

PROPOSED RESIDENTIAL ALTERNATIVE CALCULATION MANUAL (ACM) APPROVAL METHOD

for the 2013 Building Energy Efficiency Standards



CALIFORNIA
ENERGY COMMISSION
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1. Overview

This Manual explains the requirements for approval of residential Alternative Calculation Methods (ACMs or Compliance Software). Residential Compliance Software is used to demonstrate compliance with the performance approach to the California Energy Efficiency Standards for Low-Rise Residential Buildings (Standards).

The approval procedure is one of self-testing and self-certification by the Compliance Software vendor. The vendor conducts the specified tests, evaluates the results and certifies in writing that the Compliance Software passes the tests. The California Energy Commission (Commission) will perform spot checks and may require additional tests to verify that the proposed Compliance Software is suitable for compliance purposes. The vendor is required to develop a compliance supplement (program user manual) explaining how to use the program ~~for showing to show~~ compliance with the Standards. The compliance supplement will also be checked by the Commission for accuracy and ease of use.

Residential Compliance Software that implements the 2013 Standards must use the energy simulation and compliance rule implementation software specified by the Commission. This open source software, called the Compliance Manager in this document, will be made available at no cost to potential Compliance Software vendors. The ACM tests submitted by the vendor will confirm that the Compliance Manager version officially issued by the Commission has been successfully integrated into the vendor software.

~~When energy analysis techniques are compared, there are two basic sources of discrepancies: differences in user interpretation when entering the building specifications, and differences in the compliance software's algorithms for estimating energy use. The approval tests in this manual are designed to minimize differences in interpretation by providing explicit detailed descriptions of the test buildings that shall be analyzed.~~

This chapter presents the general requirements for residential Compliance Software. ~~Chapter 2 addresses the standard reports that all Compliance Software must generate. Chapter 3 has the rules for defining the Standard Design and algorithms and modeling assumptions used in the reference method. Chapters 34 and 45 describe the have certification tests accuracy tests to be completed by the Compliance Software vendors and spot checked by the Commission. Chapter 6 has requirements for compliance software vendors.~~ Chapter 2 describes the required content of the Compliance Supplement. The certification tests are documented in detail in the Residential ACM Reference Manual, a document that is developed and maintained by the Energy Commission to document the details of the performance compliance modeling implemented in the Compliance Manager software, and to explain the certification tests all Compliance Software must pass. The Residential ACM Reference Manual is approved by the Commission after the adoption of each Building Energy Efficiency Standards update, and updated as necessary to resolve issues identified during the implementation of the performance compliance approach using Compliance Software.

1.1 Minimum Modeling Capabilities

Minimum modeling capabilities shall be included in all compliance software. If candidate compliance software does not have all of these capabilities, then it cannot be approved for compliance. The minimum modeling capabilities are summarized below:

- ~~Conditioned Zone Model (CZM) Includes conductive and radiant energy transfer using energy balance simulation method.~~duction gains and losses through opaque and fenestration surfaces
- ~~Attic Modeling (UZM)~~
- ~~Slab edge gains and losses~~
- ~~Infiltration gains and losses~~
- ~~Solar gains through glazing including the effects of internal shading devices.~~
- ~~Natural ventilation cooling~~
- ~~Mechanical Ventilation for Indoor Air Quality (IAQ)~~
- ~~Thermal mass effects to dampen temperature swings~~
- ~~Space conditioning equipment efficiency and distribution systems~~
- ~~Water heating equipment efficiency and distribution systems~~
- ~~Maximum Cooling Capacity~~
- ~~Building additions~~
- ~~Building alterations~~
- ~~Attic Modeling (UZM)~~
- ~~Maximum Cooling Capacity~~

1.2 Optional Modeling Capabilities

Candidate compliance software may have more capabilities than the minimum required. Compliance software can be approved for use with none, a few, or all of the optional capabilities. The following optional capabilities are recognized for residential compliance software:

- ~~Raised floors with automatically operated crawl space vents~~
- ~~Zonal control or multi-zone modeling of the sleeping and living areas of the house~~
- ~~Attached sunspaces for collection and possible storage of heat for transfer to the main house~~
- ~~Passive Solar Unconditioned Spaces~~Exterior mass walls
- ~~Overhangs and Side Fin Shading~~
- ~~Combined hydronic space and water heating~~
- ~~Building alterations~~
- ~~Solar water heating~~
- ~~Gas fired and Absorption Cooling~~

- ~~Evaporatively cooled condensing units~~
- ~~Ice storage air conditioner~~
- ~~Evaporative coolers~~
- ~~Photovoltaic performance modeling~~

~~Many of the optional modeling capabilities have been previously approved by the Commission through the exceptional methods process. The approval tests for optional modeling capabilities are included in Chapter 5.~~

1.31.1 Application Checklist

~~The following is a checklist of all the items that shall be included in an application package for Ceompliance Ssoftware certification by the Commission. ~~Some materials are required only for general purpose compliance software and are so indicated.~~~~

- **Compliance Ssoftware Vendor Certification Statement.** A statement from the Ceompliance Ssoftware vendor certifying the ~~compliance software, and, its reliability and accuracy of the software when used for Standards compliance purposes (see Residential ACM Approval Manual Appendix A). This certification statement shall also include a declaration from the vendor that the compiled version of the Compliance Manager and accompanying rulesets and supporting data officially issued by the Commission has been included in the vendor's Compliance Software.~~
- ~~Computer Run Summary Sheets. Hard copy summary sheets of all the required computer runs (see Residential ACM Manual Appendix A).~~
- **Computer Runs and Summary Sheets.** Copies of the computer runs specified in ~~Chapters 4 and 3 and 45 of this Manual~~the Residential ACM Reference Manual, including complete input and output files, on diskettes or in provided electronically to the Commission in computer readable form acceptable to the Commission to enable spot checks. Summary sheets of all the required computer runs also provided electronically to the Commission.
- **Compliance Supplement.** A copy of the Compliance Supplement discussed in Chapter ~~26~~. The Compliance Supplement and the Compliance Ssoftware uUser's mManual may be combined into the same document.
- **Copy of the Ceompliance Ssoftware.** An executable ~~computer readable version~~copy of the Ceompliance Ssoftware (in a format agreed to by the Commission staff) for the Commission's use during the software certification process verification of analyses and random verification of compliance analyses. Weather data shall be included.
- **Application Fee.** An application fee of \$~~12,000.00 (onetwo thousand dollars)~~ is required to cover the costs of evaluating the application. The total fee shall cover the Commission's cost of reviewing and analyzing the application. Within 75 days of receipt of an application, the Commission will provide an estimate of the total maximum cost to review and analyze the application. After the Commission determines the total costs, if the costs exceed the initial fee, the Commission shall assess an additional fee to cover the total costs. If actual cost is less than the initial or any estimated maximum fee, the Commission shall refund the difference to the applicant.

1.4.1.2 Types of Approval

This Manual addresses ~~three~~ four types of Compliance Software approval: full approval, streamlined approval ~~of new program features~~, approval by notification, and amendments to full approvals.

1.4.1.2.1 Full Approval

Full approval is required when a ~~candidate~~ Compliance Software product has never been previously approved by the Commission, ~~and/or when the Compliance Software vendor makes a changes to the executable program code or algorithms, or any other change that significantly in any way affects the results.~~ The Commission may also require that all Compliance Software be approved again when the Standards are updated ~~on the three year cycle~~ or whenever substantial revisions are made to the approval process, ~~for instance, if new analysis capabilities come into widespread use, and the Commission declares them to be minimum capabilities for all compliance software.~~

When re-approval is ~~necessary, then~~ mandated by the Commission, ~~will notify all Compliance Software vendors will be notified of the renewal timetable for renewal.~~ There will also be a revised ~~ACM compliance software Approval Manual published, with complete instructions for re approval.~~

Full approval is required for all Compliance Software changes, unless they qualify for the streamlined approval process ~~or for an addendum~~, as discussed below.

1.4.21.2.2 Streamlined Approval

Changes to the official version of the Compliance Manager (CM) completed by the Commission must be incorporated in all certified Compliance Software. This streamlined approval process shall be used whenever the Commission issues a new official version of the Compliance Manager. Streamlined approval shall also be used whenever the Commission determines that it is necessary to review and approve changes to Compliance Software made by software vendors, which are identified through the Approval by Written Notification process (see below, Section 1.2.3). For streamlined approval, Certain types of changes may be made to approve Residential compliance Software through a streamlined procedure. Examples of changes that qualify for streamlined approval are modifications to the user interface or implementation on a different operating system, as long as there are no changes to the compliance executable program code that would in any way affect the results calculated by the software.. Changes to the Compliance Manager by the Energy Commission that must be integrated into Compliance Software is another example of when streamlined approval is appropriate. II

~~If a Compliance Software modification qualifies for streamlined approval, then the following procedures shall be is followed:~~

~~—When the Energy Commission makes a a minor change to the Compliance Manager, Compliance Software vendors can update their Compliance Software voluntarily upon release of the modified Compliance Manager software, and must update their Compliance Software by January 1 of the following year.~~

- ~~• When the Energy Commission makes a major change to the Compliance Manager CM, Compliance Software vendors can update their Compliance Software voluntarily upon release of the modified Compliance Manager (CM) software, and must update their Compliance Software~~

within ~~45~~ 30 days of the CM release date, unless otherwise stated by the Energy Commission in the CM release notice.

- The Compliance Software vendor prepares an addendum to the compliance supplement, when appropriate, describing the change to the Compliance Software.
- ~~The Compliance Software vendor notifies the Commission by letter of the change. The letter shall describe in detail the nature of the change and why it is being made. The notification letter shall be included in the Compliance Supplement.~~
- ~~The Compliance Software vendor Provides the Commission with an updated copy of the Compliance Software and include any new reports created by the compliance software (or modifications in the standard reports).~~
- ~~_____~~
- The Commission responds in 45 days. The Commission response may take several forms. The Commission may approve the updated software, request additional information, refuse to approve the change, or require that the Compliance Software vendor make specific changes to either the Compliance Supplement addendum or the Compliance Software.
- With Commission approval, the vendor may issue new copies of the Compliance Software with the Compliance Supplement addendum and notify Compliance Software users and building officials.

1.4.31.2.3 Approval By Written Notification

For all Compliance Software changes not requiring full or streamlined approval, vendors shall provide a written notice to the Commission whenever a new version of the Compliance Software is released. The vendor may release the new Compliance Software version if the Commission has not responded to the written notification within three days. The Commission may at any time gather evidence and determine whether a full or streamlined approval process is required for any Compliance Software change implemented through this written notification process. The vendor must provide the Commission and all building departments the version numbers for all changes made to Compliance Software using this written notification process, such that it is clear which software versions are approved for Standards compliance.

1.4.41.2.4 Amendments

Compliance Software approval shall be amended when optional modeling capabilities are added. The vendor shall provide the additional computer runs required for the optional modeling capability. It is not necessary to include computer runs previously submitted.

An amendment to approved Compliance Software shall be accompanied by a cover letter explaining the type of amendment requested, and copies of other documents as necessary. All items on the application checklist should be submitted, when applicable. The timetable for approval of amendments is the same as for full approval.

