2016

ALTERNATIVE CALCULATION METHOD APPROVAL MANUAL

(MARKED VERSION)

FOR THE 2016 BUILDING ENERGY EFFICIENCY STANDARDS

TITLE 24, PART 6, AND ASSOCIATED ADMINISTRATIVE REGULATIONS IN PART 1.

CALIFORNIA ENERGY COMMISSION
Edmund G. Brown Jr., Governor

TABLE OF CONTENTS

APPENDIX A – RESIDENTIAL CERTIFICATION TESTS

APPENDIX B – NONRESIDENTIAL CERTIFICATION TESTS

~~Section 1. Overview~~ABSTRACT

This ~~Manual~~manual explains the requirements for approval of ~~residential~~ Alternative Calculation Methods (ACMs ~~or~~), which include compliance software~~). Residential.~~ Compliance ~~Software~~software is used to demonstrate compliance with the performance approach to the ~~California~~2016 Building Energy Efficiency Standards for ~~Low-Rise~~ Residential and Nonresidential Buildings (Standards~~).~~.)[1].The residential requirements of this document apply to buildings covered by the low-rise residential provisions of the Standards. All building types other than low-rise residential that are within the scope of the Standards are covered by the nonresidential requirements of this document.

The approval procedure for ACM compliance software 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~~performs spot checks and ~~may~~can 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 to show compliance with the Standards. The ~~compliance supplement will also be~~user manual must include a tutorial, user guidance for each program input, and an index. The manual is checked by the Energy 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~~developed by the Energy Commission.~~.~~ This open source software, called the Compliance Manager in this document, ~~will be~~is made available at no cost to potential compliance software vendors. The ACM tests submitted by the vendor ~~will~~ confirm and document that the Compliance Manager ~~has been~~is successfully integrated into the vendor software.

~~This chapter~~Section 1 presents the general requirements for ~~residential~~ compliance software. ~~. Chapter 2 describes the~~2~~Section 2~~ provides basic details required ~~content of~~by the Compliance ~~Supplement.~~ Manager in establishing the standard design energy use of residential and nonresidential buildings. The ~~certification tests are documented in detail in the~~ Residential and Nonresidential ACM Reference ~~Manual, a document~~Manuals are documents that ~~is~~are developed and maintained by the Energy Commission to document in greater detail the ~~details of the~~building performance ~~compliance~~ modeling calculations implemented in the Compliance Manager software~~, and to explain the certification tests all Compliance Software must pass. The Residential ACM Reference Manual is~~. These reference manuals are approved by the ~~Commission after the adoption of each Building Energy Efficiency Standards update,~~Energy Commission and updated as necessary to resolve issues identified during ~~the~~ implementation ~~of the performance compliance approach using Compliance Software.~~ 3~~Section 3~~ describes the required content of the user manuals

---

[1] Cal. Code Regs., tit. 24, pt. 6, and associated administrative regulations in pt. 1, ch. 10.

provided by software vendors for their compliance products. The certification tests that compliance software must pass in order to receive approval are documented in detail in Appendix A for low-rise residential buildings and Appendix B for nonresidential buildings.

1. Approval of Compliance Software

1.1 Application Checklist

The following is a list of the items that ~~shall~~must be included in an application package for compliance software ~~certification~~approval by the Energy Commission~~:~~.

1.1.1. Compliance Software Vendor Certification Statement. ~~A~~

The compliance software vendor shall include a signed, dated statement ~~from the Compliance Software vendor~~ certifying ~~the reliability and accuracy~~under penalty of perjury under the laws of the State of California that the ~~software when used for Standards compliance purposes (see Residential ACM Approval Manual~~ vendor's compliance software integrates the current version of the Compliance Manager and successfully passes the tests specified in Appendix A~~).~~ or B that are applicable to the software seeking approval.

1.1.2. Computer Runs and Summary Sheets. ~~Copies of the computer runs specified in the Residential ACM Reference Manual, including complete input and output files, provided electronically to the Commission in computer readable form. 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 2. The Compliance Supplement and the Compliance Software User's Manual may be combined into the same document.~~

~~**Copy of the Compliance Software.**~~ The compliance software vendor shall provide copies of the input files for the computer runs related to the tests required by Section 1.1.2, which includes, but is not limited to, all input and output files, the file necessary for transferring information to a HERS provider as generated by the software, and a summary sheet of the compliance results from all required computer runs. These files shall be provided to the Energy Commission in an electronic format. These files shall demonstrate that the criteria in Section 10-109 are met, as required by Sections 10-109(b)2B and 10-109(c)2.

Full approval of new software and approval following major compliance manager updates requires completion of all tests applicable to a program's capabilities. Minor compliance manager updates require completion of only the tests relevant to the update. The Energy Commission shall, when it publishes a minor update, specify the tests determined to be relevant to the update.

1.1.3. User Manual and Changelog

An electronic copy of the user manual specified in Section 2 shall be included with the approval application. This document shall contain a description of the functional and analytical capabilities of the software, as required by Section 10-109(b)2A.

Applications for approval of an updated version of currently approved software shall also include a complete list of changes to the software.

1.1.4. Compliance Software

• An executable version of the compliance software for ~~the~~ which approval is sought shall be provided for the Energy Commission's use ~~during the software certification process~~. The software must include the ability to generate the file necessary to register the compliance documentation with a HERS provider.

1.1.5. Application Fee~~.~~

An application fee is required to cover the costs of evaluating an application when the software has not previously been approved by the Energy Commission, or for the first approval following an update to the Title 24, Part 6, Building Energy Efficiency Standards (Standards). In these cases, the applicant shall provide a deposit of $1,000.00 (one thousand dollars) ~~is required to cover the costs of evaluating the application. The total fee shall~~ to cover the ~~Commission's cost of reviewing and analyzing the application.~~ Energy Commission's evaluation costs, as required by Section 10-109(b)2C.

Within 75 days of receipt of an application, the Commission will provide the applicant with an estimate of the total maximum cost to review and analyze the application. After the Energy Commission ~~determines the total costs~~completes its review, if the costs exceed the initial ~~fee~~deposit, the Energy Commission shall assess an additional fee to cover the total costs. ~~If actual cost~~ up to the estimated amount provided to the applicant. If the cost of reviewing the application is less than the initial ~~or any estimated maximum fee~~deposit, the Energy Commission shall refund the difference to the applicant.

Following submittal of the application package, the Energy Commission may request additional information pursuant to Title 24, Part 1, Section 10-110. Failure to provide such information in a timely manner may be considered cause for rejection or disapproval of the application. Resubmittal of a rejected or disapproved application is considered a new application, and may include a new application fee.

1.2 *Approval of Received Applications*

1.2.1 ~~Types of~~ Approval Process

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

~~1.1.1 Full Approval~~

~~Full approval is~~For approval of an application, the following procedures apply:

The compliance software vendor submits an application to the Energy Commission containing all of the materials required ~~when a Compliance Software product~~ by Section 1.1. For software that has ~~never been~~not previously been approved ~~by the Commission or when the Compliance Software vendor makes~~, or approval following a change ~~that significantly affects the results. The Commission may also require that all Compliance Software be approved again when the~~ to the Standards ~~are updated or whenever substantial revisions are made to the approval process.~~

- ~~When re-approval is mandated by~~, the applicant will also provide the ~~Commission, all Compliance Software vendors will be notified of the renewal timetable. Full approval is~~deposit required ~~for all Compliance Software changes, unless they qualify for the streamlined approval process discussed below.~~by Section 1.1.5.

~~1.1.2 Streamlined Approval~~

~~Certain types of changes may be made to approve Compliance Software through a streamlined process. 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 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. If a Compliance Software modification qualifies for streamlined approval, then the following procedure is followed:~~

- ~~When the Energy Commission makes 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, Compliance Software vendors can update their Compliance Software voluntarily upon release of the modified Compliance Manager (CM) software, and must update their Compliance Software~~The Energy Commission shall respond to the application within 45 days ~~of~~, letting the ~~CM release date, unless otherwise stated by the~~ applicant know whether their application is complete and able to be approved. The Energy Commission **shall** ~~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.~~

  ~~The Commission responds in 45 days. The Commission response may take several forms. The Commission may~~either approve the ~~updated~~ software, request additional information,~~, refuse to approve the change~~ or require that the ~~Compliance~~

~~Software~~compliance software vendor make specific changes to either the ~~Compliance Supplement addendum~~user manual or the ~~Compliance Software~~compliance software.

~~With Commission~~ Applications shall be approved either by the Energy Commission at a business meeting or by the Executive Director, as appropriate for the application.

The Energy Commission will provide a written approval upon completion of evaluation and approval of the compliance software application. Once approved, the vendor may issue new copies of the compliance software with the ~~Compliance Supplement addendum~~user manual and notify compliance software users and building officials.

~~1.1.3   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.~~

1.2.2   When Approval Is Not Required

Changes to the compliance manager that affect functionality (see Section 2.4) do not require vendors of compliance software to follow the process set forth in Section 1.2.1. Changes to compliance software that do not affect compliance with the Standards do not require ~~full or streamlined~~ approval. However, the compliance software vendor ~~shall~~must notify ~~the Commission~~ and provide the Energy Commission with an updated copy of the program ~~,~~ a list of changes, and an updated copy of the user manual. ~~Re-approval is required~~ in order for ~~any Compliance Software change that affects the compliance results, the format and/or content of compliance forms, or any other change that would affect a building's~~versions of the software that include such changes to remain eligible for demonstrating compliance with the Standards.

Any questions regarding applicable approval procedures should be directed to the Energy Commission.

~~2.2.   Challenges~~

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

~~2.3. Decertification of Compliance Software~~

1.3 ~~The Commission may decertify (rescind approval of) Compliance Software through various means~~ **Compliance Manager Version Updates**

The Energy Commission periodically makes changes to the Compliance Manager to correct functional and analytical errors, incorporate software modules to address compliance options approved by the Energy Commission, add building systems, assemblies, and construction materials, or to make changes necessary to accurately estimate the energy use of buildings covered by Title 24, Part 6, and demonstrate compliance with the Building Energy Efficiency Standards.

Changes to the Compliance Manager may be a major change, a minor change, or a functionality correction, as described below.

Approved compliance software is expected to incorporate the most current version of the Compliance Manager. Depending on the nature of the update to the Compliance Manager, compliance software vendors will have different deadlines for incorporating the most current version of the Compliance Manager into their software, and different allowances for the use of approved software incorporating the previous version of the Compliance Manager.

1.3.1 Major Changes to the Compliance Manager

A major change to the Compliance Manager is any change that is determined by the Energy Commission to be a significant change in software input or output, meaning a change that would affect either a significant number of users of the software or a significant fraction of modeled buildings.

Major changes will be shown, in part, by incrementing the version number of the compliance manager software. When a new version of the Compliance Manager is released that includes a major change, the Energy Commission shall determine a schedule of 90 days or longer, based on the extent of the change, for vendors of approved compliance software to incorporate the new version of the Compliance Manager. When the Energy Commission approves the updated compliance software that incorporates the new version of the Compliance Manager, approval of previous versions expires 90 days after approval of the new version of the compliance software. Versions with expired approval may not be used to show standards compliance for new permit applications.

1.3.2 Minor Changes to the Compliance Manager

A minor change to the Compliance Manager is any change that is not determined to be a major change.

Minor changes will be shown, in part, by appending a letter or sub-number to the compliance software version number. When a new version of the compliance manager is released that includes a minor change and does not include a major change, the Energy Commission shall

determine a schedule of 45 days or longer, based on the extent of the change, for vendors of approved compliance software to incorporate the new version of the Compliance Manager.

When the Energy Commission approves the updated compliance software that incorporates the new version of the Compliance Manager, approval of previous versions expires 60 days after approval of the new version of the compliance software. Versions with expired approval may not be used to show standards compliance for new permit applications.

1.4 *Changes that Do Not Require Approval*

The following changes do not require approval by the Energy Commission, However, the compliance software vendor must notify and provide the Energy Commission with an updated copy of the program, a list of changes, and an updated copy of the user manual in order for versions of the software that include such changes to remain eligible for demonstrating compliance with the Standards.

1.4.1 Functionality Corrections to the Compliance Manager

A change to the compliance manager that solely affects functionality, including but not limited to editing the content of error messages, modifying the appearance of screens, correcting an error that causes an incorrect or unexpected result (i.e., a bug fix), or accommodating a new operating system, shall be indicated by the Energy Commission appending a version letter or sub-number to the version number.

When a new version of the compliance manager is released that includes solely functionality corrections, compliance vendors may update their compliance software to incorporate the updated compliance manager at their discretion. Vendors that do so may request an extension of their approval to cover this updated version. This type of change must be indicated by appending a version letter or sub-number to the version number of the compliance software in order for the Energy Commission to reference the updated version in the written approval.

When approval is extended to a newer version in this manner, approval of the previous version or versions will not expire.

1.4.2 Changes Made by Compliance Software Vendors

Vendors may, when they update their compliance software in a manner that results in no change in compliance results but addresses other aspects of their software's performance, request that approval of their software be extended to apply to this newer version.

Vendors requesting extension of approval shall provide a signed, dated statement certifying under penalty of perjury under the laws of the State of California that the changes have no effect on the determination of compliance with the Standards. This type of change must be indicated by appending a version letter or sub-number to the version number of the compliance software in order for the Energy Commission to reference the updated version in the written approval.

