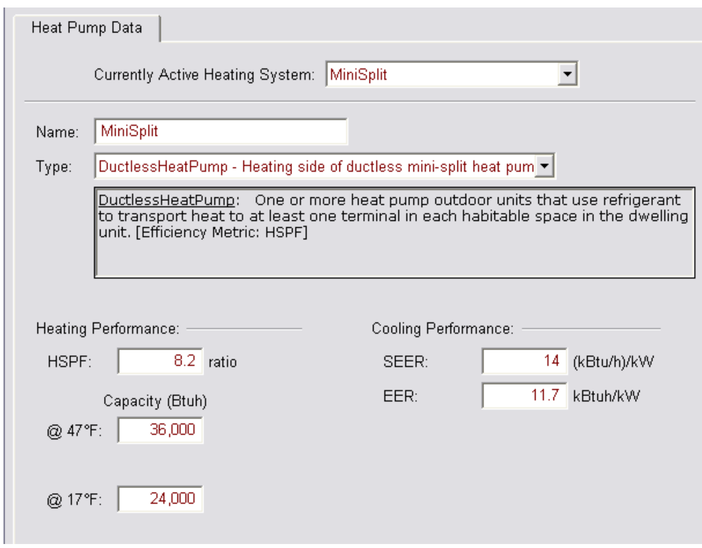
Cooling equipment Seasonal Energy Efficiency Ratio (EER).

8.2.5.7 EER

Cooling equipment Energy Efficiency Ratio (EER).

Required inputs for a mini-split or multi-split heat pump are the HSPF, capacity at 47°F and 17°F, the SEER and EER. Mini-split and multi-split heat pumps are assumed to be equivalent to a standard design ducted HVAC system.

Figure 8-8: Mini-Split Heat Pump Data

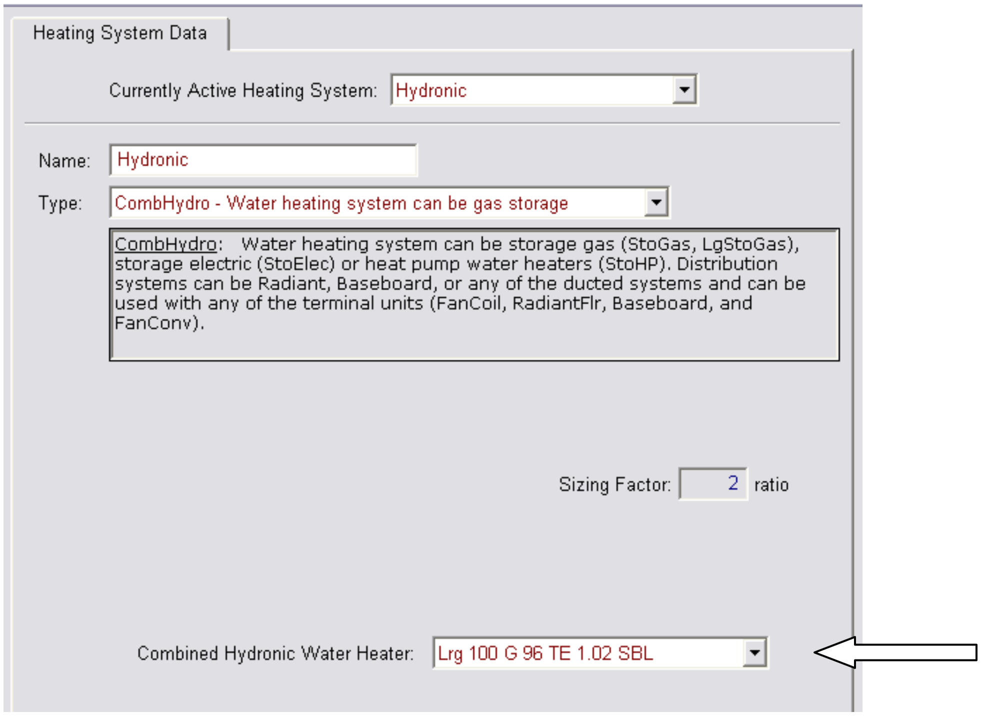


8.2.6 Hydronic Heating and Combined Hydronic Heating

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 source for the space and/or water heating, which may be a boiler or a water heater (see Figure 8-9).

An example file included with the program (2StoryExample16.ribd) is a combined hydronic system using a boiler.

Figure 8-9: Hydronic Heating Data



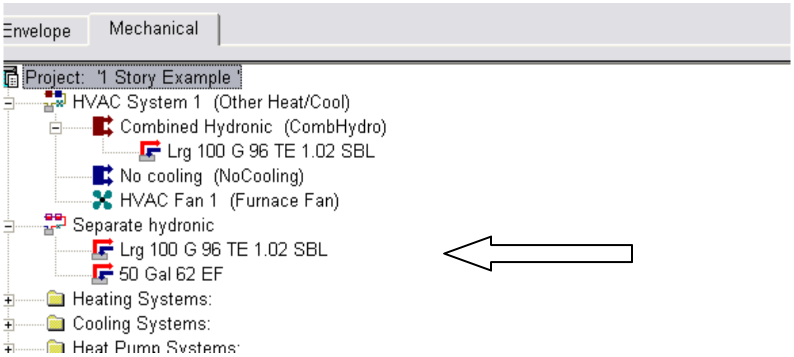
8.2.6.1 Water Heating, Combined Hydronic

To receive the full credit for a combined hydronic system, rather than leaving the water heating field as “none”, list the same device providing the space heating as the water heating system (for example, Lrg 100 G 96 TE 1.02 SBL).

8.2.6.2 Water Heating, Separate

If the system has a separate water heater, list both the device providing space heating and the device providing water heating as shown below (for example, Lrg 100 G 96 TE 1.02 SBL plus a 50-gallon gas water heater).

Figure 8-10: Hydronic Water Heating (Separate)



8.2.7 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-ft²- °F/Btu).* The installed R-value of the pipe insulation. Minimum pipe insulation for hydronic systems is as specified in Section 150.1(j).

8.2.8 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”).

8.2.9 Electric Heat (other than heat pump)

Electric heat is modeled with a default efficiency of 3.413 HSPF.

8.2.10 Non-central Heating

Wall and floor furnaces, or any non-central gas heating systems are modeled with a default efficiency.

For the distribution system, model either “none” or a “distribution systems without ducts” as specified in Section 8.4.1.2. **Error! Bookmark not defined.**

8.3 Cooling Systems

The cooling system is the equipment that supplies cooled air to an HVAC System (see Figure 8-11). 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. 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]
EvapCondenser	Evaporatively-cooled condenser. The default distribution system is duct in attic; evaporatively cooled condenser duct insulation requirements are the same as those for air conditioner ducts. Requires refrigerant charge testing, EER verification, and compliance with RA4.3.2. [Efficiency metric: EERa and EERb]
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 air conditioner that is designed as a unit for mounting in a window, through a wall, or as a console. 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

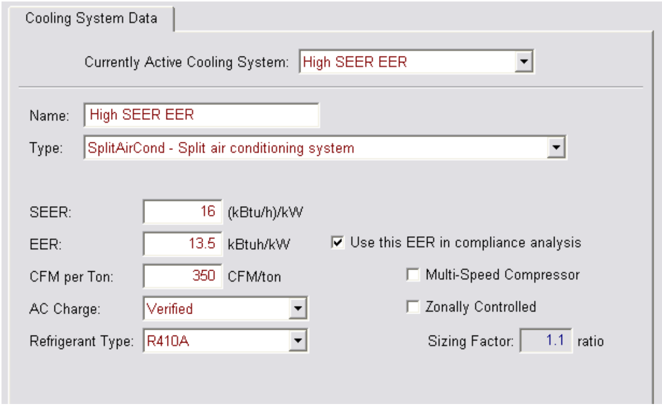
8.3.1.1 Name

User-defined name for the cooling system.