1.4.51.2.5 When Approval Is Not Required

Changes that, as determined by the Commission, do not significantly affect compliance with the Energy Efficiency Standards for residential buildings do not require full, ~~or~~ streamlined or

notification-type approval. However, the Ceompliance Ssoftware vendor shall notify the Commission and provide the Commission with an updated copy of the program and user manual. Re-approval is required for any Compliance Software change that, as determined by the Commission, significantly affects the compliance results, the format and/or content of compliance forms, or any other change that would significantly affect a building's compliance with the Standards. Any questions regarding applicable approval procedures should be directed to the Commission. ~~Re-approval is required for any Ceompliance Ssoftware program change that affects the energy use calculations for compliance, the modeling capabilities for compliance compliance results, the format and/or content of compliance forms, or any other change that which would affect a building's compliance with the Standards. Any questions regarding applicable approval procedures should be directed to the Energy Commission.~~

4.51.3 Challenges

Building officials, program users, program vendors or other interested parties may challenge any residential Ceompliance Ssoftware approval. If any interested party believes that a compliance program, an algorithm, or method of calculation used in a Ceompliance Software program, a particular capability or other aspect of a program provides inaccurate results, the party may challenge the program.

4.61.4 Decertification of Compliance Software

The Commission may decertify (rescind approval of) ~~an alternative calculation~~ Compliance Software method through various means:

- All Ceompliance Ssoftware products are decertified when the Sstandards undergo substantial changes, ~~which usually occur occurring with each Standards updates every three years.~~
- Any Ceompliance Ssoftware product can be decertified by a letter from the Ceompliance Ssoftware vendor requesting that a particular version (or versions) of the producte compliance software be decertified. The decertification request shall briefly describe the nature of the program errors or "bugs" which justify the need for decertification.
- Any "initiating party" may commence a procedure to decertify a Ceompliance Ssoftware product according to the steps outlined below. The intent is to include a means whereby serious program errors, flawed numeric results, improper forms and/or incorrect program documentation not discovered in the certification process can be verified, and use of the particular Ceompliance Ssoftware version discontinued. In this process, there is ample opportunity for the Commission, the Ceompliance Ssoftware vendor and all interested parties to evaluate any alleged errors in the Ceompliance Ssoftware program.

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Following is a description of the process for challenging Ceompliance Ssoftware or initiating a decertification procedure:

1. Any party may initiate a review of Ceompliance Ssoftware's approval by sending a written communication to the Commission's Executive Director. (The Commission may be the initiating party for this type of review by noticing the availability of the same information listed here.)

The initiating party shall:

- (a) State the name of the Compliance Software and the program version number(s) ~~that~~which contain the alleged errors;
 - (b) Identify concisely the nature of the alleged errors in the Compliance Software ~~that~~which require review;
 - (c) Explain why the alleged errors are serious enough in their effect on analyzing buildings for compliance to justify a decertification procedure; and
 - (d) Include appropriate data electronically (in a format agreed to by the Commission staff) and/or information sufficient to evaluate the alleged errors.
2. The Executive Director shall make a copy or copies of the initial written communication available to the Compliance Software vendor and interested parties within 30 days. Comments from interested parties must be received within 60 days of the acceptance of the original application.
 3. Within 75 days of receipt of the written communication, the Executive Director may request any additional information needed to evaluate the alleged Compliance Software errors from the party who initiated the decertification review process. If the additional information is incomplete, this procedure will be delayed until the initiating party submits complete information.
 4. Within 75 days of receipt of the initial written communication, the Executive Director may convene a workshop to gather additional information from the initiating party, the Compliance Software vendor and interested parties. All parties will have 15 days after the workshop to submit additional information regarding the alleged program errors.
 5. Within 90 days after the Executive Director receives the application or within 30 days after receipt of complete additional information requested of the initiating party, whichever is later, the Executive Director shall either:
 - (a) Determine that the Compliance Software need not be decertified; or
 - (b) Submit to the Commission a written recommendation that the Compliance Software be decertified.
 - ~~6. The initial written communication, all other relevant written materials and the Executive Director's recommendation shall be placed on the consent calendar and considered at the next business meeting after submission of the recommendation. The matter may be removed from the consent calendar at the request of any person.~~
 76. If the Commission approves the Compliance Software decertification, it shall take effect 60 days later. During the first 30 days of the 60 day period, the Executive Director shall send out a Notice to Building Officials and Interested Parties announcing the decertification.

All initiating parties have the burden of proof to establish that the review of alleged Compliance Software errors should be granted. The decertification process may be terminated at any time by mutual written consent of the initiating party and the Executive Director.

~~T~~As a practical matter, the Compliance Software vendor may use the 180 to 210-day period outlined here to update the Compliance Software ~~program~~, get it re-approved by the Commission, and release a revised version that does not contain the ~~error~~bugs initially brought to the attention of the Commission. ~~Sometimes the compliance software vendor may wish to be the initiating party to ensure that a faulty program version is taken off the market.~~

4.71.5 Compliance Software Tests

This Manual provides tests to verify that Compliance Software ~~is~~are accurate. These tests are provided in Chapters 4 and 5 of this Manual. The Compliance Software vendor may propose

alternate tests when the vendor believes that one or more of the standard tests are not appropriate for the Compliance Software. Alternate tests will be evaluated by the Commission and will be accepted if they are considered reasonable. If accepted, the alternate test(s) will be added to ~~this the Residential ACM Reference Manual manual~~ as an addendum and the alternate test(s) will be available for use by all Compliance Software. ~~The alternate test will coexist with the standard test presented in this Manual until the Manual is revised. When a new version of this Manual is produced, the alternative test may be substituted for the current test or may continue to coexist with the original test.~~

4.81.6 Approval of New Exceptional Methods

The Commission may approve new exceptional methods. Exceptional methods are special modeling capabilities or calculation methods necessary to recognize building features that cannot be adequately modeled with existing Compliance Software. When an Exceptional Method is approved, a new optional capabilities test may be approved as part of the process. ~~Exceptional Methods do not necessarily produce optional capabilities for compliance software. For instance, radiant heating systems are recognized by an adjusted equipment efficiency that may be used directly in compliance software or other compliance methods.~~ To be approved for the new optional capability, vendors shall ~~amend their~~ resubmit their Compliance Software for approval using the Streamlined Approval process.

Even if the Compliance Software already incorporates the Exceptional Method, the vendor shall receive approval to use the Exceptional Method in the compliance process. The Compliance Software vendor shall demonstrate that the Compliance Software automatically uses the correct fixed and restricted inputs for the Exceptional Method and that the standard reports identify the building feature(s) recognized by the Exceptional Method. Additionally, the ACM Compliance Supplement shall be updated, referencing the use of the new Exceptional Method.

~~To receive a copy of the Exceptional Method contact the Building and Appliances Office at (916) 654-406~~

2. Standard Reports

2.1 General

For consistency and ease of enforcement, the manner in which building features are reported by Compliance Software is standardized. This and the subsequent chapter of the compliance software Approval manual describes the required standard reports. All residential Compliance Software shall automatically produce standardized compliance reports. These *Standard Reports* are required to enable building officials to evaluate the results without having to learn each computer program. Included in every compliance package will be reports CF-1R and other related forms, which are described in detail in this manual.

The Certificate of Compliance (CF-1R) is the principal compliance report. The CF-1R shall indicate the features and performance specifications needed to comply with Part 6 of Title 24 and shall be approved by the local enforcement agency by stamp or authorized signature. The CF-1R and supporting documentation shall be readily legible and of substantially similar format, and informational order and content to the CF-1R model provided in the appropriate 2013 Residential Compliance Manual and as approved by the CEC Executive Director. A.

At the beginning of the CF-1R, notification of the use of that the compliance report is part of a HERS or NSHP process shall be prominently displayed. A run identification code shall be placed on each page of the CF-1R per the requirements in Section 2.2.

The CF-1R shall have two highly visible sections, one for *Special Features Inspection Checklist* and a second for features requiring *Hers Required Verification*. These two sections serve as “punch lists” during compliance verification by the local building department. Items listed in the *Special Features Inspection Checklist* section indicate the use for compliance of unusual features or assumptions, and call for special care by the local building department. Items listed in the *Hers Required Verification* section are for features that require diagnostic testing or *independent* verification to insure proper field installation in addition to local building department inspection.

Only user inputs are described and included in the standard reports. The fixed and restricted inputs are not included in the standard reports since compliance software shall be designed so that the fixed and restricted inputs and default values are automatically used in the absence of specific user input.

Deviations from the standard reports will be approved by the Commission on a case-by-case basis, when they are necessary because of conceptual differences between compliance software or because of special modeling features. However, the categories of information represented in the tables and the standard headings shall not be changed. Additional columns or additional tables may be added when necessary and column headings may be abbreviated, and reports may be reformatted with different character spacing, line spacing, row heights or column widths to permit better readability or paper conservation. Compliance Software may also provide additional customized information at the bottom of the standard reports, separated from the standard report by a line.

Some of the information in the standard reports may not be applicable for all buildings. When information is not applicable for a particular building, it should be omitted. When a feature exists, however, all the information about that feature should be included, even if some of the detail is not applicable to the proposed design.

The Standard Reports are designed to accommodate the optional modeling capabilities included in this manual. Approval of additional optional modeling capabilities may require modification of the standard report format.

2.2 Certificate of Compliance – Residential Computer Method (CF-1R)

The Certificate of Compliance (report CF-1R) is the principal standard report that shall be produced. The Certificate of Compliance is required by the Administrative Regulations (Title 24, Part 1, §10-103).

The CF-1R (Residential Computer Method) shall include all information provided by the program user. If the standard report does not fully document all user inputs, additional tables or notes shall be added by the program vendor to fully document all user inputs.

Information on the Certificate of Compliance is provided below to illustrate the use of all the standard tables.

2.2.1 Report Headings

The following heading shall appear on the first page and contain the following information:

- Date
 - Project Title
 - Project address
 - Documentation author, telephone, email and address
 - A box for use by the building department containing the building permit number, the plan check date, the field check date and other information to be specified by the CEC Executive Director.
 - Run identification information shall be provided to verify the compliance run. This shall include information such as the computer simulation file name, a run code, the run title, the run date, etc.
- The filename and computer run identification information shall appear as part of the header information for all pages of the Certificate of Compliance.

2.2.2 Energy Use Summary

This section compares the energy use of the proposed building to the energy budget of the standard design building. ~~The energy budgets for the proposed and standard designs~~ All units in this table are TDV (time dependent valuation) energy (kTDV/ft² yr). TDV Energy shall be separately reported for space heating, space cooling, hot water, ventilation, and other uses. Additionally, the proposed building electricity and gas energy use shall be reported in kWh and therms, respectively. The energy budgets are determined from the standard design using the custom budget method. The water heating budget is calculated from the custom budget water heating calculation methods described in this document. Compliance software vendors may add additional columns or rows to this report when appropriate, such as for multi-zone building analyses or breaking out energy use components such as HVAC fans.

2.2.3 Building Features

The features of the proposed building shall be entered in a manner to match the building plans. The features and characteristics of the proposed design shall be described in a series of tables that are described in the subsequent chapter.

2.2.4 Special Features Inspection Checklist

This listing shall **stand out and command the attention** of anyone reviewing the CF-1R to emphasize the importance of verifying these Special Features and the aspects of these features that were modeled to achieve compliance or the energy use results reported. This listing in the Certificate of Compliance shall include any special features of the building that affect the building's compliance with the standards. The use of certain non-default values shall also be included in this list. These special default values are indicated in the subsequent text. Statements in this section shall use the special feature statements listed in Appendix C of this manual, unless other text is approved. This is a free-format section for the CF-1R report to note any special features about the building that are needed to verify compliance. The following is an example of the type of information to include in the special features and modeling section of the CF-1R.