When approval is extended to a newer version in this manner, approval of the previous version or versions will not expire.

1.5   Expired Approval and Decertification

Decertification is a formal process to withdraw approval of compliance software and is distinct from expiring approval of a particular obsoleted version of approved compliance software.

1.5.1   Expiring Approval

Approval of a prior version of software expires, and is replaced by approval of a newer version, as part of the typical cycle of updating compliance software to account for bug fixes and changes to the compliance manager. When new versions of compliance software are approved by the Energy Commission, the approval of previous versions for use with new permit applications shall expire after 90 days, except upon request for a longer period by the software vendor.

A vendor asking for a longer period before expiration shall provide a letter stating the exceptional circumstances that require a longer period in order to prevent harm to the users of the software or the public at large. The Executive Director shall review the letter and determine whether to allow a longer period for the software in question.

During the first 30 days following approval of a new version of compliance software, the Energy Commission shall update the approved compliance programs website, and the Executive Director shall send a notice to building officials and interested parties announcing the expiring approval of the prior version and the current approval of the newer version.

1.5.2   Decertification

Decertification is a formal process for withdrawing approval of compliance software, distinct from expiring approval of an obsolete version of otherwise approved software. Decertification may occur as a result of the following:

- All compliance software products are automatically decertified when the Standards undergo substantial changes, usually occurring such that the software would fail to confirm compliance with eachthe Standards update.

- Any compliance software product can be decertified without a proceeding by a letter from the compliance software vendor requesting that a particular version (or versions) of thetheir product be decertified. The decertification request shall briefly describe the nature of the program errors or "bugs" whichthat justify the need for decertification or the reason why decertification is appropriate.

- Any "initiating party" may commence a procedure to decertify a compliance software product according to the steps outlined below. The intent is to include This process provides 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 compliance software version discontinued. ~~In this process, there is ample opportunity for the Commission, the Compliance Software vendor and all interested parties to evaluate any alleged errors in the Compliance Software program.~~

1.5.3   Initiating a Decertification Proceeding

<u>The </u>following is ~~a description of ~~the process for challenging compliance software or initiating a decertification procedure:

1. Any party may initiate a review of compliance software<u>'</u>~~'s~~ approval by sending a written communication to the <u>Energy </u>Commission's Executive Director~~. (The~~<u>, with copies to the Building Standards Office. Alternatively, the Energy</u> Commission may be the initiating party for this ~~type of ~~review ~~by noticing the availability of the same information listed here.)~~<u>.</u> The initiating party shall:
    (a) State the name of the compliance software and the program version number(s) that contain the alleged errors;
    (b) Identify concisely the nature of the alleged errors in the compliance software that 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 <u>other </u>information ~~sufficient~~<u>relevant</u> to evaluate the alleged errors.
2. The Executive Director shall <u>notify and </u>make a copy ~~or copies ~~of the initial written communication available to the compliance software vendor and <u>any known </u>interested parties within 30 days~~. Comments from interested~~ <u>of receipt. Interested</u> parties ~~must be received within 60~~<u>shall have 45</u> days <u>from the date </u>of the ~~acceptance of the original application~~<u>notification provided by the Executive Director to submit comments to the Energy Commission relating to the request</u>.
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~~<u>compliance software</u> errors from the party who initiated the decertification review process. ~~If ~~<u>The party initiating </u>the <u>process must respond within 30 days of the request for </u>additional information ~~is incomplete, this procedure will be delayed until the initiating party submits complete information. ~~<u>.</u>
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~~<u>a</u> 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~~<u>compliance software</u> need not be decertified; or
    (b) Submit to the Commission a written recommendation that the ~~Compliance Software~~<u>compliance software</u> be decertified.

6. If the <u>Energy </u>Commission approves the compliance software decertification, it shall take effect 60 days later. ~~During~~<u>Within</u> 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~~<u>performed</u>. The decertification process may be terminated at any time by mutual written consent of the initiating party and the Executive Director.

The compliance software vendor may use the ~~180 to 210-day ~~period outlined here to update the compliance software~~, get it re-approved~~<u>, obtain approval</u> by the Commission, and release a revised version that ~~does not contain~~<u>corrects</u> the errors initially brought to the attention of the Commission.

1.6 Compliance Software Tests

<u>Compliance software vendors applying for approval of their software shall perform a series of computer runs. Each of these runs shall be a systematic variation of the applicant base case model as described in the tests in Appendix A or B. The results from the vendor's software shall be compared to the reference results to verify that the vendor's software meets the requirements for approval as compliance software.</u>

1.6.1 <u>Alternate </u>Compliance Software <u>Tests</u>

The compliance software vendor may propose alternate tests <u>from those specified in Appendix A and Appendix B </u>when the vendor believes that one or more of the standard tests are not appropriate for the<u>ir</u> compliance software. Alternate tests will be evaluated by the Commission <u>on a case-by-case basis </u>and will be ~~accepted~~<u>applied to that vendor's software</u> if they are considered reasonable. ~~If accepted, the alternate test(s) will be added to the Residential ACM Reference Manual as an addendum and the alternate test(s) will be available for use by all Compliance Software.~~

1.7 Approval of New Exceptional Methods

The Commission may approve new exceptional methods. Exceptional methods <u>may include</u> special modeling capabilities or calculation methods necessary to recognize building features that cannot be adequately modeled with existing compliance software. <u>See California Code of Regulations, Part 1, Chapter 10, Sections 10-109 and 10-110. </u>When an exceptional method is approved, a new optional capabilities test may be approved as part of the process. To be approved for the new optional capability, vendors ~~shall~~<u>must</u> amend their compliance software<u> and update their user manual</u>.

Even if the compliance software ~~already~~ incorporates the ~~Exceptional Method~~<u>exceptional method prior to the exceptional method's approval by the Energy Commission</u>, the vendor ~~shall~~<u>must</u> receive approval to use the exceptional method in the compliance process~~.~~ <u>as though inclusion of the exceptional method was a minor change to their software.</u>

2   <u>Compliance Manager Capabilities</u>

The Compliance ~~Software vendor shall~~ <u>Manager is the simulation and compliance rule implementation software developed by the Energy Commission. The Compliance Manager software simulates the energy use of a proposed residential or nonresidential building and compares it to a standard design energy budget to determine if the building complies with the Standards.</u>

<u>Residential and nonresidential compliance software that is used to</u> demonstrate ~~that the~~ compliance ~~software~~<u>with the Standards must incorporate this simulation and compliance rule implementation software.</u>

2.1   <u>*Standard Design*</u>

<u>The standard design building is a building simulated to establish the baseline energy budget for space heating, space cooling, indoor air quality ventilation, and water heating for a proposed building.</u>

<u>For newly constructed buildings, the standard design building shall be modeled as existing in the same location and having the same characteristics, including but not limited to floor area, volume, and configuration, as the proposed building, except that wall and fenestration areas shall be distributed equally between the four main compass points, North, East, South and West. For additions and alterations, the standard design shall be modeled as existing in the same location and having the same characteristics, and shall have the same wall and fenestration areas and orientations as the existing building.</u>

<u>Where the Energy Commission specifies that the standard design building includes a covered product subject to 42 USC 6295, or an appliance</u>~~s~~ <u>regulated by the Appliance Efficiency Regulations, the standard design building shall be modeled to meet but not exceed the efficiency level required by 42 USC 6295 for that covered product or applicable standards required by the Appliance Efficiency Regulations for that regulated appliance, respectively.</u>

<u>The standard design building shall be modeled to include the mandatory requirements of the 2016 Standards, and the prescriptive options that would apply to or most closely match the building features specified for the proposed building.</u>

<u>The process of generating the standard design shall be performed</u> 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.~~ <u>by the compliance manager software. The compliance manager shall perform this modeling based on the inputs that describe the proposed building, substituting the assumptions for wall and fenestration area distribution, required efficiency for the covered</u>

products subject to 42 USC 6295 that the Energy Commission specifies in the standard design, and the applicable standards for the appliance regulated by the Appliance Efficiency Regulation that the Energy Commission specifies in the standard designs, and mandatory and prescriptive options applicable to the proposed building, thereby creating a standard design building against which the energy use of the proposed building can be evaluated.

2.2   Time Dependent Valuation

The compliance manager shall convert all electricity, gas or propane used within the modeled buildings to time dependent valuation energy (TDV energy). TDV energy is defined in Joint Appendix 1 and further specified in Joint Appendix 3.

The compliance manager shall calculate the modeled energy budgets of the standard design building and the energy consumption of the proposed buildings in terms of TDV energy, thereby ensuring that all modeled building features are specified on a one-for-one equivalent energy use or equivalent energy cost basis. Compliance credit for covered products subject to 42 USC 6295 having efficiencies exceeding the efficiency levels required by 42 USC 6295 shall be calculated in terms of TDV energy, thereby ensuring that the compliance credit is on a one-for-one equivalent energy or equivalent cost basis.

2.3   Climate Zone

Compliance requirements, weather, design temperatures, and the Time Dependent Valuation of energy are partly a function of climate. The Commission has established typical weather data, prescriptive packages and energy budgets for 16 geographic areas of California, called climate zones, as specified in the 2016 Standards and Joint Appendix 2.

The compliance manager software shall incorporate modeling of climate zone dependent information based on the climate zone or zip code specified for the proposed building.

Where the compliance manager incorporates climate elements into the modeling calculations for the standard and proposed buildings, the compliance manager shall calculate the effects of weather, temperature, and other climate elements based on the climate zone specified for the proposed building, and shall apply the same adjustments to both buildings.

The standard design shall be modeled as incorporating prescriptive options appropriate to the climate zone specified for the proposed building.

For covered products subject to 42 USC 6295, and for appliances regulated by the Appliance Efficiency Regulations, the estimated energy use of those covered products or appliances used to calculate the total energy use of the standard design and proposed buildings shall be determined using the test procedure prescribed by 42 USC 6293 or the Appliance Efficiency Regulations, respectively. This estimated energy use shall be adjusted to reflect the conditions where Part 6 is being applied, as a part of calculating the total TDV energy of each building, consistent with the Alternative Calculation Approval Manual and as documented in the Alternative Calculation Approval Method Reference Manual.

2.4 Reference Manual

The Energy Commission shall publish a Reference Manual for the Compliance Manager software that specifies the standard design and documents the calculations and methods used by the Compliance Manager software to model building performance, calculate TDV energy, and determine compliance with the 2016 Standards.

3 ~~2~~ User's Manual ~~including Compliance Supplement~~

Each approved compliance software vendor ~~is required to~~ shall publish a user's manual ~~that includes a Compliance Supplement as a component of the user manual. The user manual,__ __which__ shall contain sufficient information ~~so that~~for users ~~can develop an understanding of~~ to understand how to ~~run the program and~~ correctly prepare complete and operable files~~.~~, and how to generate standard compliance documentation. The ~~Compliance Supplement~~user manual shall describe the specific procedures for using the ~~Compliance Software for~~ compliance software to comply with the Building Energy Efficiency Standards. This includes instructions for preparing the building input and using the correct 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 requirement may be met with a~~ A copy of the user manual ~~incorporated into the software, however, a printed version of the user manual which includes all help items~~ must be submitted ~~as part of the user manual,~~ with the vendor's application ~~that both the performance standards and the Compliance Software are implemented properly~~for approval of their software.

~~Also included are procedures for generating the standard reports and documenting the analysis. A sample of a properly documented building analysis shall be included.~~

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

The following sections describe the information that ~~shall~~must be included in ~~all~~ user manuals~~. It also presents the required organization for that information~~.

~~This section includes a copy of the official Energy Commission notice of approval 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 any restrictions on its use for compliance. The Energy Commission will provide this notice upon completion of evaluation of the Compliance Software application.~~

3.1 Software Capabilities

~~This~~The user manual shall include a section that discusses the program capabilities~~, with supporting written material explaining, as necessary, how the Compliance Software treats~~

each one. Reference may be made to ~~non-compliance~~other sections of the ~~Compliance Software User's Manual~~user manual for more complete descriptions, if appropriate.

2.5. 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.~~

2.6. 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 User's Manual explains 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.~~

3.2 Preparing Basic Input

~~This section covers~~The user manual shall cover the basic use of the ~~Compliance Software for~~ compliance. ~~Reference may be made to the User's Manual, but this section should~~ software for compliance. This section shall include a complete summary of all inputs and~~/or~~ commands necessary for compliance.

2.7. Special Features and Modeling Assumptions

~~This section explains 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.~~

2.8. Field Verification

~~This section explains the use of the Field Verification and Diagnostic Testing 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 Appendix RA3, and other sections of this manual, or may refer to other Commission documents.~~

3.3 Checklist for Compliance Submittal

This section should The user manual shall contain a concise checklist of all items that shallmust be included in a compliance submittal to a building official using the compliance software.

3.4 Sample Compliance Documentation

This section shouldThe user manual 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 should, however,shall include all documentation and standard reports that would normally be submitted to a building official. This example will serveshall be usable as a model to for compliance software users and building officials of what a proper compliance submittal should look like.

3.5 Compliance Statement

The following statement shall appear within the first severalthree (3) pages of the Supplement:user's manual:

> [Compliance software name] may be used to show compliance with California's Residential2016 Building Energy Efficiency Standards.