8.3.1.2 Type

Cooling system type (see Table 8-3).

Figure 8-11: 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). CBECC has default values for the EER based on the SEER value modeled. Two conditions will result in a HERS verified EER. (a) An EER higher than the default of 11.3 for "Compliance 2014" or higher than 11.7 for "Compliance 2015", and (b) checking the box "☑ Use this EER in compliance analysis." Because the EER depends on the specific combination of coil and condenser model numbers, other than default EER ratings can 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.

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).

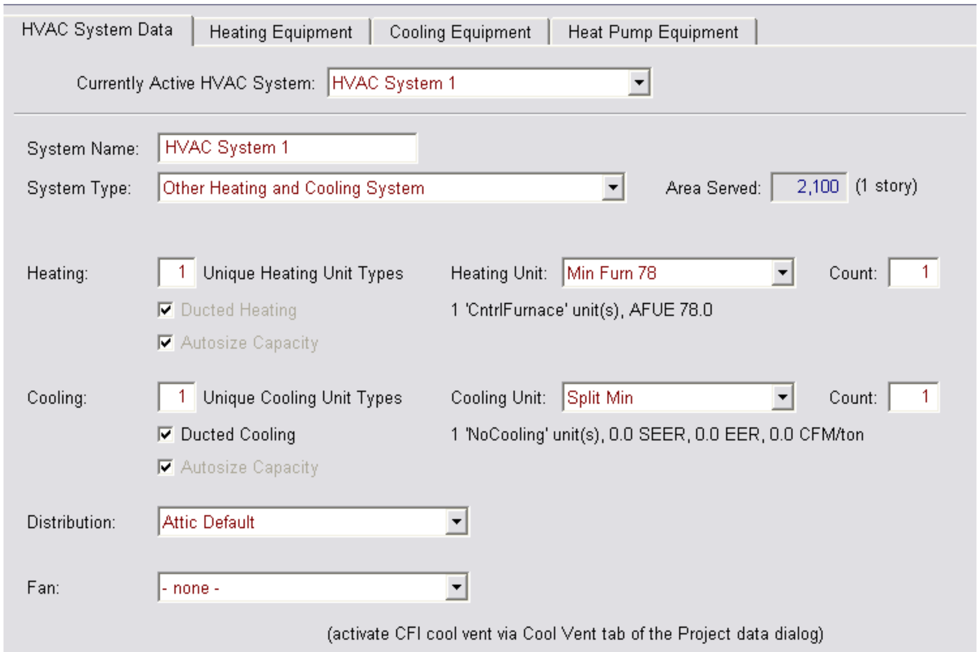
8.3.2 No Cooling

When no cooling system is installed in a dwelling, create a cooling system using the system type NoCooling (see Figure 8-12).

The software sets the default cooling system to a ducted split system air conditioner that exactly meets Package A for the efficiency, airflow, and refrigerant charge for both the proposed and standard design. The duct system should be the same as the heating system ducts (if any), or a system equivalent to Package A (NOTE: the software will model the appropriate conditions).

The fan system can be set to none.

Figure 8-12: No Cooling System



8.3.3 Evaporatively Cooled Condensing

This type of air conditioning is suited for hot dry climates. The efficiencies are reported as multiple EER values at different conditions. More information can be obtained from the 2013 Residential Manual, Section 4.7.9 and a full list of compliance requirements is included in the 2013 Residential Appendices, Residential Appendix RA4.3.2. Requires HERS verification of EER, refrigerant charge, and duct leakage testing.

An example file (1StoryExample16EvapCond.ribd) is included in the projects folder.

8.3.3.1 EERa

EER at 95°F dry bulb and 75°F wet bulb, obtained from AHRI Certified Products Directory http://www.ahridirectory.org.

8.3.3.2 EERb

EER at 82°F dry bulb and 65°F wet bulb. This value must be tested and published by the manufacturer according to AHRI guidelines.

8.3.4 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”.

8.3.5 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).

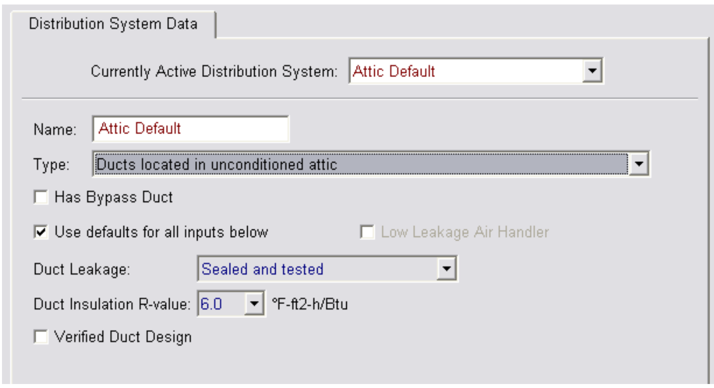
Direct evaporative coolers are assumed to be equivalent to a minimum split system air conditioner. The evaporative cooling modeling methodology addresses two performance issues: (1) rising indoor relative humidity during periods with extended cooler operation, and (2) evaporative cooler capacity limitations. 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

Model the distribution system (ducts) associated with the HVAC system within a given zone. 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 8-13: 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).

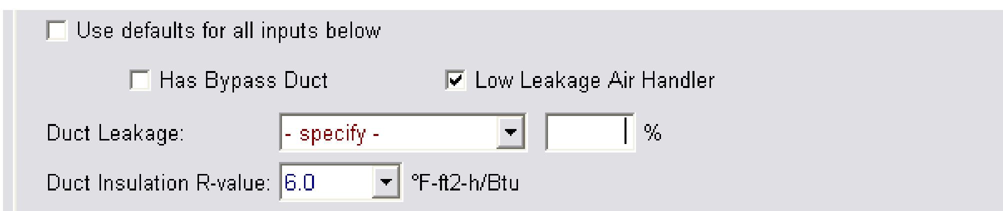
Table 8-6 summarizes the duct conditions that require HERS verification, including sealed and tested ducts, which are a mandatory requirement.

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 8-14: Duct Leakage



8.4.1.4 Duct Leakage

Select sealed and tested. To specify a target leakage number, select Low Leakage Air Handler (see Figure 8-14). 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 attic	Ducts located overhead in the attic space (and default condition for no cooling).
Ducts located in a crawl space	Ducts located in crawl space.
Ducts located in a garage	Ducts located in 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 window air conditioners, 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 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. Buried ducts shall have a minimum of R-4.2 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 8-15) 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 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 8-15) and enter the return duct length (in feet) for ducts installed in lowered areas of ceiling and covered by at least 3.5 inches of insulation above the top of the duct insulation jacket. Model R-25 duct R-value for fiberglass ceiling insulation or R-31 duct R-value for cellulose ceiling insulation.