Table R2-1 – CF-1R Report – SPECIAL FEATURES INSPECTION CHECKLIST: (Example Listing)

High-mass building features	High-mass building features are described in the THERMAL MASS FOR HIGH MASS DESIGN table of compliance form CF-1R.
Non-standard Ventilation Height Difference	Non-standard ventilation height difference must be verified according to the rules in Residential ACM Chapter 3 under Building Zone Information.
Higher U-factors are specified than the vintage defaults.	Field verification of U-factors as specified is required.
Non-NAECA large storage gas water heater	A non-NAECA large storage gas water heater is specified for this building. System specifications are shown in the SPECIAL WATER HEATER/BOILER DETAILS table of compliance form CF-1R.

2.2.5 HERS Required Verification

This listing shall **stand out and command the attention** of anyone reviewing this form to emphasize the importance of HERS Required Verification and to call attention to the building features that require such verification and testing.

All items in the *Hers Required Verification* listings shall also report that the installer and HERS rater shall both provide the appropriate CF-6R and CF-4R documentation, respectively, for proper installation, testing, and test results for the features that require verification by a HERS rater. The installer shall document and sign the CF-6R to verify compliance with design and installation specifications. The HERS rater shall document and sign the CF-4R to confirm the use of proper testing procedures and protocol to report test results, and to report field verification of installation consistent with the design specifications needed to achieve these special compliance efficiency credits.

The following table is an example of the type of information to be included:

Table R2-2 – CF-1R Report – HERS REQUIRED VERIFICATION

<p>This house is using reduced duct leakage to comply and shall have diagnostic site testing of duct leakage performed by a certified HERS rater under the supervision of a CEC-approved HERS provider. The results of the diagnostic testing shall be reported on a CF-4R form and list the target and measured CFM duct leakage at 25 pascals.</p>
<p>This house has tight construction with reduced infiltration and a target blower door test range between 586 and 1250 CFM at 50 pascals. The blower door test shall be performed using the ASTM Standard Test Method for Determining Air Leakage Rate by Fan Pressurization, ASTM E 779-03.</p>
<p>This house is using an HVAC system with all ducts and the air handler located within the conditioned space. This results in a higher distribution efficiency rating due to elimination of conduction losses (losses due to leakage are not changed) and shall be visually confirmed by a certified HERS rater under the supervision of a CEC-approved HERS provider. This verification shall be reported on a CF-4R form.</p>
<p>WARNING: If this house tests below 586 CFM at 50 pascals, the house shall either be provided with a ventilation opening that will increase the tested infiltration to at least 586 CFM at 50 pascals (SLA = 1.5) OR mechanical supply ventilation shall be provided that can maintain the house at a pressure of at least -5 pascals relative the outside average air pressure while other continuous ventilation fans are operating. Note also that the Commission considers an SLA ≤ 1.5 to be “unusually tight” per the California Mechanical Code.</p>

2.2.6 Compliance Statement and Signatures

The CF-1R also requires a signature block, as required by §10-103(a)1 of the Administrative Regulations (Title 24, Part 1). The following is an example of the type information to be included with the compliance statement and signature block.

Table R2-3 – CF-1R Report – COMPLIANCE STATEMENT

<p>This certificate of compliance lists the building features and performance specifications needed to comply with the Energy Standards in Title 24, Parts 1 and 6, of the California Code of Regulations, and the Administrative regulations to implement them. This certificate has been signed by the individual with overall design responsibility.</p>	
<p>Designer or Owner (per Business & Professions Code)</p> <p>Name _____</p> <p>Title/Firm _____</p> <p>Address _____</p> <p>City & Zip Code _____</p> <p>Telephone _____</p> <p>License Number _____</p> <p>Signature/Date _____</p>	<p>Documentation Author</p> <p>Name _____</p> <p>Title/Firm _____</p> <p>Address _____</p> <p>City & Zip Code _____</p> <p>Telephone _____</p> <p>Signature/Date _____</p>
<p>Enforcement Agency</p> <p>Name _____</p> <p>Title _____</p> <p>Agency _____</p> <p>City _____</p> <p>Telephone _____</p> <p>Signature/Date _____</p>	

3.4. Minimum Capabilities Tests

This chapter describes the methods used to test the minimum modeling capabilities of candidate compliance software programs. There are separate tests for space conditioning tests and water heating tests. Most of the space conditioning tests are performed using a simple square building prototype (see Figure R4-7). The water heating tests are performed relative to two prototype water heating systems. Most of the tests are performed in only five climate zones, but some are performed in all sixteen climate zones. Tests may be modified, added, or requested to be preformed with fixed inputs to verify specific modeling features.

3.1 Overview

Two types of tests are performed: accuracy tests and standard design generator tests (or custom budget tests). While compliance software programs shall pass all these tests, the Energy Commission, at its discretion, may require additional tests to justify the accuracy of the candidate compliance software to confirm other required features.

3.1.1 Accuracy Tests

This section describes the general testing concept that is used for the accuracy tests. For the prototype buildings and the specified variations, candidate compliance software programs shall generate an estimate of TDV energy and this is compared to the TDV energy that is estimated with the reference method. The TDV energy of the candidate compliance software shall be within an acceptable tolerance of the reference method in order for the compliance software to pass the test. The margin of acceptability is defined below and may change for each group of tests. For the space conditioning tests, only the TDV energy for space conditioning is considered and for the water heating test only the TDV for water heating is considered.

3.1.1.1 General Procedure

Basecase. Each test begins with a prototype building or system that exactly complies with the prescriptive criteria (package D); this is the basecase building or system. The basecase has a zero compliance margin, e.g. it exactly complies with the standard. In another parlance, it is the custom budget building.

Discrete Modifications. A set of discrete modifications are then made to the basecase building or system, e.g. the ducts are sealed, walls and ceilings are field verified for good construction quality or a different type of heating or cooling equipment is installed. The discrete modifications are defined for each test and may vary slightly for each climate zone identified for the test. The discrete modifications are selected to represent important compliance measures. The discrete modifications will either improve or degrade the TDV energy performance of the basecase building, e.g. the compliance margin of the modified basecase will become either positive or negative.

Continuous Variable. A continuous variable, which is identified for each test, is then increased or reduced so that the modified basecase complies by a specified tolerance and fails by a specified tolerance. The continuous variables have a predictable and continuous impact on the TDV energy of the proposed design. Examples are SEER, AFUE, and glass area (above 20 percent of the floor area). The value for the continuous variable that causes the modified basecase to pass by the specified

tolerance is the “passing solution” and the value that causes failure by the specified tolerance is the “failing solution”. The “failing solution” shall result in TDV energy as close as possible to the negative tolerance, but shall be greater than the negative tolerance. The “passing solution” shall result in TDV energy as close as possible to the positive tolerance but shall be less than the positive tolerance. The positive and negative tolerances are defined for each test, but in general they are 1.0 kTDV/ft² y or 3 percent of the baseline TDV energy whichever is greater.

The procedure is illustrated in Figure R4-1 through Figure R4-4. In these diagrams, the base case building is represented by point “A”. The vertical axis represents the compliance margin with a positive compliance margin (building or system passes) above the horizontal axis and a negative compliance margin (building or system fails) below the horizontal axis. Figure R4-1 and Figure R4-3 show instances when the discrete modifications produce a positive compliance margin and Figure R4-2 and Figure R4-4 are examples of discrete modifications that produce a negative compliance margin. When the discrete modifications produce a change in TDV energy that is within the specified tolerances, the passing solution or failing solutions are equal to the base case value of the continuous variable. This situation is illustrated in Figure R4-3 and Figure R4-4.

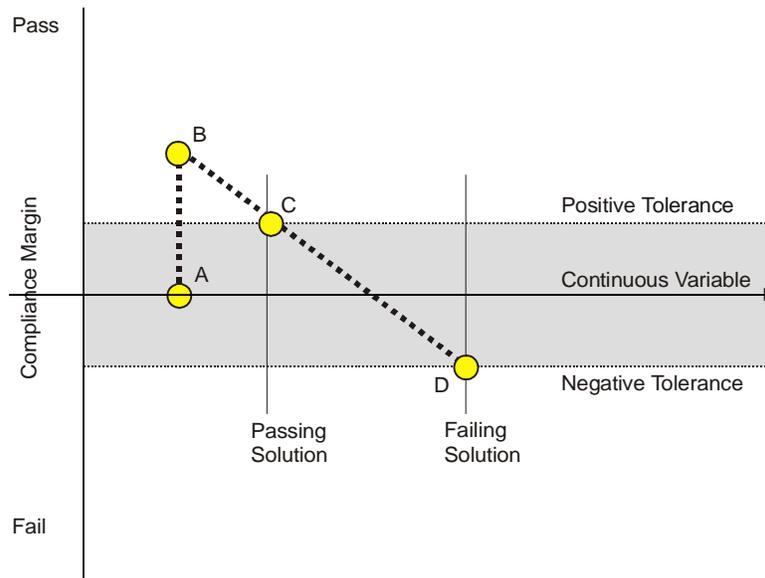


Figure R4-1 — Testing Concept — Discrete Modifications Produce Positive Compliance Margin

The discrete modifications produce a positive compliance margin that exceeds positive tolerance. Both the passing solution and the failing solutions for the continuous variable are determined.

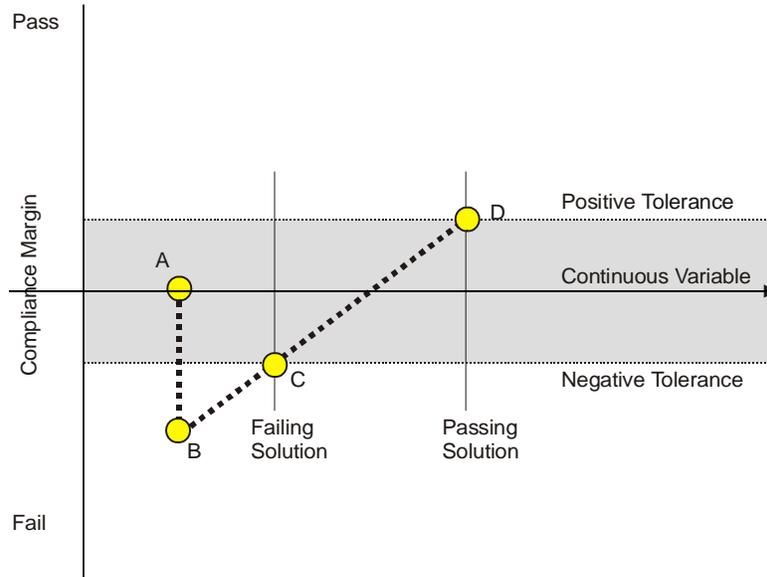


Figure R4-2—Testing Concept—Discrete Modifications Produce Negative Compliance Margin
 The discrete modifications produce a negative compliance margin that exceeds negative tolerance. Both the passing solution and the failing solutions for the continuous variable are determined.

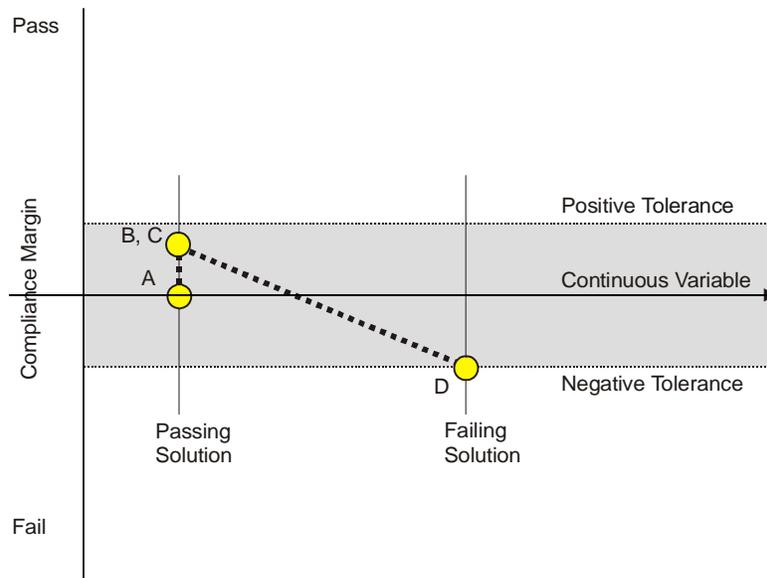


Figure R4-3—Testing Concept—Discrete Modifications Produce Positive But Small Compliance Margin
 The discrete modifications produce a positive compliance margin that is less than the positive tolerance. The passing solution for the continuous variable is equal to the basecase; the failing solution is determined by the vendor.