3.6 Related Publications

The User's Manual shoulduser manual shall refer users to the following related Energy Commission publications and where to obtain them:

- *20132016 Building Energy Efficiency Standards* (publication number unknown at time of printing)

- *20132016 Residential Compliance Manual* (publication number unknown at time of printing)

- *2016 Nonresidential Compliance Manual* (publication number unknown at time of printing)

Both publications are available from:

California Energy Commission
Publications Unit

~~1516 Ninth Street~~
~~Sacramento CA 95814~~
~~(916) 654-5200~~

APPENDIX A. RESIDENTIAL CERTIFICATION TESTS

The purpose of ACM testing is to demonstrate that candidate software submitted for approval successfully integrates Compliance Manager into the candidate software. This includes testing a variety of both inputs and reporting to ensure that buildings are being accurately modeled under the rules established by the Energy Commission.

A test data set with specific description and details of the tests, inputs, and a spreadsheet of compliance results is available from the Energy Commission to assist vendors in preparing the certification tests. The tests are based on the Energy Commission 2100 ft^2, 2700 ft^2 and 6960 ft^2 new construction prototypes and the 1665 ft^2 addition/alteration prototype described in Section F.

A.   *Test Data Set (TDS) Descriptions*

The TDS runs are based on the prototypes described in Section F. below. The exact details of the TDS runs are provided in the form of reference software input files, currently an .ribd format.

Tests T01, T02, and T03 show that the compliance software matches the standard design in all climate zones for the three prototype buildings. The glass and walls are equally distributed, with no overhangs modeled. The prototype buildings (as shown in Table A-1) for these tests are named S2100, S2700 and S6960. The "S" indicates that the building is in the standard configuration.

Tests T04, T05, and T06 run the prototype buildings using actual building features such as unequal glass and wall distribution, overhangs and other non-prescriptive requirements. The standard design for these tests will be equal to the standard design in Tests T01-T03. The prototype buildings for these tests are named P2100, P2700, and P6960. The "P" indicates that the building is in the proposed configuration.

Tests T07, T08, T09, and T11 are based on a single prototype in a single climate zone - T01R12. Test T07 models common compliance measures and test T08 runs water heating variations. T09 test multiple orientations. T11 tests source energy calculations.

Test T10 covers multifamily central water heating starting with on T03R12 inputs.

Tests T12 and T13 cover existing plus addition plus alteration calculations using P1665 prototype for climate zone 12.

Additional tests will be added as needed to reasonably test candidate software against the reference as features are added or changed. There will also be non-numeric tests added to verify that the candidate software can complete the compliance process by generating reports.

Table A-1 contains a list of the tests.

Table A-1: Test Data Set Files and Descriptions

Test #	Run #	# of Runs	Description	Prototype
			Standard and Proposed Design Tests	
T01	R01-R16	16	Standard Design Test	S2100
T02	R01-R16	16	Standard Design Test	S2700
T03	R01-R16	16	Standard Design Test	S6960
T04	R01-R16	16	Proposed Design Test	S2100
T05	R01-R16	16	Proposed Design Test	S2700
T06	R01-R16	16	Proposed Design Test	S6960
T07			**Common Measures in Climate Zone 12**[1]	
T07	R01	1	Package A	T04R12
T07	R02	1	Fenestration U 0.40/S 0.40	T04R12
T07	R03	1	Wall R13	T04R12
T07	R04	1	Ceiling R49	T04R12
T07	R05	1	Furnace AFUE 92	T04R12
T07	R06	1	Air Conditioner SEER 16/EER 14	T04R12
T07	R07	1	No Cool Vent	T04R12
T07	R08	1	Ducts 2% Leakage	T04R12
T07	R09	1	Insulation Construction Quality Improved	T04R12
T07	R10	1	Air Leakage CAH50 2.0	T04R12
T08			**Water Heating in Climate Zone 12**[2]	
T08	R01	1	Package A	T04R12
T08	R02	1	Parallel Piping	T04R12
T08	R03	1	Small Tankless EF 0.80/Input 195000/0 gal	T04R12
T08	R04	1	Large Tankless RE 0.76/Input 300000/0 gal	T04R12
T08	R05	1	Large Storage RE 0.77/Input 100000/75 gal/Stby 0.01	T04R12
T08	R06	1	Large Storage RE 0.77/Input 100000/75 gal/Stby 0.03	T04R12
T08	R07	1	Electric Resistance EF 0.92/Input 4500	T04R12
T08	R08	1	Heat Pump EF 2.4/Input 4500	T04R12
T08	R09	1	2 Water Heaters using multiplier	T04R12
T08	R10	1	2 Water Heaters using 2 entries	T04R12

1. Tests have the same standard design as T01R12.

1.2. Some tests will have a standard design different than T01R12.

Test #	Run #	# of Runs	Description	Prototype
T09			**Multiple Orientation, Climate Zone 12**	
T09	R01	1	Single Standard Front 45	T04R12
T09	R02	1	East Standard	T04R12
T09	R03	1	South Standard	T04R12
T09	R04	1	West Standard	T04R12
T09	R05	1	North Standard	T04R12
T09	R06	1	Single Proposed Front 45	T04R12
T09	R07	1	East Proposed	T04R12
T09	R08	1	South Proposed	T04R12
T09	R09	1	West Proposed	T04R12
T09	R10	1	North Proposed	T04R12
T10			**Multi Family Water Heating in Climate Zone 12**[3]	
T10	R01	1	8 Storage	T06R12
T10	R02	1	8 Storage 2 Systems	T06R12
T10	R03	1	8 Large Storage	T06R12
T10	R04	1	2 Large Storage Central Solar	T06R12
T10	R05	1	2 Large Storage Central Solar Recirc	T06R12
T10	R06	1	2 Large Storage Central Recirc	T06R12
T10	R07	1	2 Small Instant Central Solar	T06R12
T10	R08	1	2 Small Instant Central Solar Recirc	T06R12
T10	R09	1	1 Indirect Central Solar	T06R12
T10	R10	1	1 Indirect Central Solar Recirc	T06R12
T11			**Source Energy in Climate Zone 12**[4]	
T11	R01	1	Package A	T04R12
T11	R02	1	Package A no Natural Gas	T04R12
T11	R03	1	Electric DHW	T04R12
T11	R04	1	Electric DHW no Natural Gas	T04R12
T11	R05	1	Heatpump DHW	T04R12
T11	R06	1	Heatpump DHW no Natural Gas	T04R12
T11	R07	1	Heatpump HVAC	T04R12
T11	R08	1	Heatpump HVAC no Natural Gas	T04R12
3. Some tests will have a standard design different than T03R12.				
2.4. Some tests will have a standard design different than T01R12				

Test #	Run #	# of Runs	Description	Prototype
T11	R09	1	Heatpump HVAC & DHW	T04R12
T11	R10	1	Heatpump HVAC & DHW no Natural Gas	T04R12
T12			**E+A+A Base & Windows**[5]	
T10	R01	1	E 1440 ft2 as New Construction	P1665
T10	R02	1	E 1440 ft2 as Addition/Alteration	P1665
T10	R03	1	EA 1665 ft2	P1665
T10	R04	1	EAA Ceiling R38 Verified	P1665
T10	R05	1	EAA Ceiling R38 Verified Wind U 0.41/S 0.36	P1665
T10	R06	1	EAA Ceiling R38 Verified Wind U 0.41/S 0.36 Verified	P1665
T10	R07	1	EAA Ceiling R38 Verified Wind U 0.40/S 0.35	P1665
T10	R08	1	EAA Ceiling R38 Verified Wind U 0.40/S 0.35 Verified	P1665
T10	R09	1	EAA Ceiling R38 Verified Wind U 0.39/S 0.34	P1665
T10	R10	1	EAA Ceiling R38 Verified Wind U 0.39/S 0.34 Verified	P1665
T13			**E+A+A Walls & HVAC**[5]	
T10	R01	1	EAA Ceiling R38 Verified Wall R11	P1665
T10	R02	1	EAA Ceiling R38 Verified Wall R11 Verified	P1665
T10	R03	1	EAA Ceiling R38 Verified Wall R13	P1665
T10	R04	1	EAA Ceiling R38 Verified Wall R13 Verified	P1665
T10	R05	1	EAA Ceiling R38 Verified HVAC Worse	P1665
T10	R06	1	EAA Ceiling R38 Verified HVAC Worse Verified	P1665
T10	R07	1	EAA Ceiling R38 Verified HVAC Equal	P1665
T10	R08	1	EAA Ceiling R38 Verified HVAC Equal Verified	P1665
T10	R09	1	EAA Ceiling R38 Verified Better	P1665
T10	R10	1	EAA Ceiling R38 Verified Better Verified	P1665

5. Standard design varies with features and verification.

B. Test Data Set

The test data set is maintained by the Energy Commission and made available to vendors. This data consists of:

1. The reference program input files (currently .ribd files) for all runs that describe all inputs for each run.

2. The test data set spreadsheet that describes each test and compares the current reference results to the candidate results to determine if it passes the numeric results test. The results for the reference software will be imported using the AnalysisResults.csv file generated by CBECC-Res reference software. Results for the candidate software may be imported or manually entered.

3. Additional intermediate results and reports for a small subset of runs that is used to demonstrate that the candidate software is capable of completing the entire compliance process of input, run, and reporting. These results will be verified either by visual review or with the use of a file comparison utility program.

C. Software Vendor Requirements

Candidate software needs to:

1. Secure the latest copy of the test data set from the Energy Commission.

2. Create input files in the candidate software's user interface to match those in the test data set.

3. Run the test data set and load the results into the spreadsheet to verify that the results match.

4. Compare the intermediate results and reports to verify that the results match, as described in the test data set spreadsheet

D. Submittals for Approval

Submittals to the Energy Commission requesting approval shall include:

1. Access to the candidate software in a manner that allows the Energy Commission to use the software.

2. All files necessary to compare results to the test data set, including the input files, the results spreadsheet and the specified intermediate results and reports.

3. Any other documentation required in the ACM Approval Manual or the ACM Reference Manual.

The Energy Commission will review the test data set results to verify that the software works and that the documentation meets ACM requirements.

E. Compliance Manager Updates

When new versions of Compliance Manager or its components become available, the Energy Commission will run the test data set to verify that the results match. If the results do not match, but it is determined that the new results are the correct results, the test data set will be updated to substitute the results of the new version as the test data set.

F. Prototype Buildings

One-Story Prototype

Figure A-1 through Figure A-3 and Table A-2 define the 2100 ft^2 prototype.