Figure 8-15: Buried Ducts

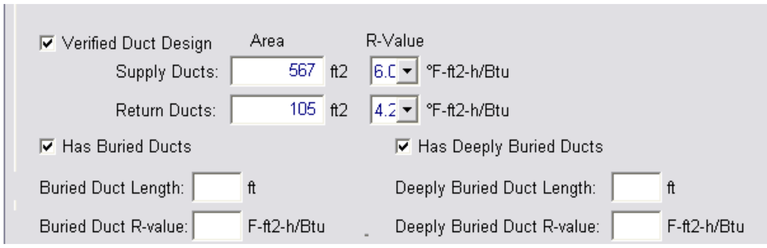


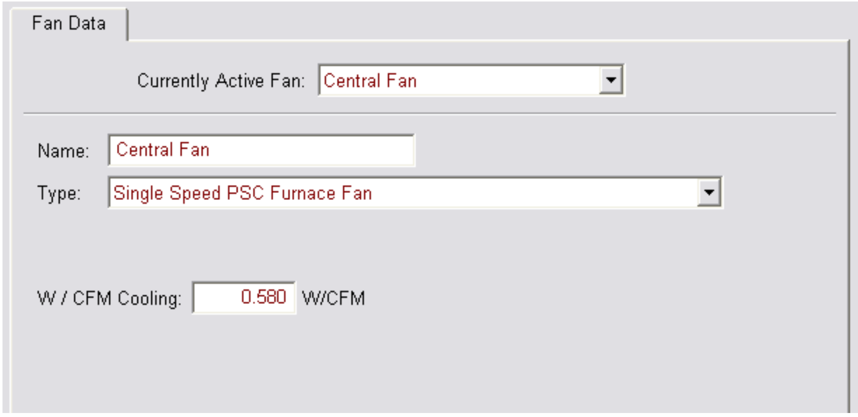
Table 8-7: Buried Duct Effective R-values

	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 8-16: HVAC Fan



8.5.1.1 Name

User-defined name.

8.5.1.2 Type

Default single speed furnace fan.

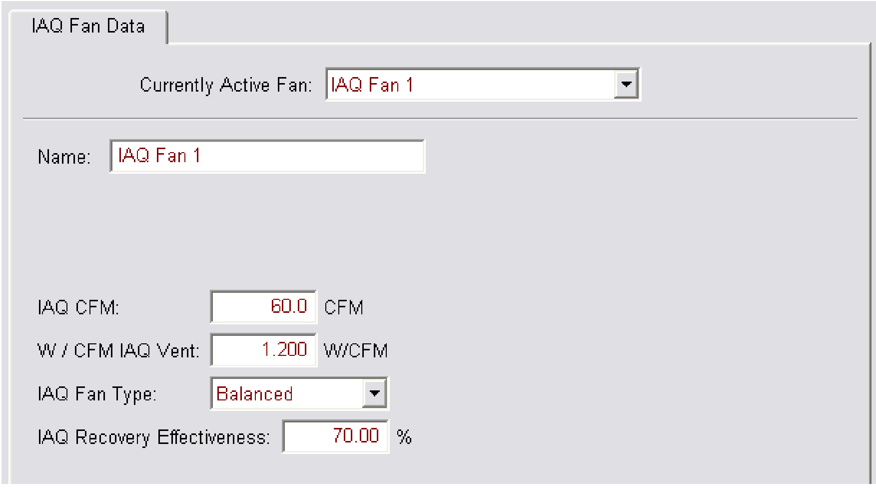
8.5.1.3 Watts/CFM Cooling

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 8-17: 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

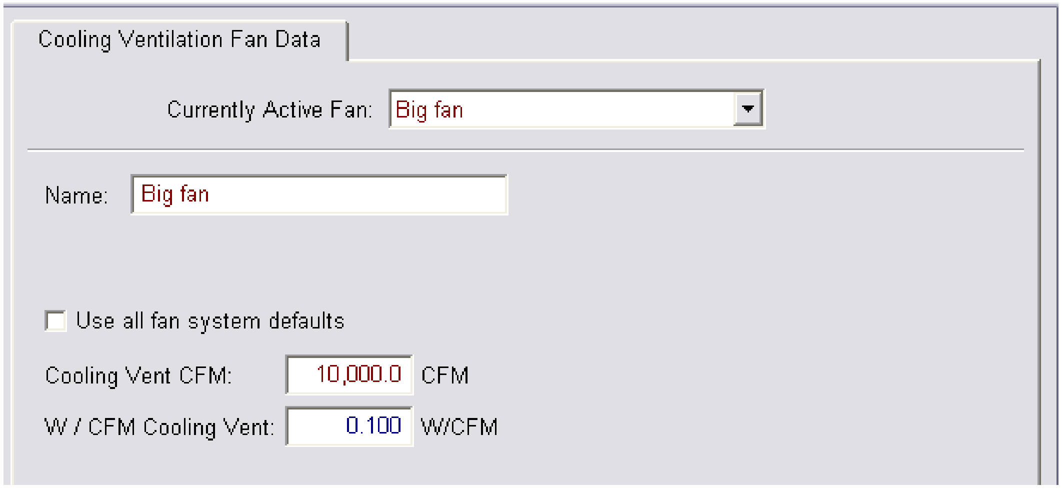
When the fan type is balanced, enter the IAQ Recovery Effectiveness.

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 8-18: 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 5.5.1.11), 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 energy factor used to establish the standard design changes for small water heaters effective April 16, 2015.

Type	Volume	Current	Effective April 16, 2015
Gas-fired storage	≤ 55 gallons	0.67-(0.0019 x Volume)	0.675-(0.0015 x volume)
	> 55 gallons		0.8012-(0.00078 x Volume)
Electric storage	≤ 55 gallons	0.97-(0.00132 x Volume)	0.960-(0.0003 x Volume)
	> 55 gallons		2.057-(0.00113 x Volume)

For a 50-gallon water heater, the change is from 0.575 to 0.60 Energy Factor for gas and 0.904 to 0.945 Energy Factor for electric.

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

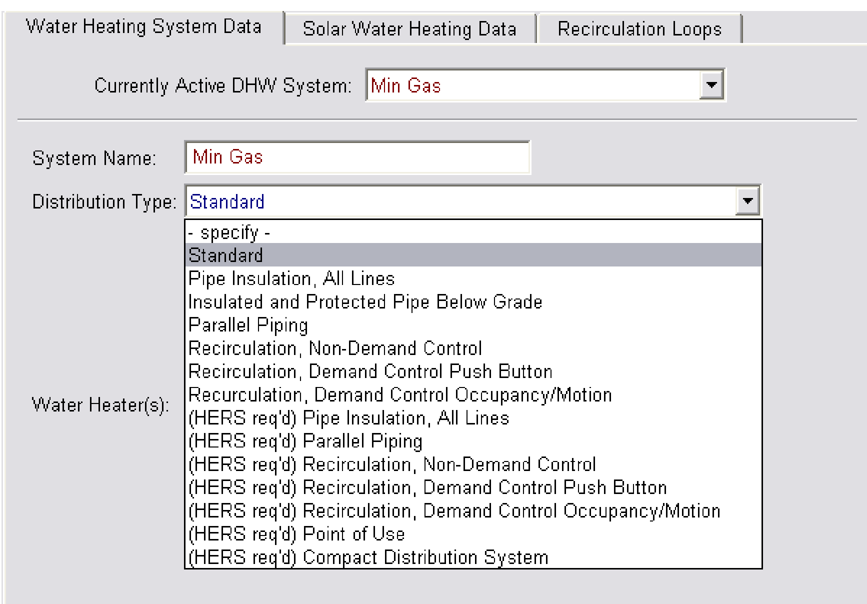


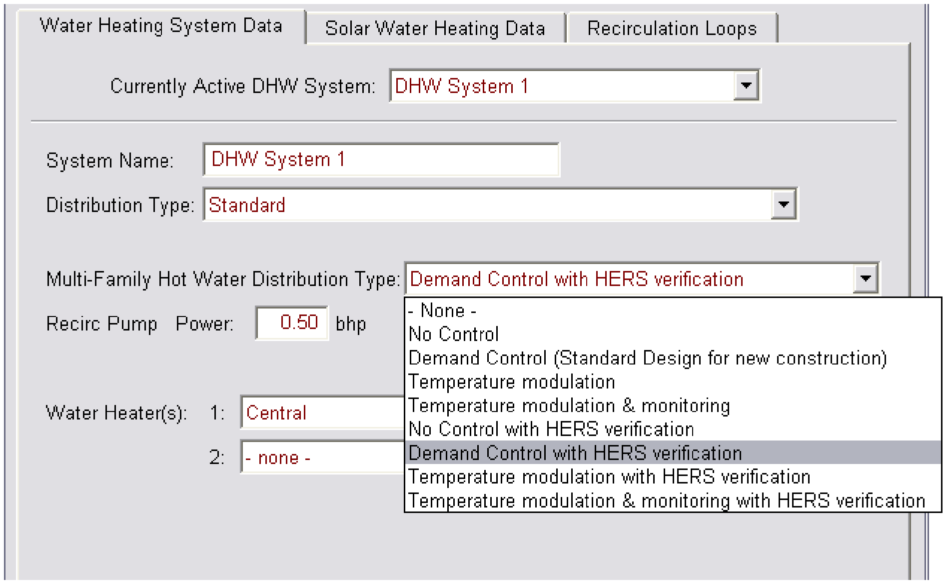
Table 9-1: Water Heater Distribution System Multipliers