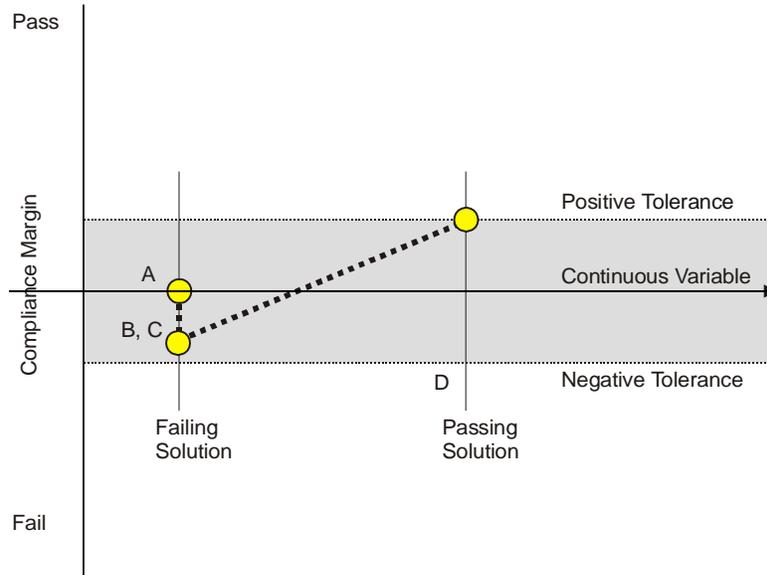


Figure R4-4—Testing Concept—Discrete Modifications Produce Negative But Small Compliance Margin
The discrete modifications produce a negative compliance margin that is within the negative. The failing solution for the continuous variable is equal to the basecase; the passing solution is determined by the vendor.

3.1.1.2 Acceptance Criteria

For every test, the Energy Commission reference method shall pass the modified basecase when data for the passing solution is entered and fail the modified basecase when data for the failing solution is entered. The acceptance criteria shall be satisfied for all tests. In addition to producing estimates that are within the tolerances, the tests are also used to verify that the standard reports are correctly produced, as required in Chapter 2. For instance, many of the discrete modifications trigger measures that shall be listed in the “Special Features and Modeling Assumptions” section of the Certificate of Compliance. Finally, the tests will be used to verify that the standard design building is correctly defined, as specified in Chapter 3.

3.1.2 Standard Design Tests

The acceptance criteria for the standard design generator tests use a different approach from the accuracy tests. Two types of tests are used to verify that the standard design is created according to the rules specified in Chapter 2: These are defined below along with the acceptance criteria for each.

3.1.2.1 Standard Design Equivalent Tests

The standard design equivalent tests consist of matched pairs of computer runs: a proposed design and its standard design equivalent. The standard design equivalent is the proposed design reconfigured according to the standard design rules in Chapter 3 to be in exact compliance with the prescriptive requirements (package D). The compliance software vendor is required to create the proposed design and standard design equivalent input files and submit them with the application for approval. Two Certificates of Compliance are produced: one for the proposed design and one for the standard design equivalent. The standard design TDV energy budget on the proposed design Certificate of Compliance shall be equal to the TDV energy use shown in both the standard design energy budget and proposed design columns of the standard design equivalent computer run. See Figure R-

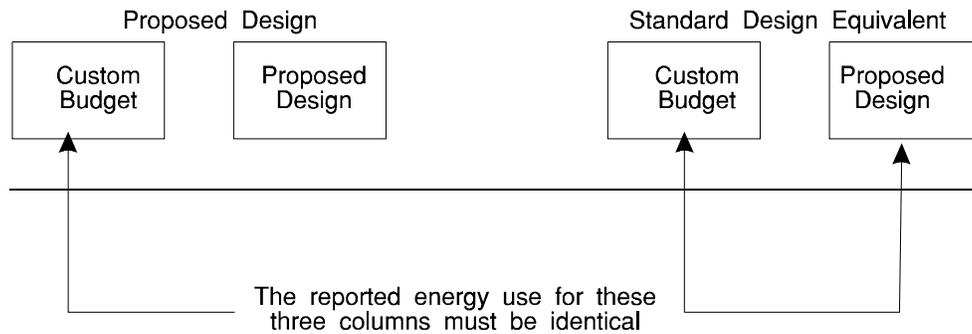


Figure R4-5—Custom Budget Tests

3.1.2.2 Neutral Variable Tests

The second series of standard design equivalent tests are the neutral variable tests. Neutral variables are building features that are unchanged between the standard design and the proposed design. An example of a neutral variable is glass area, below the prescriptive limit of 20 percent. In this series of tests, a change is specified in one of the neutral variables and the compliance margin has to remain within a certain tolerance.

3.1.3 Labeling Tests and Computer Simulations

Each of the tests has a specific label that includes the test series, the number of the test, the prototype used in the test and the climate zone for which the test is performed. Using a precise designation to make it easier to keep track of the many computer simulations will ease the Energy Commission review process. The following labeling scheme described in Figure R shall be used:

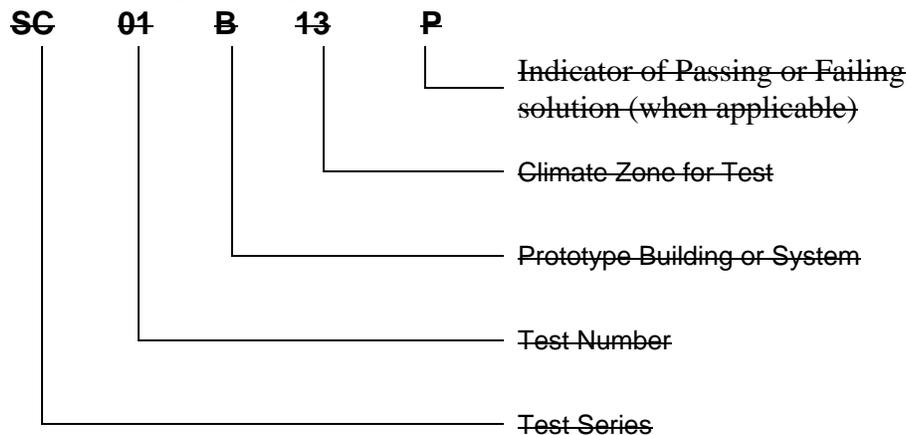


Figure R4-6—Labeling of Computer Simulations

Compliance Software input and output files shall use the same labeling scheme, but with a “P” or “F” concatenated on the end to indicate if the file represents the passing or failing solution.

3.1.4 Documentation

The compliance software vendor shall record the results of the tests on the forms provided in RACM Appendix A and provide electronic copies of the input files to the Energy Commission. The filenames shall include the test label (see below) with a “P” or “F” concatenated to the file name to indicate if the file represents the passing solution or the failing solution. The form (RACM Appendix A) includes an entry for the TDV energy for the passing solution and the failing solution. The forms also include the continuous variable values for the passing and failing solutions as well as the compliance software filenames for the passing and failing cases.

3.2 Space Conditioning Tests

This section describes the space conditioning tests that shall be performed by the compliance software vendor. Three groups of tests are described. The first verify that space conditioning TDV energy is predicted with an acceptable tolerance of that predicted by the reference method. The second series of tests verify that the custom budget or standard design is correctly defined. The third series of tests verify that the compliance software calculates TDV energy correctly for additions and alterations to low rise residential buildings.

3.2.1 Accuracy Tests (SC)

The accuracy tests verify that the candidate compliance software passes and fails buildings in a manner consistent with the reference method.

3.2.1.1 Prototype Buildings

The space conditioning accuracy tests are performed with two prototype buildings. The geometry of the prototype buildings and other features are described below and illustrated in Figure R4-7. The attic is not shown in Figure R4-7 since the dimensions and configuration of the attic are determined by the ceiling area.

Both prototype A and B are a square box measuring 40 ft by 40 ft and 10 ft tall. A single 80 ft² window on each façade (total window area is 20 percent of the floor area). The facades face exactly north, east, south and west. The thermal performance of all building envelope elements is in exact compliance with the prescriptive requirements (package D in the standards). The prototypes have a gas furnace and a split system air conditioner with air distribution ducts located in the attic.

A—Prototype A has a slab on grade.

B—Prototype B has raised floor construction.

Figure R4-7—Prototype Buildings A and B

3.2.1.2 Test Descriptions

Table R4-51 describes each of the space conditioning tests that shall be performed. The space conditioning accuracy tests use the series designation “SC.”

Table R4-51 – Summary of the Space Conditioning Tests

Series	Number	Prototypes	Climates	Discrete Modification(s)	Continuous Variable
SC	0	A, B	All	None	None
SC	01	A	3, 9, 12, 14, 16	Ceiling U-factor. Reduce the ceiling U-factor from the basecase condition to R-48. The U-factor for this condition shall be taken from Reference Joint Appendix JA4. Do not assume field verification for construction quality. Produces a positive compliance margin.	South Glass Area. Increase south glass area to find the Passing Solution and the Failing Solution.
SC	02	A	3, 9, 12, 14, 16	Wall U-factor. Increase wall insulation to the equivalent of R-22 in a 2x6 wood framed cavity with R-14 continuous insulation. The U-factor for this condition shall be taken from Reference Joint Appendix JA4. Do not assume field verification for construction quality. Produces a positive compliance margin.	West Glass Area. Increase west glass area to find the Passing Solution and the Failing Solution.
SC	03	A	12, 14, 16	Slab edge losses. Add R-7 slab insulation for climate zones 12 and 14. In climate zone 16, increase slab edge insulation from the basecase R-7 to R-21. Produces a positive compliance margin.	North Glass Area. Increase north glass area to find the Passing Solution and the Failing Solution.
SC	04	A	3, 9, 12, 14, 16	Fenestration Type. Replace the basecase fenestration with a super high performance product with a U-factor of 0.25 and a SHGC of 0.40. Produces a positive compliance margin.	North Glass Area. Increase north glass area to find the Passing Solution and the Failing Solution.
SC	05	A	3, 9, 12, 14, 16	Fenestration Type. Replace the basecase fenestration with a product that fails to comply with the package D requirements. The replacement product shall have a U-factor of 0.90 and an SHGC of 0.70. Produces a negative compliance margin.	AFUE. Increase or reduce the heating equipment AFUE to find the Passing Solution and the Failing Solution.
SC	06	A	12, 14, 16	Exposed Thermal Mass. Increase the percent of the slab-on-grade that is exposed from the basecase condition of 20% to 40%. Produces a positive compliance margin.	South Glass Area. Increase south glass area to find the Passing Solution and the Failing Solution.
SC	07	A	3, 9, 12, 14, 16	South Overhangs. Add a two foot projection from the surface of the south glass. Its bottom edge is located six inches above the top of the window. The window is assumed to be 6 ft 6 in. high and the overhang is assumed to extend an infinite distance beyond the sides of the windows (see Figure R4-8). Produces a positive compliance margin.	South Glass Area. Increase south glass area to find the Passing Solution and the Failing Solution.
SC	08	A	3, 9, 12, 14, 16	Building Envelope Sealing. Reduce the building (SLA) from 4.9 to 2.9 through diagnostic testing and sealing. Produces a positive compliance margin.	Glass Area. Increase glass area uniformly on all orientations to find the Passing Solution and the Failing Solution.
SC	09	A	3, 9, 12, 14, 16	Building Envelope Sealing and Mechanical Ventilation. The building leakage (SLA) is reduced from 4.9 to 2.9 through diagnostic testing and sealing. In addition, mechanical ventilation is added that provides 80 cfm (0.375 air changes per hour) of continuous ventilation and consumes 20 watts of power continuously. Produces a positive compliance margin.	Glass Area. Increase glass area uniformly on all orientations to find the Passing Solution and the Failing Solution.
SC	10	A	3, 9, 12, 14, 16	Construction Quality. Assume that the proposed design has been field verified to have quality wall and ceiling insulation quality. Produces a positive compliance margin.	AFUE. Reduce the heating equipment AFUE to find the Passing Solution and the Failing Solution.
SC	11	A	9, 12, 14	Cool Roofing Products / Radiant Barrier. Remove the radiant barrier (or equivalent cool roof) from the proposed design. Produces a negative compliance margin.	SEER. Increase the SEER (using default EER) to find the Passing Solution and the Failing Solution.