Note that the glass area and distribution provided on these drawings is only to show a realistic image of the home. Glass area and orientation for impact and cost effectiveness is set using a glass distribution typical of California homes. Glass area, distribution and other details for the ACM tests are specified in the test data set.
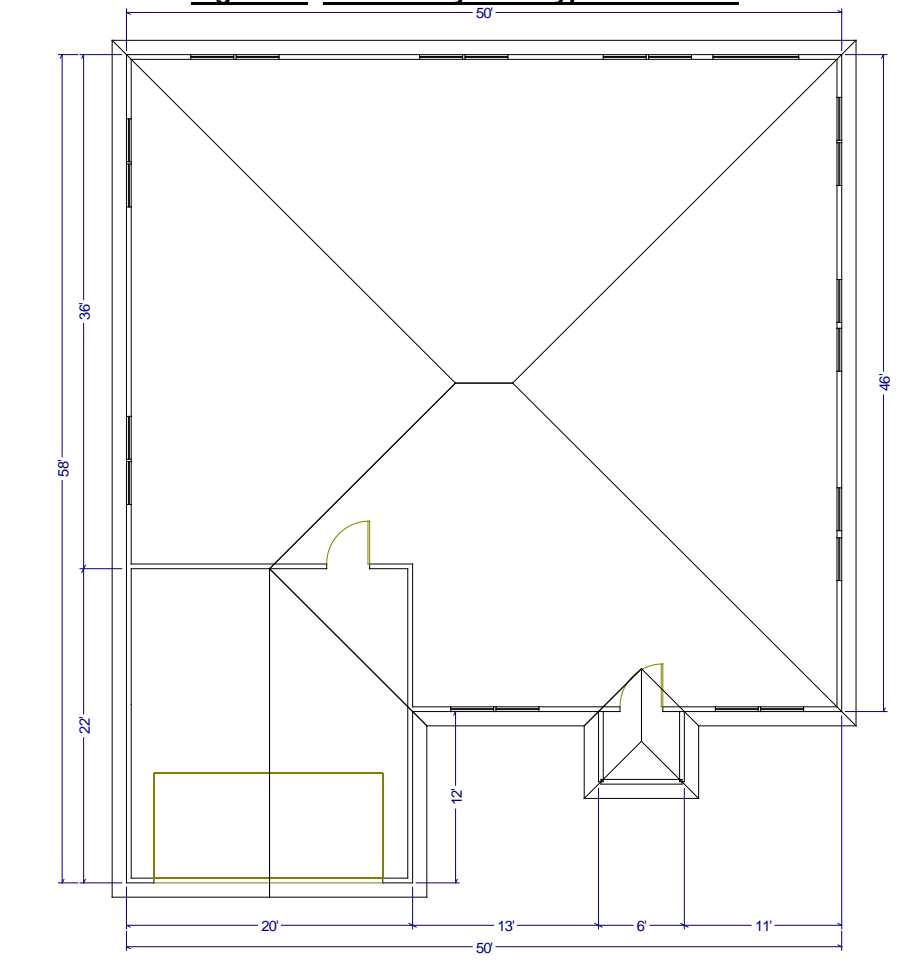
Figure A-1: One-Story Prototype Front View
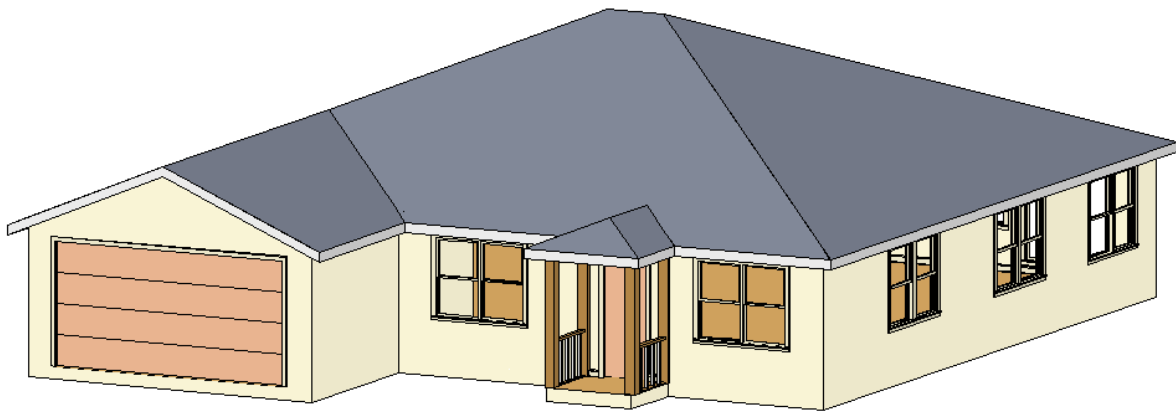
Figure A-2: One-Story Prototype Back View
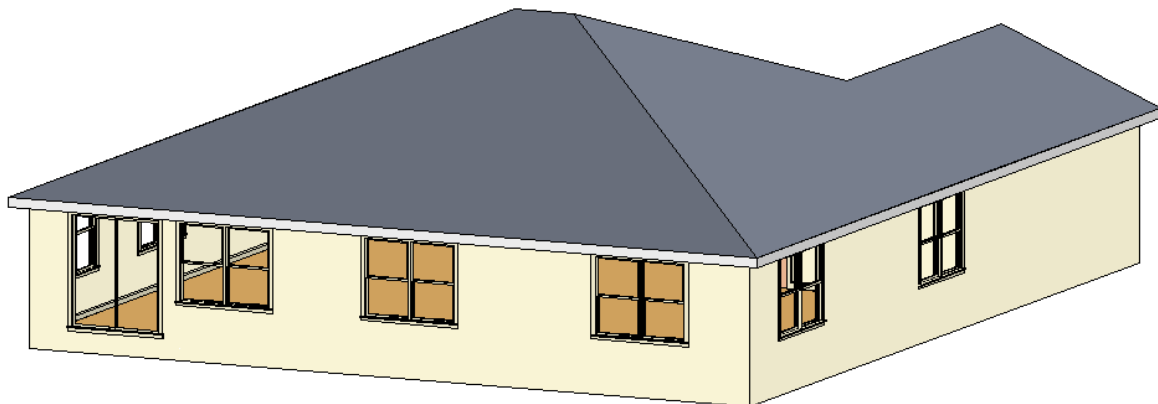
Figure A-3: One-Story Prototype Floor Plan

Table A-2: One-Story Prototype Description

Component	Description
Ceiling height	9 ft
Conditioned floor area	2100 ft2
Gross areas	
Slab	2100 ft2
Slab perimeter, outside	162 ft
Slab Garage	440 ft2
Slab perimeter, garage	54 ft from garage to outside
Ceiling	2100 ft2, vented attic
Front wall	270 ft2
Front garage wall	180 ft2
Left wall	324 ft2
Left garage wall	90 ft2
Back wall	450 ft2
Right wall	414 ft2
Garage front wall	180 ft2 from garage to outside
Garage left wall	198 ft2 from garage to outside
Garage right wall	108 ft2 from garage to outside
Doors	
Front door	20 ft2
Garage door	20 ft2
Garage car door	128 ft2
Overhangs	1 ft (when modeled)

Two-Story Prototype

Figure A-4 through Figure A-7 and Table A-3 define the 2700 ft^2 prototype.

Note that the glass area and distribution provided on these drawings is only to show a realistic image of the home. Glass area and orientation for impact and cost effectiveness is set using a glass distribution typical of California homes. Glass area, distribution and other details for the ACM tests are specified in the test data set.

Figure A-4: Two-Story Prototype Front View

Figure A-5: Two-Story Prototype Back View

Figure A-6: Two-Story Prototype Floor Plan – 1st Floor
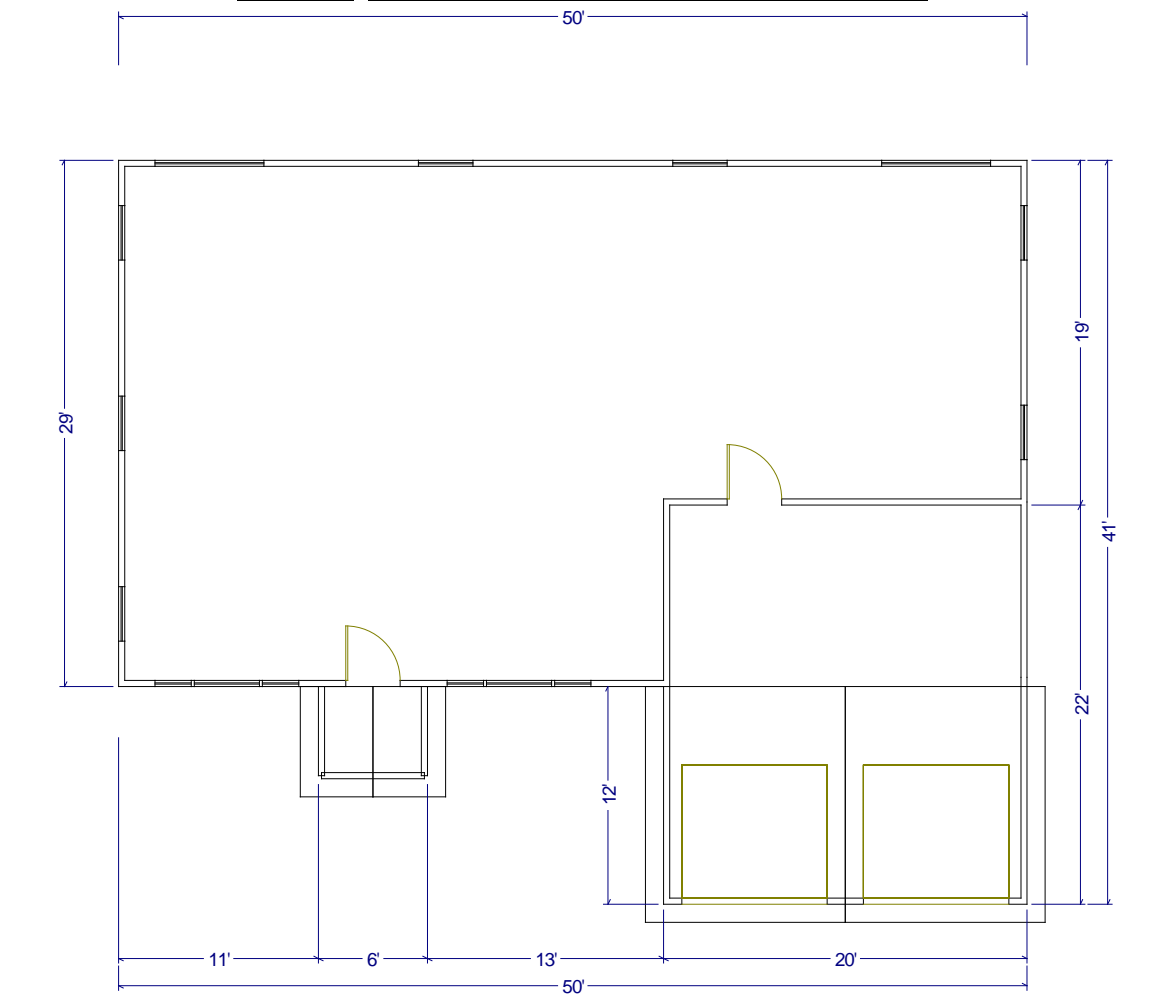
Figure A-7: Two-Story Prototype Floor Plan – 2nd Floor
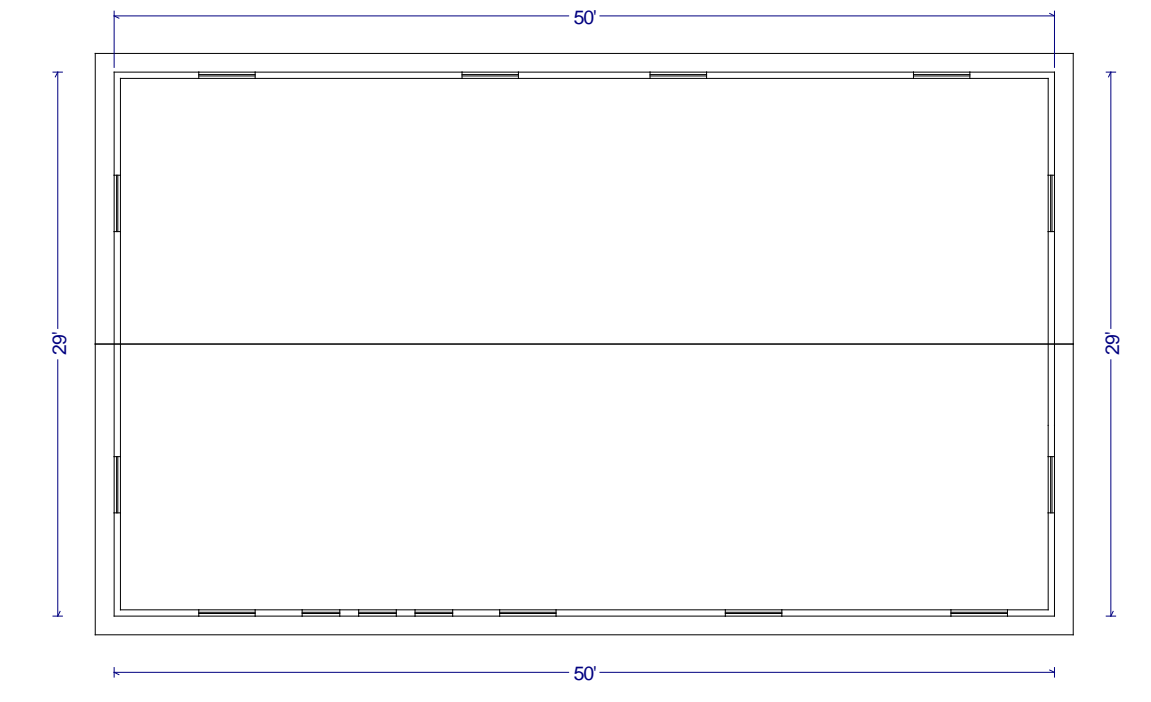
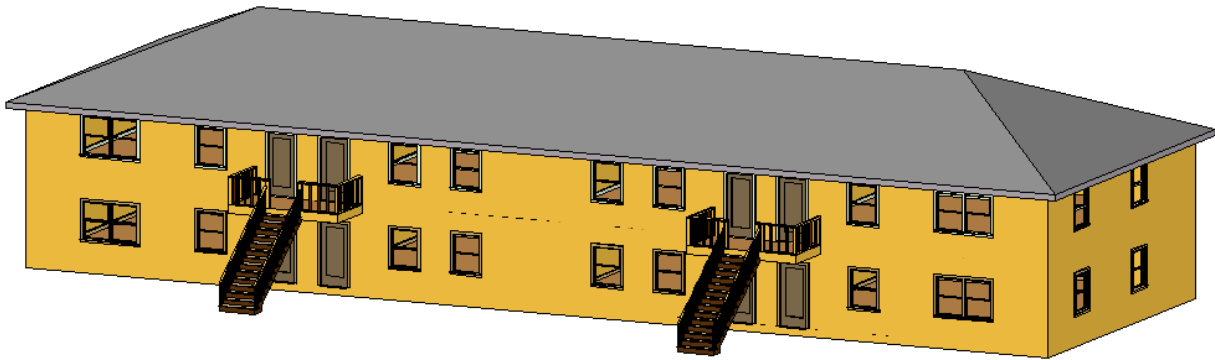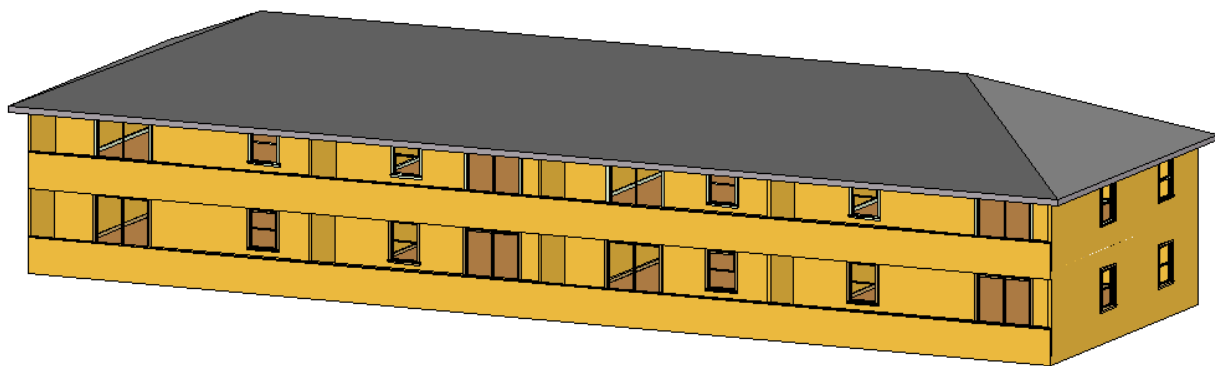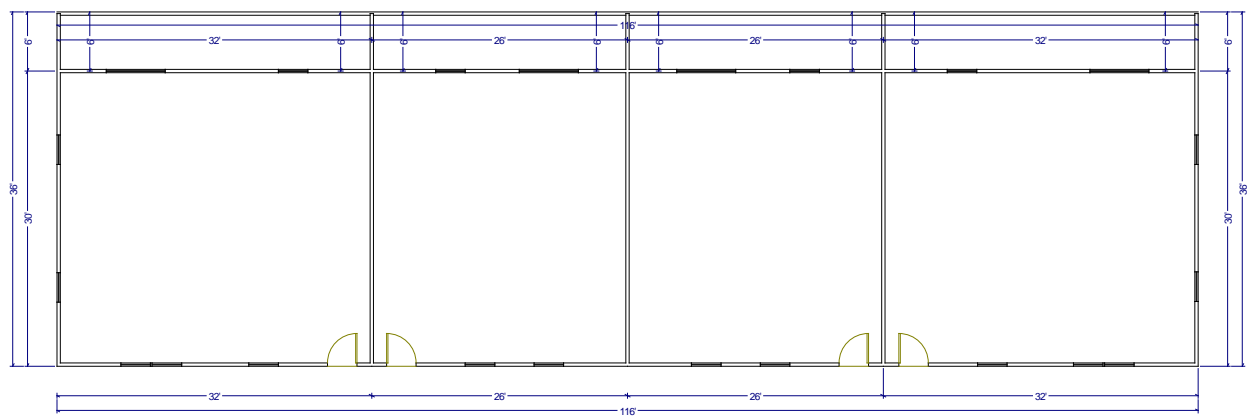**Table A-3: Two-Story Prototype Description**