Distribution System	Distribution System Multiplier
NO HERS INSPECTION REQUIRED	
Standard	1.00
Pipe Insulation, All Lines	0.90
Parallel Piping	1.05
Recirculation, Non-demand Control (no control, runs 24 hrs/day)	9.00
Recirculation, Manual Demand Control Push Button	1.60
Recirculation, Demand Control Occupancy/Motion	2.40
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	1.45
Recirculation, Demand Control Occupancy/Motion	2.20
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 5.5.1.11).

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	

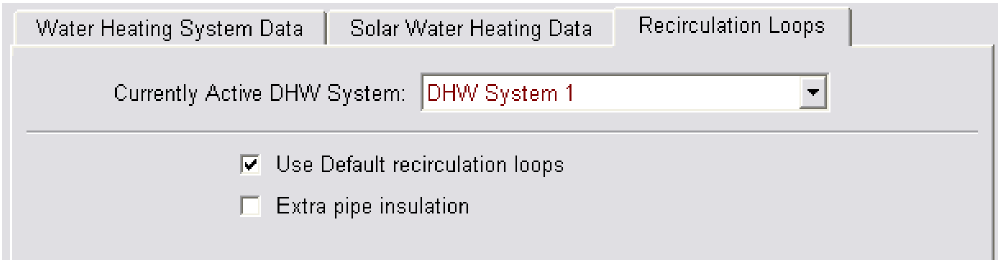
9.4.1.6 Water Heater(s)

The name of the water heater (which holds more information about the water heater, see Section 5.5.1.11).

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

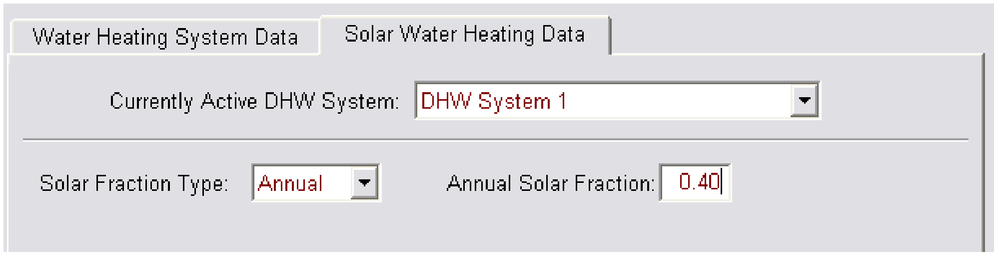
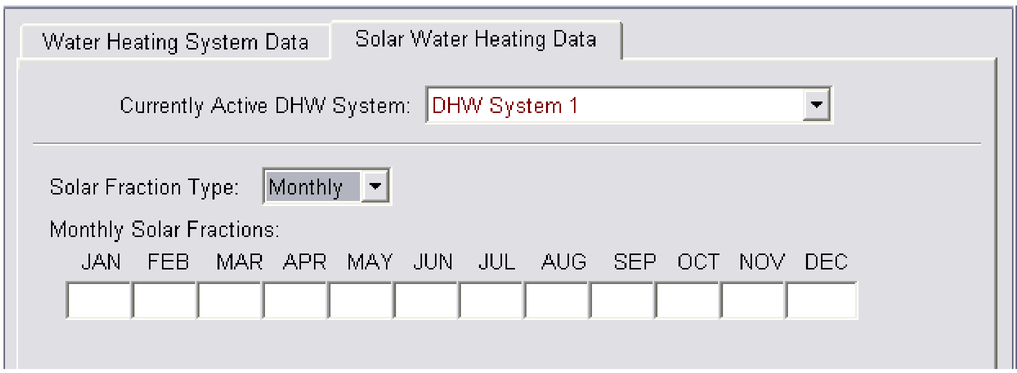


Figure 9-5: Solar Water Heating Data, Monthly



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

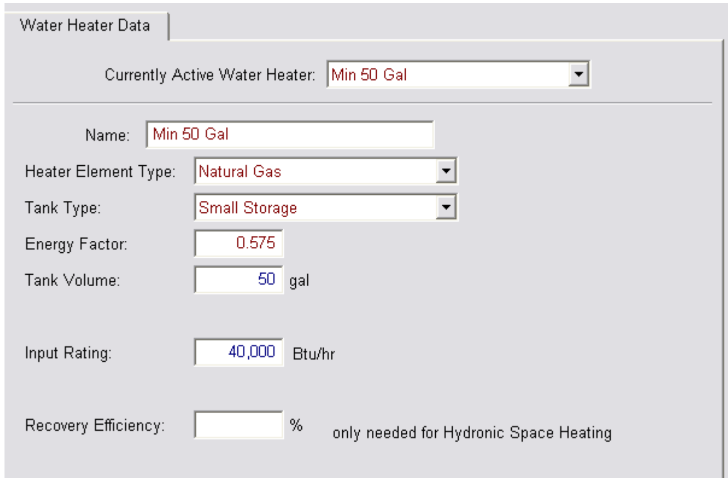
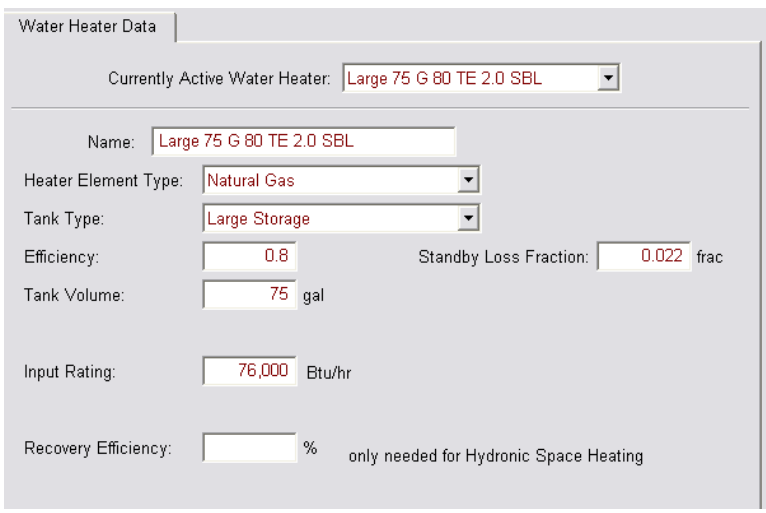


Figure 9-7: Large Storage Water Heater Data



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 or Pilot Energy

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)

There is no source for pilot energy. Leave this value as 0.

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).

9.7 Hydronic and Combined Hydronic

A combined hydronic system uses a device typically used for water heating for both space heating and water heating. If there is a device that is only providing water heating, this is a separate hydronic system.

9.8 Ground Source Heat Pump and Air to Water Heat Pump

The water heating portion of a ground source heat pump or air to water heat pump is modeled by first defining the HVAC system, as described in Section 8.2.3 and checking the box “System Heats DHW” or domestic hot water.