Series	Number	Prototypes	Climates	Discrete Modification(s)	Continuous Variable
SC	12	A	9, 12, 14	Side Fins. For this test side fins are added to the east and west facades of prototype A. The side fins extend 40 feet from the surface of a window that is assumed to be 10 feet wide. The fins are 5 feet from the edge of the window. The top of the side fins are 20 feet above the top of the window. See Figure R4-9. Sides fins are expected to produce a positive compliance margin.	SEER. Vary the SEER (keep EER at the default) to find the passing solution and fail the failing solution.
SC	13	A	9, 12, 14	Natural Ventilation. Change the window types to increase the free ventilation area from the default of 10% of the total window area to 20% of the window area, and assume a 10 ft elevation difference between the air inlet and the outlet. Produces a positive compliance margin.	SEER. Reduce the SEER (using default EER) to find the Passing Solution and the Failing Solution.
SC	14	A	9, 12, 14	Roofing Type Change roofing type from tile to composition shingles. Produces a negative compliance margin.	Attic Ventilation. Increase the attic ventilation to find the Passing Solution and the Failing Solution.
SC	15	A	9, 12, 14	Deck Insulation Add R-4 insulation to the roof deck.. Produces a positive compliance margin	Ceiling Insulation. Reduce the ceiling insulation to find the Passing Solution and the Failing Solution.
SC	16	A	3, 9, 12, 14, 16	SEER. Increase the cooling equipment efficiency (SEER) from the base case condition of 13.0 to 14.0. Use the default EER for both the SEER 13.0 and SEER 14.0 cases. Make no changes to the air distribution system or other HVAC system components. Produces a positive compliance margin.	AFUE. Reduce the heating equipment AFUE to find the Passing Solution and the Failing Solution.
SC	4	A	3, 9, 12, 14, 16	EER. Increase the cooling equipment efficiency (SEER) from the base case condition of 13.0 to 14.0. Use an EER 13 for the SEER 14.0 case. Make no changes to the air distribution system or other HVAC system components. Produces a positive compliance margin.	SHGC. Increase the SHGC of the windows on all orientations to find the Passing Solution and the Failing Solution.
SC	18	A	3, 9, 12, 14, 16	Duct Leakage. Do not seal the ducts as required by the prescriptive standards. Produces a negative compliance margin.	SEER. Increase the SEER (using default EER) to find the Passing Solution and the Failing Solution.
SC	19	A	3, 9, 12, 14, 16	Duct Surface Area. Through diagnostic verification, reduce duct surface area from the default of 27% of the floor area to 10% of the floor area. Produces a positive compliance margin.	SEER. Reduce the SEER (using default EER) to find the Passing Solution and the Failing Solution.
SC	20	B	9, 12, 14	Duct Location. Move the HVAC ducts from the crawlspace (the default for one story, raised floor buildings) to the attic. Produces a negative compliance margin.	SEER. Reduce the SEER (using default EER) to find the Passing Solution and the Failing Solution.
SC	21	B	9, 12, 14	Buried Ducts. Change the status of the ducts to deep buried. Produces a positive compliance margin.	AFUE. Decrease the AFUE to find the Passing Solution and the Failing Solution.
SC	22	B	9, 12, 14	Change HVAC type. Replace the existing furnace with a heat pump. Change the HSPF to 9 and the SEER to 14. Produces a positive compliance margin.	HSPF. Decrease the HSPF to find the Passing Solution and the Failing Solution.
SC	23	A	9, 12, 14	Duct Insulation. Reduce the duct R-value from the R-8 prescriptive requirement to R-4.2. Produces a negative compliance margin.	SEER. Increase the SEER (using default EER) to find the Passing Solution and the Failing Solution.
SC	24	A	9, 12, 14	Energy Efficiency Ratio (EER). Instead of using the default EER of 10.415 for the default SEER 12 assume an EER of 11.5 with the same SEER of 12). Produces a positive compliance margin.	SHGC. Increase the SHGC of the windows on all orientations to find the Passing Solution and the Failing Solution.
SC	25	A	9, 12, 14	Charge Indicator Light / Charge Testing. Do not install a Charge Indicator Light and do not field verify that the split system has the correct refrigerant charge. Produces a negative compliance margin.	SHGC. Reduce the SHGC of the windows on all orientations to find the Passing Solution and the Failing Solution.

Series	Number	Prototypes	Climates	Discrete Modification(s)	Continuous Variable
SC	26	A	9, 12, 14	Airflow Across Evaporator Coil. Verify through field verification that there is adequate airflow for compliance credit (350 cfm/ton for a wet coil) across the evaporator coil. Produces a positive compliance margin.	SHGC. Increase the SHGC of the windows on all orientations to find the Passing Solution and the Failing Solution.
SC	27	A	9, 12, 14	Air Conditioner Fan Power. Reduce fan power through field verification. The default is 0.51 W/cfm. Reduce this to 0.20 W/cfm. Produces a positive compliance margin.	SHGC. Increase the SHGC of the windows on all orientations to find the Passing Solution and the Failing Solution.
SC	28	A	3, 9, 12	Electric Heat. Replace the gas furnace and air distribution system in the basecase with electric resistance baseboards (no air distribution or duct losses). In addition, increase the ceiling insulation to R-60. The U-factor for this condition shall be taken from Reference Joint Appendix JA4 Do not assume field verification for construction quality. Produces a negative compliance margin.	Fenestration U-factor. Reduce the fenestration U-factor on all orientations to find the Passing Solution and the Failing Solution.

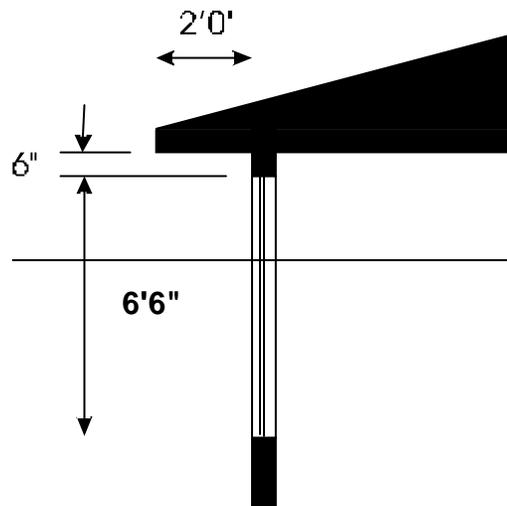
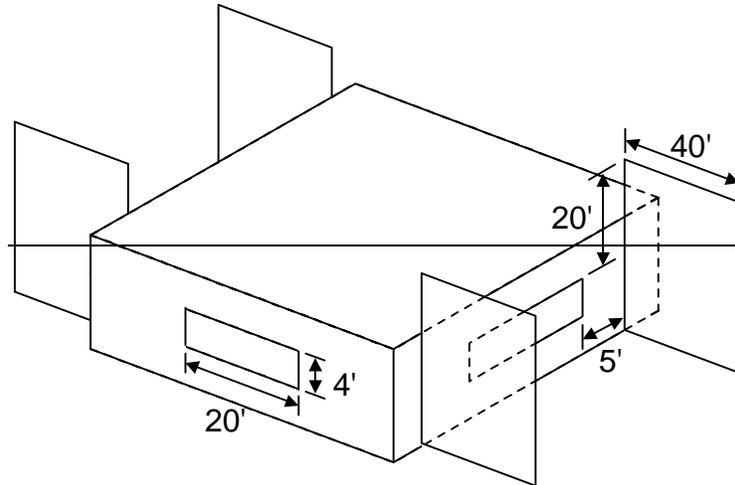


Figure R4-8 – Overhang Characteristics



*Figure R4-9—Side Fins for Optional Capabilities Test
The north and south façades are the ones that do not have the sidefins.*

3.2.1.3 Acceptance Criteria

The positive tolerance is the basecase TDV energy for space conditioning plus 3 percent or 1 kTDV/ft² y, whichever is greater. The negative tolerance is the basecase TDV energy for space conditioning less 3 percent or 1 kTDV/ft² y, whichever is greater. The Energy Commission reference method shall pass the modified basecase when data for the passing solution is entered and fail the modified basecase when data for the failing solution is entered.

In addition to producing estimates that are within the tolerances, the tests are also used to verify that the standard reports are correctly produced, as required in Chapter 2. For instance, many of the discrete modifications trigger measures that shall be listed in the “Special Features and Modeling Assumptions” section of the Certificate of Compliance.

3.2.2 Standard Design Generator Tests (SD)

This section describes the standard design tests that shall be performed by the compliance software vendor. The standard design tests use the series designation “SD.” Compliance software shall automatically create the standard design building, as defined in Chapter 3. The standard design run is made automatically at the same time as the proposed design run, and the results are reported together on the Certificate of Compliance discussed in Chapter 2. The tests described in this section verify that the standard design is correctly defined for the proposed design and that the custom budget is correctly calculated. These tests supplement the SC tests, which also verify certain standard design features:

3.2.2.1 Prototypes Buildings

The custom budget tests use three prototype buildings as described below.

C—Prototype C is a 2,100 ft², one-story, single-family detached home. Two versions of this prototype are used in the tests. One has a slab floor and one has a raised floor. Details are available from the Energy Commission.

D—Prototype D is a 2,700 ft², two-story detached home. Details are available from the Energy Commission.