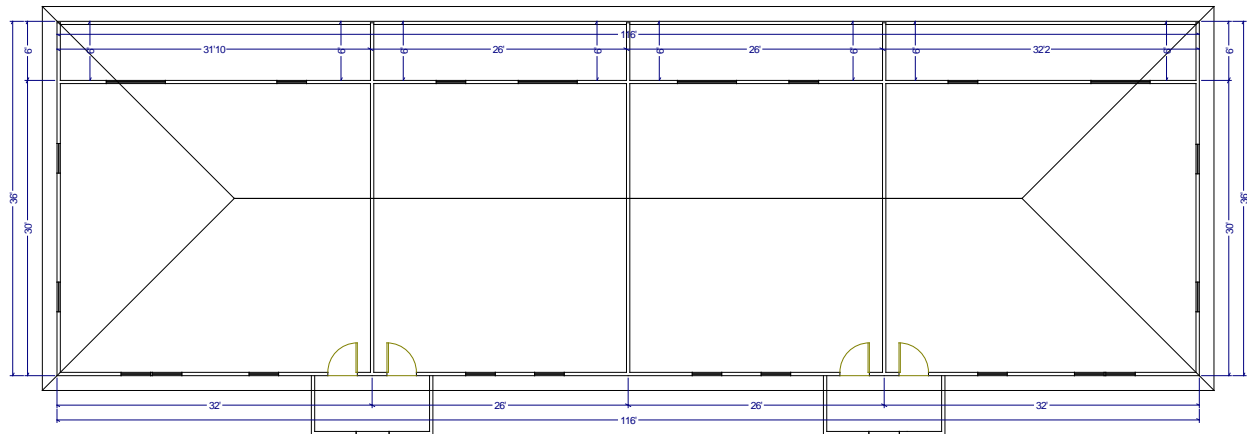| Component	Description
Ceiling height	9 ft with 1 ft between floors
Conditioned floor area	2700 ft2
Gross areas	
Slab	1250 ft2
Slab perimeter, outside	128 ft
Slab, garage	440 ft2
Slab perimeter, garage	54 ft from garage to outside
Ceiling	1450 ft2, vented attic
Floor over garage	200 ft2
Front wall	728 ft2
Front garage wall	180 ft2
Front garage kneewall	42 ft2
Left wall	551 ft2
Back wall	950 ft2
Right wall	461 ft2
Right garage wall	90 ft2
Garage front wall	180 ft2 from garage to outside
Garage left wall	108 ft2 from garage to outside
Garage right wall	198 ft2 from garage to outside
Doors	
Front door	20 ft2
Garage door	20 ft2
Garage car door	128 ft2
Overhangs	1 ft (when modeled)

Multifamily Prototype

The multifamily prototype is a 6960 ft^2 eight-unit two-story apartment building consisting of four 780 ft^2 (26 ft wide by 30 ft deep) one-bedroom apartments and four 960 ft^2 (32 ft wide by 30 ft deep) two-bedroom apartments. The units share common walls and either common floors or ceilings. Multiples of this layout may be combined to represent other typical multifamily configurations.

Figure A-8 through Figure A-11 and Table A-4 define the 6960 ft2 prototype.

Note that the glass area and distribution provided on these drawings is only to show a realistic image of the home. Glass area and orientation for impact and cost effectiveness is set using a glass distribution typical of California construction. Glass area, distribution and other details for the ACM tests are specified in the test data set.

Figure A-8: Multifamily Prototype Front View

Figure A- 9: Multifamily Prototype Back View

Figure A-10: Multifamily Prototype Floor Plan – 1st Floor

Figure A-11: Multifamily Prototype Floor Plan – 2nd Floor


Table A-4: Multifamily Prototype Description

| Component	Description
Ceiling height	8 ft with 1 ft between floors
Conditioned floor area	6960 ft2
Dwelling units	8
Gross areas	
Slab	3480 ft2
Slab perimeter, outside	292 ft
Ceiling	3480 ft2, vented attic
Front wall	1972 ft2
Left wall	510 ft2
Back wall	1972 ft2
Right wall	510 ft2
Doors	
Front door	160 ft2
Overhangs	1 ft (when modeled)

Addition/Alteration Prototype

Figure A-12 through Figure A-14 define the addition/alteration 1665 ft2 prototype without the addition.
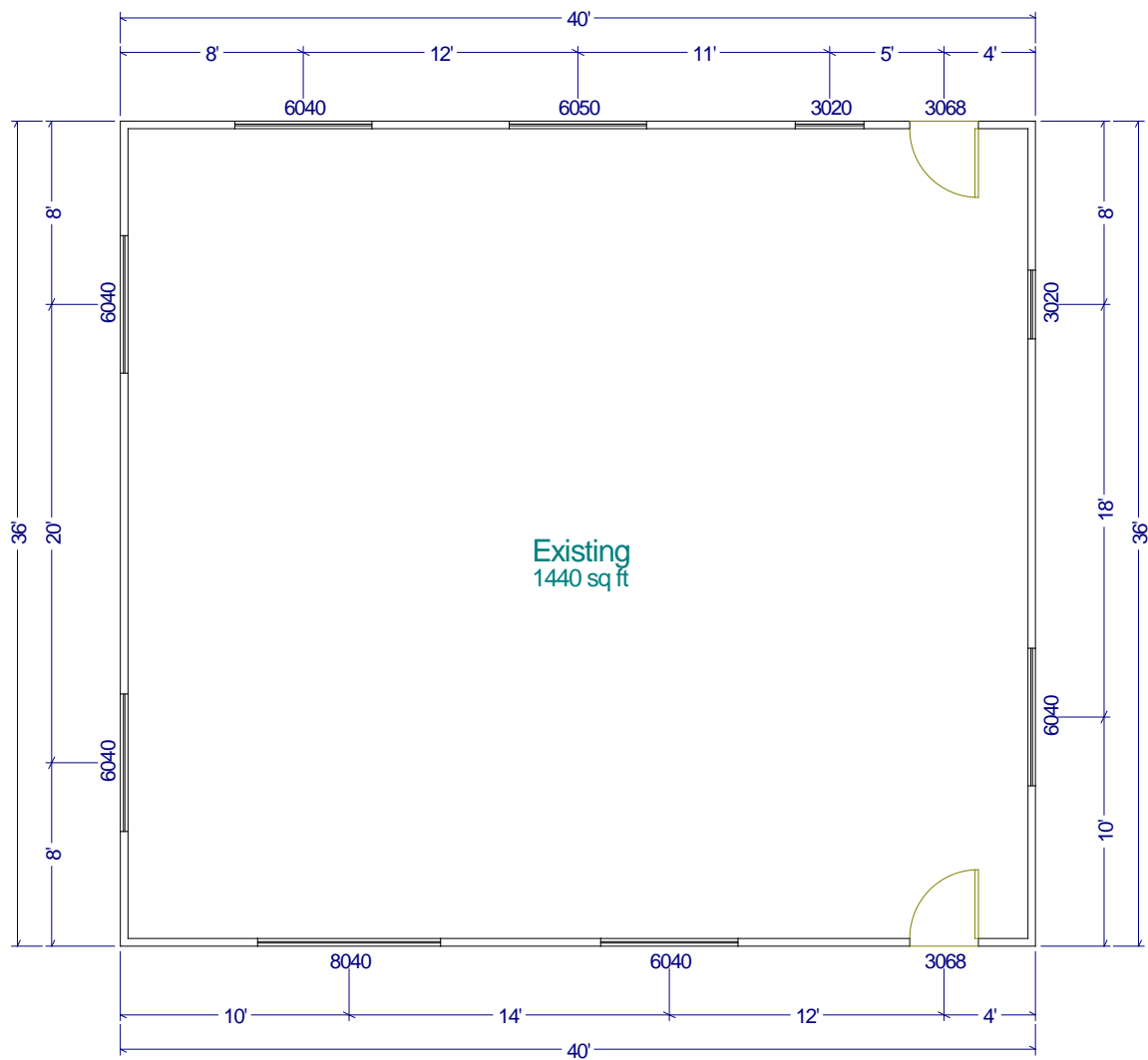
Figure A-15 through Figure A-16 and Table A-5 define the addition/alteration with the addition.

Figure A-12: Addition/Alteration Prototype Front View without Addition
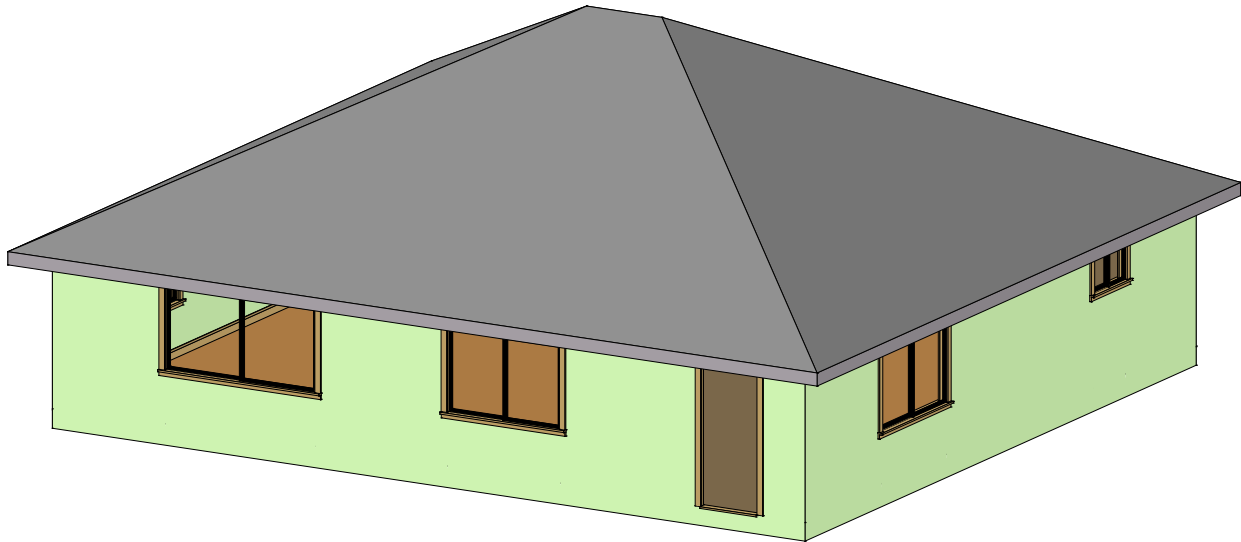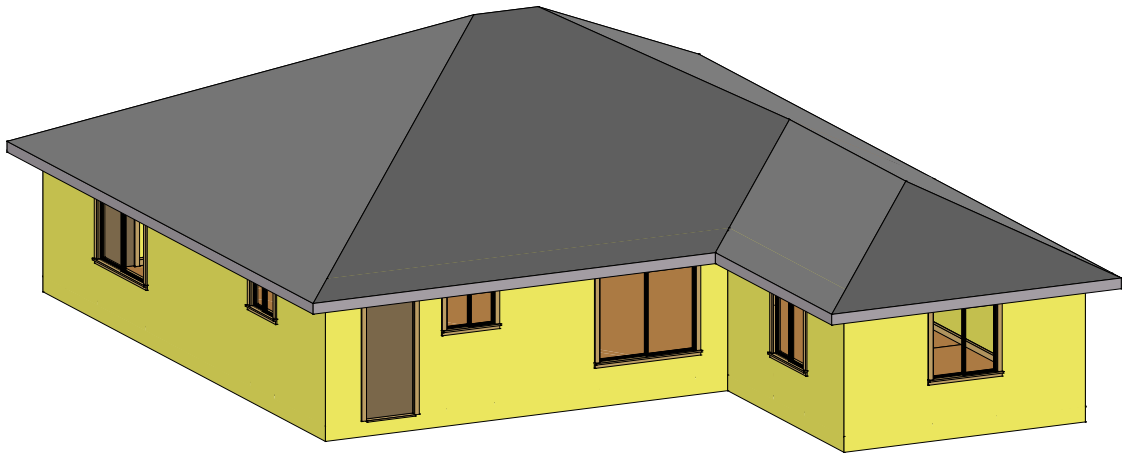