The inputs for the water heating equipment data are:

9.8.1.1 Tank Volume

Enter the tank volume (in gallons).

9.8.1.2 Insulation R-value

R-value of external tank insulation.

9.8.1.3 Ambient Conditions

Specify whether it is installed in unconditioned or conditioned space.

The final step is to connect the HVAC system to the DHW system. In this example, an HVAC system named Ground Source HP was specified and can be selected to serve as the water heating system for the zone. Once this connection is made, the mechanical tab will look like Figure 9-9 (in order to refresh the screen, click on the envelope tab and then the mechanical tab).

Figure 9-8: Water Heater from an HVAC System

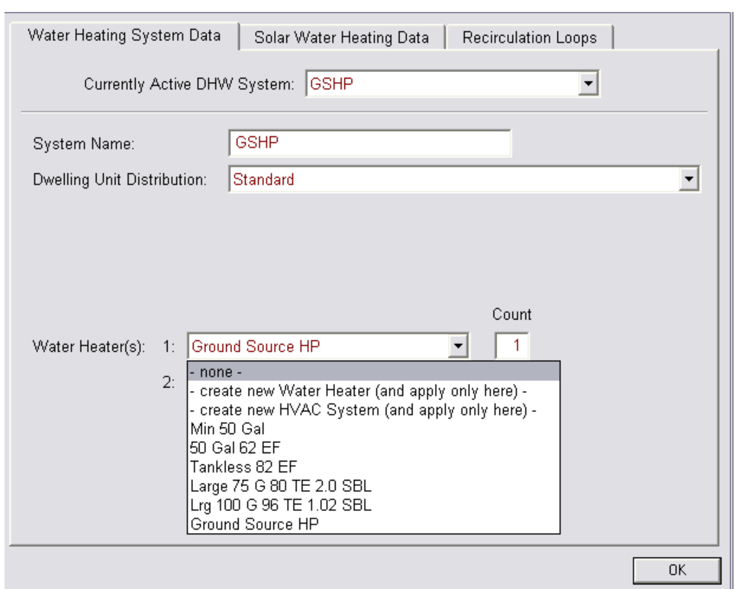
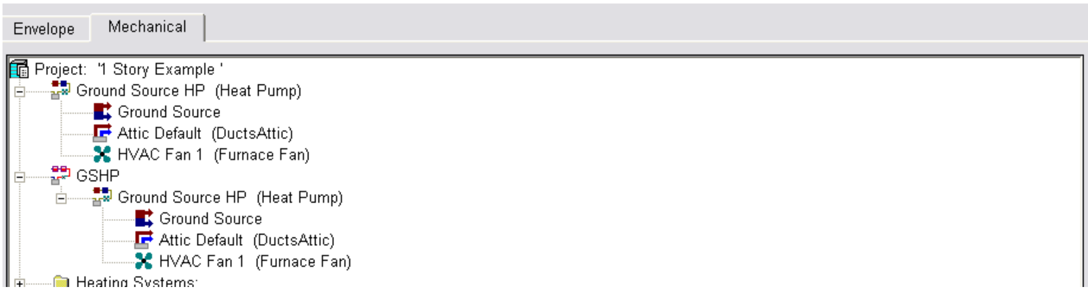


Figure 9-9: Water Heating Screen When from HVAC

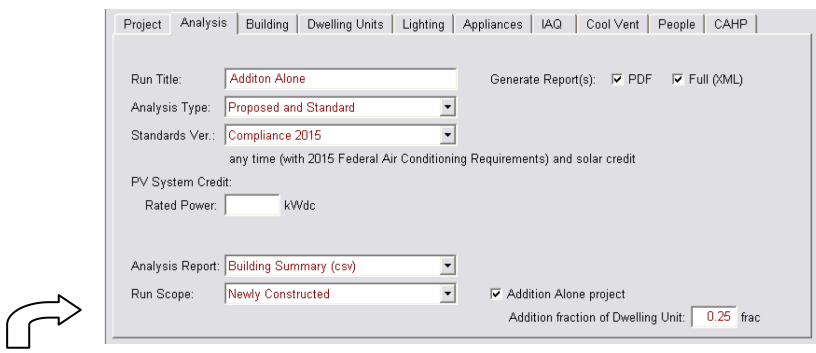


Chapter 10. Additions and Alterations

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) as Alteration and/or Addition which includes any case exception Addition Alone.

Figure 10-1: Run Scope



10.1 How to Use the Status Fields

10.1.1 Zone Status

Status for the zone is either ***existing*** or ***new***. Only characteristics of the zone are altered, not the zone itself.

10.1.2 Surface Status

Surfaces (windows, walls, floors, ceilings) in an existing zone are either (a) ***existing*** (if not being altered), (b) ***altered*** (with or without verified existing conditions), or (c) ***new*** if the surface did not previously exist.

Surfaces in the new zone are always ***new*** (if the surface previously existed, it is still considered new if it is in the new zone).

NOTE: If creating a new project rather than using an existing file, the default status is always new, even when adding surfaces to the existing zone. This can negatively impact your results, so pay close attention to the input screens and check the CF1R for accuracy with regard to the status.

10.1.3 Space Conditioning Status

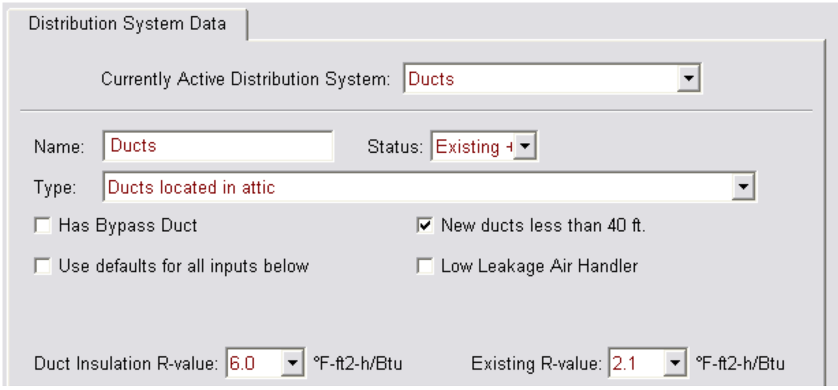
Space conditioning equipment in the existing zone can be ***existing*** or ***altered***, but not new. If some or all of the space conditioning system is being replaced or changed, model this as altered.

Space conditioning equipment in the new zone is ***existing***, ***altered*** or ***new***. If the same equipment as defined in the existing zone will provide space conditioning to the addition, set the status to match that of the existing zone HVAC status. If a system is being added to serve only the addition, that system will have a status of ***new***.

10.1.4 Duct Status

If the same space conditioning equipment is used in both the existing and new zones, the ducts are defined as either ***existing + new*** or ***altered***. Model ***existing + new*** if the existing ducts are not being changed. Check new ducts less than 40 feet if that condition applies (see Figure 10-2). This provides an exception to duct sealing as provided in Exception 2 to Section 150.2(b)1E. If the existing ducts are being altered, model the entire duct system as ***altered***.

Figure 10-2: Less than 40 feet of new duct



10.1.5 Water Heating Status

In the existing zone, water heating status is ***existing*** or ***altered***.

In the new zone, model any status with "none" for the system name unless a ***new*** system is being added as part of the addition. (NOTE: water heating is assigned to the dwelling unit, not to specific floor area.)

10.2 Setting the Standard Design

The standard design against which additions and alterations are compared will depend on (1) of the existing conditions were verified by a HERS rater ***prior*** to creating the building model, and (2) whether the proposed alteration meets or exceeds a minimum efficiency threshold (which may be mandatory or prescriptive). See Section 150.2 of the *Standards* to determine whether mandatory (Section 150.0) or prescriptive (section 150.1) requirements establish the minimum threshold.