~~E Prototype E is an eight unit, two story multi family building, with a total conditioned floor area of 6,960 ft². Details are available from the Energy Commission.~~

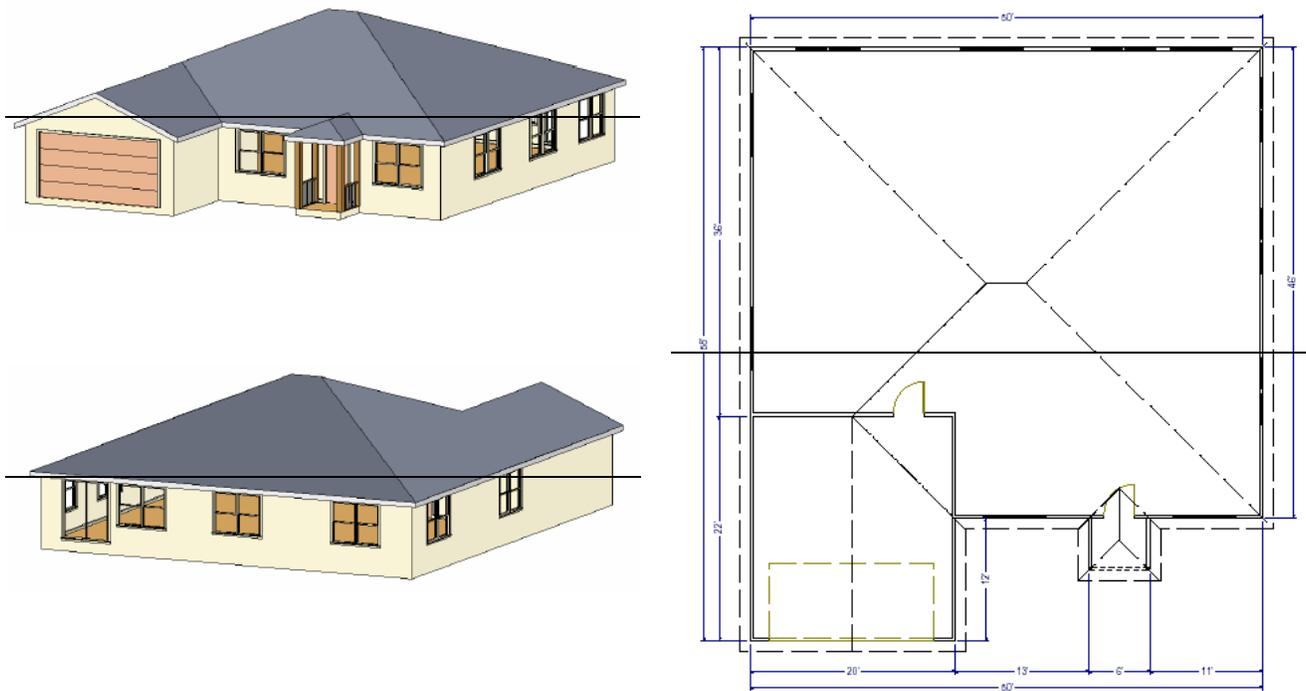


Figure R4-10—Prototype C

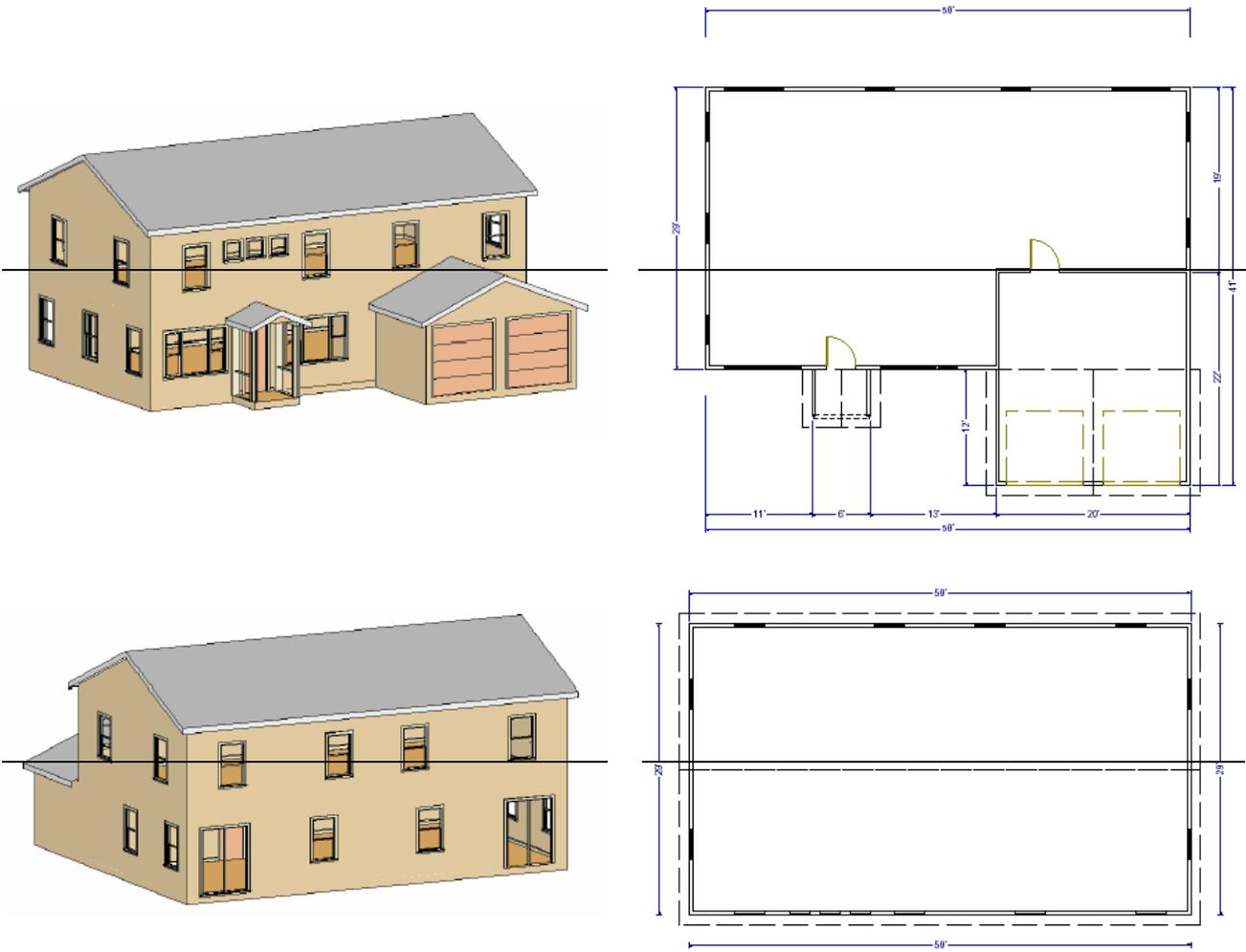


Figure R4-11—Prototype D

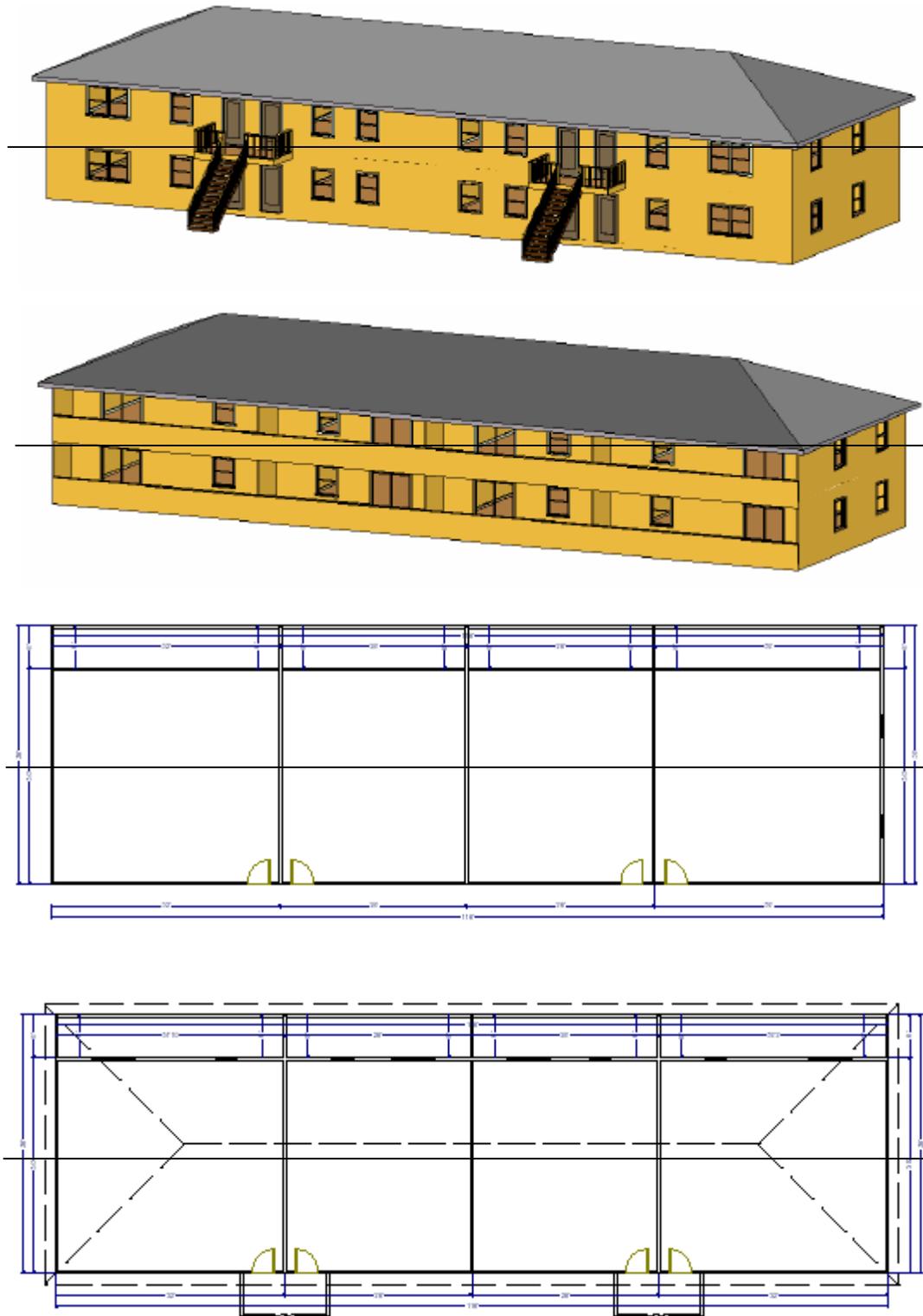


Figure R—Prototype E

3.2.2.2 Standard Design Equivalent Tests

The standard design equivalent tests are described in Table R4-52. For each of these tests, the standard design equivalent budget and proposed design TDV energy shall equal each other. In addition, the TDV energy shall equal the budget TDV energy for the proposed building.

Table R—Standard Design Tests

<i>Series</i>	<i>Number</i>	<i>Prototypes</i>	<i>Climates</i>	<i>Description</i>
SD	00	A, B	All	Basecase Prototypes. These tests were also performed in the SC series. For each of these tests, the standard design and proposed design TDV energy shall be equal. There is no proposed design case for these tests.
SD	01	C	All	Slab-On-Grade. The purpose of this test is to verify that the standard design generator correctly defines the standard design for proposed designs using slab-on-grade designs. The “SC01C**” files are run in all 16 climate zones.
SD	02	D	All	Raised Floor. The purpose of this test is to verify that the standard design generator correctly defines the standard design for proposed designs using raised floor buildings. The “SC01D**” files are run in all 16 climate zones.
SD	03	E	All	Multi-Family. The purpose of this test is to verify that the standard design generator correctly defines the standard design for multi-family buildings. The “SC01E**” files are run in all 16 climate zones.
SD	04	A	All	Equipment Change Heating. The purpose of this test is to verify that the standard design generator correctly defines the standard design for proposed designs using non-ducted mechanical systems. The “SC01D**” files are run in all 16 climate zones. Heating equipment is switched to Gas Wall heater with 0.62 AFUE no ducts.
SD	05	A	All	Equipment Change Cooling. The purpose of this test is to verify that the standard design generator correctly defines the standard design for proposed designs using non-ducted mechanical systems. The “SC01D**” files are run in all 16 climate zones. Cooling equipment is switched to Wall AC with a 10 EER.