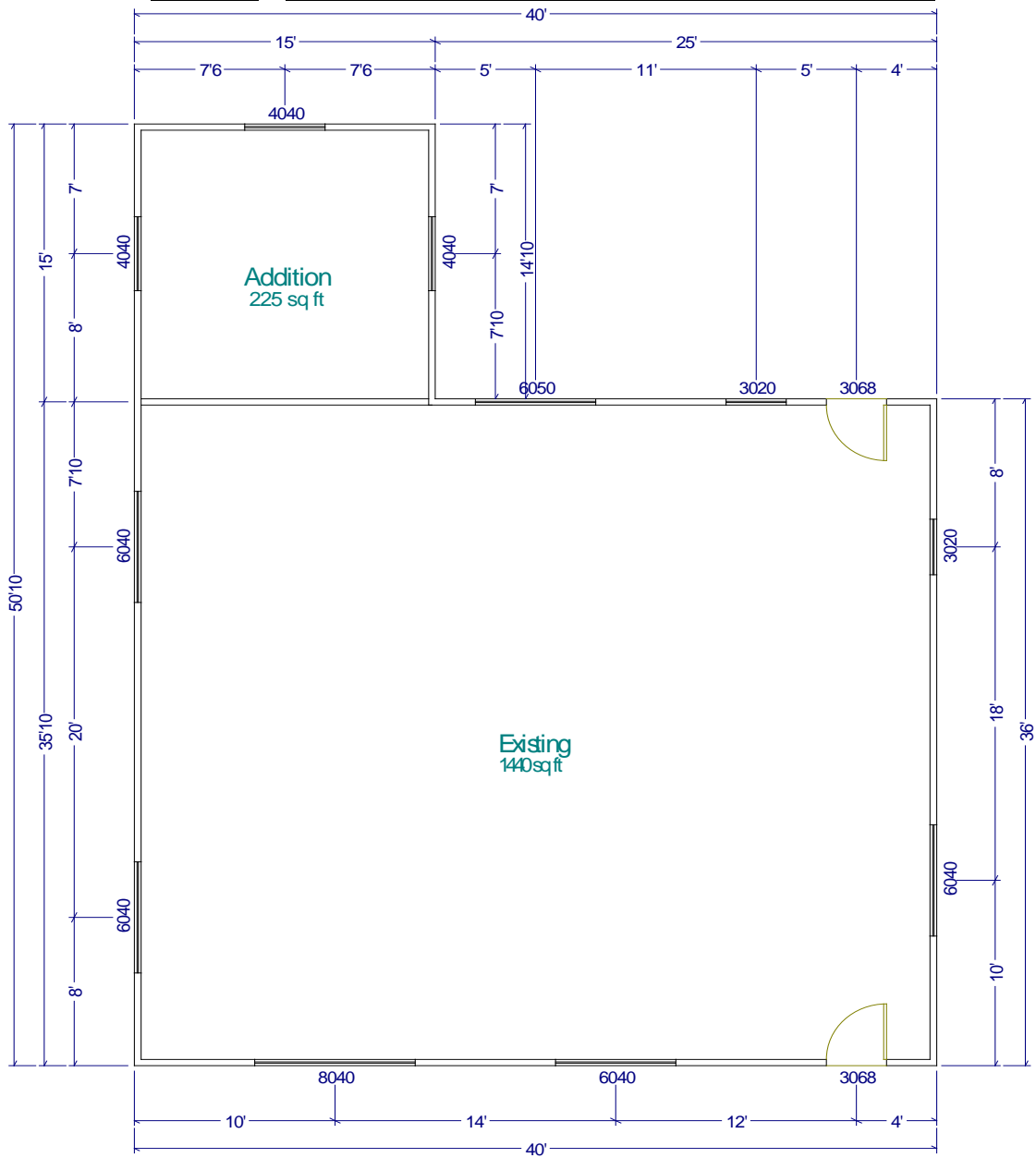**Figure A-13: Addition/Alteration Prototype Back View without Addition**
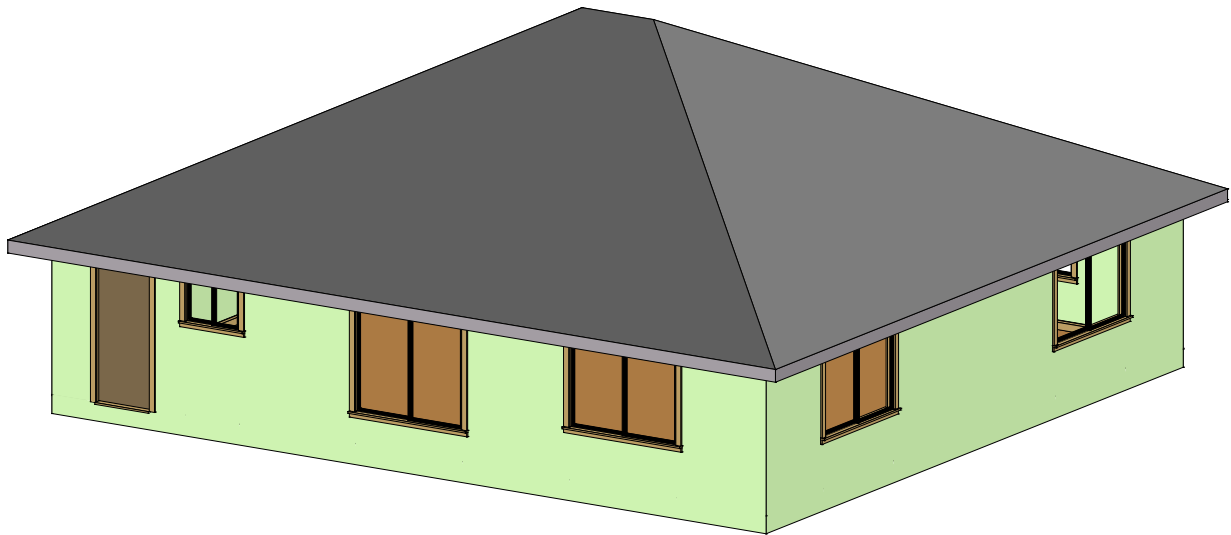
Figure A-14: Addition/Alteration Prototype Floor Plan without Addition

Figure A-15: Addition/Alteration Prototype Back View with Addition

<u>Figure A-16: Addition/Alteration Prototype Floor Plan with Addition</u>

Table A-5: Addition/Alteration Prototype Description

Component	Description
Ceiling height	8 ft
Existing floor area	1440 ft2
Addition floor area	225 ft2
Gross areas	
Existing Slab	1440 ft2
Addition Slab	225 ft2
Exisiting Slab perimeter	137 ft
Addition Slab perimeter	45 ft
Existing Ceiling	1440 ft2, vented attic
Addition Ceiling	225 ft2, vented attic
Existing Front wall	320 ft2
Existing Left wall	288 ft2
Addition Left wall	120 ft2
Existing Back wall	320 ft2
Addition Back wall	120 ft2
Existing Right wall	288 ft2
Addition Right wall	120 ft2
Windows	
Existing Front Window 1	24 ft2
Existing Front Window 2	32 ft2
Existing Left Window 1	24 ft2
Existing Left Window 2	24 ft2
Addition Left Window	16 ft2
Addition Back Window	16 ft2
Existing Right Window 1	6 ft2
Existing Right Window 2	24 ft2
Addition Right Window	16 ft2
Doors	
Existing Front door	20 ft2
Existing Back door	20 ft2

APPENDIX B. NONRESIDENTIAL CERTIFICATION TESTS

This section contains the procedures used to test and certify vendor's Compliance Software as acceptable for compliance with Title 24. Part 6. Compliance software is expected to conform to the modeling guidelines specified in the Nonresidential ACM Reference Manual. The tests used to verify software functionality and accuracy of simulation results are referred to as the Reference Method. The tests fall into the following categories:

1. Tests to verify that the software is evaluating thermal loads and the response of the HVAC systems to these loads in a manner that is acceptable. These tests reference *ASHRAE Standard 140-2007, Standard Method of Test for Evaluation of Building Energy Analysis Computer Programs.*

2. Tests that verify that compliance software is capable of modeling envelope, lighting, HVAC and water heating efficiency features and provides precise estimates of energy tradeoffs and reasonably accurate predictions of building energy consumption.

3. Tests to verify that the Standard Design (baseline building) is created correctly, e.g., that the baseline HVAC system is properly specified, that other components of the baseline are correctly defined and that rules that fix and restrict inputs (such as schedules and plug loads) are properly applied. These tests do not verify simulation outputs, but may require simulations to be run to specify inputs that are dependent on system sizing.

4. The Reference Method is designed to cover vendor software functionality for building envelope, space uses, lighting, daylighting, HVAC and water heating, both for simulation performance and for proper implementation of ACM rules described in the Nonresidential ACM Reference Manual. The California Energy Commission reserves the right to add Ruleset Implementation Tests or Software Sensitivity Tests to verify existing or future compliance software requirements. Moreover, the California Energy Commission reserves the right to adjust the passing criteria (see Test Criteria, Section 1.7) for the Software Sensitivity Tests to reflect the capabilities of commonly available energy simulation programs.

## 1.1 *ASHRAE Standard 140-2007 Tests*

This method of testing is provided for analyzing and diagnosing building energy simulation software using software-to-software and software-to-quasi-analytical-solution comparisons. The methodology allows different building energy simulation programs, representing different degrees of modeling complexity, to be tested by comparing the predictions from other building energy programs to the simulation results provided by the Compliance Software in question.

Vendor software must pass the ASHRAE 140-2007 tests and provide a written statement verifying this in the Self Certification Form (see Appendix B).

ACM Appendix B – Nonresidential Certification Tests

1.2 Ruleset Implementation Tests

The Ruleset Implementation Tests are labeled using the format:

(S) 0200CZ-OffSml- Run01

Run Name Number

Prototype Model Type

Climate Zone

Test Type
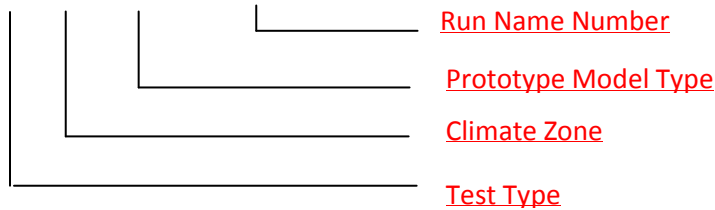
The following tests shall be performed to verify that the compliance software correctly creates the Standard Design model and applies modeling rules as per the modeling guidelines provided in the 2016 Nonresidential ACM Reference Manual. The user model shall be created by modifying the appropriate Prototype Model type. The Standard Design Model for each test case shall be generated automatically by the compliance software.

The intent of each test run, characteristics of the user model, and inputs to be verified in the Proposed and Standard Design models, are described below.

1. (D/S) 020006-OffSml-Run01– This test will verify that the applicant software models the wall, floor, and roof construction correctly in the Standard Design model and that the envelope and fenestration performance requirements for the Standard Design are correctly modeled.

2. (D/S) 020015-OffSml-Run02– This test will verify that the applicant software models the wall, floor, roof construction, and fenestrations correctly, and that the envelope performance requirements for the Standard Design are correctly modeled.

The user model is a small office building in climate zone 15 with the following envelope characteristics:

3. (D) 070015-HotSml-Run03 – This test will verify that the applicant software models the wall, floor and roof construction correctly in the Standard Design model and that the envelope and fenestration performance requirements for the Standard Design are correctly modeled.