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.

10.2.1 Third Party Verification

While not required to be verified by a HERS Rater, the amount of credit received for proposed alterations is reduced when not verified by a HERS Rater. It is still feasible to comply without this added step that was introduced in the 2013 Standards.

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 HERS Rater verification is based on the existing windows having a 0.40 U-factor and 0.35 SHGC (or 0.50 in zones with no SHGC requirement). So the amount of credit received for this proposed alteration is based on how much lower than 0.40 is the U-factor of the proposed windows, or how much lower is the SHGC than 0.35. While, iIf 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.

The standard design (energy budget) is not based on the vintage of the building as it was prior to the 2013 Standards. Instead, existing conditions are either set to actual conditions verified by a HERS Rater or default conditions (see *Standards*, Section 150.2, Table 150.2-B).

10.2.2 Efficiency Threshold

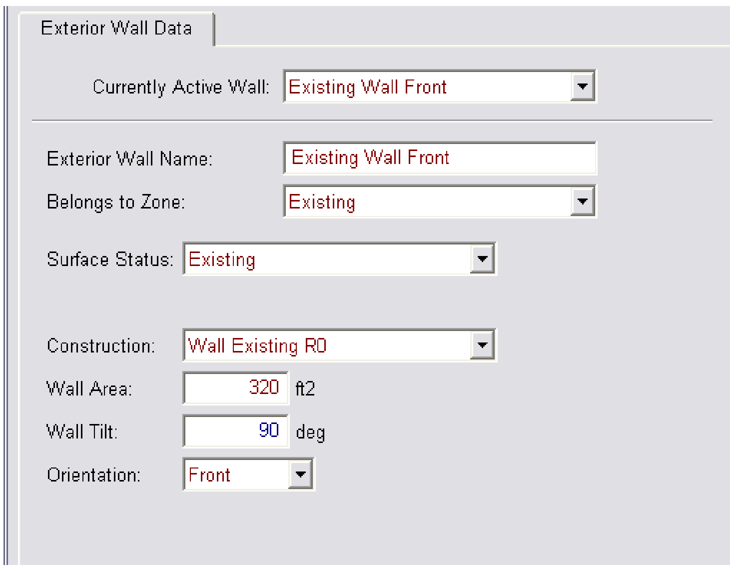
Another factor in determining the amount of credit or even a penalty that is achieved by an alteration is the proposed efficiency of the alteration. If an altered component does not meet the mandatory or prescriptive requirement set out in Section 150.2, the standard design will be based on the higher 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 alteration will receive an energy penalty.

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 10.5.

If an existing garage is being converted to conditioned space, do not model the unconditioned garage. The garage is the addition because it is becoming conditioned space.

Figure 10-3: Existing Surface

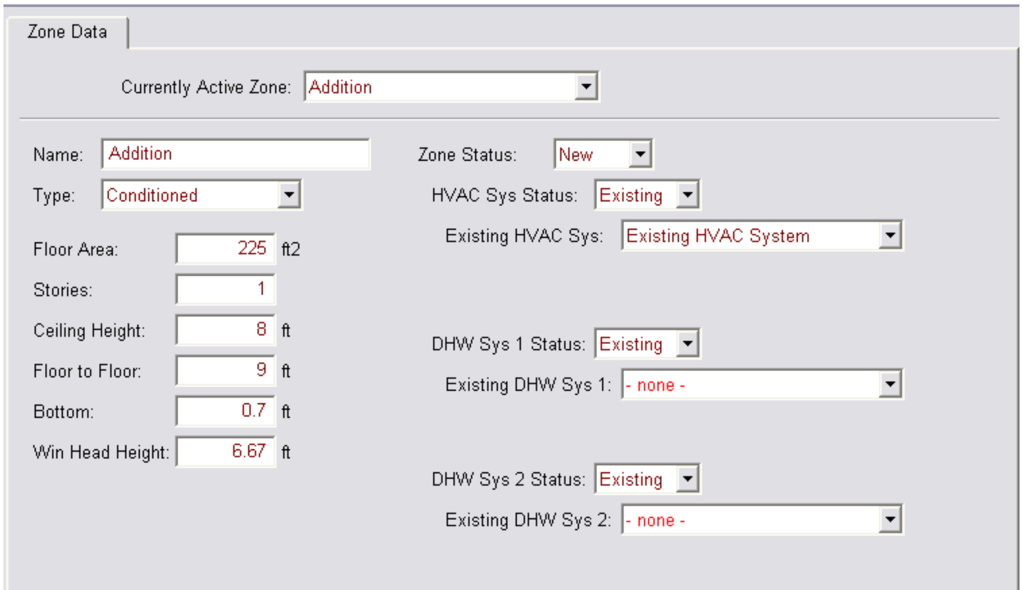


10.4 Addition

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. The exception is an existing HVAC system being extended for the addition (see Section 10.5.2 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.

Define the connection to the existing dwelling, if any, with an interior surface. If this is a wall, select the field "is a party surface."

Figure 10-4: 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 10-5 and Figure 10-6). The “verified” check box opens additional fields to define the existing conditions and affect the standard design (see Section 10.2). 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 10-5: Altered with Verified Existing Conditions

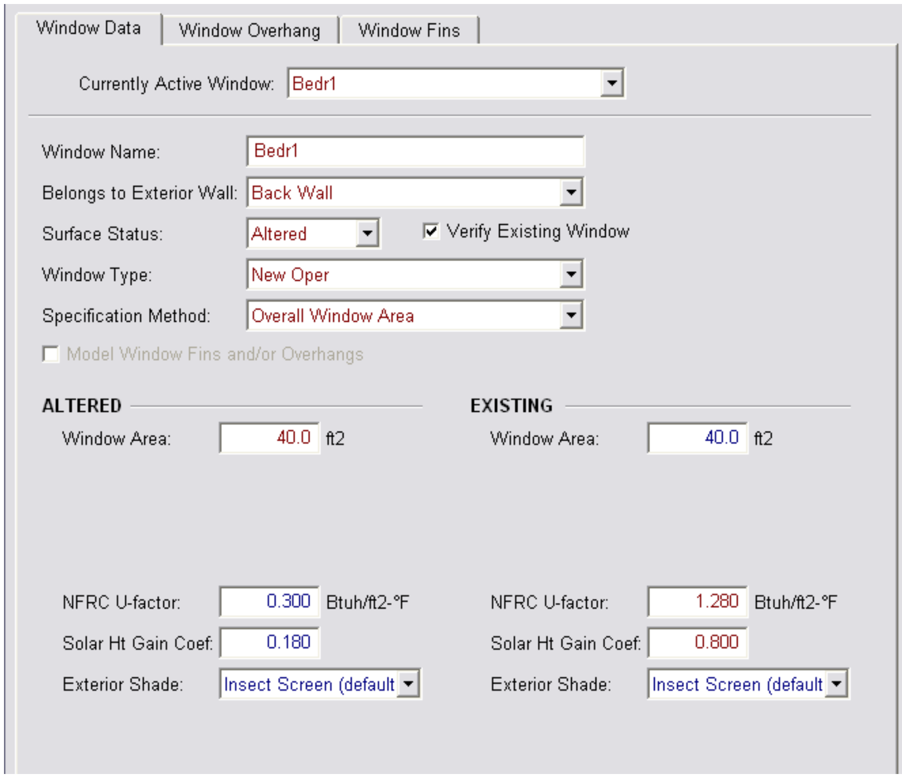
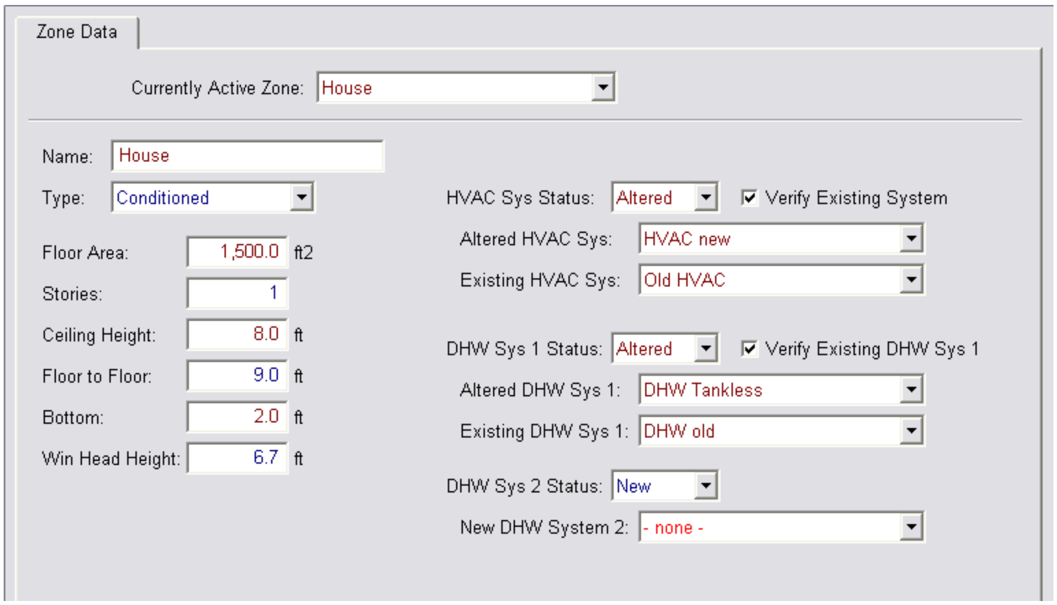