3.2.2.3 Neutral Variable Tests

The neutral variable tests are described in Table R3. For each of these tests, the compliance margin shall remain within one percent of zero.

Table R3-2—Neutral Variable Design Tests—Space Conditioning

<i>Series</i>	<i>Number</i>	<i>Prototypes</i>	<i>Climates</i>	<i>Description</i>
SD	06	A	3, 9, 12, 14, 16	Window Area. Reduce window area from 20% of the floor area to 15% of the floor area. Reduce the size of the window on each façade to 60 ft ² . Do not change any other features.
SD	07	A	3, 9, 12, 14, 16	Wall Area. Increase the gross wall area on each façade from 400 ft ² to 600 ft ² .

3.2.3 Additions and Alternations (AA)

This section describes the tests for alternations and additions that shall be performed by the compliance software vendor. The additions and alternations tests use the series designation “AA.” Additions are treated as new buildings except that internal heat gains are allocated on a fractional dwelling unit basis. With the Addition + Existing + Alternation approach, energy credit may be taken for improvements to the existing building. This series of tests exercises the various default assumptions (see Table R3-50 in Section 3.16.4) based on the vintage of the existing building and the various reporting requirements for modeling an addition with an existing building. In addition, these tests verify the proper determination of the energy budget and compliance criteria for an addition with an improved existing building.

3.2.3.1 Prototype Buildings

The prototype used in these tests consists of an existing building and an addition. The existing building has the same physical configuration as Prototype A but the thermal performance of building envelope components is downgraded to be more typical of older existing buildings. Prototype E (Figure R4-12) has the thermal characteristics of 1977 construction practice and Prototype F has the thermal characteristics of 1989 construction practice. See the Additions and Alternations section of Chapter 3 for details on construction assemblies. Each window is 4 ft high and 20 ft wide centered on the façade. The addition is 12 ft deep by 40 ft long and 10 ft high and covers the whole west side of the existing building.

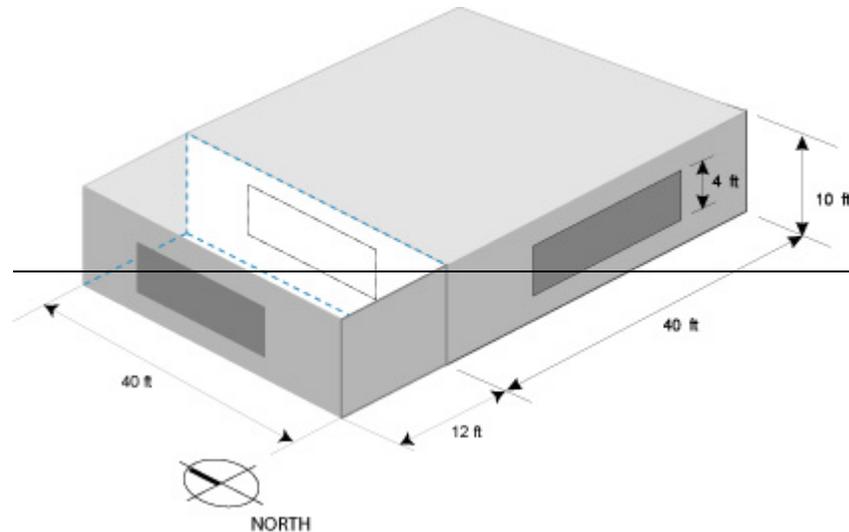


Figure R4-13—Prototypes E and F

3.2.3.2 Test Descriptions

These tests are also be used to confirm that reporting requirements are met when modeling an addition with an existing building and that the appropriate budgets have been correctly determined. Two of the three compliance approaches for additions and alternations are evaluated with these tests: the addition alone approach and the Existing + Addition + Alteration approach. The whole building approach is not evaluated since this is identical to new construction. Table R4-54 describes the tests to perform with the Addition Alone approach. Table R4-55 describes the tests to perform with the Existing + Addition + Alteration approach.

Table R4-54 – Summary of the Addition-Along Tests

Series	Number	Prototypes	Climates	Discrete Modification(s)	Continuous Variable
AA	01	E 1977	3, 9, 12, 14, 16	Baseline. The features of the addition shall all exactly meet the prescriptive requirements. The addition is served by an HVAC system in the existing house.	None. This is a standard design generator test.
AA	02	E 1977	3, 9, 12, 14, 16	Increase Glass. Increase fenestration area on the west side of the addition to 144 ft ² . This discrete change will fail compliance because the glass area exceeds 20% of the floor area.	Fenestration Area U-factor. Reduce the fenestration U-factor in the addition to find the Passing Solution and the Failing Solution.
AA	03	F 1989	3, 9, 12, 14, 16	New HVAC. Install a separate minimal efficiency HVAC split system gas/electric system for the addition that has no duct testing. This will create a negative compliance margin.	Duct Testing/Insulation. Change the assumption to duct testing and increase the duct insulation until a failing and passing compliance margin are met.

Table R4-55 – Summary Existing + Addition + Alternation Tests

Series	Number	Prototypes	Climates	Discrete Modification(s)	Continuous Variable
EA	1	E 1977	3, 9, 12, 14, 16	Baseline. The features of the addition shall all exactly meet the prescriptive requirements. The addition is served by an HVAC system in the existing house. Remove 80 ft ² from the existing west wall and include 80 ft ² with the addition (no net increase in glass area)	None. This is a standard design generator test.
EA	2	E 1977	3, 9, 12, 14, 16	Increase Glass. Increase fenestration area on the west side of the addition to 144 ft ² . This discrete change will fail compliance because the glass area exceeds 20% of the floor area.	Fenestration U-factor. Reduce the fenestration U-factor in the addition to find the Passing Solution and the Failing Solution.
EA	3	F 1989	3, 9, 12, 14, 16	New HVAC. Install a separate HVAC split system gas/electric system for the addition that has an SEER of 14 and an EER of 13. This will create a positive compliance margin.	Fenestration U-factor. Increase the fenestration U-factor in the addition to find the Passing Solution and the Failing Solution.
EA	04	E 1977	3, 9, 12, 14, 16	New Ducts. Install new ducts in an alteration with no duct testing and no duct insulation. This will create a negative compliance margin.	Duct Insulation. Change the assumption to duct testing and increase the duct insulation until a failing and passing compliance margin are met.

3.2.3.3 Acceptance Criteria

For each test, the Energy Commission reference method shall pass the addition plus existing building when data for the passing solution is entered and fail the addition plus existing building when data for the failing solution is entered. The positive tolerance is the TDV space conditioning energy for the basecase plus 3 percent or 1 kBtu/ft² y, whichever is greater, and the negative tolerance is also 3 percent or 1 kBtu/ft² y, whichever is greater. In addition to producing estimates that are within the tolerances, the Energy Commission will also verify that the correct performance factors are used, based on the vintage of the existing building, and that the standard reports are correctly produced, as required in Chapter 2.

3.3 Water Heating Tests (WH)

This section describes the water heating tests that shall be performed by the compliance software vendor. The water heating tests use the series designation “WH”. The water heating tests are defined in a similar manner as the space conditioning tests, except that the tests are performed relative to a water heating system, not whole building TDV energy. See the Overview section of this chapter for a

description of the procedures. For the water heating tests, only the TDV energy for water heating is considered in the comparison.

3.3.1 Prototype Systems

Two prototype water heating systems are used. The first is a system which serves the single family home represented by space conditioning prototype C (the water heating system also uses the “C” designation). The second is a system that serves the multi-family apartment building represented by prototype E (this uses the “E” designation). More information on the buildings served is provided above in the prototype descriptions for the space conditioning tests. The water heating systems for the two prototypes are described in Table R.

Table R—Base Case Water Heating Systems

Prototype	Prototype C	Prototype E
Building Information		
Dwelling Units	4	16
Total Building Area	2,100 ft ²	6,960 ft ²
Average Dwelling Unit Size	2,100 ft ²	870 ft ²
Water Heating Equipment		
Number of Water Heaters	4	4
Water Heater Type	Storage Gas (SG)	Large Storage Gas (SG)
Energy Factor/Thermal Eff/Standby	0.575	0.80/700 Btu/h per unit ⁴
Tank Size	50	4 @ 100
Distribution System	Standard (PIK)	Recirculation with timer controls
Multi-Family Recirculation System		
Linear Feet of Pipe (Note 1)	n.a.	200
PF Outdoor Air	n.a.	0.10
PF Ground	n.a.	0.20
PF Conditioned or semi-conditioned air within the building envelope	n.a.	0.70
Pipe Diameter for Recirculation System	n.a.	1.5 in.
Recirculation Pipe Insulation	n.a.	1.0 in.
Pump Size (brake horsepower)	n.a.	½ hp
Pump Motor Efficiency	n.a.	0.85
Note 1. Total Linear feet used for recirculation between dwelling units (input to Section 3.15). PF is the fraction of the total linear feet that is used either outside, in the ground, or in the conditioned or semi-conditioned air within the building envelope, as defined in RACM Appendix E4.		

3.3.2 Accuracy Tests (WH)

As described in the Overview of this chapter, the compliance software vendor shall find the passing and failing solution for each test described in Table R4-57. The Energy Commission reference method shall then pass the modified basecase when data for the passing solution is entered and fail the modified basecase when data for the failing solution is entered. The acceptance criteria shall be satisfied for all tests. The water heating tests use a 2 percent passing tolerance and a 2 percent failing tolerance, or 1.0 kTDV/ft² y, whichever is greater.

Table R4-57—Accuracy Tests—Water Heating

Type	Test	Prototypes	Climates	Discrete Modification(s)	Continuous Variable
WH	0	C, E	All	None	None
WH	4	C		Disribution Type Add uncovered below grade plumbing to the distribution system. Produces a negative compliance.	Energy Factor Increase the EF for the water heater until the passing and failing solutions are reached
WH	2	C	3, 9, 12, 14, 16	Electric Instantaneous Water Heater. Change the water heater type from gas storage to electric Instantaneous and use a point of use (POU) distribution system. This produces a negative compliance margin.	Solar Savings Fraction (SSF). Increase the SSF to find the passing and failing solutions.
WH	3	C	3, 9, 12, 14, 16	Recirculation Control. Change the distribution system from the default to demand recirculation with manual control. This produces a positive compliance margin.	Energy Factor. Reduce the EF of the water heater until the passing and failing solutions are reached.
WH	4	E	3, 9, 12, 14, 16	Recirculation Control. Add monitored system controls (MCS) for the recirculating system. This produces a positive compliance margin.	Thermal Efficiency. Decrease thermal efficiency (recovery efficiency or AFUE) until the failing solution is reached.
WH	5	C	3, 9, 12, 14, 16	Large Storage Water Heater. Change water heater type to a 80-gallon large gas storage, SBL of 800 btuhr, thermal (recovery) efficiency= 0.80	Thermal Efficiency. Increase thermal efficiency (recovery efficiency or AFUE) until the passing solution is reached.
WH	7	C	3, 9, 12, 14, 16	Number of Water Heaters. Use 2 water heaters for the single residence; both are the same size and performance as the basecase. This will produce a negative compliance margin	Energy Factor. Increase the energy factor of both water heaters together to find passing and failing solutions.
WH	8	E	3, 9, 12, 14, 16	Pump Controls. Baseline assumes timer pump controls. Change to no pump control. This produces a negative compliance margin.	Thermal Efficiency. Increase thermal efficiency (recovery efficiency or AFUE) until the passing and failing solution is reached.