The user model is a small hotel building in climate zone 15 with the following characteristics:

4. (D/S) 030006-OffMed-Run04 – This test will verify that mandatory minimum opaque envelope insulation requirements are applied. The user model is a small office building in climate zone 6, with a metal-framed wall containing R-5 continuous insulation on the exterior and a U-factor of 0.136.

    a. For this test, the user model should be ***undefined***, and the compliance simulation should not run.

5. (D) 040006-OffLrg-Run05 – Run 05 tests whether the applicant software correctly determines the window area of the Standard Design model.

The user model is the Large office building in climate zone 6 with an overall window-to-wall ratio (WWR) of 52% made of a continuous band of glass distributed evenly across all facades.

6. (D) 040006-OffLrg-Run06 – Run 06 tests whether the applicant software correctly determines the window area of the Standard Design model.

The user model is the Large office building in climate zone 6 with overall building WWR-46% and 50% WWR in the west, 40% in South, 45% in East, and 50% in the North façade.

7. (D) 080006-Whse-Run07 – This tests verifies whether the applicant software models the Standard Design skylight correctly, and checks whether the applicant software determines the skylight area of the Standard Design model correctly.

8. (D) 080006-Whse-Run08 – This test checks whether the applicant software determines the skylight area of the Standard Design model correctly.

9. (D) 080006-Whse-Run09 – This test checks whether the applicant software determines the skylight area of the Standard Design model correctly.

10. (D) 030006-OffMed-Run10 – This test verifies whether the applicant software inserts the correct Standard Design inputs for schedules, occupant density, equipment power density, lighting power density, hot water load and ventilation rates using the Complete Building lighting method.

11. (D) 040006-OffLrg-Run11 – This test verifies whether the applicant software inserts the correct Proposed Design and Standard Design inputs for schedules, occupant density, equipment power density, lighting power density, hot water load and ventilation rates. This run also tests the capability of the applicant software to model Standard Design inputs for multiple space types using the Area Category lighting method.

12. (D) 030006-OffMed-Run12 – This test verifies if the applicant software applies the requirements of the Tailored Lighting Method appropriately.

13. (D) 030006-OffMed-Run13 – This test verifies if the applicant software applies the requirements of the Tailored Lighting Method appropriately.

14. (D/S) 020006-OffSml-Run14 – This test verifies if the applicant software correctly models lighting power density and schedules for eligible Califonia Power adjustment factors.

15. (D) 080006-Whse-Run15 – This test verifies the ability of the applicant software to correctly model daylighting controls.

16. (D) 050006-RetlMed-Run16 – This test verifies the ability of the applicant software to correctly model daylighting controls.

17. (D) 040006-OffLrg-Run17 – This test verifies if the rules for exterior lighting are applied accurately for exterior lighting power, exterior lighting control and schedules. This test also verifies if the Service Hot Water systems are modeled correctly.

18. (D/S) 020006-OffSml-Run18 – This test checks if the applicant software correctly models the Standard Design HVAC system.

19. (D) 030006-OffMed-Run19 – This test checks if the applicant software correctly models the Standard Design HVAC system.

20. (D) 040006-OffLrg-Run20 – This test checks if the applicant software correctly models the Standard Design HVAC system.

21. (D) 080006-Whse-Run21 – This test checks if the applicant software correctly models the Standard Design HVAC system.

22. (D) 07006-HotSml-Run22 – This test checks if the applicant software correctly models the Standard Design HVAC system.

23. (D) 030006-OffMed-Run23 – This test checks the Standard Design building for an existing, altered building that has the roof replaced with a metal building roof, R-15 continuous insulation, and that has the windows replaced on the South façade with low-e, double glazed windows with U=0.40, SHGC=0.33 and VT=0.50. The windows on the North, East and West facades are existing, unchanged single-paned windows with U=0.55, SHGC=0.56, VT=0.6.

24. (D) 020006-OffSml-Run24– This test checks the Standard Design building for an existing, altered building.

25. (D) 020006-OffSml-Run25– This test checks the Standard Design building for an existing, altered building.

26. (D) 020006-OffSml-Run26– This test checks the Standard Design building for an existing, altered building.

27. (D) 050006-RetlMed -Run27– This test checks the Standard Design building for an addition, modeled alone.

28. (D) 050006-RetlMed -Run28– This test checks the Standard Design building for an addition, modeled with existing, unaltered building.

29. (D) 030006-OffMed -Run29– This test checks the Standard Design building for an Envelope Only, partial compliance project.

30. (D) 020006-OffMed –Run30– This test checks the Standard Design building for a Lighting and Mechanical partial compliance project

1.2.1 Results Comparison

The applicant shall perform all tests specified in Section IV and report the outputs in their application. Forms for reporting this output are provided in the 2016 Nonresidential ACM Reference Manual. Note that the Standard Design for some inputs, such as cooling efficiency and pump power, are dependent upon the autosizing of the HVAC equipment. The ruleset implementation tests do not check that the autosized capacity matches the Reference Method, but rather, that the Standard Design input is properly defined in relation to the autosized capacity.

1.3 *Software Sensitivity Tests*

This section details the eligibility requirements for an applicant simulation program to be approved for use as compliance software as specified in the 2016 ACM Approval Manual. A series of quantitative tests called the Software Sensitivity Tests shall be performed to measure the change in energy consumption when changing specified input parameters. Applicant software results will be compared against predetermined Reference results to demonstrate that the applicant software is acceptable for use in code compliance. There are a total of 96 tests. All the test cases described here shall be performed and results summarized in the approval application. Forms for providing this summary are provided in the 2016 Nonresidential ACM Reference Manual.

Each test case in the Software Sensitivity test is labeled uniquely to make it easier to keep track of the runs and to facilitate analysis. The following scheme is used:

XXYYZZ-Prototype-RunDescription

Where, XX denotes the Prototype Number

YY denotes Test Run Number

ZZ denotes Climate zone

Example:

05 01 15-RetlMed-EnvelopeRoofInsulation

	Run Description
	Prototype
	Climate Zone
	Test Run Number
	Prototype Number

Example for Simple Geometry Test case

02 11 015-OffSml-SG-EnvRoofInsulation

Run Description

Prototype

Climate Zone

Test Run Number

Prototype Number

1.3.1 Reporting Test Results

For each test case, the TDV energy use of the modeled building is reported (kBtu/ft2), along with the TDV energy use attributed to the major fuel types (electricity, gas), site energy use, and energy end use intensity for the regulated end uses (cooling, heating, lighting, etc.). The following energy totals are reported:

1. Annual TDV EUI (kBtu/ft2)

2. Annual Site EUI – Electricity (kWh/ft2)

3. Annual SiteEUI – Natural Gas (therm/ft2)

4. Annual Total End Use Site Energy EUI – kBtu/ft2

Site Energy End Uses

5. Site Energy: Heating (kBtu/ft2)

6. Site Energy: Cooling (kBtu/ft2)

7. Site Energy: Interior Lighting (kBtu/ft2)

8. Site Energy: Interior Equipment (kBtu/ft2)

9. Site Energy: Fans (kBtu/ft2) (Airside Fans, does not include tower fans)

10. Site Energy: Pumps (kBtu/ft2)

11. Site Energy: Towers (kBtu/ft2)Water heating (kBtu/ft2)

12. **TDV % Variation** – this field is used for the compliance test

13. Total End Use Site Energy % - percentage change in site energy use

14. Pass/Fail – test fails if it does not meet passing criteria

15. Unmet load hours – these are defined as the zone with the most unmet load hours

      a. Reference Model Occupied Unmet Load Hours

      b. Applicant Model Occupied Unmet Load Hours

      c. Reference Model Number of Zones with excess unmet load hours (>150)

      d. Applicant Model Number of Zones with excess unmet load hours (>150)

1.3.2 TDV Variation Test

Compiled results shall include annual site energy consumption for each end-use, overall site energy consumption, total unmet load hours and annual TDV and % variation of annual TDV and total end use site energy.

The annual TDV % variation shall be calculated using the formula:

$TDV_\% = (TDV_b - TDV_n)/TDV_b$

Where, $TDV_\%$ is the TDV % variation,

TDV_n is the annual TDV for test case number n and

TDV_b is the annual TDV for the base case run.

In order to be accepted, the applicant software shall fulfill the passing criteria below:

The change in energy for each test case must be in the same direction as the Reference Method test case result, and must be equal to the Reference Method test case percentage change in TDV energy, plus or minus 0.5% of baseline TDV energy.

1.3.3 Software Sensitivity Test Cases

Test cases assess the energy impact of one or more of the building or system input characteristics on the baseline model. Each test suite consists of a series of unique test cases aimed to test the impact of a specific characteristic on building energy performance. Simulations are grouped according to test criteria and sub-grouped based on the reference model type to allow for direct comparison of results. For each test case, the applicant software will modify the applicant baseline model with specific inputs as described in the Test Case description section.

The test cases are simulated on multiple California weather files to evaluate the sensitivity of the building or system input to extremes in climate. Results of the test case runs and the TDV percent variation over the baseline run shall be compiled and compared against the reference results.

Detailed descriptions of the Standard Design models are provided in the 2016 Nonresidential ACM Reference Manual. Reference Method input files for all baseline and test case models are available from the California Energy Commission upon requested. Details on each Test Description can also be found in the 2016 Nonresidential ACM Reference Manual.

Table 1 – Baseline Runs for Sensitivity Test Cases

Test Case Name	Baseline	Description
050115-RetlMed-EnvelopeRoofInsulation	050015-RetlMed-Baseline	Decrease overall U value of Roof compared to baseline case
050215-RetlMed-EnvelopeWallInsulation	050015-RetlMed-Baseline	Decrease overall U value of Exterior Wall compared to baseline case
050315-RetlMed-EnvelopeHeavy	050015-RetlMed-Baseline	Change Roof and Wall construction assembly to Wood Framed Roof and Heavy Mass wall.
050416-RetlMed-EnvelopeRoofInsulation	050016-RetlMed-Baseline	Decrease overall U value of Roof compared to baseline case
050516-RetlMed-EnvelopeWallInsulation	050016-RetlMed-Baseline	Decrease overall U value of Exterior Wall compared to baseline case
050616-RetlMed-EnvelopeHeavy	050016-RetlMed-Baseline	Change Roof and Wall construction assembly to Wood Framed Roof and Heavy Mass wall.
050706-RetlMed-EnvelopeRoofInsulation	050006-RetlMed-Baseline	Decrease overall U value of Roof compared to baseline case
050806-RetlMed-RetlMed-EnvelopeWallInsulation	050006-RetlMed-Baseline	Decrease overall U value of Exterior Wall compared to baseline case
050906-RetlMed-RetlMed-EnvelopeHeavy	050006-RetlMed-Baseline	Change Roof and Wall construction assembly to Wood Framed Roof and Heavy Mass wall.
031015-OffMed-FloorSlabInsulation	030015-OffMed-Baseline	Change slab F-factor
031215-OffMed-GlazingWindowU	030015-OffMed-Baseline	Decrease SHGC of windows by 20% compared to baseline case
031315-OffMed-GlazingWindowSHGC	030015-OffMed-Baseline	Decrease U value & SHGC of windows by 20% compared to baseline case
031415-OffMed-GlazingWindowUSHGC	030015-OffMed-Baseline	Change Floor slab F factor of permiter zones in the bottom floor to 0.45 0.46
031516-OffMed-FloorSlabInsulation	030016-OffMed-Baseline	Increase Exterior Wall Infiltration by 10% compared to baseline case
031716-OffMed-GlazingWindowU	030016-OffMed-Baseline	Decrease SHGC of windows by 20% compared to baseline case
031816-OffMed-GlazingWindowSHGC	030016-OffMed-Baseline	Decrease U value & SHGC of windows by 20% compared to baseline case
031916-OffMed-GlazingWindowUSHGC	030016-OffMed-Baseline	Change Floor slab F factor of perimeter zones in the bottom floor to 0.45 0.46
032006-OffMed-FloorSlabInsulation	030006-OffMed-Baseline	Increase Exterior Wall Infiltration by 10% compared to baseline case
032206-OffMed-GlazingWindowU	030006-OffMed-Baseline	Decrease SHGC of windows by 20% compared to baseline case
032306-OffMed-GlazingWindowSHGC	030006-OffMed-Baseline	Decrease U value & SHGC of windows by 20% compared to baseline case
032406-OffMed-	030006-OffMed-Baseline	Reduce window area