Figure 10-6: Altered Without Verified Existing Conditions

10.5.1 Radiant Barrier

Current software limitations do not allow modeling multiple attics to accommodate a radiant barrier in an addition but not in the existing attic. What can be modeled is a radiant barrier in an addition alone, or an entire attic being altered to include radiant barrier.

Figure 10-7: Altered HVAC and DHW



10.5.2 HVAC

First determine (1) if an existing system will be extended to serve an addition, (2) if a replacement (altered) system (including ducts) will be installed for the whole house, or (3) 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)).

10.5.2.1 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 (Figure 10-8). The distribution system data will have both existing and new sections of the system defined (Figure 10-9).

10.5.2.2 Replacement system for whole house.

For the existing and new zones, set the system status to "altered" and model the proposed conditions for the equipment (if selecting specify the existing conditions as verified by the HERS Rater). Model the appropriate conditions for the ducts, which may be altered, new (if ducts did not previously exist) or existing + new if only the ducts in the addition are new.

Figure 10-8: Existing System

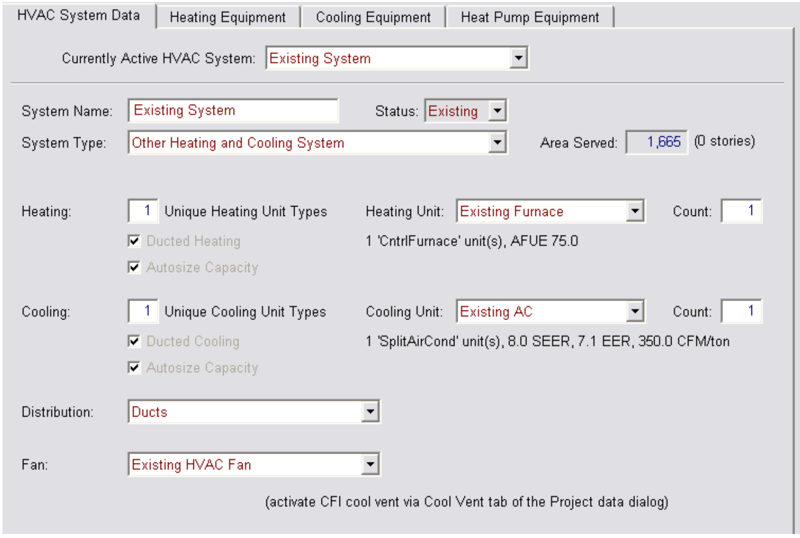
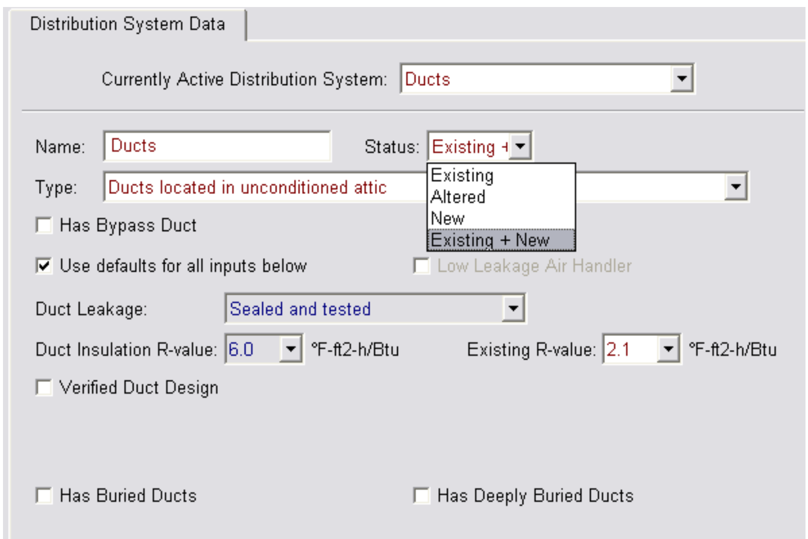


Figure 10-9: Duct System



10.5.2.3 Adding a system for the addition.

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 an 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

It is not feasible to model ventilation cooling that serves only the addition.

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.

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 addition to a 1500 ft^2 house = 500/(1500+500) = 0.25.

INDEX

2013 standards effective date 1-1

ACH50 4-6

Addition

Party wall 10-4

Addition alone 4-5, 10-9

Addition/alteration 10-1

Alteration 10-5

Deleted surfaces 10-5

Existing building 10-4

Existing HVAC 10-7

HVAC 10-7

Radiant Barrier 10-7

Replacing HVAC 10-7

Standard Design 10-3

Status fields 10-1

Verified by a HERS Rater 10-3

water heating 10-8

Water heating 10-4

Aggregate

ballasted roof default 5-5

built up roof default 5-5

Air leakage 4-6

Air to water heat pump

HVAC inputs 8-9

water heating inputs 9-9

Alteration alone 10-1

Appliance directory 9-1

Appliance energy use

multi-family 5-10

Single family 4-8

Appliance/miscellaneous energy use 4-8

Attached garage 4-7

Attic 5-2, 6-3

area 5-4

conditioned 5-3

venting 5-3

Attic roof terminology 6-3

Automated defaults

Restore default 4-2

Bedrooms 4-7

Blower door test 4-6

Bottom 5-8

in a multi-story building **5-8**

Building Energy Efficiency

ACM Reference Manual 1-4

Compliance Manual 1-4

Reference Appendices 1-4

Standards 1-4

Built up attic roof 6-6
Built-up roof 6-10
Buried ducts.. 8-23
CAHP 4-4
  score 4-10
CAHP results... 2-7
Cathedral ceiling 6-4, 7-3
Cavity R-value... 6-1
CBECC-Res 1-1
  create a component 2-6
  error message... 2-8
  installing... 2-1
  menu bar 2-1
  project files 2-10
  right-click menu 2-4
  software updates 1-2
  status bar 2-10
  tool bar... 2-3
  tool tips 4-1
  tutorial 3-1
Ceiling below attic 6-4
Ceiling height 5-8
CF1R
  Generating draft 2-3
  Generating final... 1-3
  Registering 1-3
  Watermark 1-3
CF1R registered... 4-4
CFM50 4-6
Climate zone...1-6, 4-2
Close cell spray foam insulation 6-2
Combined hydronic
  water heating 8-13
Combined hydronic heating 8-12
Compliance manager 1-5
Conditioned zone 5-7
Construction types enabled.............................. 6-1
Controlled ventilation crawl space.................. 5-6
Cool roof 5-5
Cooling
  Evaporatively cooled condensing............. 8-18
  Non-central systems 8-18
Cooling equipment types 8-15
Cooling ventilation 4-9
  CFI... 8-26
COP to HSPF equation...................................... 8-6
Crawl space 5-6
CVC 5-6
Documentation author 1-3
Domestic hot water system 5-8