3.3.3 Standard Design Tests (WD)

This section describes a series of tests that verify that the standard design is being correctly defined for water heating systems. The acceptance criteria for these tests are different from the accuracy tests. For this series of tests, a change is defined, which according to the rules for defining the standard design should be neutral. Being neutral means that the change is reflected for both the standard design and the proposed design. The compliance margin shall be within plus or minus 2 percent of the standard design TDV energy for water heating (space conditioning is not considered). In addition, TDV energy for water heating shall move in the direction indicated in each test description.

3.3.3.1 Standard Design Equivalent Tests

For water heating the standard design equivalent tests consist of running the basecase water heating systems in all 16 climates. For each case, the standard design TDV energy shall equal the proposed design TDV energy. See Table R-4.

Table R-4 – Standard Design Equivalent Tests – Water Heating

<i>Type</i>	<i>Test</i>	<i>Prototypes</i>	<i>Climates</i>	<i>Discrete Modification(s)</i>	<i>Continuous Variable</i>
WD	0	C, E	All	None	None

3.3.3.2 Neutral Variable Tests

The neutral variable tests are shown in Table R-. For these tests, the compliance margin shall remain at zero, unchanged.

Table R-5 – Neutral Variable Tests – Water Heating

<i>Type</i>	<i>Test</i>	<i>Prototypes</i>	<i>Climates</i>	<i>Discrete Modification(s)</i>
WD	1	C	3, 9, 12, 14, 16	House Size. Increase house size to 2,500 ft ² . TDV energy for both the <i>Standard Design</i> and the <i>Proposed Design</i> shall increase.
WD	2	C	3, 9, 12, 14, 16	House Size. Increase house size to 3,500 ft ² . The TDV energy for both the <i>Standard Design</i> and the <i>Proposed Design</i> shall equal the TDV energy for test 1.
WD	3	E	3, 9, 12, 14, 16	Pipe Length. Increase recirculation piping length to 400 ft. TDV energy for both the <i>Standard Design</i> and the <i>Proposed Design</i> shall increase.
WD	4	E	3, 9, 12, 14, 16	Pipe Location. Move all the piping outdoors. PF ground and plenum become zero and PF outdoors becomes 1.00. TDV energy for both the <i>Standard Design</i> and the <i>Proposed Design</i> shall increase.
WD	5	E	3, 9, 12, 14, 16	Individual Water Heaters. Replace the central water heating system with individual water heaters in each dwelling unit, which meet the basecase specification for single-family homes (see Table R-)

4.2. Users Manual including Compliance Supplement

Each Compliance Software vendor is required to publish a Users' Manual that includes a Compliance Supplement as a component of the users' manual. The users' manual shall contain sufficient information so that users can develop an understanding of how to run the program and correctly prepare building project information required by the software, complete and operable files. The Compliance Supplement shall describe the specific procedures for using the Compliance Software for compliance with the Building Energy Efficiency Standards. This includes instructions for preparing the building software input and using the correct explanations of the fixed and restricted inputs. In addition, the compliance supplement shall include a list of all error messages and information on how to resolve them. The compliance supplement This requirement may be met with a users' help manual incorporated into the software, however, a printed version of the help-users' manual which include all help items must be submitted as part of the Compliance Supplement users' manual with the application. The Compliance Supplement serves two major purposes. First, it helps building permit applicants to use the Compliance Software correctly and to prepare complete documentation of their analyses. Second, it helps building officials to check permit applications for compliance with the low-rise residential Building Energy Efficiency Standards. As a result, it helps to assure that both the performance standards and the Compliance Software are used implemented properly.

The Compliance Supplement shall describe the specific procedures for using the Compliance Software for compliance with the Building Energy Efficiency Standards. The supplement shall provide instructions for preparing the building input and, using the correct fixed and restricted inputs, and for using each of the optional capabilities for which the Compliance Software is approved. Also included are procedures for generating the standard reports and documenting the compliance analysis must also be included in the Compliance Supplement. A sample of a properly documented building compliance analysis shall be included.

All Users' Manuals and Compliance Supplements shall be written in a clear and concise manner and with an organization and format that will allow users to quickly locate the topic and understand the instructions. Also, vendors of approved Compliance Software are required to make copies of their user s' manuals and Compliance Supplement available to all building departments in California.

The following sections describe the information that shall be included in all Compliance Supplements users' manuals compliance supplements. It also presents the required organization for that information.

4.42.1 Energy Commission Approval

This section includes a copy of the official Energy Commission notice of approval for of the Compliance Software. The notice may include restrictions or limitations on the use of the Compliance Software. It will also include the date of approval, and may include an expiration date for approval as well. The notice will indicate which optional capabilities the Compliance Software is approved for and other any restrictions on its use for Standards compliance. The Energy Commission will provide this notice upon completion of evaluation of the Compliance Software application.

4.22.2 Software Capabilities

This section ~~shall discuss~~ the program capabilities, with supporting ~~written~~ material explaining, as necessary, how the Compliance Software treats each one. Reference may be made to non-compliance sections of the Compliance Software ~~Users' m~~Manual for more complete descriptions, if ~~they exist~~ appropriate.

4.32.3 Standard Input/Output Report

Inputs files shall be organized so that data is presented in the same order as that used by the required output reports.

4.42.4 Fixed and Restricted Inputs

Approved Compliance Software shall automatically use the standard fixed and restricted inputs for the standard design run. It shall also default to the standard assumptions for the proposed design run. When alternative fixed and restricted inputs are used for the proposed design run, the Compliance Software shall report this in the *Special Features and Modeling Assumptions* sections of the standard reports.

This section of the ~~Users Manual~~ Compliance Supplement Compliance Supplement shall explain the fixed and restricted inputs and how they are invoked in the Compliance Software. This is especially important if the Compliance Software offers the possibility of non-compliance runs which can deviate from the fixed and restricted inputs.

4.52.5 Preparing Basic Input

This section ~~shall cover~~ the basic use of the Compliance Software for compliance. ~~Optional capabilities are described in greater detail.~~ Reference may be made to the Compliance Software user manual ~~Users' M~~manual, but this section ~~should~~ shall include a complete summary of all inputs and/or commands necessary for Standards compliance.

4.6 Optional Capabilities

This section ~~explains the procedures for using each of the optional capabilities of the Compliance Software. It is a parallel section to the basic inputs section above. The section for each optional capability should explain how to prepare inputs, how to document assumptions, and what the limitations are of each analysis capability.~~

4.72.6 Special Features and Modeling Assumptions

This section ~~shall explain~~ the use of the Special Features and Modeling Assumptions listing to highlight the importance of verifying the special features and the aspects of those features that were modeled to achieve compliance.

4.82.7 Field Verification

This section ~~shall explain~~ the use of the Field Verification and Diagnostic Testing documentation in the compliance forms listing to highlight the special features that require diagnostic testing by a certified home energy rater under the supervision of an Energy Commission approved HERS provider

~~to assure proper installation and verification.~~ This section may rely on the information provided in Residential Reference Residential Appendix RA3, the Residential ACM Reference Manual and other sections of this manual, or may refer to other Commission documents.

4.92.8 Checklist for Compliance Submittal

This section ~~should~~ shall contain a concise checklist of all items that ~~shall~~ will be included in a compliance submittal to a building official using the Compliance Software.

4.102.9 Sample Compliance Documentation

This section ~~should~~ shall include a complete set of compliance documentation for a sample building. ~~The building need not be overly complex, nor need it include every software capability.~~ The example ~~shall should, however,~~ include all documentation and standard reports that would normally be submitted to a building department. This example will serve as a model to Compliance Software users and building officials of what a proper compliance submittal should look like.

4.112.10 Compliance Statement

The following statement shall appear within the first several pages of the Supplement:

[Compliance Software Name] may be used to show compliance with California's Residential Building Energy Efficiency Standards.

4.122.11 Related Publications

The ~~Users mManual~~ Compliance Supplement ~~should~~ shall refer users to the following related Energy Commission publications and where to obtain them:

- 2013 Building Energy Efficiency Standards (CEC 400-2012-004) ~~publication number unknown at time of printing~~
- 2013 Residential Compliance Manual (publication number unknown at time of printing)
- 2013 Residential Alternative Calculation Methods Reference Manual (publication number unknown at time of printing)

~~Both~~ These publications are available from:

California Energy Commission
 Publications Unit
 1516 Ninth Street
 Sacramento CA 95814
 (916) 654-5200

Residential ACM Appendix A

RACM Appendix A – Certification of Alternative Calculation Method

Energy Efficiency Standards for Residential Buildings, Sections 150.0 to 150.2

I, _____ (name), certify that this alternative calculation method (compliance program), _____ (name of compliance program), version number _____, dated _____, developed by, _____ (personnel or company), _____ (address) _____ (city, state) _____ (zip), passes all of the Compliance Software tests and gives results that are reliable and accurate when used for calculating custom budgets and annual energy use estimates to comply with ~~CEC~~ (California Energy Commission) ~~(Commission)~~ regulations, subject to the fixed and restricted assumptions specified in the Residential Alternative Calculation Method (ACM) Approval Manual and the Residential Alternative Calculation Method (ACM) Reference Manual for the 2013~~08~~ Energy Efficiency Standards for Residential Buildings, and the fixed and restricted inputs specified in the manuals describing the use of this method (Users Manual and Compliance Supplement thereto). I certify that the calculation of energy use in buildings, following the instructions in the manuals, and using accurate and complete plans and specifications for a building will achieve reliable and accurate energy analysis results with this compliance program. Moreover, the calculations are verifiable when modeling the same building and accurately applying the fixed and restricted assumptions and inputs mentioned above. I further certify that all variables used by the program that are not subject to ready verification in the plans and specifications or that are subject to occupant use are either fixed, carefully restricted, or defaulted in this compliance program. I certify that I have incorporated the official version of the Compliance Manager software that has been certified for use in Compliance Software by the Commission.

I also certify that the inputs, default values, and assumptions specified for compliance runs in the manuals, and used in the accompanying application for the ~~CEC~~ Commission residential compliance program approval, are consistent with the inputs, default values, and assumptions specified by the ~~CEC~~ Commission in the Residential Alternative Calculation Method (ACM) Approval Manual and the Residential Alternative Calculation Method (ACM) Reference Manual for the 2013~~08~~ Energy Efficiency Standards for Residential Buildings for use when generating standard design budgets and annual energy use estimates. I also certify that all specific inputs, variables, and assumptions needed to achieve the accuracy required to pass the capability tests in the Residential ACM Approval Manual and Residential ACM Reference Manual are either not subject to user variation, are defaulted to the values used for compliance, or are clearly specified as restricted or required inputs in the manuals for the compliance program. In addition, the manuals clearly indicates that an easily verified list of the actual values of any such variables used for performance approach compliance which are subject to programmatic or user variation are to be included with the compliance documentation supplied by a building permit applicant to the enforcement agency. In summary, I also certify that the results of this alternative calculation method as specified in the manuals for the compliance program in conjunction with an accurate and adequate set of plans and specifications for a building are not subject to significant variation by the manipulation of unrestricted user specified inputs that are difficult or impossible to verify.

In certifying the reliability and accuracy of this compliance program, I certify that the results of this compliance program's calculations, algorithms and assumptions are open to inspection by any individual or State entity, that this compliance program may be challenged for its validity and accuracy as specified by the ACM Approval Manual, and that if challenged, I will prepare an adequate response or face possible withdrawal of compliance program approval.

This certification is based upon the tests and requirements specified in the Residential Alternative Calculation Method (ACM) Approval Manual and the Residential Alternative Calculation Method (ACM) Reference Manual for the 2013~~08~~ Energy Efficiency Standards for Residential Buildings, and upon personal knowledge and experience with the use of this alternative calculation method.

Signed _____

Date _____

Title _____