GlazingWindowUSHGC		
042507-OffLrg-WWR20%	040007-OffLrg-Baseline	Increase window area
042607-OffLrg-WWR60%	040007-OffLrg-Baseline	
042801-OffLrg-WWR20%	040001-OffLrg-Baseline	Increase window area
042901-OffLrg-WWR60%	040001-OffLrg-Baseline	Decrease LPD by 20% compared to baseline case
033015-OffMed-LightingLowLPD	030015-OffMed-Baseline	Increase LPD by 20% compared to baseline case
033115-OffMed-LightingHighLPD	030015-OffMed-Baseline	Decrease LPD by 20% compared to baseline case
033216-OffMed-LightingLowLPD	030016-OffMed-Baseline	Increase LPD by 20% compared to baseline case
033316-OffMed-LightingHighLPD	030016-OffMed-Baseline	Decrease LPD by 20% compared to baseline case
033406-OffMed-LightingLowLPD	030006-OffMed-Baseline	Increase LPD by 20% compared to baseline case
033506-OffMed-LightingHighLPD	030006-OffMed-Baseline	Decrease EPD by 20% compared to baseline case
044207-OffLrg-Daylighting Cont.DimHighVT	040007-OffLrg-Baseline	Change daylighting controls in Primary and Secondary daylit areas
044307-OffLrg-Daylighting StepDim	040007-OffLrg-Baseline	Change daylighting controls in Primary and Secondary daylit areas and increase visible transmittance
044407-OffLrg-Daylighting StepDimHighVT	040007-OffLrg-Baseline	Increase Visible Transmittance of windows compared to baseline case. Reduce window area
044507-OffLrg-Daylighting WWR20Cont.DimHighVT	042507-OffLrg-WWR20%	Change daylighting controls in Primary and Secondary daylit areas. Reduce window area
044607-OffLrg-Daylighting WWR20StepDim	042507-OffLrg-WWR20%	Change daylighting controls in Primary and Secondary daylit areas and increase visible transmittance of windows. Reduce window area
044707-OffLrg-47CZ07LargeOffice Daylighting WWR20StepDimHighVT	042507-OffLrg-WWR20%	Increase Visible Transmittance compared to baseline case. Increase window area
044807-OffLrg-48CZ07LargeOffice Daylighting WWR60Cont.DimHighVT	042607-OffLrg-WWR60%	Change daylighting controls in Primary and Secondary daylit areas. Increase window area
044907-OffLrg-49CZ07LargeOffice Daylighting WWR60StepDim	042607-OffLrg-WWR60%	Change daylighting controls in Primary and Secondary daylit areas and increase visible transmittance of windows. Increase window area
045007-OffLrg-50CZ07LargeOffice Daylighting WWR60StepDimHighVT	042607-OffLrg-WWR60%	Increase Visible Transmittance of windows compared to baseline case
045101-OffLrg-51CZ01LargeOffice Daylighting	040001-OffLrg-Baseline	Change daylighting controls in Primary and Secondary daylit areas

Cont.DimHighVT		
045201-OffLrg-52CZ01LargeOffice Daylighting StepDim	040001-OffLrg-Baseline	Change daylighting controls in Primary and Secondary daylit areas and increase visible transmittance of windows
045301-OffLrg-53CZ01LargeOffice Daylighting StepDimHighVT	040001-OffLrg-Baseline	Increase Visible Transmittance of windows compared to baseline case. Reduce window area
045401-OffLrg-Daylighting WWR20Cont.DimHighVT	042801-OffLrg-WWR20%	Change daylighting controls in Primary and Secondary daylit areas. Reduce window area
045501-OffLrg-Daylighting WWR20StepDim	042801-OffLrg-WWR20%	Change daylighting controls in Primary and Secondary daylit areas and increase visible transmittance of windows. Reduce window area
045601-OffLrg-Daylighting WWR20StepDimHighVT	042801-OffLrg-WWR20%	Increase Visible Transmittance of windows compared to baseline case. Increase window area
045701-OffLrg-Daylighting WWR60Cont.DimHighVT	042901-OffLrg-WWR60%	Change daylighting controls in Primary and Secondary daylit areas. Increase window area
045801-OffLrg-Daylighting WWR60StepDim	042901-OffLrg-WWR60%	Change daylighting controls in Primary and Secondary daylit areas and increase visible transmittance of windows. Increase window area
045901-OffLrg-Daylighting WWR60StepDimHighVT	042901-OffLrg-WWR60%	Increase Visible Transmittance of skylights compared to baseline case
056007-RetlMed-Daylighting SRRBaseHighVT	050007-RetlMed-Baseline	Increase skylight area.
056107-RetlMed-Daylighting SRR3.04	050007-RetlMed-Baseline	Increase skylight area and visible transmittance of skylights compared to baseline case.
056207-RetlMed-Daylighting SRR3.04HighVT	050007-RetlMed-Baseline	Increase Visible Transmittance of skylights compared to baseline case
056301-RetlMed-Daylighting SRRBaseHighVT	050001-RetlMed-Baseline	Increase skylight area
056401-RetlMed-Daylighting SRR3.04	050001-RetlMed-Baseline	Increase skylight area and visible transmittance of skylights compared to baseline case
056501-RetlMed-Daylighting SRR3.04HighVT	050001-RetlMed-Baseline	Increase ductloss in the zones served by Pacakaged Single Zone systems.
056616-RetlMed-HVAC DuctLoss	050016-RetlMed-BaselineDuctLoss	
056716-RetlMed-HVAC DuctLoss	050006-RetlMed-BaselineDuctLoss	Increase ductloss in the zones served by Pacakaged Single Zone systems.
036815-OffMed-HVACPVAV Design	030015-OffMed-Baseline	Change static pressure and motor efficiency of all VAV fans. See details below

036915-OffMed-HVACPVAV SATControl	030015-OffMed-Baseline	Change supply air temperature reset based on Outside air. See details below
037015-OffMed-HVACPVAV VAVControl	030015-OffMed-Baseline	Change VAV damper control to dual maximum.
037115-OffMed-HVACPVAV EconomizerType	030015-OffMed-Baseline	Change Economizer Type to Fixed Dry bulb with 70 F high limit
037216-OffMed-HVACPVAV Design	030016-OffMed-Baseline	Change static pressure and motor efficiency of all VAV fans. See details below
037316-OffMed-HVACPVAV SATControl	030016-OffMed-Baseline	Change supply air temperature reset based on Outside air. See details below
037416-OffMed-HVACPVAV VAVControl	030016-OffMed-Baseline	Change VAV damper control to dual maximum
037516-OffMed-HVACPVAV EconomizerType	030016-OffMed-Baseline	Change Economizer Type to Fixed Dry bulb with 70 F high limit
037606-OffMed-HVACPVAV Design	030006-OffMed-Baseline	Change static pressure and motor efficiency of all VAV fans. See details below
037706-OffMed-HVACPVAV SATControl	030006-OffMed-Baseline	Change supply air temperature reset based on Outside air. See details below
037806-OffMed-HVACPVAV VAVControl	030006-OffMed-Baseline	Change VAV damper control to dual maximum.
037906-OffMed-HVACPVAV EconomizerType	030006-OffMed-Baseline	Change Economizer Type to Fixed Dry bulb with 70 F high limit
048015-OffLrg-HVACVAV ChillerCOP	040015-OffLrg-Baseline	Increase Chiller COP compared to baseline case
048115-OffLrg-HVACVAV CHWdeltaT	040015-OffLrg-Baseline	Change the Chilled water loop design temperature difference
048215-OffLrg-HVACVAV CWSetpoint	040015-OffLrg-Baseline	Change condenser water setpoint reset based on Outdoor air wet bulb temperature
048315-OffLrg-HVACVAV TowerEff	040015-OffLrg-Baseline	Change Tower Efficiency
048416-OffLrg-HVACVAV ChillerCOP	040016-OffLrg-Baseline	Increase Chiller COP
048516-OffLrg-HVACVAV CHWdeltaT	040016-OffLrg-Baseline	Change the Chilled water loop design temperature difference
048616-OffLrg-HVACVAV CWSetpoint	040016-OffLrg-Baseline	Change condenser water setpoint reset based on Outdoor air wet bulb temperature
048706-OffLrg-HVACVAV TowerEff	040016-OffLrg-Baseline	Change Tower Efficiency
048806-OffLrg-HVACVAV ChillerCOP	040006-OffLrg-Baseline	Increase Chiller COP
048906-OffLrg-HVACVAV	040006-OffLrg-Baseline	Change the Chilled water loop design

CHWdeltaT		temperature difference
049006-OffLrg-HVACVAV CWSetpoint	040006-OffLrg-Baseline	Change condenser water setpoint reset based on Outdoor air wet bulb temperature
049106-OffLrg-HVACVAV TowerEff	040006-OffLrg-Baseline	Change condenser water setpoint reset based on Outdoor air wet bulb temperature
109215-RetlStrp-HVACPSZ DXCOP	100015-RetlStrp-BaselinePSZ	Increase COP of DX coil
109315-RetlStrp-HVACPSZ HeatEff	100015-RetlStrp-BaselinePSZ	Increase efficiency of the Heating coil
109415-RetlStrp-HVACPSZ EconomizerControl	100015-RetlStrp-BaselinePSZ	Change Economizer from Integrated as in baseline to NonIntegrated.
109516-RetlStrp-HVACPSZ DXCOP	100016-RetlStrp-BaselinePSZ	Increase COP of DX coil
109616-RetlStrp-HVACPSZ HeatEff	100016-RetlStrp-BaselinePSZ	Increase efficiency of the Heating coil
109716-RetlStrp-HVACPSZ EconomizerControl	100016-RetlStrp-BaselinePSZ	Change Economizer from Integrated as in baseline to NonIntegrated.
109806-RetlStrp-HVACPSZ DXCOP	100006-RetlStrp-BaselinePSZ	Increase COP of DX coil
109906-RetlStrp-HVACPSZ HeatEff	100006-RetlStrp-BaselinePSZ	Increase efficiency of the Heating coil
1010006-RetlStrp-HVACPSZ EconomizerControl	100006-RetlStrp-BaselinePSZ	Change Economizer from Integrated as in baseline to NonIntegrated.
1010115-RetlStrp-HVACPTAC DXCOP	100015-RetlStrp-BaselinePTAC	Increase COP of DX coil
1010215-RetlStrp-HVACPTAC DXCOP	100016-RetlStrp-BaselinePTAC	Increase COP of DX coil
1010315-RetlStrp-HVACPTAC DXCOP	100006-RetlStrp-BaselinePTAC	Increase COP of DX coil
1010415-RetlStrp-HVACPTAC vsFanCoil	100015-RetlStrp-BaselinePTAC	Comparison of PTAC system with Fan Coil system
1010516-RetlStrp-HVACPTAC vsFanCoil	100016-RetlStrp-BaselinePTAC	Comparison of PTAC system with Fan Coil system
1010606-RetlStrp-HVACPTAC vsFanCoil	100006-RetlStrp-BaselinePTAC	Comparison of PTAC system with Fan Coil system
0211015-OffSml-SG-EnvRoofInsulation	0200015-OffSml-SG-Baserun	Decrease overall U value of Roof by 20% compared to baserun case
0211116-OffSml-SG-EnvRoofInsulation	0200016-OffSml-SG-Baserun	Decrease overall U value of Roof by 20% compared to baserun case
0211206-OffSml-SG-EnvRoofInsulation	0200006-OffSml-SG-Baserun	Decrease overall U value of Roof by 20% compared to baserun case
0211315-OffSml-SG-EnvWallInsulation	0200015-OffSml-SG-Baserun	Decrease overall U value of Exterior Wall by 20% compared to baseline case
0211416-OffSml-SG-EnvWallInsulation	0200016-OffSml-SG-Baserun	Decrease overall U value of Exterior Wall by 20% compared to baseline case
0211506-OffSml-SG-	0200006-OffSml-SG-Baserun	Decrease overall U value of Exterior

EnvWallInsulation		Wall by 20% compared to baseline case
0311615-OffMed-SG-WWR40	0300015-OffMed-SG-Baseline	Change WWR from 33% to 40%
0311715-OffMed-SG-WWR20	0300015-OffMed-SG-Baseline	Change WWR from 33% to 20%
0311816-OffMed-SG-WWR40	0300016-OffMed-SG-Baseline	Change WWR from 33% to 40%
0311916-OffMed-SG-WWR20	0300016-OffMed-SG-Baseline	Change WWR from 33% to 20%
0312006-OffMed-SG-WWR40	0300006-OffMed-SG-Baseline	Change WWR from 33% to 40%
0312106-OffMed-SG-WWR20	0300006-OffMed-SG-Baseline	Change WWR from 33% to 20%
0312215-OffMed-SG-WinUSHGC	0300015-OffMed-SG-Baseline	Decrease U value of windows by 20% compared to baseline case
0312316-OffMed-SG-WinUSHGC	0300016-OffMed-SG-Baseline	Decrease SHGC of windows by 20% compared to baseline case
0312406-OffMed-SG-WinUSHGC	0300006-OffMed-SG-Baseline	Decrease U value & SHGC of windows by 20% compared to baseline case
0511615RetlMed-SG-SRR5	050015RetlMed-SG-Baseline	Change SRR to 5%
0511716RetlMed-SG-SRR5	050016RetlMed-SG-Baseline	Change SRR to 5%
0511806RetlMed-SG-SRR5	050006RetlMed-SG-Baseline	Change SRR to 5%
0511915RetlMed-SG-SRR1	050015RetlMed-SG-Baseline	Change SRR to 1%
0512016RetlMed-SG-SRR1	050016RetlMed-SG-Baseline	Change SRR to 1%
0512106RetlMed-SG-SRR1	050006RetlMed-SG-Baseline	Change SRR to 1%
0512215RetlMed-SG-SkyUSHGC	050015RetlMed-SG-Baseline	Decrease U value of skylights by 20% compared to baseline case
0512316RetlMed-SG-SkyUSHGC	050016RetlMed-SG-Baseline	Decrease U value of skylights by 20% compared to baseline case
0512406RetlMed-SG-SkyUSHGC	050006RetlMed-SG-Baseline	Decrease U value of skylights by 20% compared to baseline case