Doors
garage ... 7-8
opaque U-factor ... 7-8
with glass ... 7-7, 7-16
Duct Leakage
Target leakage ... 8-20
Ducts ... 8-20
buried ... 8-22
bypass duct ... 8-22
HERS verified conditions ... 8-22
type and location ... 8-21
Duplex ... 4-7
Dwelling unit ... 5-2, 5-10
multi-family ... 5-9
EER
HERS verified EER ... 8-7, 8-16
EER verified ... 4-1
Electric heat ... 8-14
Emissivity
see Emittance ... 5-4
Emittance default ... 5-4, 7-4
Energy use results ... 2-6
Equipment
Status fields ... 10-2
Error messages ... 2-8
Log file ... 2-2
Evaporative cooling ... 8-1, 8-19
Evaporatively cooled condensing ... 8-18
Fan efficacy
mandatory requirement ... 8-25
Federal appliance standard ... 4-3
Fenestration ... 7-13
Fins ... 7-15
Files
Blank project ... 4-1
Example input files ... 4-1
Floor
mandatory insulation ... 6-2
over exterior ... 7-8
over garage ... 6-17
raised ... 6-15
Floor elevation ... 5-8, 7-9, 7-10
Floor furnace ... 8-14
Floor to floor ... 5-8
Floor to floor height ... 5-8
Frequently Asked Questions ... 2-3
Front orientation ... 4-6
Garage ... 4-7, 5-1
multi-family ... 5-9
zone ... 5-8

Garage door 7-8

Geothermal heat pump 8-11

Ground source heat pump 8-11

water heating inputs 9-9

Heat pump

efficiency 8-6

mini-split inputs 8-11

Heat Pump

Air to water source 8-8, 8-10

Ground source 8-1, 8-8, 8-11

Heat pump equipment types 8-8

Heated slab 7-11

heater 8-14

Heating equipment types 8-5

Heating sytem

COP to HSPF equation 8-6

HERS provider 1-3

HERS Provider 1-6

HERS registration

File for uploading 1-3, 4-4

High quality insulation 4-6

HVAC

different efficiencies 8-3

different equipment types 5-1

different fuel types 8-3

multiple duct conditions 5-1

multiple systems 8-3

supplemental heat 8-3

zonal control 5-1

HVAC Equipment

Status fields 10-2

HVAC System 5-8

HVAC system type 8-1

Hydronic

water heating combined 8-13

water heating separate 8-13

Hydronic heating 8-12

indoor air quality ventilation

multi family 5-11

single family 4-8

Infiltration 4-6

Insulation quality 4-6

Knee wall 6-4, 6-14, 7-4

Log file 2-2

Low slope aggregate surface 5-5

Low slope roof 5-5, 6-4

aged solar reflectance 6-4

Mandatory requirements 1-6

Mini-split 8-1, 8-12

Multi-family

Bedrooms 5-10
DHW 5-10
HVAC 5-10
IAQ 5-11
Multi-family building 4-7
defining the building 5-1
Multiple conditioned zones 5-1
Multi-split 8-1, 8-12
Natural gas availability 4-7
No cooling 8-17
air leakage 4-6
CFM/ton 8-16
Watts/CFM 8-25
Number of stories 5-7
Open cell spray foam insulation 6-2
Orientation
building front 4-6
walls 7-1
Package A 1-5
Party surface 7-5
Party wall 5-9, 7-5
Perform analysis 2-3
Print CF1R 2-4
Project
climate zone 4-2
zip code 4-2
Proposed design 1-5
Proxy server settings 2-2
PV System Credit 4-4, 4-5
QII 4-6
spray foam insulation 6-3
Quick Start Guide 2-3
Radiant barrier 6-4, 6-7
Rafter roof 6-4
Raised floor 6-15, 7-9
crawl space zone 5-6
over exterior 7-9
over garage 7-9
Registered CF1R 1-3
Report manager 1-5
Restore default 4-2
Return ducts 8-22
Roof 6-4
above deck insulation 6-6
aged solar reflectance 5-4, 7-4
cathedral ceiling 6-4
cool roof 5-5
emittance 5-4, 7-4
Exceptions for emittance 5-4
Exceptions for solar reflectance 5-4

- insulation 6-7
- low slope 6-5
- mandatory insulation 6-2
- no attic 6-4
- pitch 7-3
- rafter roof 6-4
- raised heel truss 6-8
- rise 7-3
- solar reflectance 7-4
- steep slope 6-5

Roof construction 5-4

Roof pitch 5-4

Roof rise 5-4

Room air 8-1

SEER

- HERS verified high SEER 8-16

Single-family dwelling 4-7

SIP ceiling 6-10

SIP Walls 6-14

Skylight 7-17

Slab 7-11

- covered/exposed 7-12
- edge insulation 7-12

Software updates 1-2

Solar reflectance default 5-4, 7-4

SPF

- closed cell 6-2
- default R-values 6-3
- non-standard check box 6-2
- open cell 6-2

Spray foam insulation

- verified insulation quality 6-3

Standard design 1-5

Standards documents 1-4

Standards version

- Compliance 2014 4-3
- Compliance 2015 4-3

Status fields 10-1

Steep slope roof 5-5, 6-5

Supply duct 8-21

Surface status 7-5

Townhome 4-7

Ventilation cooling 4-9

- whole house fan 4-9

Verified insulation quality 4-6

Wall

- Advanced Wall Framing 6-3
- mandatory insulation 6-2
- mass insulation 6-2

Wall area 7-5

Wall furnace 8-14
Wall orientation 7-5
Walls 6-11
  between house and garage 6-14
  demising 6-14
  garage exterior 6-15
  interior 6-14
  knee walls 6-4, 6-14, 7-4
  Mass 6-13
  SIP 6-14
  uninsulated 6-15
Water heater
  different types in same zone 5-1
  distribution type 9-2, 9-4
  heating element 9-7
  pilot energy 9-8
  small or large 9-1
  solar fraction 9-6
  solar system 9-5
  standby loss 9-8
  tank type 9-1, 9-7
Water Heating
  Status fields 10-2
Watermark
  Not registered 1-3
  Not useable 2-3
Watts/CFM
  mandatory requirement 8-25
  no cooling 8-25
Whole house fan 4-9
Window
  glass doors 7-16
  mandatory maximum U-factor 7-12
  multiplier 7-14
  overall window area 7-13
  SHGC 7-14
  skylight 7-17
  type 6-18
  types 4-1
  U-factor 7-14
  window dimensions 7-13
  window type 7-13
Window head height 5-8
Window type 7-12
Wood heat 8-14
Zip code 4-2
Zonal control 4-7, 5-1, 5-7, 8-4
  bypass duct 8-21
  multi-speed compressor 8-17
Zone

Status fields.. 10-1

Zone type

conditioned 5-7

living or sleeping.. 5-7